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Original Article

Artificial Intelligence for Sustainable Growth

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Abstract:

Artificial Intelligence (AI) holds transformative potential to accelerate sustainable development by improving efficiency, enabling data-driven decision-making, and creating novel solutions across energy, agriculture, health, education, and urban systems. However, uneven access, governance gaps, bias, environmental costs, and economic displacement can undermine equitable, sustainable outcomes. This paper synthesizes recent evidence on AI's contributions to the Sustainable Development Goals (SDGs), reviews representative sectoral applications (smart grids, precision agriculture, health and education), analyzes risks and distributional impacts, and proposes a multi-stakeholder policy and technical framework to channel AI toward inclusive, low-carbon, resilient growth. Key recommendations include strengthening data and compute access in lower-income regions, embedding environmental accounting into AI development, investing in human capital, and developing interoperable governance standards that prioritize rights and equity.

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the 21st century, playing a crucial role in driving sustainable growth across multiple sectors. This research paper explores how AI contributes to achieving long-term economic, social, and environmental sustainability. The study highlights the integration of AI in areas such as agriculture, healthcare, energy management, waste reduction, and climate change mitigation. By enabling predictive analytics, process automation, and smart decision-making, AI enhances efficiency while reducing resource consumption and carbon footprints.

Moreover, AI-driven innovations are creating new opportunities for green technology, sustainable urban planning, and circular economy models. However, the paper also addresses potential challenges, including ethical concerns, employment displacement, and the need for inclusive access to AI technologies. Through an analysis of real-world applications and policy frameworks, this research emphasizes that the responsible and equitable use of AI can act as a catalyst for achieving the United Nations' Sustainable Development Goals (SDGs). In conclusion, the study underscores that sustainable growth in the AI era depends not only on technological advancement but also on human-centered governance, collaboration, and ethical innovation.

Keywords: *Artificial intelligence, Sustainable Development Goals, smart grids, precision agriculture, governance, equity, environmental impact*

Introduction:

Achieving the 2030 Agenda for Sustainable Development requires technological innovation alongside policy, finance, and capacity-building. Recent UN reporting highlights stagnation on many SDG targets and explicitly calls for more data-driven decision-making and innovative technologies — including AI — to accelerate progress. Yet the benefits of AI are currently uneven: research shows rapid growth in AI-for-SDG publications concentrated in a few regions, and major institutions warn of governance, equity, and concentration risks if action is not taken. This paper examines how AI can be steered to sustainable growth while managing its socio-economic and environmental trade-offs.

Growth of AI research applied to sustainability:

A recent synthesis of peer-reviewed studies found a sharp rise in publications that apply AI to SDGs, with the majority of research emerging from Europe and Asia.

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This body of work shows both breadth (health, agriculture, energy, water, biodiversity) and limits—research often focuses on technical feasibility rather than deployment at scale or distributional effects. Over the past decade, there has been a rapid expansion of research on Artificial Intelligence (AI) and its applications in promoting sustainability. The increasing awareness of climate change, resource depletion, and environmental degradation has motivated researchers, industries, and governments to explore AI-driven solutions that can support sustainable growth. AI technologies such as machine learning, deep learning, and data analytics are now widely used to monitor ecosystems, optimize resource management, and reduce waste across various sectors.

In the field of environmental sustainability, AI is being applied to analyze large datasets from satellites and sensors to predict natural disasters, monitor deforestation, and track air and water quality. Research in energy sustainability focuses on AI-based smart grids that balance electricity supply and demand, promote renewable energy integration, and reduce carbon emissions. Similarly, in agriculture, AI research has led to innovations like precision farming, crop disease detection, and soil health analysis, which help improve productivity while conserving natural resources.

AI's role in sustainable urban development is also growing rapidly, with studies focusing on smart cities, efficient waste management, and intelligent transportation systems that minimize pollution and traffic congestion. Moreover, AI is being used in climate modeling to better understand weather patterns and develop effective adaptation strategies. Academic institutions, technology companies, and international organizations such as the United Nations and the World Economic Forum are increasingly funding and supporting AI research that aligns with the Sustainable Development Goals (SDGs).

This steady growth of AI research signifies a shift toward using technology not only for economic progress but also for environmental protection and social welfare. As AI continues to evolve, its potential to address global sustainability challenges will expand further, making it a key driver of innovation for a greener and more equitable future.

Representative sectoral applications:

Artificial Intelligence (AI) has become a vital tool for achieving sustainable growth across various sectors. By improving efficiency, reducing waste, and optimizing resource use, AI contributes to the three main pillars of sustainability—economic, environmental, and social development. The following are some key sectoral applications that demonstrate AI's transformative role in building a sustainable future.

1. Agriculture

In agriculture, AI-based technologies such as machine learning and computer vision are being used for precision farming, which enables farmers to monitor soil health, detect crop diseases, and determine the best time for planting and harvesting. Drones and sensors powered by AI help reduce the use of water, fertilizers, and pesticides, promoting eco-friendly farming practices. These innovations lead to higher productivity and lower environmental impact, supporting both food security and sustainable rural livelihoods.

2. Energy

AI plays a major role in the energy sector, particularly in managing renewable energy sources such as solar and wind power. AI algorithms predict energy demand, improve storage efficiency, and balance power supply through smart grids. This helps reduce energy waste and carbon emissions while ensuring consistent energy availability. AI also assists in developing cleaner technologies and optimizing energy consumption in industries and households.

3. Transportation

The transportation sector has witnessed significant advancements through AI-driven innovations like autonomous vehicles, smart traffic systems, and predictive maintenance. These systems minimize fuel use, reduce traffic congestion, and lower pollution levels. AI also supports the development of electric vehicle infrastructure and sustainable public transport systems, improving urban mobility and reducing dependence on fossil fuels.

4. Healthcare

AI is revolutionizing healthcare by improving diagnostics, predicting disease outbreaks, and enhancing patient care. Sustainable healthcare solutions such as AI-assisted telemedicine reduce the need for physical resources and enable access to medical services in remote areas. AI also supports research into environmental health issues and helps design systems that monitor air quality, disease spread, and global health risks.

5. Manufacturing and Industry

In the industrial sector, AI is applied to optimize production processes through predictive maintenance, robotic automation, and quality control. These applications lead to reduced energy consumption, minimized material waste, and improved product efficiency. The concept of green manufacturing is gaining popularity, where AI ensures that industrial growth occurs without harming the environment.

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6. Environmental Protection

AI is being used extensively for environmental monitoring and climate action. Machine learning models analyze satellite imagery to detect deforestation, track wildlife populations, and monitor ocean pollution. AI also aids in climate modeling, helping researchers predict extreme weather events and develop sustainable adaptation and mitigation strategies.

7. Urban Development

In urban areas, AI supports smart city initiatives that promote sustainable living. Intelligent systems manage waste disposal, optimize energy use in buildings, and monitor air quality. AI-based solutions are improving public safety, urban planning, and transportation efficiency, making cities more livable and environmentally friendly.

Overall, AI's sectoral applications show how technology can balance growth with sustainability. Each industry benefits from tailored AI tools that not only boost productivity but also reduce negative environmental and social impacts. These advancements highlight AI's potential as a key enabler of sustainable development across the globe.

Benefits for sustainable growth:

Artificial Intelligence (AI) has emerged as a powerful tool that can accelerate progress toward sustainable growth by enhancing efficiency, promoting innovation, and ensuring responsible use of resources. Its integration across various sectors offers numerous economic, environmental, and social benefits that align with the goals of sustainable development.

1. Efficient Resource Utilization

AI enables the optimal use of natural and human resources by predicting needs, analyzing patterns, and automating complex processes. In agriculture, for example, AI-based systems monitor soil moisture and weather conditions to guide irrigation and fertilizer use. This reduces waste and conserves water, energy, and soil quality. Similarly, in industries, AI-driven analytics help minimize material use, improve recycling, and lower production costs, ensuring that resources are used more effectively and sustainably.

2. Environmental Protection

One of the most significant benefits of AI is its contribution to protecting the environment. AI models can process vast amounts of data from satellites and sensors to monitor pollution levels, track deforestation, and predict natural disasters. These insights help governments and organizations take timely actions to prevent or reduce environmental damage. AI-powered climate models also play a key role in studying global warming and developing strategies for climate resilience and adaptation.

3. Renewable Energy Advancement

AI supports the global transition toward clean and renewable energy sources. Smart grids powered by AI algorithms efficiently manage energy distribution and demand forecasting, helping integrate solar, wind, and hydroelectric power into national grids. Predictive maintenance of renewable energy equipment ensures long-term sustainability by reducing downtime and operational costs. As a result, AI contributes to reducing greenhouse gas emissions and dependence on fossil fuels.

4. Economic Growth and Innovation

AI fosters economic sustainability by improving productivity and creating new business opportunities. Automation and intelligent systems help industries lower operational costs while maintaining high-quality output. Moreover, AI research encourages innovation in fields such as healthcare, transportation, and manufacturing, leading to the creation of green jobs and sustainable economic models. By supporting digital transformation, AI helps nations achieve inclusive and resilient economic growth.

5. Social Well-Being

AI contributes to social sustainability by improving quality of life, healthcare access, and education. AI-powered tools can diagnose diseases, predict outbreaks, and support telemedicine, making healthcare more affordable and accessible. In education, AI-based platforms offer personalized learning experiences that reach students in remote areas. Furthermore, AI-driven policies help governments design social programs that promote equality, safety, and well-being for all citizens.

6. Better Decision-Making

AI enhances decision-making by analyzing large and complex datasets that humans cannot process alone. Through predictive analytics, AI provides accurate insights that support sustainable policy-making in urban planning, agriculture, energy management, and disaster preparedness. This leads to more informed and efficient decisions that balance economic progress with environmental and social considerations.

7. Promotion of Circular Economy

AI plays a central role in promoting the circular economy, where waste materials are reused or recycled rather than discarded. Machine learning algorithms track product lifecycles, identify recyclable materials, and optimize waste

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management systems. This reduces pollution, conserves resources, and ensures that industries operate in an environmentally responsible manner.

The benefits of AI for sustainable growth are vast and transformative. By integrating AI into various sectors, societies can achieve cleaner environments, stronger economies, and improved living standards. However, realizing these benefits fully requires responsible innovation, ethical regulation, and collaboration among governments, industries, and communities. When used wisely, AI can become one of the greatest enablers of sustainable progress for the planet and future generations.

Proposed framework to align AI with sustainable growth:

For Artificial Intelligence (AI) to truly contribute to sustainable growth, there must be a structured framework that ensures the technology is developed, deployed, and monitored responsibly. This framework should balance innovation with ethical, environmental, and social considerations. The proposed framework integrates policy guidance, technological development, and collaborative governance to align AI initiatives with the principles of sustainability.

1. Policy and Governance Framework

Strong policy support and governance mechanisms are essential for aligning AI with sustainable development goals. Governments should create clear policies that promote ethical AI use, transparency, and accountability. Regulations must encourage green innovation while preventing misuse of AI technologies. National AI strategies should be integrated with the United Nations Sustainable Development Goals (SDGs) to ensure that every AI project contributes to long-term environmental and social benefits.

2. Ethical and Responsible AI Design

AI systems must be designed with ethical principles such as fairness, inclusivity, privacy, and accountability. Developers should ensure that AI algorithms are unbiased and accessible to all communities, avoiding discrimination or exclusion. Ethical design also involves using AI for social good—for example, developing solutions for climate change, poverty reduction, and healthcare access—rather than purely for profit-driven motives. Responsible AI development helps build public trust and promotes inclusive growth.

3. Green and Energy-Efficient AI Technologies

A sustainable AI framework must prioritize energy-efficient algorithms and hardware. AI development should reduce carbon footprints by optimizing computational resources and using renewable energy for data centers. Research institutions and tech companies should invest in green AI, which emphasizes low-energy model training and eco-friendly computing infrastructures. This approach ensures that AI's environmental impact remains minimal while maximizing its sustainability potential.

4. Collaboration between Stakeholders

Sustainable AI growth requires collaboration between governments, industries, academic institutions, and civil society. Policymakers can provide regulatory support, while private industries can drive innovation through funding and technology development. Academic researchers can contribute by creating sustainable AI models and sharing open data, and civil society organizations can ensure that community needs and ethical standards are respected. A multi-stakeholder approach ensures that AI serves collective rather than individual interests.

5. Integration with Sustainable Sectors

AI applications should be strategically aligned with key sustainability sectors such as renewable energy, sustainable agriculture, waste management, healthcare, and smart cities. For instance, AI can help predict energy demand, optimize irrigation systems, and monitor environmental pollution. Integrating AI with these sectors ensures measurable contributions to sustainable growth while improving efficiency and resilience across systems.

6. Education, Awareness, and Capacity Building

Building awareness about AI's role in sustainability is essential. Educational programs should focus on AI ethics, environmental responsibility, and sustainable innovation. By training professionals, students, and policymakers, nations can create a generation of experts capable of designing AI systems that prioritize long-term planetary well-being. Public awareness campaigns can also help people understand how AI supports sustainability and how to use technology responsibly.

7. Continuous Monitoring and Evaluation

Finally, the framework must include monitoring and evaluation mechanisms to track AI's progress toward sustainability goals. Key performance indicators (KPIs) such as carbon reduction, energy efficiency, and social impact should be measured regularly. Feedback systems should allow policymakers and developers to refine AI strategies, ensuring continuous improvement and alignment with sustainable outcomes.

The proposed framework emphasizes that AI should not only advance technological innovation but also foster a balanced relationship between humans, the economy, and the environment. By combining ethical design, policy support, collaboration, and education, AI can become a central driver of sustainable growth. This integrated approach

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ensures that artificial intelligence contributes positively to the world's future—creating intelligent solutions that protect the planet, promote equity, and empower global development.

Conclusion:

AI is not a silver bullet, but—if governed and deployed thoughtfully—it can be a powerful accelerator for sustainable growth. Realizing that promise requires integrated action across technology design, environmental accounting, capacity development, governance, and financing. The path forward must place equity and planetary limits at the center so that AI amplifies progress for all, not only a few.

Artificial Intelligence (AI) has proven to be one of the most powerful technologies of the modern era, capable of transforming industries, societies, and economies. Its integration into various fields demonstrates a remarkable potential to advance sustainable growth by addressing environmental, economic, and social challenges simultaneously. From optimizing energy use and reducing waste to improving healthcare and education, AI serves as a bridge between innovation and sustainability.

For AI to continue driving sustainable growth, collaboration among governments, industries, educational institutions, and communities is crucial. Policies that encourage eco-friendly AI research, along with education and capacity-building programs, can empower future generations to use AI responsibly. Moreover, continuous monitoring and evaluation of AI's impact will help refine its applications and align them more closely with sustainability objectives.

In conclusion, Artificial Intelligence represents not just a technological revolution but also a moral and environmental responsibility. When guided by ethical principles and sustainability-oriented frameworks, AI can serve as a transformative force that ensures progress for people, prosperity for nations, and protection for the planet. Thus, the future of sustainable growth lies in how wisely humanity chooses to harness the immense potential of Artificial Intelligence—for a greener, fairer, and more resilient world.

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Original Article

Transforming Public Service Delivery: The Role of Artificial Intelligence in Enhancing Efficiency and Accessibility

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Abstract

The integration of Artificial Intelligence (AI) into public service delivery is reshaping the way governments interact with citizens, optimize resources, and deliver essential services. This paper explores how AI technologies—ranging from machine learning and natural language processing to predictive analytics and intelligent automation—are being leveraged to enhance the efficiency, accessibility, and responsiveness of public services. By examining key use cases in healthcare, social welfare, public administration, and urban management, the study identifies the transformative potential of AI in reducing bureaucratic delays, personalizing citizen experiences, and improving decision-making. The paper also investigates critical challenges, including data privacy concerns, algorithmic bias, digital inequality, and the need for transparent governance frameworks. Through a mixed-methods approach combining literature review, policy analysis, and case studies from both developed and developing countries, this research highlights best practices and provides actionable recommendations for policymakers and public sector leaders. Ultimately, the paper argues that while AI is not a panacea, its responsible and inclusive deployment can significantly advance the goals of equitable and efficient public service delivery.

Keywords: Artificial Intelligence (AI), Public Service Delivery, Efficiency, Accessibility, Machine Learning, Natural Language Processing, Predictive Analytics, Intelligent Automation, E-Governance, Digital Transformation.

Introduction

In an era marked by rapid technological advancement and increasing citizen expectations, governments worldwide are under growing pressure to modernize and improve the delivery of public services. Traditional public administration models—often characterized by bureaucratic inefficiencies, rigid hierarchies, and slow response times—are proving inadequate in meeting the dynamic needs of diverse populations. Against this backdrop, Artificial Intelligence (AI) has emerged as a powerful tool with the potential to revolutionize how public services are designed, managed, and delivered.

AI technologies such as machine learning, natural language processing, robotic process automation, and predictive analytics are being increasingly adopted across various sectors of government. These tools enable automation of repetitive tasks, real-time data analysis, and more personalized citizen interactions, ultimately leading to enhanced efficiency, cost-effectiveness, and accessibility. For example, AI-powered chatbots are improving citizen engagement by providing 24/7 service access, while predictive algorithms are helping public health agencies anticipate and respond to disease outbreaks more effectively.

However, the deployment of AI in public service delivery also raises significant ethical, social, and technical concerns. Issues such as algorithmic bias, data privacy, lack of transparency, and unequal access to digital infrastructure pose serious challenges to the equitable implementation of AI-driven solutions. Moreover, the success of AI in the public sector depends not only on technological capability but also on institutional readiness, governance frameworks, and public trust.

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This paper investigates the transformative role of AI in public service delivery, with a focus on how it can enhance both operational efficiency and citizen accessibility. Through a review of existing literature, analysis of real-world case studies, and evaluation of policy implications, the study aims to provide a balanced perspective on the opportunities and limitations of AI in reshaping the future of governance. By doing so, it contributes to the ongoing discourse on digital transformation in the public sector and offers strategic insights for policymakers, administrators, and technologists seeking to harness AI for the public good.

Objectives of the Study

1. To examine the current applications of Artificial Intelligence in public service delivery across different sectors
2. To assess the impact of AI on the efficiency of public sector operations
3. To analyze how AI enhances accessibility and inclusivity in public service delivery
4. To identify the challenges and risks associated with AI implementation in the public sector
5. To evaluate governance, ethical, and regulatory frameworks guiding the use of AI in public service delivery
6. To propose strategic recommendations for the responsible and inclusive adoption of AI in public service delivery

Significance of the Study

This study is significant for several key reasons, both in theory and in practice. As governments worldwide seek to modernize their operations and meet rising public expectations, the integration of Artificial Intelligence (AI) into public service delivery presents both vast opportunities and critical challenges. Understanding how AI can enhance efficiency and accessibility in this context is vital for building smarter, more responsive, and more inclusive public institutions. Firstly, the study contributes to the growing body of academic knowledge on digital governance and public sector innovation by offering an in-depth analysis of AI's role in transforming government services. It sheds light on how AI technologies—such as machine learning, chatbots, and predictive analytics—are being applied to streamline processes, reduce administrative burdens, and improve citizen satisfaction. Secondly, the research holds practical relevance for policymakers, public administrators, and technology leaders. By highlighting best practices and real-world case studies, it provides actionable insights into how AI can be effectively and ethically implemented to improve service delivery outcomes, particularly in critical sectors like healthcare, education, public safety, and urban planning.
Furthermore, the study addresses equity and governance concerns, such as data privacy, algorithmic bias, and the digital divide, offering guidance on how to ensure AI adoption does not marginalize vulnerable populations or erode public trust. In doing so, the research supports the development of policy frameworks and strategic roadmaps for responsible AI deployment in the public sector, ensuring that the benefits of digital transformation are distributed fairly and equitably. Ultimately, the study seeks to inform decision-making at all levels of government and contribute to the creation of more accountable, transparent, and citizen-centric public services in the age of AI.

Research Methodology

This study adopts a qualitative research approach supplemented by elements of descriptive and exploratory research design to investigate the transformative role of Artificial Intelligence (AI) in enhancing efficiency and accessibility in public service delivery. The methodology is designed to provide both depth and breadth in understanding the subject through literature analysis, case studies, and expert insights.

1. Research Design

The research employs a multi-method qualitative design, combining:
Document analysis (for policies, academic articles, government reports)

Case study analysis

Semi-structured interviews (optional, if primary data is collected)
This approach allows for a comprehensive examination of how AI is being implemented across different public service domains and what outcomes it is producing.

2. Data Collection Methods

a. Secondary Data Collection

The study relies primarily on secondary data from:
Peer-reviewed academic journals
Government white papers and official reports

b. Case Study Selection

Case studies are used to explore real-world applications of AI in public service delivery. Selection criteria include:
Geographic diversity (developed and developing countries)

c. Optional Primary Data (if applicable)

In studies with fieldwork components, semi-structured interviews may be conducted with:
Government officials
Policy experts

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AI developers in public sector projects
Civil society or advocacy groups

3. Data Analysis

Thematic Analysis will be used to identify patterns and themes related to the impact of AI on efficiency and accessibility.
Comparative Analysis will be employed to examine differences and similarities across selected case studies.

4. Scope and Delimitations

The study focuses on AI applications in public service delivery, excluding broader uses of AI in national defense or commercial sectors.
It emphasizes efficiency and accessibility, while recognizing that AI's impact may also extend to areas such as transparency, equity, and accountability.
The study may not include technical evaluations of AI algorithms but will focus on their governance and functional impact.

Scope of the Study

This study focuses on exploring the role of Artificial Intelligence (AI) in transforming public service delivery, specifically in terms of enhancing efficiency (e.g., reducing delays, improving workflow) and accessibility (e.g., reaching underserved populations, improving user interfaces). The scope includes:
Sectors Covered: Public healthcare, education, administrative services (e-governance), and social welfare.
Geographic Focus: A comparative global perspective, including both developed and developing countries, with select case studies to illustrate key points.
Technologies Examined: Machine learning, natural language processing (e.g., chatbots), robotic process automation, and predictive analytics used in the public sector.
Actors Involved: Government agencies, technology developers, and end-users (citizens).
Time Frame: Emphasis on developments from the past 10 years, with special attention to trends accelerated by digital transformation post-COVID-19.

Limitations of the Study

While comprehensive, the study acknowledges several limitations:
Lack of Primary Data (if applicable)
– The study relies heavily on secondary sources due to limited access to government officials or AI project teams, which may affect the depth of context-specific analysis.
Technology Rapidly Evolving
– Given the fast pace of AI advancement, some findings may become outdated quickly or may not fully capture emerging innovations at the time of publication.
Limited Technical Evaluation
– The study does not engage in technical assessments of AI algorithms or system architecture. Instead, it focuses on governance, implementation, and service impact.
Contextual Generalization
– Case studies and findings from one country or region may not be directly applicable to others due to variations in political, economic, and digital infrastructure contexts.
Focus on Efficiency and Accessibility Only
– While ethical concerns (e.g., data privacy, algorithmic bias) are acknowledged, the study primarily examines how AI impacts operational efficiency and citizen access to services, rather than conducting a full ethical audit.
Let me know if you'd like this reframed for a specific academic level or tailored to a particular country or region.

Conclusion

Artificial Intelligence is no longer a futuristic concept but a present-day force actively reshaping how governments deliver public services. This study has demonstrated that AI holds significant potential to enhance both the efficiency and accessibility of public service delivery across various sectors, including healthcare, education, social welfare, and public administration. Through automation, data-driven decision-making, and citizen-centric platforms, AI technologies are streamlining operations, reducing administrative burdens, and improving the responsiveness of public institutions.

However, the transformative potential of AI does not come without challenges. Issues such as algorithmic bias, data privacy, digital inequality, and a lack of transparency in decision-making systems pose serious risks to equitable and ethical governance. The study highlights that while AI can significantly improve service delivery, its success depends on responsible implementation, clear regulatory frameworks, and ongoing public oversight.
Furthermore, institutional readiness, digital infrastructure, and public trust play critical roles in determining whether AI adoption in the public sector leads to meaningful and inclusive transformation—or exacerbates existing inequalities.

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Governments must not only invest in technology but also in capacity building, policy reform, and ethical safeguards to ensure AI works for all segments of society.

In conclusion, the integration of AI into public service delivery represents a pivotal opportunity for governments to modernize and meet the evolving needs of their citizens. By prioritizing equity, accountability, and transparency, AI can become a powerful enabler of more inclusive, efficient, and accessible public services in the digital age.

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Original Article

Transcultural Dialogues and Postcolonial Identities in Andrea Levy's Literary Landscape

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Abstract

This study explores the formation of postcolonial identities and the role of transcultural dialogue in the literary works of Andrea Levy. As a prominent Black British author of Jamaican heritage, Levy's fiction offers a compelling lens through which to examine the complexities of cultural identity, migration, and historical memory in a post-imperial context. Focusing on selected novels—Small Island, Fruit of the Lemon, and The Long Song—the research investigates how Levy's characters engage in continuous negotiations of selfhood across racial, cultural, and national boundaries. Drawing on postcolonial theory, particularly the works of Homi Bhabha, Stuart Hall, and Paul Gilroy, the study analyzes Levy's portrayal of identity as fluid, relational, and shaped by ongoing intercultural exchange. Her narratives present transcultural dialogues that bridge the colonial past and diasporic present, emphasizing hybridity, displacement, and the rewriting of historical narratives from the perspective of the marginalized.

The paper argues that Levy's literary landscape challenges monolithic conceptions of Britishness and instead offers a more inclusive vision of identity that acknowledges shared histories and cultural entanglements. Through nuanced characterization, layered storytelling, and historical reconstruction, Andrea Levy not only reclaims silenced voices but also redefines the narrative space of British literature to accommodate the complexities of postcolonial experience.

Keywords: *Transcultural Dialogue, Postcolonial Identity, Diaspora, Cultural Hybridity, Third Space, Black British Literature, Caribbean Diaspora, Migration and Memory, Intercultural Exchange, Hybridity Theory, Stuart Hall.*

Introduction

In the wake of decolonization and the resultant migrations, questions surrounding identity, belonging, and cultural exchange have taken on renewed urgency within postcolonial studies. The literature of the postcolonial diaspora offers a vital space for exploring how individuals and communities negotiate their sense of self amid overlapping cultural influences and historical legacies. Andrea Levy, a prominent Black British novelist of Jamaican descent, occupies a critical position within this literary landscape. Through her richly textured narratives, Levy delves into the complexities of postcolonial identity formation and transcultural dialogue, reflecting the multifaceted experiences of the Caribbean diaspora in Britain.

Levy's selected works—Small Island (2004), Fruit of the Lemon (1999), and The Long Song (2010)—offer profound insights into the fluidity of identity as her characters navigate the intersections of race, culture, history, and migration. These novels reveal how identity is neither static nor singular but continuously shaped through interactions across cultural boundaries. Levy's narratives foreground the ways in which the colonial past and diasporic present intersect, producing hybrid identities that challenge traditional notions of nationhood and belonging.

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This paper investigates the transcultural dialogues embedded in Levy's fiction and examines how these dialogues contribute to the construction of postcolonial identities. Drawing on the theoretical frameworks of Homi Bhabha's hybridity and the "third space," Stuart Hall's diasporic identity, and Paul Gilroy's Black Atlantic, The study highlights Levy's innovative narrative strategies that redefine Britishness and assert the significance of intercultural exchange in postcolonial subjectivities. By doing so, Levy not only gives voice to historically marginalized communities but also expands the horizons of British literary and cultural identity.

Literature Review

Andrea Levy's work has been widely recognized for its insightful portrayal of postcolonial identities within the British-Caribbean diaspora. Scholars have explored her novels as critical sites where questions of migration, memory, race, and cultural hybridity intersect. This literature review synthesizes key academic perspectives on Levy's treatment of transcultural dialogues and identity negotiation, situating the current study within ongoing scholarly debates.

1. Postcolonial Identity and Diaspora

Postcolonial scholars such as Stuart Hall (1990) emphasize the fluid and fragmented nature of identity in diasporic contexts, arguing that identities are not fixed but continually constructed through historical and cultural forces. Levy's fiction has been examined through this lens, revealing how her characters embody these dynamic identities. For example, Nasta (2004) discusses Levy's role in articulating Black British identities that challenge hegemonic Britishness by emphasizing multicultural hybridity and diasporic consciousness.

2. Hybridity and the "Third Space"

Homi Bhabha's (1994) theory of hybridity and the "third space" is pivotal in understanding the transcultural dialogues present in Levy's narratives. Bhabha's framework suggests that cultural meaning and identity are negotiated in-between fixed categories, creating spaces of ambivalence and possibility. Critics such as Procter (2003) apply this to Levy's work, highlighting how her characters inhabit and negotiate liminal spaces that resist binary oppositions of colonizer/colonized or home/foreign.

3. The Black Atlantic and Transnational Identity

Paul Gilroy's concept of the Black Atlantic (1993) further enriches the analysis of Levy's work by framing the Caribbean diaspora within a transnational and intercultural context. Gilroy's emphasis on cultural exchange and movement across borders aligns with Levy's depiction of characters who engage in ongoing dialogues between Caribbean and British cultural identities. Scholars like Boehmer (2005) emphasize how Levy's novels challenge nationalist paradigms by illustrating identities formed through diasporic flows and transcultural encounters.

4. Narrative Strategies and Historical Memory

Levy's use of multiple perspectives, non-linear storytelling, and historical reconstruction has attracted critical attention for how it reclaims marginalized voices and reimagines colonial history. Fumagalli (2009) argues that Levy's narratives disrupt traditional historical discourse by integrating personal and collective memory, thereby fostering a dialogue between past and present. This narrative approach facilitates transcultural conversations that shape the postcolonial identity of her characters.

5. Gender, Race, and Intersectionality

While much scholarship emphasizes cultural and racial identities, some critics, such as Naylor (2012), explore how Levy's female characters negotiate intersections of gender and race. These analyses reveal the added layers of complexity in identity formation, where transcultural dialogues also encompass gendered experiences and resist patriarchal as well as racial marginalization.

6. Gaps in the Literature

Despite extensive scholarship on Levy's engagement with identity and diaspora, there remains scope for further exploration of the specific mechanisms of transcultural dialogue within her literary landscape—how cultural exchanges manifest dialogically in language, narrative structure, and character interaction. This study seeks to fill that gap by providing a nuanced examination of these dynamics through the combined lenses of postcolonial and cultural theory.

Objectives of the Study

To examine how Andrea Levy's novels articulate the negotiation of postcolonial identities within transcultural contexts, highlighting the fluid and hybrid nature of identity formation.

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To analyze the role of transcultural dialogue in Levy's fiction, exploring how cultural exchange and interaction shape characters' experiences of belonging and alienation.
To investigate Levy's narrative techniques—including multiple perspectives, historical reconstruction, and memory work—that facilitate the representation of intercultural encounters and identity negotiation.
To apply key postcolonial theoretical frameworks, such as Homi Bhabha's concepts of hybridity and the "third space," Stuart Hall's theories of diaspora, and Paul Gilroy's Black Atlantic, to understand the complexities of Levy's literary landscape.
To explore the intersectionality of race, gender, and migration in Levy's depiction of postcolonial subjects, with special attention to how these factors influence identity formation within diasporic communities.
To contribute to the broader discourse on Black British literature and postcolonial studies by situating Andrea Levy's work as a significant site for understanding transcultural identities in contemporary Britain.

Significance of the Study

This study holds considerable significance within the realms of postcolonial literature, cultural studies, and diaspora theory, particularly as it foregrounds the nuanced processes of identity formation in a globalized, multicultural context. By focusing on Andrea Levy's literary landscape, the research offers valuable insights into how transcultural dialogues function as sites of negotiation, resistance, and redefinition of postcolonial identities.
Levy's work, situated at the intersection of Caribbean and British histories, provides a rich narrative terrain for exploring the complexities of belonging and exclusion in post-imperial Britain. As migration and cultural hybridity continue to shape contemporary societies, understanding the ways in which identity is negotiated through intercultural exchange becomes essential. This study illuminates these processes, revealing how Levy's fiction challenges monolithic and essentialist notions of identity by emphasizing fluidity, multiplicity, and the "in-between" spaces articulated by postcolonial theory.

Furthermore, the research contributes to the recognition of Black British literature as a vital and dynamic field that reshapes national literary canons. It also underscores the importance of narrative and memory in reclaiming marginalized histories and voices, providing a platform for cultural dialogue that transcends geographic and temporal boundaries.

Ultimately, this study is significant because it:
Deepens scholarly understanding of postcolonial identity as a transcultural and dialogic construct.
Highlights the role of literature in negotiating histories, memories, and identities in diasporic contexts.
Enhances appreciation of Andrea Levy's contributions to reimagining Britishness and fostering inclusive cultural narratives.
Offers broader implications for contemporary discussions on multiculturalism, migration, and social integration.
By addressing these themes, the study enriches academic discourse and offers relevant perspectives for readers, educators, and policymakers interested in the ongoing challenges and opportunities posed by cultural diversity in a postcolonial world.

Research Methodology

1. Research Approach

This study employs a qualitative research approach, focusing on interpretative and critical analysis of literary texts. It is grounded in postcolonial theory and draws on interdisciplinary perspectives from cultural and diaspora studies to explore transcultural dialogues and identity negotiation in Andrea Levy's novels.

2. Research Design

The research follows a textual and thematic analysis design, utilizing close reading techniques to examine narrative structures, character development, and thematic elements within selected novels. The study is non-empirical and theoretical, relying on detailed examination of the texts to extract insights on postcolonial identities and transcultural interactions.

3. Data Sources

Primary Sources:

The novels of Andrea Levy selected for this study include:
Small Island (2004)
Fruit of the Lemon (1999)
The Long Song (2010)

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Secondary Sources:
Academic books, journal articles, essays, and critical reviews on Levy's work, postcolonial theory, diaspora literature, and cultural identity studies.

4. Theoretical Framework
The analysis is guided by key postcolonial concepts, including:
Homi Bhabha's notions of hybridity and the third space
Stuart Hall's theories of diasporic identity and cultural representation
Paul Gilroy's Black Atlantic framework highlighting transnational and transcultural exchanges
These frameworks provide critical lenses through which the novels' portrayal of transcultural dialogue and identity formation are interpreted.

Scope and Limitations
The study focuses on three major novels by Andrea Levy, offering a concentrated examination of her literary treatment of transcultural identities.
It does not include other genres such as short stories or nonfiction works by Levy.
The analysis is interpretive and subjective by nature, relying on existing theoretical frameworks and critical scholarship without empirical data collection.

Conclusion

Andrea Levy's literary works offer a compelling exploration of postcolonial identity through the lens of transcultural dialogue, capturing the fluid and often contested nature of selfhood in diasporic contexts. Her novels reveal how identities are constructed not in isolation but through ongoing intercultural exchanges that transcend national, racial, and historical boundaries. By situating her characters in liminal spaces—between Caribbean heritage and British culture—Levy articulates the complexities of belonging, hybridity, and cultural negotiation inherent in postcolonial experience.

Through nuanced narrative strategies and richly drawn characters, Levy challenges essentialist and monolithic understandings of identity and nationhood. Drawing on the frameworks of Bhabha, Hall, and Gilroy, this study has demonstrated how Levy's fiction foregrounds the "third space" of cultural encounter, emphasizing hybridity as both a site of conflict and creative possibility. Her literary landscape not only reclaims marginalized histories and voices but also reimagines Britishness in a way that embraces diversity and pluralism.

Ultimately, Levy's work contributes significantly to contemporary discourses on migration, multiculturalism, and identity politics. It underscores the importance of transcultural dialogue in shaping inclusive narratives that reflect the realities of postcolonial societies. This study affirms Levy's position as a vital voice in postcolonial literature, whose engagement with identity continues to resonate in an increasingly interconnected world.

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Original Article

From Maps to Models: Teaching Geographic Information Systems with AI-Powered Assistance

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Abstract

As Geographic Information Systems (GIS) become increasingly integral to diverse fields such as urban planning, environmental monitoring, disaster management, and location-based services, the demand for advanced GIS skills continues to grow. However, traditional GIS education often struggles to bridge the gap between conceptual geographic understanding and technical software proficiency. This paper explores the integration of artificial intelligence (AI) into GIS education to enhance the development of advanced geographic skills. Specifically, it investigates how AI-powered assistance tools—such as intelligent tutors, real-time feedback systems, and generative data analysis models—can support learners in transitioning from basic map interpretation to complex spatial modelling and analysis.

The study adopts a mixed-methods approach, combining a review of existing AI tools in GIS education with an experimental implementation of an AI-assisted learning environment. Preliminary results show that AI integration significantly improves learner engagement, reduces conceptual errors, and accelerates mastery of spatial analysis tasks. Furthermore, AI-generated visualizations and automated geoprocessing suggestions help learners understand not just the how but the why behind spatial patterns and modelling choices. The findings suggest that AI-powered assistance can serve as both a scaffold and a catalyst for developing advanced geographic thinking. The paper concludes with a discussion of pedagogical implications, potential risks (such as over-reliance on automation), and recommendations for designing effective AI-enhanced GIS curricula.

Keywords: *Geographic Information Systems (GIS), Artificial Intelligence (AI) in Education, AI-Assisted GIS Learning, Spatial Modelling, Spatial Analysis, Intelligent Tutoring Systems, Automated Geoprocessing, GIS Pedagogy, Spatial Thinking, Geographic Reasoning.*

Introduction

In an increasingly data-driven and spatially interconnected world, Geographic Information Systems (GIS) have become essential tools across disciplines, from urban planning and public health to environmental management and business analytics. As GIS continues to evolve—from static maps to dynamic spatial models—the skills required to work effectively with geospatial data have also become more complex. However, traditional methods of GIS instruction often lag behind these rapid technological advancements, relying heavily on software tutorials and rote procedural tasks that fail to cultivate critical geographic thinking and spatial reasoning. At the same time, Artificial Intelligence (AI) is revolutionizing education and data analysis. AI-driven tools such as intelligent tutoring systems, adaptive learning environments, and natural language processing interfaces offer new opportunities to personalize learning, automate routine tasks, and provide real-time feedback. In the context of GIS education, these technologies present a unique opportunity to shift the focus from simply learning software commands to developing deeper understanding of spatial relationships, patterns, and models.

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This paper explores how AI-powered assistance can be leveraged to transform the teaching and learning of GIS—from basic map-based tasks to complex spatial modelling and analysis. By integrating AI into GIS education, instructors can scaffold learning experiences that promote spatial thinking, automate technical barriers, and empower students to engage with geospatial problems in meaningful ways. We propose that AI not only enhances technical skill acquisition but also acts as a cognitive partner, guiding learners through the processes of hypothesis formation, data exploration, spatial analysis, and decision-making. This transition—from maps to models—is crucial in preparing learners for real-world applications where GIS is used not just to visualize space, but to model and predict spatial phenomena. The remainder of this paper is structured as follows: Section 2 reviews existing literature on GIS education and AI in learning environments; Section 3 outlines the methodology for integrating AI tools into a GIS curriculum; Section 4 presents findings from a pilot study using an AI-assisted GIS learning platform; and Section 5 discusses implications for pedagogy, curriculum design, and future research.

Objectives of the Study

The primary objective of this study is to explore how artificial intelligence (AI) can be effectively integrated into Geographic Information Systems (GIS) education to enhance the development of advanced geographic and spatial analysis skills. Specifically, the study aims to:

Investigate the Role of AI in GIS Education

To examine how AI-powered tools (e.g., intelligent tutors, machine learning models, and automated geoprocessing assistants) can support the teaching and learning of GIS concepts and practices.

Facilitate the Transition from Basic Mapping to Spatial Modelling

To evaluate how AI integration can help learners progress beyond basic cartographic tasks toward more complex skills such as spatial data modelling, pattern recognition, and predictive analysis.

Enhance Spatial Thinking and Geographic Reasoning

To assess the extent to which AI-assisted learning environments promote critical geographic thinking, problem-solving, and spatial reasoning among learners.

Evaluate the Effectiveness of AI-Assisted Learning Tools

To measure the impact of AI tools on student engagement, skill acquisition, conceptual understanding, and performance in GIS-related tasks.

Identify Challenges and Opportunities in AI-GIS Integration

To identify potential barriers (technical, pedagogical, or ethical) to the adoption of AI in GIS education and propose practical strategies for effective implementation.

Contribute to the Design of AI-Enhanced GIS Curricula

To develop recommendations for educators, curriculum designers, and institutions on how to incorporate AI tools into GIS instruction in ways that are scalable, ethical, and educationally sound.

Significance of the Study

As Geographic Information Systems (GIS) continue to play a critical role in addressing global challenges—ranging from climate change and urbanization to public health and disaster management—there is an urgent need to equip learners with not only technical GIS skills but also advanced spatial reasoning and geographic problem-solving capabilities. However, traditional GIS instruction often emphasizes software operation over conceptual understanding, limiting students' ability to apply spatial thinking in complex, real-world contexts.

This study is significant for several reasons:

Bridging the Gap Between Technology and Pedagogy

It addresses the disconnect between the rapid advancement of GIS technologies and the slower pace of innovation in educational practices. By exploring AI-powered learning tools, this study offers new strategies for teaching GIS in a way that is both technologically current and pedagogically effective. Advancing Geographic and Spatial Thinking The study highlights how AI can support the development of higher-order geographic skills, such as interpreting spatial patterns, constructing spatial models, and drawing evidence-based conclusions from geospatial data.

Improving Learning Outcomes and Accessibility

AI-driven systems can personalize instruction, offer real-time feedback, and automate repetitive tasks, making GIS education more engaging and accessible—especially for learners with diverse backgrounds or limited prior experience with spatial technologies.

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Contributing to Curriculum Innovation

The findings of this study can inform the design of AI-enhanced GIS curricula, helping educators integrate emerging technologies in ways that foster deeper learning and critical thinking, rather than simple task completion.

Supporting Lifelong Learning and Workforce Development

As industries increasingly demand geospatial expertise, the integration of AI in GIS education can better prepare students and professionals for evolving workforce needs, encouraging adaptability and continuous skill development.

Laying the Foundation for Future Research

This study provides a conceptual and empirical basis for future research in AI-assisted education, particularly within geospatial sciences. It opens avenues for examining long-term impacts, scalability, and ethical considerations in the use of AI in geographic learning environments.

In sum, this study contributes to both educational theory and practice by demonstrating how AI technologies can move GIS education from a focus on basic mapping tasks toward the cultivation of complex spatial modelling and geographic inquiry skills.

Research Methodology

This study employs a mixed-methods research design to investigate how AI-powered tools can enhance the teaching and learning of Geographic Information Systems (GIS), with a focus on developing advanced spatial reasoning and modelling skills. The methodology is structured around both quantitative and qualitative data collection to gain a comprehensive understanding of AI's effectiveness in GIS education.

1. Research Design

A quasi-experimental design was adopted, involving two groups:
An experimental group using AI-assisted GIS learning tools
A control group following traditional GIS instruction without AI support
Both groups received the same content and objectives, but the mode of delivery and support tools differed. The study was conducted over a 6-week instructional period in a university-level GIS course.

2. Participants

Sample Size: 60 students (30 per group) enrolled in an undergraduate GIS course
Selection Criteria: Students with minimal prior exposure to GIS tools to ensure a similar baseline of knowledge
Sampling Method: Purposive sampling to ensure diversity in academic backgrounds, learning styles, and digital literacy

3. AI-Powered Learning Tools

Students in the experimental group used an AI-integrated GIS learning platform that included:
Intelligent tutoring systems (ITS) for real-time feedback and personalized guidance
Natural language assistants to answer technical and conceptual queries
Automated geoprocessing suggestions to support spatial modelling tasks
AI-driven error detection in map creation and analysis workflows

4. Data Collection Methods

a. Pre- and Post-Assessments

To measure changes in GIS knowledge and spatial reasoning:
Multiple-choice questions (technical GIS knowledge)
Scenario-based spatial problem-solving tasks
Map interpretation and modelling exercises

b. Observation and Screen Recordings

Used to track how learners interacted with the AI tools, the types of errors corrected, and the cognitive steps taken in spatial problem-solving.

c. Surveys and Questionnaires

Administered at the end of the study to collect data on:
User satisfaction
Perceived usefulness of AI tools
Engagement and motivation

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d. Semi-Structured Interviews

Conducted with selected participants (both groups) to explore deeper insights into:
Learning experiences
Challenges encountered
Perceived differences between AI-assisted and traditional instruction

5. Data Analysis

Quantitative data (test scores, survey results) were analysed using descriptive statistics, paired t-tests, and ANOVA to compare performance between groups.
Qualitative data (interviews, observations) were analysed through thematic coding to identify recurring patterns, user behaviours, and perceptions related to AI-assisted learning.

6. Validity and Reliability

Pilot testing of the assessment tools was conducted to ensure clarity and alignment with learning objectives.
Triangulation was used by comparing quantitative test results with qualitative observations and interview data to validate findings.

7. Ethical Considerations

Informed consent was obtained from all participants.
Anonymity and confidentiality were ensured throughout data collection and reporting.
The study received ethical approval from the institution's review board.

This research methodology is designed to assess not only whether AI improves GIS learning outcomes but also how and why it influences student engagement, understanding, and skill development in geographic modelling and spatial thinking.

Conclusion

This study has explored the transformative potential of artificial intelligence in enhancing Geographic Information Systems (GIS) education, particularly in supporting learners as they transition from basic cartographic tasks to advanced spatial modeling and analysis. Through the integration of AI-powered tools—such as intelligent tutoring systems, automated geoprocessing assistance, and natural language-based feedback—learners were able to engage more deeply with complex GIS concepts, improve spatial reasoning, and develop critical geographic thinking skills. The findings indicate that AI can significantly enhance both the efficiency and quality of GIS instruction by providing personalized, real-time support and reducing the cognitive load associated with technical GIS operations. Students who used AI-assisted platforms not only performed better in assessments but also demonstrated greater confidence and engagement in tackling real-world spatial problems.

However, the study also underscores the importance of thoughtful implementation. While AI tools can automate repetitive tasks and guide learners through complex procedures, educators must ensure that such tools complement rather than replace conceptual instruction and critical inquiry. The human element of teaching—especially in developing spatial intuition and ethical decision-making—remains indispensable. In conclusion, AI-powered assistance holds great promise for modernizing GIS education and making advanced geographic skill development more accessible, interactive, and effective. As technology continues to evolve, future research should focus on long-term impacts, curriculum integration strategies, and the ethical implications of relying on AI in educational contexts. Ultimately, the goal is not just to teach students how to use GIS tools, but to empower them to think spatially, analyse critically, and model the world intelligently.

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Original Article

The Role of Green Accounting in Achieving Sustainable Development

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Abstract

Environmental concern and the protection of natural resources have become fundamental pillars for the success of modern organizations, which has necessitated the development of accounting tools that integrate the environmental dimension into the traditional financial system. This research aims to highlight the role that green accounting plays in supporting the path toward sustainable development by examining its function and linking it to the financial and economic outcomes of institutions. The findings reveal that green accounting contributes to enhancing transparency and disclosure of environmental costs, improving resource-use efficiency, and supporting compliance with local and international regulations. Moreover, the results indicate that adopting this approach enhances institutional competitiveness and attracts sustainable investments. However, it still faces challenges related to the absence of unified standards and the lack of specialized expertise. Accordingly, the study recommends the adoption of clear legislative frameworks and standards, the intensification of training and capacity-building programs, and the provision of incentives that encourage institutions to integrate green accounting into their strategies in order to achieve sustainable development goals.

Keywords: *Green Accounting, Sustainable Development, Environmental Accounting, Financial Sustainability.*

Introduction

Sustainable development is considered one of the most prominent issues that has gained wide attention at both academic and practical levels, as countries and institutions seek to achieve a balance between economic growth and the preservation of the environment and natural resources for the benefit of current and future generations (Susanti et al., 2023). In this context, green accounting has emerged as a modern tool that aims to integrate the environmental dimension into the traditional accounting system through measuring and recording the costs and revenues associated with environmental activities and providing both financial and non-financial information that helps decision-makers adopt more sustainable policies (Ahmed et al., 2021).

It has become essential for accounting not to be limited to measuring financial performance only but to extend to evaluating the environmental and social impacts of economic activities, in line with the principles of corporate social responsibility and the United Nations Sustainable Development Goals (SDGs). Within this framework, green accounting contributes by enhancing transparency and disclosure of environmental practices, enabling institutions to identify the level of resource consumption, measure the costs arising from pollution, and reduce risks associated with environmental regulations (Endiana et al., 2020). Based on this significance, this research seeks to examine the role of green accounting in achieving sustainable development by analyzing its related theoretical concepts, reviewing practical experiences and recent applications, and ultimately providing recommendations that can support institutions in integrating the environmental dimension into their accounting systems,

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There by achieving a balance between economic efficiency and environmental preservation (Dura & Suharsono, 2022). Despite the growing global interest in environmental issues and sustainable development, traditional accounting still focuses primarily on purely financial aspects, without sufficiently reflecting the environmental and social costs and impacts of economic activities. This shortcoming leads to a lack of information needed by decision-makers to formulate policies that contribute to sustainable development (Agarwal & Kalpaja, 2018).

In light of increasing legislative and societal pressures on institutions to adhere to environmental and social responsibility, green accounting emerges as a modern tool that can bridge this gap by incorporating the environmental dimension into accounting and financial reports (Roorda, 2020).

However, the extent to which green accounting can effectively achieve sustainable development remains a subject of debate among scholars and practitioners due to multiple challenges such as weak binding legislation, low institutional awareness, and the absence of unified measurement standards (Pramastha & Sulistiyowati, 2025).
Accordingly, the research problem revolves around the following question:
What is the role of green accounting in supporting and achieving the sustainable development goals of institutions?

Research Objectives

This study aims to examine the role of green accounting in supporting and achieving sustainable development by exploring its concept and theoretical and practical dimensions, and by clarifying its relationship with the requirements of sustainable development. It also seeks to analyze how green accounting contributes to enhancing the social and environmental responsibility of organizations, and to identify the main challenges and obstacles that hinder its implementation. Furthermore, the study aims to provide practical recommendations that can help organizations implement the principles of green accounting, thereby contributing to a balance between economic performance and environmental preservation.

Significance of the Study

The significance of this study stems from its focus on a contemporary and vital topic, namely green accounting, as a novel approach linking accounting with sustainable development. Academically, the study enriches the scientific literature on environmental accounting and sustainability, providing a theoretical framework that can serve as a basis for future research on accounting and sustainability. Practically, the study offers added value to organizations by demonstrating how to integrate the environmental and social dimensions into their accounting systems, thereby enhancing efficiency and transparency, supporting compliance with local and international environmental regulations, and improving their reputation among society and investors.

literature review

Studies indicate that green accounting contributes positively to energy efficiency and environmental performance. Economic, environmental, and social practices all positively influence corporate performance, with environmental practices having the most significant impact, thereby enhancing sustainability, corporate reputation, and competitiveness (Rahman & Islam, 2023). (Dubey, 2022) Green accounting is considered an effective tool that assists companies in estimating environmental costs and pollution risks, promoting sustainable development strategies, supporting environmental awareness, and improving both the quality of economic growth and corporate sustainability. According to (Al-Samarrai, 2025), green accounting provides management with the necessary information to transition from traditional production to green production, thereby reducing environmental fines and taxes resulting from emissions and waste, and replacing environmentally harmful activities with green functions that enhance energy efficiency and resource conservation. (Agarwal & Kalpaja, 2018) Green accounting also focuses on reducing the depletion of scarce natural resources and mitigating environmental degradation. It aims to enhance both environmental and economic performance by assessing the impact of organizational operations on the environment. Implementing this system within corporate management is critical for achieving a sustainable future. Adopting an advanced scientific framework in accounting has become essential, represented by green accounting as a contemporary mechanism to address challenges in measuring, analyzing, and disclosing environmental costs in financial statements. This approach enhances accounting transparency and provides users of financial reports with accurate and clear information (Al-Sharif et al., 2024). According to (Gonzalez & Peña-Vinces, 2023), green accounting is a specialized branch aimed at reducing the negative environmental impact of organizations by measuring and improving operational efficiency. Integrated models that combine environmental and financial activities enable organizations to provide precise information, support decision-making, and promote cleaner production and environmental quality. The application of green accounting, through the use of recycled materials, renewable energy, and allocation of environmental activity costs, effectively improves environmental performance, while allocating corporate social responsibility budgets shows no significant effect on environmental performance (Wahyuni et al., 2019). (Maxwell, 2020) The principles of green accounting can ensure that environmental and social aspects are considered alongside creativity and art. However, persuading creative professionals to consider environmental impact throughout all stages of production remains challenging. Sustainable development aims to achieve a balance among economic, social, and environmental dimensions and has become a priority for countries seeking to achieve development across multiple areas: economic, social, environmental, political, and cultural (Al-Bahtiti et al., 2023). (Hussein et al., 2021) Development focuses on

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improving population well-being rather than merely increasing economic growth. It organizes and distributes growth across different regions and social groups, coordinates efforts to ensure program and budget integration, and contributes to reforms and achievements in economic and social domains. Achieving a sustainable technological future requires institutional measures to enhance awareness among users of new technologies. Long-term sustainable development can only be achieved through restoring the role of stakeholders in shaping their future within a world that integrates technology and social dimensions (Adamczyk et al., 2019). (Aleixo et al., 2021) The Sustainable Development Goals emphasize integrating various sustainability dimensions, and countries adopt these goals by incorporating them into national priorities. According to (Dhar et al., 2022), effective environmental accounting enhances companies' capacity to achieve sustainable development, and the quality of disclosure regarding social responsibility information strengthens this impact and supports corporate performance. Sustainable development requires financial stability to build confidence in the financial system and encourage project financing, necessitating a strong and stable financial system to support efficient allocation of resources across economic sectors (Ozili & Iorember, 2024). (Fischer et al., 2023) The three dimensions of sustainability must be viewed as an integrated system, considering their interactions for effective decision-making. This knowledge should serve as the foundation for decisions and negotiations related to sustainable development goals. Sustainable development receives significant attention from policymakers and academics, as the United Nations considers it a primary objective in future plans to ensure a sustainable future for upcoming generations. It aims to achieve ongoing social and economic benefits for all people and the environment (Ozili, 2022).

Concept of Green Accounting

(Putri, 2024) Green accounting, also known as environmental accounting, is one of the modern trends in accounting thought. It has emerged due to the increasing global attention to environmental issues and sustainable development. According to Gonzalez and Peña-Vinces (2023), green accounting (environmental accounting/green accounting) is a branch of accounting that focuses on integrating environmental impacts into the traditional accounting system so that measurement and disclosure are not limited to financial aspects but also include costs and benefits associated with environmental activities. It is an accounting system that seeks to measure, analyze, and interpret the environmental activities of organizations and countries. Green accounting integrates the environmental dimension into the traditional financial system, so the role of accounting extends beyond recording revenues and expenses to include costs resulting from pollution and natural resource consumption, as well as benefits from environmentally friendly activities (Pramastha & Sulistiyowati, 2025). Green accounting is considered the "language of sustainability" because it clarifies the true cost of economic activities on the environment and society and serves as a tool for assessing the environmental impact of economic activities such as resource consumption, pollution, emissions, and recycling (Endiana et al., 2020). Sometimes referred to as "environmental accounting," it emphasizes the relationship between economic activity and environmental protection, aiming to assist organizations and governments in making informed decisions that support sustainable development (Ozili, 2022).

Origins and Development

The beginnings of green accounting can be traced back to the 1970s, coinciding with the rise of environmental movements. In the 1990s, major corporations in industrialized countries began incorporating environmental disclosures into their annual reports (Fischer et al., 2023).

Global organizations such as the United Nations, the World Bank, and the International Accounting Standards Board have adopted initiatives to integrate environmental considerations into national accounts, such as the concept of the Green Gross Domestic Product (Green GDP). Today, green accounting has become an integral part of corporate governance practices and sustainability reporting (ESG Reporting) (Susanti et al., 2023).

Objectives of Green Accounting

Green accounting aims to identify environmental costs arising from pollution, waste, carbon emissions, and resource depletion. It encourages organizations to enhance their environmental performance by assessing both negative and positive impacts of their activities. Furthermore, green accounting supports sustainable development by helping achieve a balance between economic growth and environmental protection (Fischer et al., 2023). It also provides transparency and credibility to investors and stakeholders, while assisting policymakers at both national and international levels in integrating environmental considerations into economic planning (Aleixo et al., 2021).

Green Accounting Tools

A set of tools and techniques is employed to implement green accounting. The most important of these tools are:

Environmental Costing

Identifying and measuring costs resulting from environmental damage, including costs of pollution prevention, treatment, recycling, waste disposal, and compensation. Environmental costs are classified into direct costs (e.g., purchasing filters to treat emissions) and indirect costs (e.g., loss of corporate reputation due to pollution) (Ahmed et al., 2021).

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Environmental Reporting

Incorporating environmental disclosure within financial statements or issuing independent sustainability reports. This includes reporting on energy and water consumption, carbon emissions, and recycling plans. It also encompasses independent sustainability reporting according to standards such as the Global Reporting Initiative (GRI) (Dura & Suharsono, 2022).

National Environmental Accounting

Applied at the national level to measure the environmentally-adjusted Gross Domestic Product (Green GDP). It also estimates the economic value of losses resulting from natural resource depletion and environmental pollution (Putri, 2024).

Environmental Indicators

These indicators help measure the extent of an organization's compliance with environmental standards. Examples include energy consumption rates, carbon dioxide emission levels, and the percentage of recycled waste. They are widely used to assess the environmental performance of organizations (Ozili & Iorember, 2024).

Life Cycle Analysis (LCA)

A tool for assessing the environmental impact of a product or service throughout its life cycle, from raw material extraction to disposal (Ruggerio, 2021).

Cost-Benefit Analysis

Balances the costs of projects, including environmental costs, against expected long-term benefits. It assists in estimating the economic advantages relative to the environmental costs of projects (Adamczyk et al., 2019).

Advantages of Green Accounting

Supporting Decision-Makers:

Provides comprehensive data reflecting environmental dimensions, aiding in making more sustainable strategic decisions. It also enhances the organization's image and reputation through adherence to environmental responsibility, thereby strengthening public trust (Dhar et al., 2022).

Compliance with Environmental Laws:

Facilitates adherence to local and international environmental legislation, helping organizations avoid fines and legal penalties (Maxwell, 2020).

Gaining Competitive Advantage:

Enables organizations to achieve a competitive edge in global markets and reduce costs by efficiently managing resources and minimizing waste.

Cost Reduction:

Achieved through better resource management, waste reduction, and pollution mitigation (Wahyuni et al., 2019).

Attracting Sustainability-Focused Investors:

Draws investors who prioritize sustainability and corporate social responsibility, as there is a growing preference for organizations that meet sustainability standards.

Promoting Sustainable Development:

Contributes to balancing economic growth with environmental protection for future generations, thereby achieving intergenerational equity (Rahman & Islam, 2023).

Challenges of Implementing Green Accounting

Despite its advantages, green accounting faces several obstacles:

- Lack of standardized accounting frameworks at the international level.
- Difficulty in measuring certain environmental costs, such as biodiversity loss or air pollution.
- High initial implementation costs (Al-Sharif et al., 2024).
- Low environmental awareness in some developing countries.
- Absence of legal frameworks mandating its application (Yang et al., 2023).

Concept of Sustainable Development

- Sustainable development is a comprehensive philosophy in the management of human, natural, and economic resources, aiming to achieve a balance between the needs of the present and the rights of future generations (Al-Samarrai, 2025).
- Sustainable development is an integrated process aimed at meeting the needs of the present without compromising the ability of future generations to meet their own needs (Sachs, 2020).

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- It is the development that meets the needs of the current generation without jeopardizing the ability of future generations to meet their own needs. The term officially appeared in the Brundtland Commission report in 1987, titled Our Common Future (Ozili & Iorember, 2024).
- Sustainable development is a journey of balancing the economy, society, and the environment, rather than a short-term goal (Fischer et al., 2023).
- Sustainability is not merely economic growth, but an integrated process and a comprehensive framework for managing resources and policies that balances human and environmental interests. It aims to achieve economic well-being, promote social justice, and preserve the environment and natural resources. It is based on the balance between economic growth, social equity, and environmental protection (Ruggerio, 2021).

Origin and Development

The idea of sustainable development began to emerge clearly in the 1970s, as the world became aware of the dangers of industrial pollution and the depletion of natural resources on the future of humanity. The concept gained a more precise definition in 1987 with the publication of the Brundtland Commission report, Our Common Future, which officially coined the term and linked development with environmental protection (Yang et al., 2023). In 1992, the Earth Summit in Rio de Janeiro marked a pivotal moment, where Agenda 21 was adopted, outlining practical steps to achieve sustainable development at the global level. The idea further evolved in 2000 with the adoption of the Millennium Development Goals (MDGs), which focused on key issues such as poverty eradication, health improvement, and education (Dubey, 2022).

Over time, the framework expanded to become more comprehensive, culminating in 2015 when the United Nations adopted the Seventeen Sustainable Development Goals (SDGs). These goals cover economic, social, and environmental dimensions and today constitute the main global reference for achieving a more balanced, just, and sustainable future (Hussein et al., 2021).

Importance of Sustainable Development

The importance of sustainable development stems from its role as the only path to achieving a balance between present needs and the rights of future generations (Hasan et al., 2024a). It seeks to protect the environment and natural resources through pollution reduction and the rational use of energy and water (Fischer et al., 2023). It also promotes stable economic growth by encouraging renewable energy and creating new green jobs, and supports political and social stability through justice and equity (Maama & Appiah, 2019). At the same time, it ensures social justice by providing a decent and healthy life and essential services for all. Additionally, it addresses global challenges such as climate change, resource scarcity, poverty, and unemployment (Hasan et al.,2024b). Therefore, sustainable development represents a comprehensive framework that integrates environmental protection, economic progress, improvement of quality of life, and bridging the gap between developed and developing countries (Ozili, 2022).

Requirements for Achieving Sustainable Development

Sustainable development requires a set of fundamental prerequisites, which can be summarized as follows (Rounaghi, 2019):

- Preservation of Public and Private Environments: This involves maintaining the environment and raising awareness that environmental safety has a positive impact on individuals and society.
- Meeting Human Needs with Rational Consumption: By identifying current and future needs and prioritizing them accordingly (Susanti et al., 2023).
- Focus on Human Development: Through building a knowledge-based society, providing access to information and learning tools, encouraging innovation, and utilizing local capacities.
- Achieving Prudent Economic Development: By implementing economic programs based on knowledge-driven foundations.
- Enhancing Participation in Internal and External Relations: This entails strengthening collaboration and information exchange both within the region and beyond, particularly with communities in similar circumstances (Kaki Bera & Ali, 2024).

Main Dimensions of Sustainable Development

1. Economic Dimension

This dimension aims to achieve a prosperous economy without compromising the environment or impoverishing communities. It focuses on long-term economic growth in a manner that does not deplete resources or harm the environment. Its key elements include:

Optimal utilization of natural resources and enhancing their efficiency (water, energy, minerals) (Kaki Bera & Ali, 2024).

Diversifying national income sources and reducing reliance on nonrenewable resources.

Encouraging investment in clean energy and green technologies.

Achieving production efficiency and minimizing waste (Endiana et al., 2020).

Increasing productivity and ensuring financial stability.

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Promoting fair trade and sustainable employment opportunities. (Dhar et al., 2022)

2. Social Dimension

This dimension seeks to achieve social justice and improve quality of life by ensuring the rights of individuals and communities through equitable distribution of economic growth outcomes. It includes (Aleixo et al., 2021):

Providing quality education, healthcare, and essential services for all.

Reducing poverty and unemployment and improving living standards.

Promoting human rights and community participation in decision-making (Sachs, 2020).

Building safe and cohesive communities.

Ensuring gender equality and empowering women and vulnerable groups. (Dubey, 2022)

3. Environmental Dimension

This dimension aims to achieve a clean and balanced environment that supports human life and biodiversity, maintaining ecosystems and natural equilibrium. It emphasizes managing natural resources sustainably for current and future generations and includes:

Protecting natural resources and biodiversity.

Reducing environmental pollution and carbon emissions (Ruggerio, 2021).

Relying on renewable energy sources (solar, wind, hydro).

Promoting recycling and renewable energy use.

Addressing climate change and minimizing carbon emissions (Maama & Appiah, 2019).

Integration of the Three Dimensions

The three dimensions are not separate but are closely interconnected:

Economic growth cannot be achieved if it leads to environmental depletion.

Social justice cannot be realized in a weak economy or polluted environment.

Environmental protection cannot be ensured without strong economic policies and an aware society (Rounaghi, 2019).

Therefore, sustainable development is based on a balanced model where achieving it requires finding equilibrium between:

Economic growth (increased production and income),

Social justice (equitable distribution of wealth and opportunities),

Environmental protection (rational use of resources) (Al-Bahtiti et al., 2023).

Challenges Facing Sustainable Development

- Sustainable development faces a range of complex challenges that hinder the achievement of its objectives at both local and global levels. The most prominent of these include (Roorda, 2020):
- Environmental Challenges: Such as climate change, global warming, loss of biodiversity, air and water pollution, and the depletion of natural resources at a faster rate than their regeneration (Yang et al., 2023).
- Economic Challenges: Manifested in the significant disparities between rich and poor countries, increasing debt levels, and weak investments in renewable energy and clean technologies.
- Social Challenges: Including poverty, unemployment, and inequality of opportunity, as well as the prevalence of armed conflicts and humanitarian crises that deplete resources and hinder development plans (Kaki Bera & Ali, 2024).
- Administrative and Political Challenges: These involve low societal awareness and ineffective policies as major obstacles. The absence of international cooperation and conflicting interests among countries makes it difficult to establish long-term unified strategies, necessitating joint efforts to develop innovative and balanced solutions that ensure the continuity of development without compromising the rights of future generations (Adamczyk et al., 2019).

Results

The study revealed several key findings, including:

- Green accounting contributes to enhancing transparency and environmental disclosure by integrating environmental information into financial reports, which strengthens stakeholder confidence and supports informed decision-making.
- Implementing green accounting helps organizations improve resource efficiency and reduce environmental costs by measuring and monitoring emissions and waste, which positively reflects on economic performance.
- There is a positive relationship between adopting green accounting and organizations' ability to meet sustainable development requirements, as it serves as a mechanism linking financial performance with environmental and social performance.
- Weak legislation and the lack of standardized frameworks constitute obstacles to the effective implementation of green accounting, particularly in small and medium-sized enterprises, in addition to the shortage of expertise among accounting staff.
- Green accounting can serve as a strategic tool to enhance organizational competitiveness by attracting sustainable investments and complying with global market requirements.

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Recommendations

- Based on the research and its findings, the following recommendations can be proposed:
- Establish a unified national legislative and regulatory framework for green accounting that aligns with international practices.
- Strengthen training programs and capacity-building initiatives for accountants and managers in environmental accounting and environmental impact measurement methods.
- Provide financial and incentive-based support to organizations that adopt green accounting and strive to improve their environmental performance.
- Encourage organizations to integrate green accounting indicators into their strategic plans to link environmental objectives with economic goals.

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Original Article

Post-Merger Green Banking in India: Driving Climate Action and Sustainable Development – A post - merger analysis of CSR activities of SBI

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Abstract

Green banking is a type of banking for which considering the environmental and social impact of its operations is vital. This paper tries to explore the potential of green banking in India as a catalyst for climate action and sustainable development. It discusses the challenges that green banking has in India, as well as the opportunities it presents. This research paper explores the transformation of Indian banks from traditional financial institutions to proactive participants in the process of sustainable development and climate change initiatives. India has made a pledge to reduce the intensity of its emissions by 2030 and to achieve net-zero carbon emissions by the year 2070. In order to be more effective on this commitment, the country will need to invest an estimated $10 trillion in those initiatives that aims at promoting sustainability. The areas such as renewable energy, environmentally friendly infrastructure, and sustainable agriculture are all areas in which financial institutions are uniquely positioned to distribute resources. This paper investigates the significance of green banking by using State Bank of India as a case study. It also incorporates the Corporate Social Responsibility (CSR) and sustainability initiatives of State Bank of India (SBI). The study stresses on the importance of banks in supporting equitable growth, encouraging environmental conservation, and aligning their operations with the climate commitments that are imposed on them at the national and international levels. Areas such as sustainability, carbon emissions, environmental effect, ESG criteria, renewable energy sources, corporate social responsibility, and inclusive development are all part of the concept of Environmental Social, and Governance (ESG) criteria.

Keywords: *Green Banking, Sustainable Development, Climate Action, Corporate Social Responsibility (CSR), Environmental, Social and Governance (ESG), State Bank of India (SBI), Post-Merger Banking, Renewable Energy Financing, Carbon Emission Reduction, Sustainable Finance.*

Introduction

The Role of Financial Institutions in Facilitating Transformation

Banks were traditionally viewed as organizations that were primarily concerned with deposits, loans, and the maximizing of profits. Regardless of this, due to the fact that climate change is increasingly becoming a vital issue on a worldwide scale, the role of banks is witnessing a rapid evolution. At the recent time, it is expected that banks will take social and environmental aspects into consideration while making decisions. Financial institutions are required to go beyond the pursuit of maximum profit and actively encourage the achievement of national sustainability goals in order to meet the commitments that India has under the Paris Agreement, as well as to achieve its domestic climate ambitions.

The role of banks in India is no longer simply acting as financial intermediaries. They are also proactive catalysts for systemic change through the following actions: channeling capital

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toward renewable energy, reducing carbon emissions, and promoting sustainable consumption.

An Examination of the Sustainability Goals of India from a Financial Perspective

One of India's noble goals in its ambitious climate strategy is to reduce emissions intensity by 45% by the year 2030 and to achieve net-zero emissions by the year 2070. The Indian government needs to spend more than $10 trillion on green infrastructure, renewable energy and sustainable farming. The banks of India have to play a crucial role in this regard. They should aim at bridging the gap between the amount of green funds for the projected green projects and the funds which are already being used for the same in the country.

One must always remember that the government alone can not raise the entire fund for this transition. It is quite essential that the banks of the country have joined their hands with the government. They are the foundations of India's climate conscious growth as they are liable for the introduction of innovative products, the mobilisation and equitable distribution of funds.

The Role that Banks Play in the Achievement of Climate Goals

There are many ways by which the financial institutions can help by funding various climate objectives. The main component is the capital allocation in which the financial institutions prioritise funding in renewable energy resources, electric mobility and sustainable infrastructure. Banks are in the position to fasten the pace of India's transition to carbon free economy directly by financing for these endeavours. The development of sophisticated and innovative products is important requirement as banks are responsible for the creation of different financial instruments such as green bonds, loans connected to Environmental Social and Governance (ESG) factors and sustainable savings avenues. All these avenues make it convenient for customers in different segments to get access to different green financing. At the same time, they encourage sustainable projects. Banks have every opportunity to improve operational efficiency by transitioning to renewable energy sources, adopting digital platforms thereby use more and more digital communications and modernizing branch infrastructure to increase energy efficiency and to reduce carbon emission. Along with the internal initiatives, involving in the supply chain banks encourage customers and suppliers to adopt environmentally responsible practices. These practices lead to far-reaching effects for the entire economy.

Market incentives and regulatory assistance

Both Reserve Bank of India (RBI) and the Securities and Exchange Board of India (SEBI) play a key role in ensuring that banking practices involve sustainability. Securities and Exchange Board of India (SEBI) has made it necessary that big corporations report their Business Responsibility and Sustainability Reports (BRSR). The Reserve Bank of India (RBI) has encouraged banks to incorporate ESG elements into their lending operations. These frameworks improve transparency and responsibility by establishing a linkage between the actions of the organization and sustainability standards on a global level. Because of consumers and investors show an increased curiosity in items that are both environmentally friendly and ethically acceptable, market determinants are becoming more and more dynamic. As the desire for financial institutions to include environmental sustainability into their business strategies grows, banks are being forced to adopt green banking initiatives, which makes it both a regulatory requirement and a market-driven opportunity.

Literature Review

Tambi (2005) felt that the impact of mergers on the performance of various financial corporations in India, comparing parameters such as Profit Before Income Tax, Depreciation and Amortization, Profit After Tax, and Return On Capital Employed in pre and post-merger periods and concluded that mergers did not have a positive impact on profits.

Mehta and Kakani (2006) in their study recognised various reasons for adopting mergers and acquisitions from an Indian perspective, emphasizing the highly environment-dependent nature of such transactions as an key factor behind their failure.

Friedman (2006) states that "enterprise has a single and exclusive social obligation, which is to use its resources and engage in profitable endeavours as long as it plays by the rules, that is, participates in open and rivalry free from dishonesty or deceit."

Mallikarjunappa and Nayak (2013) researched that the stock prices' responses during the announcement of takeovers in India from 1998 to 2007, using a sample of 227 companies for which they calculated ARs, AARs, and CAARs based on a window period of 61 days and the standard market model. They concluded that takeovers in India created wealth for shareholders of target companies, with a cumulative average return of 27-37%.

S. Kaur (2016) studied about banks concentration on their CSR efforts on women and children. The aspects such as women's welfare, education, and rural development have been considered. The study concluded that public banking institutions have made the majority total contributions to the programmes. Private sector financial institutions and foreign banks are placed themselves behind of public sector banks in this regard.

Sharma and Sathish (2022) pointed out that there is a need for banks to adopt a clear and innovative approach to CSR, which aims at their activities are "SMART"—truthful, ethical, responsible, accountable, and transparent—while focusing on areas that encourage long-term economic growth.

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Objectives of the Study

1. To analyse the dynamic role of Indian banks from traditional financial structure to key providers of climate action and sustainable development.
2. To examine climate commitments of India including reducing carbon emission intensity by 45% by 2030 and achieving net-zero by 2070 and evaluate the necessity of financial institutions' involvement in realising India's National goals.
3. To study the initiatives undertaken by State Bank of India as a case study for green banking practices which includes strategies for emission reduction, eco-friendly financial products, and operational sustainability.
4. To find out the steps of Corporate Social Responsibility (CSR) and various sustainability initiatives of the State Bank of India (SBI) and also to assess their role in the areas such as community development, renewable energy financing, and environmental protection.
5. To identify the challenges faced by Indian banks in moving toward sustainable finance as a whole, including issues of ESG reporting, greenwashing, capacity building, and accessibility of green financial resources.
6. To highlight the opportunities and the routes ahead for green banking in India through innovations including green bonds, fintech solutions, and international collaborations.
7. To contribute to academic and policy discussions by giving importance of aligning banking operations with India's climate action plans and international sustainability standards.

Limitations of the Study

1. The study primarily focuses only on State Bank of India in particular which may not be generalised for all banks in India.
2. Only the **s**econdary data derived from various reports, policy documents, and bank disclosures were used and the absence of primary data limits the in-depth analysis.
3. The study reflected the policies, regulations, and practices as available at the time of preparing the research study that too from 2020-21 to 2024-25. As banks are functioning in a very dynamic environment in which future changes ought take place that too in banking regulations, global climate commitments, or technological innovations which may alter the findings.
4. Lack of similarity in ESG reporting across Indian banks makes it uneasy in ensuring comparability and consistency of sustainability performance.
5. The study result may not be generalised as every emerging economies have different regulatory, social, and financial systems.
6. Some of the sustainability claims made by banks may not fully translate into quantifiable results. In other words, some qualitative aspects are also involved. Reliance on self-reported data introduces potential bias.
7. The study is limited itself only to banking institutions and it does not cover the role of non-banking financial companies (NBFCs), microfinance institutions, or fintech start-ups in green finance which also paly their parts as financial intermediaries in India.

Corporate Social Responsibility (CSR) and Sustainability Initiatives of State Bank of India (SBI)

The State Bank of India (SBI) have set an example of outstanding corporate social responsibility and sustainability standards. The ideals of community development and environmental sustainability, with a particular stress on underprivileged groups in rural and urban slums, are the backing principles of the Corporate Social Responsibility (CSR) policy. State Bank of India (SBI) works in conjunction with non-governmental organizations (NGOs) and trusts in order to extend helping hands to the people who are deprived of healthcare, education, and welfare. The State Bank of India (SBI) carried out various initiatives during the COVID-19 pandemic, including the supply of food and rations, the installation of oxygen plants, the organization of vaccination programs, and the construction of COVID care facilities. The adaptability of its Corporate Social Responsibility (CSR) structure in order to address social needs in a split second was proven by both the short-term and long-term methods.

State Bank of India (SBI) is a pioneer institution in the women empowerment programs, developing integrated support centres for victims of abuses, assisting skill development projects such as sewing units, and providing funds to non-governmental organizations (NGOs) that help women and children. The bank has also contributed to the improvement of healthcare by extending loans for hospitals, ambulance donation, and the supply of important medical equipment. In the field of education too, it has made it convenient for people to establish smart classrooms, intelligent schools, and mobile science laboratories in areas that are less fortunate. They have also donated many computers to the educational institutions.

State Bank of India (SBI) has initiated a variety of activities such as installation of solar-powered systems, the financing of projects related to renewable energy, and the issuance of green bonds. The program also involves the planting of more than six hundred thousand trees throughout India, the designing and adoption of systems for managing electronic trash, and the replacement of workplaces with green energy sources. In addition to this, different digital platforms have been offered by SBI. One of its flag ship digital platforms is YONO application, which has reduced the amount of paper consumed drastically, furthering environmental goals. Through its sustainability and corporate

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responsibility strategies, SBI has merged its activities with reporting standards that are used internationally, including the Global Reporting Initiative (GRI) framework and the Business Responsibility and Sustainability Report (BRSR). The achievement of carbon neutrality by the year 2030 is included in its long-term dream, including the goal of establishing itself as a vital facilitator of India's Sustainable Development Goals (SDGs).

Challenges in the Field of Sustainable Banking

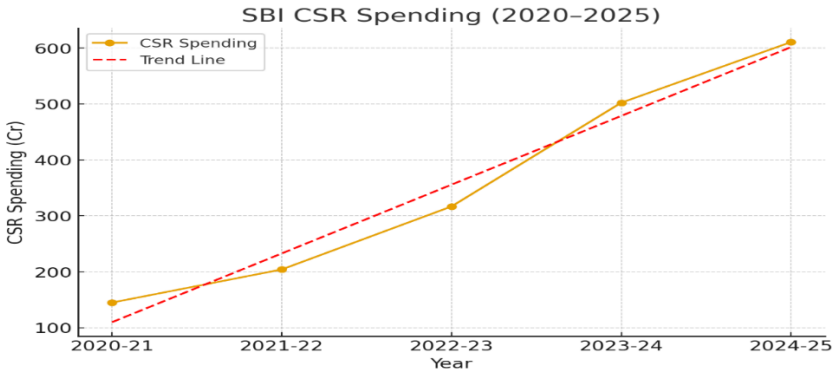
India has made a notable development in the field of green finance. Besides this, there are still a number of hindrances demanding for solutions before the country can fully transition to this type of funding. One of the most major problems is, the lack of a standardized framework for Environmental Social, and Governance (ESG) reporting. This has led to inconsistencies in the assessment of the implications of sustainability practices. There are many banks that do not have sufficient number of professionals that are qualified to manage climate risk and sustainable finance. A threat to confidence is thrown by the widespread practice of greenwashing, in which organizations overstate the claims that they make regarding their sustainability. Besides this, it is generally common for rural institutions and smaller banks to face challenges when it comes to getting green funding, which leads to an inequitable distribution of paybacks.

Opportunities for the Future and the Path to Progress

There are a large number of potential opportunities to speed up the progress of green banking in India. It is also possible that the green bond market might be improved in order to provide funding for major projects. International collaborations and mergers may help to get worldwide expertise and funds for projects through. Banks have the potential to enhance their internal capabilities while simultaneously expanding the accessibility and transparency of green products by investing in employee training and taking advantage of financial technology. These procedures, when effectively implemented, will provide banks the authority to transform the climate pledges made by India into concrete and measurable outcomes.

Analysis and interpretation

Year	CSR Spending_(in Crore)
2020-21	144.88
2021-22	204.10
2022-23	316.76
2023-24	502.32
2024-25	610.77



Descriptive Statistics

Statistic	Value
N	5
Mean	355.77
Std. Dev.	197.17
Min	144.88
Max	610.77
Median	316.76

Regression Analysis (Year → CSR Spending)

- **Model:** CSR Spending = -13.23 + 123.00 × Year
- **R^2 = 0.973** → 97.3% of variance explained by time trend
- **F(1,3) = 107.8, p = 0.0019** → statistically significant trend
- **Interpretation:** CSR spending increases on average by ₹123 Cr per year

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The analysis of CSR spending by the State Bank of India (SBI) from 2020–21 to 2024–25 reveals a clear and consistent upward trajectory. The expenditure increased from ₹144.88 crore in 2020–21 to ₹610.77 crore in 2024–25, representing more than a fourfold rise over five years. This steady growth highlights the bank's expanding commitment toward social responsibility, community development, and sustainability initiatives.

The descriptive statistics further emphasize the magnitude of this growth. The mean CSR spending across the five-year period stands at ₹355.77 crore, while the median is ₹316.76 crore. The higher mean compared to the median indicates that the sharp rise in recent years has pulled the average upward. The standard deviation of ₹197.17 crore reflects substantial variation in year-to-year spending, suggesting that SBI has progressively scaled up its CSR initiatives in response to evolving social and environmental needs. The range between the minimum value (₹144.88 crore) and maximum value (₹610.77 crore) underscores the rapid expansion of CSR commitments within a relatively short period.

Regression analysis confirms the robustness of this growth trend. The model, CSR Spending = -13.23 + 123.00 × Year**,** indicates that CSR expenditure has been increasing by an average of ₹123 crore annually. The high coefficient of determination (R^2 = 0.973) shows that 97.3% of the variation in CSR spending is explained by the passage of time, suggesting that this growth is systematic rather than random. The statistical significance of the model ($F(1,3) = 107.8$, $p = 0.0019$) provides further evidence that the upward trend in spending is not coincidental but part of a deliberate, long-term intentional strategy.

Overall, the findings indicate that SBI's CSR activities have moved beyond compliance to become a strategic priority aligned with broader Environmental Social, and Governance (ESG) goals. The steady increase in spending reflects the bank's changing role as a financial catalyst for sustainable development, contributing not only to immediate social welfare but also to India's long-term climate action and sustainability commitments.

Conclusions

The banks of India are becoming more important contributors to the nation's efforts to address climate change and achieve sustainability. Through its proactive programs for green financing and emission reduction, the Central Bank of India provides an example of how conventional institutions may adapt to the challenges of the modern era. Similarly, SBI's corporate social responsibility (CSR) and environmental endeavors are evidence of the incorporation of banking with equitable development. The role of banks will change from simply serving as financial intermediaries to taking on a leadership position in the fight against climate change as India works toward achieving its net-zero goal by the year 2070. Indian banks are actively contributing to the country's sustainable future by providing money for clean energy projects, empowering communities in rural areas, and adhering to environmental, social, and governance (ESG) standards that are followed worldwide.

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Original Article

The Influence of Firm Generated Content on Purchase Intention of Cause Related Products

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Abstract

Cause related marketing is a pivotal strategic social collaboration which enables the companies to harmoniously combine two significant motives i.e., generating profit and fulfilling their responsibilities towards the society. The proliferation of digital channels has bound the firms to embrace content-driven strategies to grab consumer attention and elicit a response, making firm-generated content (FGC) a critical component in shaping consumer buying behavior. FGC includes advertisements, blog posts and social media content created and circulated by the firm. The effect of such content on the consumer purchase intention of cause related products has remained unexplored. Hence, this study employs survey-based methodology to explore the impact of such firm-generated content on consumer purchase intention of cause-related products, with the focus on understanding the mediating effect of Brand credibility and consumer-cause identification. The results reveal that FGC is a significantly influence the purchase intention of cause-related products, while brand credibility and consumer-cause identification act as partial mediators. This contributes to the understanding of how content-driven strategies can enhance the effectiveness of cause-related marketing by influencing the consumer purchase intention.

Keywords: *Cause-related marketing, Firm-generated content, Brand credibility, consumer-cause identification, Purchase intention.*

Research Background And Motivation

In modern era, for the companies to outperform their competitors it is significant to fabricate an image that is equivalent to a socially responsible company (Natarajan et al., 2018). In addition to running of business with an objective to generate profits, companies are widely becoming conscious of their social responsibilities (Galan Ladero et al., 2015). They have realized the relevance of cause related marketing as a pivotal strategic social collaboration (Hou et al., 2008). Cause-related marketing is a particular kind of corporate social responsibility under which a brand associates itself with a relevant social and environmental cause and pledges to donate a portion of their sales proceeds towards a that specific cause (Eker Iscioglu & Borak, 2020). This allows the companies to harmoniously combine both of their motives i.e., generating profit and fulfilling their responsibilities towards the society (Aggarwal & Singh, 2019). It is being progressively utilized as an effective marketing mechanism to aid charities along with sales (Chaabouni et al., 2021). What is more captivating in CRM campaigns facilitate the customers to feel that they can make an impact via purchasing a cause-related product (Natarajan et al., 2018).

Majority of the campaigns are structured as a transactional offer wherein they pledge to donate a certain portion of their selling price towards a designated cause. Just like the way cause-related marketing was defined by Varadarajan in the year 1988 as "the process of formulating and implementing marketing activities that are characterized by an offer from the firm to contribute a specified amount to a designated cause when customers engage in revenue-providing exchanges that satisfy organizational and individual objectives" (Overview, 1988).

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"Statue of Liberty's rehabilitation project" assisted by American Express's CRM campaign was one of the most renowned and primary record of such campaign. (Aghakhani et al., 2020). After which many companies in the west began utilizing this marketing tool to gain prestige and consumer attention. For instance, "Rewrite the Future" campaign carried out by Bulgari and Save the Children in 2011 that successfully achieved more than $7.4m for educational programs is another example (Boenigk & Schuchardt, 2013).

Since this type of marketing is a novel occurrence in India, there is a huge potential for its growth as an effective marketing tactic (Deb, 2021). Also considering the growing population of India where majority of the population residing in rural areas are unable to access proper food, water, education, sanitation and unawareness leading to multiple diseases, this kind of marketing can be used to solve such problem by responsible companies involving the citizens of the country. For instance, Sani Fresh donated a part of its sales revenue towards providing hygienic sanitation facilities for women especially at various village schools in India (Thomas & Kureshi, 2020). However, Consumer attention to such campaigns and response is extremely essential for it to succeed. That is the reason why most of the previous researchers have always focused on understanding consumer response towards cause-related marketing. (Bigné-Alcañiz et al., 2012; Eker Iscioglu & Borak, 2020; Zhang et al., 2022).

The proliferation of digital channels has bound the firms to embrace these channels to launch their CRM campaigns (Handa & Gupta, 2020) so that it grabs consumer attention and elicit a response. By communicating CRM campaigns on the social media platforms companies amplify the social responsibility efforts (Guerreiro & Loureiro, 2020). A viral CRM campaign on social networks can lead to a favourable attitudinal response towards brand and the cause (Mora et al., 2021). As a result, the social media network is transforming traditional way of marketing communications (Schivinski & Dabrowski, 2016). Despite the flourishing literature on cause-related marketing, only a handful of studies have focused efforts to understand if cause-related marketing content on digital platforms can impact consumer purchase intention of cause related products. This study is an attempt to fill this gap.

Literature Review

An internet user engages for about two hours and 42 min per day with social media as per Global Web Index (Yang et al., 2022). The communication practices of the consumers are profoundly influenced by the growing significance of applications like Facebook, YouTube and others. With lengthening periods of time being spent on social networking platforms, rising portion of the transmission of information occurs within this digital landscape. This implies that bulk of the marketing campaigns and brand related interactions occurs within the same landscape, as far as marketing communication is concerned (Hutter et al., 2013). In the current tech-dominated epoch, digital platforms serve as an effective marketing instrument for the businesses apart from enabling communication (Sandunima & Jayasuriya, 2024).

Social media presents companies as well as consumers fresh methods of interacting with each other (Schivinski & Dabrowski, 2016). Both parties can create and share their content and also respond to each other's queries. Depending upon the content created by the firm or the user on the digital platforms it can be classified as firm-generated content (FGC) and user generated content (UGC). Due to the versatility of the social media, brands can design digital content in variety of forms i.e., post, blogs and advertisements and circulate it through multiple established digital spaces (e.g. Facebook, Twitter, YouTube and LinkedIn). This mechanism is known as FGC (Poulis et al., 2019). While on the other hand, any content created and communicated by the user is often labelled as user generated content (Poulis et al., 2019).

This study is based on Elaboration Likelihood Model which is dual-process theory explaining how people process a stimulus and its behavioural consequences. As per this theory people use central route (thoughtful consideration) or peripheral route (positive or negative cues in the stimulus) to process the information. Drawing upon this theory this study endorses the view that when firms tie their products with a social cause and share such marketing communication on social media platforms through generating content related to such engagement consumers are encouraged to react favourably. However, this reaction will be based on central route i.e., their trust in the firm's ability and expertise in fulfilling their promise and meeting their expectation and peripheral route i.e., their identification with the cause being supported by the firm. As a result, they will demonstrate their support to such civically engaged brands through the purchase of the products as it will trigger brand's continued efforts towards the cause.

1. Firm-generated content

Any content designed and broadcasted by the firm with the intention of engaging the customers through product promotions and dissemination of information in a strategic manner is identified as firm-generated content (FGC) (Qiao et al., 2024). Social media has been redefined as a new powerful domain for brands to socialize with their consumers straightforwardly (Poulis et al., 2019). The consumers may respond to such brand on social media via comments, feedback, feelings, judgments and intentions (Sharief & Elsharnouby, 2024). Therefore, FGC can aid to strengthen the bond between the brand and the consumers (Ghazi Khan et al., n.d.). FGC as a reference source is considered to be more systematic and consistent to the costumer (Heng Wei et al., 2023). When any CSR-related communications are shared social channels by an organization, its stakeholders including customers view such organisation to be transparent, honest and fair in its conduct (Álvarez-González et al., 2018). When observing such

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contents on social media they feel optimistic about the organisation and believe that it does not only prioritize customers' needs but it also equally champions social progress (van Prooijen & Bartels, 2019). This also increases the likelihood of accepting products and services from such trusted and socially involved companies by the customers (Mostafa & ElSahn, 2016).

Hence it is logical to propose:

H1: Firm-generated content (FGC) has a positive influence on consumer purchase intention of cause-related products.

2. Brand credibility

Brand credibility assists in making judgements about brand's attribute through a consumer lens. Brand credibility is defined as the consumers perception of the brand's ability (expertise) and willingness (trustworthiness) to align delivery with brand promises (Tu¨ et al., 2004). Brand credibility serves as a crucial element to tackle consumer evaluation of promotional content. Accordingly, consumers are prone to cultivate an advantageous position for brand's promotional content regardless of its persuasive material if they perceive it to be highly credible (Lee & Kim, 2020). Therefore, consumers demonstrate measurable preference for credible brands as credibility is an assurance of higher product values, features, durability and reliability (Atta et al., 2024).

Hence, we hypothesis the following:

H2: Brand credibility mediates the influence of firm-generated content on purchase intention of cause-related products.

3. Consumer-cause identification

Selecting a cause that feels relevant to the consumer is a significant protocol to be followed while formulating cause-related campaigns (Lopes et al., 2024). This is because, a highly effective campaign calls for identification of all the stakeholders with the cause, and have precise understanding of their own and company's contribution towards that cause (Duarte & Silva, 2020). It may be associated with the self-concept of individuals. When individuals identify with a social unit, they are more prone to favourably evaluate and actively involve with it, in an effort to elevate and reinforce their self-concept (Bigné-Alcañiz et al., 2010) Likewise, when consumers identify with a cause, they may tend to evaluate a CRM campaign positively and engage with it, as a means to enhance their self-concept. This consumer and cause identification is found to improve attitude towards the brand and intention to purchase such products (Bhattacharya & Sen, 2003). Hence, we propose the following;

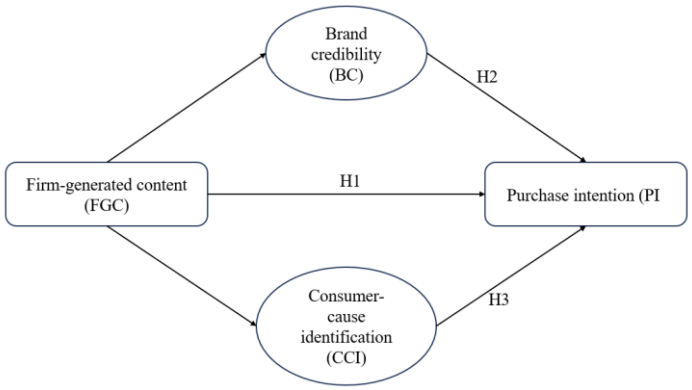
H3: Consumer-cause identification mediates the influence of FGC on purchase intention of cause-related products.

Research Methodology

1. Research Model

The following research framework is based on the hypothesis developed for the study **(Fig 1)**. This study examines the impact of FGC on the purchase intention of cause related product with Brand credibility and consumer-cause identification mediating this relationship.

Figure 1: Research Framework



2. Research design

We employed a non-probability sampling technique to collect data from respondents. A structured questionnaire was distributed to the respondents online. One of the most successful cause-related marketing campaign in India was selected for the study i.e. P&G Shiksha campaign. Respondents were asked with a screening question if they had seen any firm-generated content related to the campaign. If they responded "yes" they were allowed to answer the main survey. If they responded "no" then they were disqualified. This helped to filter the respondents on the basis of their awareness with such content. A total of 200 responses completed were received and found fit for further analysis.

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3. Research instrument and measurement

This study explored four key constructs namely, firm-generated content, brand credibility, consumer-cause identification and purchase intention adopted from (Heng Wei et al., 2023), (Ramadania et al., 2023), (Lopes et al., 2024) and (Pandey et al., 2024) respectively. Each construct's items were measured on a five-point scale Likert scale (1= "strongly disagree"; 5 = "strongly agree"). The data was obtained over a period of three months between June 2025 to August 2025.

Results And Discussion

1. Respondents' characteristics

As can be seen in Table 1, 55% of the those who qualified to respond were female and 45% were male. Among the respondents, 57% were aged between 21-30, and 35% were aged between 31 and 40. Most respondents had obtained a bachelor's degree or higher, 52.5% were employed and 39% were still pursuing education. 70.5% of the respondents spent more than 2 hours daily on social media, while the remaining 29.5% spent less than 2 hours.

Table 1: Characteristics of the respondents

Descriptive variable		Frequency	Percentage
Gender	Female	110	55.0%
	Male	90	45.0%
Age	Below 20	15	7.5%
	21 - 30	114	57.0%
	31 - 40	70	35.0%
	Above 50	1	0.5%
Educational Level	High - school	11	5.5%
	Bachelor's degree	121	60.5%
	Master's degree	68	34.0%
Occupation	Employed	105	52.5%
	Student	78	39.0%
	Student - worker	2	1.0%
	Unemployed	15	7.5%
Average time spent on social media daily	Below 1 hour	6	3.0%
	1 - 2 hours	53	26.5%
	2 - 3 hours	94	47.0%
	above 3 hours	47	23.5%

2. Measurement model

Partial least square Structural equation modelling was performed in SmartPLS 4.0 software to evaluate measurement model's reliability, convergent and discriminant validity. Table **2** and **3** presents the outcome of the assessment.

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Table 2: Reliability and convergent validity

Construct	Number of indicators	Outer loadings	Cronbach's Alpha	Composite reliability	Average Variance Extracted
Firm-generated content (FGC)	FGC 1	0.843	0.822	0.825	0.652
	FGC 2	0.803			
	FGC 3	0.798			
	FGC 4	0.785			
Brand Credibility (BC)	BC 1	0.830	0.877	0.879	0.671
	BC 2	0.821			
	BC 3	0.801			
	BC 4	0.824			
	BC 5	0.819			
Consumer-cause identification (CCI)	CC1 1	0.807	0.932	0.932	0.647
	CCI 2	0.802			
	CCI 3	0.802			
	CCI 4	0.820			
	CCI 5	0.831			
	CCI 6	0.786			
	CCI 7	0.812			
	CCI 8	0.767			
	CCI 9	0.808			
Purchase Intention (PI)	PI 1	0.847	0.907	0.907	0.729
	PI 2	0.851			
	PI 3	0.859			
	PI 4	0.857			
	PI 5	0.855			

Source: Author's own work

The reliability of the research constructs is said to be achieved when Cronbach's alpha and composite reliability is above the threshold of 0.7, as can be seen in the Table 2, both the values are above 0.7. Therefore, it can be confirmed that reliability of the constructs is achieved. Next, the convergent validity is examined by looking at the outer loadings and Average Variance Extracted (AVE) which should be above 0.7 and 0.5, respectively. Since it is evident from Table 2, that both the values are above the respected threshold of 0.7 and 0.5 the convergent validity of the constructs is also achieved. Thus, these constructs were used to perform next quantitative analysis.

Table 3: Discriminant validity - HTMT ratio

	BC	CCI	FGC	PI
BC				
CCI	0.467			
FGC	0.723	0.693		
PI	0.755	0.735	0.739	

Source: Author's own work

Discriminant validity is used to ensure that two constructs are conceptually different from one another. This can be tested using Heterotrait-Monotrait ratio (HTMT). According to the strictest standard HTMT ratio should be less than or equal to 0.85. As per Table 3 HTMT ratio are below 0.85, confirming achievement of discriminant validity.

Table 4: Model fit

	Saturated model	Estimated model
SRMR	0.048	0.049
NFI	0.890	0.892

Source: Author's own work

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The SRMR measures how accurately model captures the observed relationships. This value should be below 0.08 while other literature suggest that it should be 0.05. Our model has SRMR value of 0.048 which is below 0.05 demonstrating an excellent fit. Furthermore, NFI value above 0.90 is considered to be a good fit while 0.80 is considered acceptable. In our analysis NFI is 0.89 which is slightly below the threshold therefore, confirming an acceptable fit. This indicates that there may be room for minor refinements to increase the model's explanatory power. overall, the model fit is acceptable to proceed for further analysis.

3. Structural model

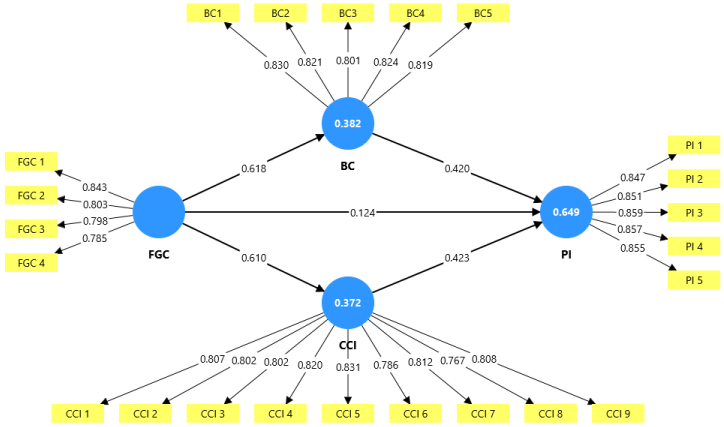
After confirming the reliability, validity and model fit we proceeded to test the proposed hypothesis by conducting a parallel mediation analysis to confirm the mediating role of brand credibility and consumer-cause identification. The results are shown Table 5 below.

Table 5: Direct and indirect effects

Hypothesis	Path	Coefficient	T statistics	P values	Result
H1	FGC -> PI	0.124	2.172	0.030	Accepted
H2	FGC -> BC -> PI	0.259	6.324	0.000	Accepted
H3	FGC -> CCI -> PI	0.258	7.938	0.000	Accepted

Source: Author's own work

The bootstrapping (5000-sample) results demonstrate a positive and significant direct effect of Firm-generated content on purchase intentions ($\beta = 0.124$, $t = 2.172$, $p < 0.05$). It also reveals a significant specific indirect effect of Firm-generated content on Purchase intention through Brand credibility ($\beta = 0.259$, $t = 6.324$, $p < 0.05$) and consumer-cause identification ($\beta = 0.258$, $t = 7.938$, $p < 0.05$). The significant direct effect of firm-generated content on purchase intention indicates that both brand credibility and consumer-cause identification act as a complementary partial mediator. This suggests that effect of FGC is both direct and indirect. Therefore H1, H2 and H3 are supported.



Source: Author's own work

Conclusion

This study builds a conceptual framework in the context of cause related marketing to explain how FGC can effectively impact consumer purchase intentions of cause-related products through brand credibility and consumer-cause identification. We tested the proposed model using SmartPLS. The findings empirically support the proposed model. The results reveal that FGC has a positive but statistically significant influence on the consumer intention to purchase cause-related product which is supported by the past study conducted by (Poulis et al., 2019) who found a significant impact of FGC on consumer purchase intention. However, further analysis revealed that FGC has a direct and strong positive impact on brand credibility. This may be because FGC aids in reducing consumer skepticism about the firm's motive. Brand credibility also showed practically meaningful impact on the purchase intention of cause related products. These results provide confirmatory evidence for the previous studies (Wang et al., 2021), (Sekhar et al., 2022), (Abu Zayyad et al., 2021). Further mediation analysis confirmed the mediating impact of brand credibility on the relationship between FGC and purchase Intention, which is closely approximating with the previous study (Abu Zayyad et al., 2021) that also found the significant mediating impact of brand credibility on the effect of CSR on patronage intention in Jordanian banking sector. Therefore, we can conclude that firm's cause-related marketing

content on social media should be not only be used for brand promotion but also to build trust. While the past studies confirm the direct influence of Consumer-cause identification on purchase intention (Silva et al., 2021) (Shetty et al., 2021) our analysis reveal that it partially mediates the effect of FGC on PI. This suggest that consumer if a consumer deeply identify with the cause being supported by the firm, firm-generated content is stronger and more effective in influencing their intention to purchase the product supporting that cause as it allows them to express their own values and identity.

Theoretical Implications

Our study adds three main contributions in the area of scientific knowledge. First, we integrate two research domain that have frequently been studied separately i.e., cause-related marketing and firm-generated content which is forms a critical component of social media communication. Second, our research deepens the understanding of the direct and indirect effect of FGC on consumer purchase intention of cause-related products. And finally, our findings reveal the critical mediating role played by brand credibility and consumer-cause identification in making FGC more effective in influencing purchase intention. This finding aligns with elaboration likelihood model which advocates that both central and peripheral route are used to process persuasive information. When using the central route consumer carefully evaluate the credibility of the brand and while using the peripheral route they rely upon their identification with the cause as a rule of thumb to process the persuasive content.

Managerial Implication

This study mainly contributes to those firms who devote their efforts to highlight and solve a social cause by aligning it with their products, and simultaneously use content-driven strategies to communicate such marketing efforts to their consumers. Our findings determine that FGC is a significant driver of purchase intention for cause-related products. This implies that marketers need to utilize digital platforms to communicate the CRM efforts in order to increase the consumer reach and impact. Our results reveal that strong brand credibility helps to transform cause-related marketing content into purchase intention. Therefore, firms should prioritize transparent and informative FGC to further strengthen brand credibility. Since consumer-cause identification has been found to partially mediate the effect it can be said that it bridges the gap between brand's CRM communication and consumer self-concept. It confirms that internal motivation is powerful heuristic to make decision when cause-related products are concerned. Hence, managers need to target consumers who follow, engage with the cause or share opinions about it online, create content explaining the why the cause matters and how the brand is contributing towards it, create exclusive forums for consumers who are passionate about the cause for discussion and suggestions. Consequently, it will lead to natural and meaningful outcome.

Limitation And Future Research

The study is not free of the limitation and does raise questions which needs future investigation to be answered. First, failed to clarify which form of FGC can be effective in cause-related marketing. Therefore, future research is needed to focus on two distinct types of FGC i.e., informative or emotional. Second, the study did not examine which social media platforms can play a major role in cause-related marketing communication. (J. Yang et al., 2020) confirmed that social media platforms can differ in terms of providing returns on CSR marketing efforts and concluded that content-based platforms such as Pinterest and YouTube can enhance the CSR activities credibility. Therefore, future investigations can focus on these two content-based platforms to understand its effectiveness in communicating cause-related marketing efforts. Also, other mediators should be explored.

Authors Contribution

Neha Parveen Haider Ali: designed the conceptual framework, writing – original draft, data collection, analysis and interpretation.

Filipe Rodrigues e Melo: Writing – review & editing, Supervision, Project administration.

Conflict Of Interest: The authors declare no known competing interest that could have influenced the work reported in this paper.

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Original Article

The Role of Corporate Governance in Enhancing Financial Sustainability

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Abstract

This study examines the role of corporate governance in enhancing financial sustainability. In recent decades, global economic, political, and social changes have increased pressures on businesses, highlighting the need for effective governance mechanisms to ensure long-term stability and growth. Financial sustainability refers to a company's ability to meet its financial obligations, manage resources efficiently, and maintain operational continuity while achieving balanced growth in a volatile environment .The research draws on key theoretical frameworks, including Agency Theory, Stakeholder Theory, and Legitimacy Theory, to analyze how governance mechanisms impact financial sustainability. Empirical and theoretical evidence indicate that strong and effective corporate governance enhances transparency, reduces financial risks, attracts long-term investment, and strengthens trust among stakeholders .The study also identifies challenges in implementing governance practices, including high costs, cultural and institutional barriers, conflicts of interest, and regulatory variations across countries. Based on these findings, practical recommendations are provided to strengthen governance structures, improve disclosure, diversify funding sources, and promote long-term financial resilience. In conclusion, corporate governance is not merely a regulatory requirement but a strategic tool that directly contributes to financial sustainability, enabling companies to achieve stable performance, withstand crises, and ensure long-term continuity.

Keyword: *Corporate Governance, Financial Sustainability, Transparency, Financial Performance.*

Introduction

In recent decades, the world has witnessed rapid transformations in the global and regional business environment, driven by multiple factors, most notably globalization, trade liberalization, financial market deregulation, and the intensification of competition among companies at both the local and international levels (Goel, 2018). These dynamics have given rise to new challenges for institutions, the most significant of which is the ability to survive, endure, and achieve sustainable growth within an environment characterized by instability and heightened risks (Jiang & Li, 2024). Within this context, financial sustainability has emerged as one of the most pressing issues attracting increasing attention from researchers, practitioners, and policymakers alike. It is regarded as a fundamental pillar for ensuring corporate survival in the long term, extending beyond the pursuit of short-term profits (Braun & Mueller, 2025).

Financial sustainability refers to the ability of firms to strike a balance between efficiency in resource utilization and effectiveness in achieving financial and economic objectives, while also maintaining the resilience to withstand crises and fluctuations. This ensures the continuity of operations and fosters investor and stakeholder confidence. It is therefore not merely a traditional financial concept, but rather a strategic framework that integrates profitability, risk management, and social and environmental responsibility (Oanh, 2023). Conversely, corporate governance has emerged as a regulatory and managerial framework designed to establish clear and effective rules for managing companies in ways that promote transparency and accountability, ensure fairness among shareholders, and safeguard the rights of various stakeholders (Maboya & McKay, 2019). The adoption of governance principles has become indispensable, particularly in the aftermath of financial crises such as the 2008 global financial crisis,

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which clearly demonstrated that the absence of sound governance practices exacerbated crises and led to the collapse of many major financial and economic institutions (Navarro-Galera et al., 2021).

From this perspective, the relationship between corporate governance and financial sustainability is no longer a mere theoretical assumption, but rather a reality substantiated by practical experiences. Evidence shows that companies effectively implementing governance standards are more capable of achieving sustainable financial stability and greater resilience in the face of shocks and crises. Conversely, weak governance often leads to fragile financial sustainability and heightened risks of bankruptcy or collapse (Al-Ahdal et al., 2020). Building on this, the present analytical study seeks to highlight the role of corporate governance in enhancing financial sustainability by addressing both theoretical and practical frameworks, and by analyzing the relationship between them. Ultimately, the study aims to derive conclusions and recommendations that could contribute to the advancement of governance practices and strengthen corporate capacity to achieve financial sustainability within a dynamic and complex business environment (Senadheera et al., 2022).

Despite the considerable body of literature addressing corporate governance and financial sustainability as independent topics, studies integrating both dimensions remain relatively limited. Furthermore, the reality of current practices indicates the existence of a gap between the formal adoption of governance principles and their tangible reflection on sustainable financial performance. This gap gives rise to the core research problem, framed in the following central question: What is the role of corporate governance in enhancing financial sustainability?

From this main inquiry, several subsidiary questions emerge:
What are the key mechanisms and principal dimensions of corporate governance?
What is the nature of the relationship between governance practices and financial sustainability in firms?

The research aims to:
Study and analyze the theoretical framework of both corporate governance and financial sustainability;
Identify the relationship between governance mechanisms and the achievement of financial sustainability;
Provide practical recommendations to improve the effectiveness of governance implementation in ways that contribute to strengthening corporate financial sustainability.

The significance of this research lies in three main dimensions:
Theoretical significance: enriching the academic literature linking corporate governance and financial sustainability, an area that still suffers from a scarcity of empirical studies.
Practical significance: offering practical indicators and recommendations that can be utilized by policymakers, investors, and boards of directors to enhance governance application and its impact on financial sustainability.
Societal significance: reinforcing public and investor confidence in the private sector through the adoption of effective governance practices that ensure transparency, accountability, and protection of the national economy from crises.

literature review

Recent literature highlights that sound corporate governance is a fundamental tool for enhancing financial performance and sustainability, as the choice of appropriate governance mechanisms directly contributes to improving corporate outcomes (Kyere & Ausloos, 2021). Economic success, moreover, relies on efficiency and innovation alongside governance practices that support financial performance, provided transparency is ensured (Goel, 2018). Studies have further demonstrated that strong governance promotes non-financial transparency through environmental and social disclosures (Lagasio & Cucari, 2019) and curbs tax avoidance behaviors while strengthening corporate social responsibility commitments (Abdelfattah & Aboud, 2020). Naciti et al. (2022) showed that board characteristics, such as independence and diversity, play a crucial role in embedding sustainability into corporate strategies, while long-term ownership patterns foster sustainable governance and mitigate short-term pressures (Kavadis & Thomsen, 2023). Additionally, effective governance mechanisms improve internal controls and transparency, thereby positively influencing financial and operational performance (Bui & Krajcsák, 2024), whereas external governance by investors and shareholders reduces unlawful and unethical behaviors by reinforcing transparency and accountability (Braun & Mueller, 2025). In the financial domain, Mim et al. (2025) found that effective management and adherence to sustainable practices enhance the stability of Canada's financial sector, while Ozili & Iorember (2024) emphasized that the impact of financial stability on sustainable development varies across countries but remains a key factor in driving growth. Similarly, Arpaci (2023) indicated that the financial sustainability of cryptocurrencies is shaped by factors such as perceived risk, price volatility, innovation, and user expectations, whereas Gleißner et al. (2022) stressed that corporate financial sustainability depends on sustainable growth, risk management, and long-term survival with attractive returns. Rodríguez et al. (2021) further argued that institutional, macroeconomic, microeconomic, and demographic factors significantly influence financial sustainability, noting that larger local authorities may be less financially sustainable. Within this framework, Zabolotnyy & Wasilewski (2019) underscored the need to balance returns and risks by focusing on profitability, liquidity, operational efficiency, and retained earnings, while Azarenkova et al. (2018) highlighted that improving operational efficiency, optimizing capital structure, and adopting well-designed investment strategies are vital for strengthening institutional financial sustainability.

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The Concept of Corporate Governance

The concept of corporate governance is relatively recent in management and economic thought, yet it has become central in both theory and practice, particularly after major financial scandals such as *Enron* and *WorldCom*, which exposed the risks of poor transparency and weak internal control (Lee et al., 2018). In essence, corporate governance refers to the framework through which companies are directed and controlled, clarifying the relationships among shareholders, boards of directors, managers, and other stakeholders (Maboya & McKay, 2019). The OECD defines it as the system that distributes rights and responsibilities among corporate participants and outlines decision-making procedures, while the World Bank views it as the legal, regulatory, and institutional structures that ensure transparency, accountability, and integrity. Similarly, the FASB highlights its role in ensuring the efficient use of financial and human resources to maximize value for shareholders and society. Scholars further describe it as both a relational and procedural system that sets corporate objectives, defines mechanisms to achieve them, and monitors performance, while ensuring fairness and the protection of stakeholders' rights (Oanh, 2023; Zattoni et al., 2020). Overall, corporate governance is best understood not as rigid rules but as an integrated system of principles, mechanisms, and structures designed to achieve responsible and sustainable corporate management.

The Emergence and Evolution of Corporate Governance

The emergence of corporate governance is closely tied to the expansion of firms, the increasing complexity of organizational structures, and the separation between ownership and management, an issue first highlighted by Berle and Means (1932) through Agency Theory, which emphasized the need for monitoring mechanisms to align managerial actions with shareholder interests (Kavadis & Thomsen, 2023). Although the term gained wide recognition in the 1990s amid globalization and financial crises such as the 1997 Asian crisis, it was the corporate scandals of the early 2000s, including the collapses of Enron and World Com, that underscored the dangers of weak transparency and poor oversight. These events led to the enactment of the Sarbanes–Oxley Act (SOX) in 2002, which introduced strict disclosure and internal control requirements and influenced international governance frameworks (Zattoni et al., 2020; Xakimovich, 2022). Thus, the evolution of corporate governance reflects both the natural outcome of corporate growth and the imperative response to global financial crises, establishing it as a strategic tool for transparency, trust, and long-term financial sustainability.

Importance of Corporate Governance

Corporate governance is significant for several groups:

- **For Companies:** Enhances corporate reputation and increases market value.
- **For Investors:** Builds confidence and reduces uncertainty.
- **For the Macroeconomy:** Mitigates financial crises, attracts foreign investment, and supports economic stability.
- **For Society:** Ensures that companies do not focus solely on short-term profits but also fulfill their social and environmental responsibilities (Rodríguez et al., 2021).

Objectives of Corporate Governance

1. **Enhancing Transparency and Disclosure:** Providing accurate and reliable financial and non-financial information to all stakeholders.
2. **Ensuring Accountability:** Clearly defining the responsibilities of management and the board of directors, monitored through effective oversight mechanisms (Lagasio & Cucari, 2019).
3. **Protecting Shareholders' Rights:** Safeguarding especially minority investors from exploitation or unfair practices.
4. **Reducing Conflicts of Interest:** Limiting opportunistic behavior by managers or controlling shareholders (Xakimovich, 2022).
5. **Improving Decision-Making:** Establishing clear governance structures that facilitate sound strategic decisions.
6. **Strengthening Investor Confidence:** Enhancing the company's ability to attract capital and investment.
7. **Achieving Long-Term Stability:** Protecting the company from financial, legal, and ethical risks (Jin et al., 2024).

Principles and Mechanisms of Corporate Governance

According to OECD recommendations and global best practice standards, corporate governance is based on several key principles and mechanisms:

1. **Transparency and Disclosure:** Publishing accurate financial reports in accordance with approved accounting standards, and disclosing strategic decisions and material risks.
2. **Accountability:** Clearly defining the roles and responsibilities of the board of directors and executive management, with the establishment of independent audit committees within companies (Chyrak, 2020).
3. **Board Independence:** Separating the roles of the chairperson and CEO where possible, and including independent non-executive members to oversee management performance (Hasan et al.,2024).
4. **Protection of Shareholders' Rights:** Enabling shareholders to participate in major decisions, ensuring equality and non-discrimination among shareholders (Daud et al., 2023).
5. **Stakeholder Consideration:** Addressing the interests of employees, customers, suppliers, society, and the environment, and promoting social and environmental responsibility practices.

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6. **Internal Control and Risk Management:** Implementing effective systems to monitor financial and operational performance, and proactively managing financial and economic risks (Mim et al., 2025).

Global Challenges in Implementing Corporate Governance

Despite the widespread adoption of governance principles and standards, several challenges hinder their effective implementation, including:

1. **Discrepancy Between Legislation and Practice:** Some companies comply formally without enacting real changes in institutional behavior.
2. **Traditional Management Culture:** Resistance to disclosure and transparency.
3. **Concentrated Ownership:** When a small number of shareholders dominate decisions, weakening the principle of equality (Gajdová, 2018).
4. **Divergent Laws and Standards Across Countries:** Creating difficulties for multinational corporations.
5. **Economic Crises:** Which sometimes expose weaknesses in governance systems even in advanced economies.

The Concept of Financial Sustainability

The concept of financial sustainability is relatively modern and has emerged alongside the growing interest in sustainability in its broader sense—economic, social, and environmental. It refers to an institution's ability to continue meeting its financial obligations and covering operational costs over the long term, while achieving stable and balanced growth that ensures survival in a volatile environment (Ozili & Iorember, 2024).

Economic literature offers multiple definitions:

- Castrillón (2021) defines financial sustainability as the institution's capacity to balance revenues and expenditures over the long term, ensuring the uninterrupted delivery of products and services without facing financial crises that threaten its existence.
- The World Bank views it as the ability to manage financial resources efficiently to maintain organizational continuity, support growth and innovation, and withstand crises, emphasizing that sustainability is not merely short-term profit but long-term stability (Gajdová, 2018).
- Other scholars note that financial sustainability requires balanced financing strategies, avoiding excessive reliance on short-term debt and ensuring diversified income sources (Al-Ahdal et al., 2020).

In conclusion, financial sustainability can be understood as a dynamic concept that integrates financial efficiency, resilience, and adaptability to economic changes.

Indicators for Measuring Financial Sustainability

To measure financial sustainability, companies and analysts rely on a set of financial and non-financial indicators, including:

1. **Profitability Ratios:**
   Return on Assets (ROA), Operating Profit Margin, Return on Equity (ROE)
2. **Liquidity Ratios:**
   Current Ratio, Quick Ratio (Almashhadani et al., 2022)
3. **Solvency Ratios:**
   Debt-to-Equity Ratio, Interest Coverage Ratio
4. **Growth and Stability Indicators:**
   Revenue and profit growth rates over a long period, Stability of cash flows (Bisogno et al., 2024)
5. **Non-Financial Indicators:**
   Customer satisfaction, Workforce stability, Corporate reputation and market trust
   Collectively, these indicators help assess whether an organization is capable of achieving sustainable financial performance that ensures long-term survival and growth (Zabolotnyy & Wasilewski, 2019).

Requirements for Achieving Financial Sustainability

For organizations to achieve financial sustainability, a set of essential requirements must be met, including:

1. **Effective Risk Management:**
   Developing policies to manage financial and operational risks, and establishing contingency plans to address economic crises (Mim et al., 2025).
2. **Diversification of Income Sources:**
   Reducing reliance on a single revenue source and developing new products and services.
3. **Efficient Resource Management:**
   Prudent utilization of financial and human resources, and investing in technology to enhance operational efficiency.
4. **Strong Financial Governance:**
   Enhancing transparency in financial reporting, activating internal controls, and combating financial and administrative corruption.

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5. **Adoption of Long-Term Strategies:**
   Strategic financial planning and linking growth objectives with broader sustainability goals (Abdelfattah & Aboud, 2020).

Financial Sustainability in the Context of Global Changes

Financial sustainability cannot be separated from the global context. Economic, political, and social changes exert significant pressures on companies, with the most prominent contemporary challenges including (Azarenkova et al., 2018):

1. **Global Financial Crises:** Such as the 2008 crisis, which revealed the vulnerability of many companies to financial collapses.
2. **COVID-19 Pandemic (2020):** Led to the shutdown of entire sectors, highlighting the importance of financial resilience and adaptability.
3. **Climate and Environmental Changes:** Requiring companies to adopt green and sustainable financing policies (Kim et al., 2021).
4. **Inflation and Rising Interest Rates:** Affecting financing costs and profit sustainability.
5. **Digitalization and Technological Transformation:** Technology has become a key tool for achieving financial efficiency, but it also imposes new investment costs (Almashhadani & Almashhadani, 2023).

The Relationship Between Corporate Governance and Financial Sustainability

Theoretical Basis of the Relationship

The relationship between corporate governance and financial sustainability is grounded in several economic and management theories, including:

1. **Agency Theory:**
- This theory assumes a potential conflict of interest between shareholders (owners) and managers (agents).
- Corporate governance serves as a mechanism to limit managerial behaviors that may threaten the company's sustainability, such as excessive risk-taking or financial reporting manipulation (Garas & ElMassah, 2018).

2. **Stakeholder Theory:**
- This theory posits that a company operates not only for the benefit of shareholders but also for employees, customers, suppliers, and society.
- Financial sustainability is achieved when the company balances these diverse interests, and governance provides the framework to achieve this balance (Arpaci, 2023).

3. **Legitimacy Theory:**
- Suggests that a company's survival depends on its adherence to societal values and norms.
- Governance enhances corporate legitimacy through transparency and social responsibility, thereby supporting long-term sustainability (Senadheera et al., 2022).

The Role of Corporate Governance in Enhancing Financial Sustainability

Corporate governance plays a pivotal role in achieving financial sustainability through:

1. **Enhancing Transparency and Disclosure:**
   Facilitates the provision of accurate financial data, preventing misinformation, attracting investors, and maintaining their trust.
2. **Reducing Financial Risks:**
   Internal control mechanisms and audit committees help limit fraud and manipulation, ensuring stability in financial performance (Ullah et al., 2019).
3. **Improving Operational Efficiency:**
   Clear governance policies reduce waste and promote optimal utilization of resources.
4. **Attracting Long-Term Investments:**
   Investors prefer companies with strong governance due to their perceived ability to deliver stable and sustainable returns.
5. **Strengthening Corporate Trust:**
   Companies committed to governance build a strong reputation, facilitating access to financing at lower costs (Gleißner et al., 2022).

Challenges and Constraints in Implementing the Relationship

Despite the significant role of corporate governance in enhancing financial sustainability, several challenges affect this relationship:

1. **Formalistic Implementation of Governance:**
   Some companies establish governance policies only on paper without actual implementation, reducing their impact on financial sustainability.

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2. **Weak Organizational Culture:**
   A lack of commitment and transparency makes it difficult to translate governance principles into daily practices (Sulimany et al., 2021).
3. **Conflicts of Interest:**
   In many companies, board decisions remain influenced by controlling shareholders at the expense of long-term sustainability.
4. **Implementation Costs:**
   Adopting governance mechanisms, such as internal audit systems and advanced disclosure practices, may require substantial financial and human resources.
5. **Globalization and Divergent Regulations:**
   Multinational companies face difficulties in standardizing governance practices in accordance with the requirements of different markets (Naciti et al., 2022).

Conclusion

The study concluded that corporate governance represents a fundamental pillar in enhancing financial sustainability. Both theoretical and empirical studies indicate that companies adopting strong and effective governance mechanisms achieve more stable financial performance and long-term growth. The research emphasized that governance is not limited to legal or regulatory compliance but constitutes a strategic framework that ensures transparency, accountability, reduces financial risks, and strengthens trust among investors and stakeholders.

It was also found that financial transparency and disclosure, board independence, effective audit committees, and the protection of shareholders' rights are among the most critical governance elements directly impacting corporate financial sustainability. At the same time, governance implementation faces challenges, including high financial costs, discrepancies in regulations across countries, and varying degrees of commitment among companies, which may limit its impact on sustainability if not effectively addressed.

In summary, the relationship between corporate governance and financial sustainability is not merely theoretical but practical and dynamic, demonstrating that the adoption of sound governance practices contributes to financial stability, enhances the ability to cope with crises, and ensures the long-term continuity of companies.

Recommendations

Based on the study's findings, the following recommendations can be made:

1. Companies should enhance transparency and financial disclosure by regularly publishing accurate and reliable financial reports and clearly disclosing strategic decisions and potential risks to stakeholders, which enhances trust and reduces unexpected financial risks.
2. Board independence should be strengthened by increasing the number of independent non-executive members and separating the positions of CEO and board chair to ensure a balance of power and fair and effective decision-making.
3. Internal controls and audit committees should be activated, with clear policies for managing financial and operational risks and periodic reviews of financial and administrative operations to enhance transparency and accountability within the company.
4. Shareholders' rights should be protected, ensuring equality among all shareholders and involving key stakeholders in major decisions to balance interests and ensure financial stability.
5. Companies should diversify funding and revenue sources and develop future financial plans to face crises, ensuring the ability to achieve sustainable growth and financial objectives.
6. Values of transparency, accountability, and adherence to governance should be embedded at all levels, with management and employees trained on best practices to enhance sustainable commitment and achieve financial stability.

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Original Article

GLP-1 Medications: Redefining Food Choices and Industry Trends

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Abstract

Glucagon-like peptide-1 receptor agonists (GLP-1 RAs), such as semaglutide and tirzepatide, have rapidly evolved from diabetes treatments into cultural and economic disruptors. By suppressing appetite, slowing gastric emptying, and enhancing satiety, these medications reduce energy intake, shift food preferences, and drive sustained weight loss. Their impact extends beyond clinical outcomes—transforming food relationships, grocery spending, restaurant traffic, and corporate strategies. This paper synthesizes medical, behavioral, and economic evidence to examine the emerging "appetite economy" shaped by GLP-1 adoption. Drawing on clinical trials, regulatory data, consumer panels, and industry responses, it explores how appetite suppression affects real-world food choices and spending. Special attention is given to the food industry's adaptation—through protein-forward launches, portion-controlled products, and "GLP-1 companion" meals—and to India's unique intersection of rising obesity and changing urban diets. GLP-1 medications represent not just a medical advance but a social and economic shift. Companies that anticipate changing consumption and align with health-focused, portion-conscious trends will be best positioned to thrive.

Keywords: *GLP-1 medications; eating behaviour; semaglutide; tirzepatide; food industry; consumer patterns; obesity; nutrition economics.*

Introduction

The global food system is undergoing a major transition, driven by cultural change, economic pressures, sustainability goals, and medical breakthroughs. Among these, GLP-1 receptor agonists have captured unprecedented attention. Initially developed for type 2 diabetes, drugs like semaglutide (Ozempic, Wegovy) and tirzepatide (Mounjaro, Zepbound) are now recognized as powerful weight-management tools. Beyond clinical use, they are changing what people eat, how much they consume, and how food companies compete—a phenomenon termed the "appetite economy."

Unlike diet trends, GLP-1 medications work biologically by enhancing satiety, slowing digestion, and reducing cravings. This leads to smaller portions, fewer snacks, and lower intake of calorie-dense processed foods. The ripple effects extend to supermarkets, restaurants, and supply chains. For an industry worth trillions globally, these shifts are significant.

The Broader Context of Obesity and Food Consumption

Obesity has surged over four decades, with over 1 billion people worldwide now classified as obese (WHO). This rise has fueled non-communicable diseases like diabetes, cardiovascular disorders, and certain cancers—often linked to dietary patterns and processed foods. Traditional approaches such as lifestyle changes, counseling, and public campaigns have had limited long-term impact. Earlier drugs were modest or unsafe.

GLP-1 medications are a turning point because they regulate appetite at its root. They represent both a medical solution and a cultural force reshaping food behavior.

From Clinical Tool to Cultural Phenomenon

GLP-1 adoption has been rapid. Following semaglutide's 2021 approval for chronic weight management, prescriptions, media coverage, and cultural discourse surged.

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Celebrity use, social media discussion, and insurance coverage brought these drugs into mainstream conversation. By 2023–24, they were viewed not only as therapies but as disruptors of consumer behavior. Walmart has already reported slight calorie purchase declines among GLP-1 users. Market research shows reduced grocery spending, especially on snacks, frozen foods, and sugary drinks. Though modest now, the potential impact across millions of users is vast—making GLP-1 medications a unique case of health innovation reshaping entire industries.

The Need for Study

Despite media and market visibility, research on GLP-1's broader social and economic effects is scarce. Most literature focuses on efficacy and safety, not consumer behavior or industry response. Without integration, policymakers and businesses may misjudge the scale of change.;

Research Objectives

1. Examine Biological and Nutritional Dimensions
2. Analyse Consumer and Industry Responses
3. Identify Contextual and Future Research Needs

Literature Review

GLP-1 receptor agonists represent a major advance in obesity and diabetes management, delivering average weight losses of 15–21% in non-diabetic populations and gaining approval for reducing cardiovascular risk (Wilding et al., 2021; Jastreboff et al., 2022; FDA, 2024). By delaying gastric emptying and dampening reward responses to high-calorie foods, they reduce appetite, caloric intake, and cravings, while often shifting preferences toward protein-rich diets (Van Bloemendaal et al., 2014; Jalleh et al., 2025). Yet concerns remain: 15–40% of lost weight may be lean mass, leading to recommendations for higher protein intake and resistance training, which in turn shape nutritional demand (Anderson et al., 2024). Consumer data reflect these biological effects. Walmart and panel studies report reduced calorie purchases, with Cornell and Numerator (2025) showing ~6% lower grocery spending among GLP-1 households, especially in snacks, frozen meals, and sweetened beverages. Analysts project small but significant long-term category declines, while food companies such as Nestlé are launching portion-controlled, protein-forward offerings. However, research is largely U.S.-centric. In India, high costs restrict access to affluent urban consumers, but rising obesity and Westernized diets suggest potential demand for portion-conscious, protein-based foods. Broader affordability and long-term studies remain critical to assess sustainability, equity, and nutritional adequacy under widespread adoption.

Research Methodology

This study employs a descriptive research methodology, aiming to present and synthesize existing evidence on the effects of GLP-1 medications. The approach integrates findings from medicine, nutrition, consumer behaviour, and industry economics to describe emerging patterns and industry responses. Data is drawn from diverse sources including clinical studies, market analyses, regulatory reports, and grey literature. The focus is not on statistical aggregation but on providing a coherent descriptive account of how GLP-1 adoption is reshaping eating habits and the food industry.

Sources of Data

The study draws on four main categories of evidence.

1. Clinical and Biomedical Literature: Peer-reviewed journals such as The New England Journal of Medicine, The Lancet, and Nature Reviews Endocrinology, along with primary trials including the STEP (semaglutide) and SURMOUNT (tirzepatide) programs, and reviews addressing weight loss, appetite regulation, and changes in lean mass.
2. Regulatory and Policy Documents: Official FDA drug approval releases for Wegovy and Zepbound, as well as reports from international health organizations such as the WHO and ICMR.
3. Consumer and Market Data: Shopper panel studies from Numerator, Circana, and NIQ, alongside retailer reports (e.g., Walmart's data on reduced calorie purchases) and analyst projections from Morgan Stanley, Barclays, and eMarketer.
4. Industry Responses and Grey Literature: Press releases and product launches such as Nestlé's Vital Pursuit meals for GLP-1 users, corporate commentary from companies like PepsiCo, Hershey, and Conagra, and trade publications including Food Dive, Fortune, and Reuters.

Inclusion and Exclusion Criteria

The review includes studies and reports published between 2010 and 2025 that specifically address GLP-1 medications, food consumption, consumer behavior, or food industry adaptation. Both peer-reviewed and grey literature are incorporated to reflect the broad scope of the topic. Pre-2010 studies were excluded, except for seminal biological research on GLP-1 mechanisms. Sources irrelevant to eating behavior or industry outcomes, as well as opinion pieces lacking empirical evidence, were also excluded.

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Limitations of Methodology

In examining the biological and nutritional dimensions, the study relies heavily on secondary clinical evidence, and gaps remain regarding long-term nutritional outcomes such as lean mass preservation and micronutrient adequacy. When analyzing consumer and industry responses, dependence on grey literature, corporate reports, and consumer panel data may introduce bias or limit accuracy, as sales shifts cannot always be attributed solely to GLP-1 use and may overlap with broader wellness or economic trends. Finally, in addressing contextual and future research needs, much of the available literature is U.S.-centric, with limited data from regions such as India; early adoption patterns in these contexts remain underexplored. Despite these limitations, the descriptive approach provides a useful interdisciplinary foundation for mapping current evidence and identifying directions for future inquiry.

Data Analysis

The analysis demonstrates how GLP-1 medications reshape eating behaviour and industry responses through interconnected biological, consumer, and market effects.

1. Examine Biological and Nutritional Dimensions

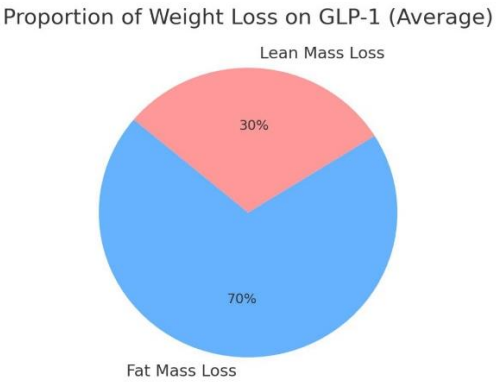
Mechanism of Action: GLP-1 receptor agonists (semaglutide, tirzepatide) mimic the gut hormone GLP-1. They enhance satiety, delay gastric emptying, and suppress appetite, reducing energy intake at a physiological level (Wilding et al., 2021).

Impact on Body Weight: Clinical trials show average weight loss of 15–21% in non-diabetic populations (STEP, SURMOUNT trials).

Nutritional Implications: Preference shifts: decline in high-fat, high-sugar foods; increased inclination toward protein-rich diets.

Risk of lean body mass loss (15–40% of total weight loss from muscle), raising concern about protein adequacy. Recommendations include higher protein intake, micronutrient monitoring, and resistance training.

Public Health Context: In obesity management, GLP-1 drugs represent a turning point compared to lifestyle/diet-based interventions, which often lack long-term adherence.

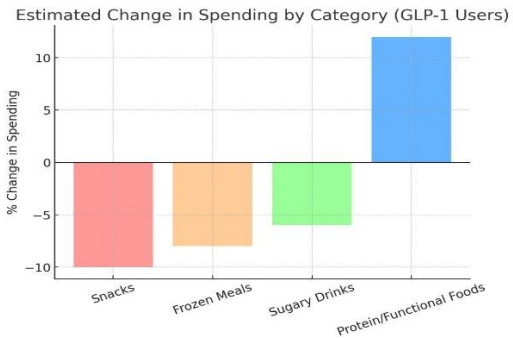


Interpretation

Shows 70% fat mass loss vs. 30% lean mass loss (average values reported in clinical studies). Highlights nutritional concern about muscle preservation which in turn supports discussion on protein needs.

2. Analyse Consumer and Industry Responses

Consumer Shifts: Shopper panel studies show ~6% lower grocery spending in GLP-1 households. Declines in snacks, frozen meals, sugary drinks (~10–11% in savory snacks). Adoption of smaller meals, fewer snacks, portion-controlled, and functional foods. Restaurant Impact: Reports of fewer visits to quick-service and casual dining outlets; more focus on lighter menus and portion sizes.



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Industry Adaptation: Nestlé launched "Vital Pursuit" – protein-rich, portion-controlled meals marketed as GLP-1 companion foods. Conagra, PepsiCo, Hershey shifting toward high-protein snacks, reduced-sugar lines. Retailers like Walmart report modest but measurable declines in caloric product sales. Market Projections: Analysts forecast long-term disruption of indulgent food categories, with growth in wellness-aligned products.

Interpretation

Change in Spending - Snacks: –10%
Change in Spending - Frozen Meals: –8%
Change in Spending - Sugary Drinks: –6%
Change in Spending - Protein/Functional Foods: +12%
Reflects the shift in the 'appetite economy' from indulgent, calorie-dense foods toward functional, health-oriented options.

3. Identify Contextual and Future Research Needs

Contextual Dimensions: Research is largely U.S.-centric; limited insights from Asia, Africa, and Latin America. In India, rising obesity and diabetes rates suggest demand, but high costs limit access to affluent urban populations. Urban diets already trend toward processed and calorie-dense foods, making India an important test case for nutritional equity.

Equity Concerns: Widespread GLP-1 adoption may exacerbate inequalities if only elites can access medication and companion foods. Affordable alternatives, local dietary integration, and policy interventions are critical.

Future Research Needs: Long-term sustainability of weight loss (do effects persist after discontinuation). Nutritional adequacy: tracking lean mass preservation, micronutrient sufficiency. Industry adaptation: monitoring whether food companies reformulate responsibly or "health-wash" products. Cross-cultural comparisons: how appetite suppression interacts with different cuisines and food environments.

Dimension	Current Knowledge	Future Research Need
Nutrition Adequacy	Protein need identified; lean mass loss risk documented	Study micronutrient sufficiency & fortified diets
Long-term Effects	Weight loss maintained for ~2 years in trials	Track sustainability beyond drug discontinuation
Equity & Access	High costs restrict access to affluent populations	Assess affordability & health policy interventions
Cultural Contexts	Mostly US-centric studies; little data from Asia/India	Cross-cultural adoption patterns and local diets

Findings

- GLP-1 drugs reduce appetite by slowing digestion and dampening reward signals, leading to sustainable calorie reduction and behaviour-driven weight loss.
- Users move toward smaller, less frequent meals and show reduced interest in heavy, sugary foods, while preferring lighter, protein-rich options.
- Snacking declines in indulgent categories, but functional and portion-controlled products gain traction, pushing demand toward healthier formats.
- Companies like Nestlé are adapting with protein-forward meals, while concerns over muscle loss and nutrient gaps highlight the need for protein-rich, fortified, and affordable food solutions.

Suggestions

- Integrating Nutrition and Lifestyle: GLP-1 adoption should be supported by strategies that promote protein-enriched, fortified foods and encourage resistance training and balanced diets to safeguard lean mass and overall nutrition.
- Driving Industry Transformation: Food companies must innovate by expanding functional, portion-controlled offerings while repositioning indulgent product lines into health-conscious categories that resonate with evolving consumer preferences.

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- Ensuring Equity and Public Health Alignment: Policies should prioritize affordable access in emerging markets such as India, paired with public health

Conclusion

GLP-1 medications are reshaping how people eat by reducing appetite at its core, leading to smaller meals, fewer snacks, and a shift toward lighter, protein-rich foods. These changes disrupt traditional demand for indulgent, calorie-dense products but create opportunities for portion-controlled, functional, and nutrient-focused options. Early moves by companies like Nestlé and Conagra show how innovation can capture this new market, while consumer data already signal shifts in household spending. In India, rising obesity and diabetes make the potential impact significant, though affordability and access remain key challenges. Overall, GLP-1s reveal how biology, behaviour, and industry are deeply connected, and companies that adapt with health-focused and inclusive strategies will be best placed to succeed in this new appetite economy.

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Original Article

GST Rate Rationalisation and Its Implications for Inflation, MSMEs, and Consumer Welfare

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Abstract

This paper examines the policy debate and economic implications surrounding rationalisation of the Goods and Services Tax (GST) rate structure in India. Since its introduction on 1 July 2017, GST has sought to replace an inherited system of cascading state and central indirect taxes with a unified, transparent, and digitally-enabled framework. However, the multi-slab rate architecture that India adopted — encompassing zero, 5%, 12%, 18% and 28% slabs alongside a variety of exemptions and cesses — has introduced distortions that affect price stability, the compliance burden of Micro, Small and Medium Enterprises (MSMEs), and consumer welfare. This study draws on a wide range of secondary data sources including GST Council communiqués, Reserve Bank of India analyses, Economic Survey chapters, Ministry of MSME reports, and international comparative literature to assess how rate rationalisation can influence inflationary dynamics, MSME competitiveness, and equitable consumption. The analysis suggests that a phased, evidence-based rationalisation — moving towards a simpler two- or three-slab structure while protecting essentials and ensuring revenue neutrality — can reduce classification disputes, lower compliance costs for small firms, and mitigate regressive tax incidence on low- and middle-income households. Policy recommendations emphasise (i) a phased model for rate consolidation, (ii) targeted support for MSMEs through simplified compliance and digital capacity-building, (iii) selective tax incentives for green and essential goods, and (iv) improved administrative mechanisms for seamless input tax credit (ITC) reconciliation. These reforms should be accompanied by stakeholder consultations and revenue impact modelling to preserve fiscal stability while enhancing the GST system's effectiveness as an instrument of sustainable and inclusive development.

Keywords: *Goods and Services Tax (GST), GST Rate Rationalisation Multi-slab Tax Structure, Inflation, Consumer Welfare, MSMEs (Micro, Small and Medium Enterprises), Compliance Burden, Input Tax Credit (ITC), GST Council, Tax Simplification, Revenue Neutrality, Price Stability, Digital Compliance.*

Introduction

India's indirect tax reform culminating in the Goods and Services Tax (GST) was a watershed moment in the country's fiscal history. Prior to GST, the indirect tax landscape was fragmented: excise duties, multiple state-level value added taxes (VAT), varying state surcharges, and a patchwork of local entry taxes created cascading tax effects, compliance complexity, and administrative arbitrage. The GST reform, implemented in July 2017, aimed to realise a single market across India, remove cascading, and modernise taxation with digital platforms. The initial promise of GST extended beyond simplification: the reform was pitched as an enabler of formalisation, a booster for compliance through technology, and a medium to strengthen the tax base and fiscal resources. In practice, GST has delivered notable gains. The GST Network (GSTN), e-way bills, and e-invoicing regimes have fostered transparency and provided richer data to authorities. Registered taxpayers now operate within an ecosystem that facilitates electronic ITC claims and automated reconciliation. These changes have supported tax buoyancy and improved indirect tax governance. Nevertheless, India adopted a multi-rate structure with multiple exemptions and a compensation cess for certain goods.

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The multiplicity of rates — 0, 5, 12, 18, and 28 percent — reflected an attempt to balance social equity (lower rates on essentials) with revenue needs (higher rates on luxury/sin goods). Over time, however, this multi-tiered architecture created several unintended consequences: classification disputes, administrative complexity, cascading of indirect costs in certain supply chains, and uneven incidence of tax across income groups. The policy conversation has therefore shifted towards rationalising GST rates as part of a broader agenda: improve price predictability, reduce compliance friction for MSMEs, and enhance fairness of the indirect tax system. This paper situates the rationalisation debate within India's macroeconomic priorities — stabilising inflation, fostering MSME-led employment, achieving fiscal targets, and promoting sustainable consumption patterns aligned with global obligations under the Sustainable Development Goals (SDGs). The paper proceeds as follows. The literature review summarises empirical findings and policy analyses on GST's effects. The methodology section explains data sources and analytical approach. The subsequent sections examine the effects of rate structure on inflation, MSMEs, and consumers, incorporating international comparisons and case illustrations. The final sections outline policy implications and practical recommendations for a phased rationalisation that is both economically sensible and administratively feasible.

Literature Review

A substantial body of literature has examined the design and consequences of GST and value-added taxes more broadly. Early evaluative studies of India's GST focused on expected gains: removal of tax cascading, greater compliance brought about by ITC mechanisms, and improved interstate trade flows. Authors such as Kelkar (2019) and institutional reports from NIPFP emphasised that these structural gains were significant for long-term growth. However, subsequent empirical work highlighted operational challenges and distributional consequences. Mukherjee (2021) and others used price index decompositions to show that certain segments of the consumption basket had experienced higher effective indirect tax incidence post-GST due to classification and rate choices. Reserve Bank of India analyses (2018–2022) underscored that while GST fostered formalisation, the compliance burden — particularly for small enterprises lacking digitisation — could constrain microeconomic activity. Policy commentaries and the Economic Survey (2020, 2023) advocated for simplification of the rate structure. The Economic Survey argued that a narrower band of rates would reduce litigation and administrative costs, as well as simplify enforcement. Academic comparisons with countries like New Zealand (single rate), Singapore (near-uniform rate with limited exemptions), and several OECD economies with simplified VAT regimes provide robust evidence that fewer rates tend to correlate with higher compliance and lower enforcement costs. Other scholars have cautioned against a simplistic transition. Studies on fiscal incidence emphasise the importance of revenue neutrality: an abrupt consolidation of rates can alter the tax burden on vulnerable households and may necessitate compensatory measures. Research on MSMEs highlights that compliance simplification must be complemented with capacity-building to ensure that small firms can effectively transition to digital compliance models. The literature therefore indicates a nuanced perspective: while rate rationalisation provides economic and administrative benefits, its design and implementation must be calibrated to preserve distributive equity and fiscal stability.

Objectives

This paper seeks to:
(a) evaluate the economic rationale for rationalising GST rates in India;
(b) analyse the potential effects of rate consolidation on inflation dynamics;
(c) assess implications for MSME compliance and competitiveness;
(d) examine consequences for consumer welfare across income groups; and
(e) propose pragmatic, evidence-based policy recommendations for phased implementation of rate rationalisation that safeguard revenue neutrality and promote inclusive growth.

Research Methodology

The study utilises a descriptive-analytical methodology based on secondary data and comparative policy analysis. Primary sources include GST Council communiqués, Ministry of Finance reports, Economic Survey chapters, Reserve Bank of India publications, and Ministry of MSME statistics. Academic articles from peer-reviewed journals, policy working papers from institutions such as NIPFP, World Bank and OECD reports on VAT/GST structures complement the empirical base. The analytical approach triangulates evidence from (i) macro-level indicators (CPI and WPI trends, sector-specific price indices), (ii) micro-level MSME statistics (registrations, employment, export contributions), and (iii) qualitative case studies drawn from practitioner accounts and industry reports. Comparative analysis juxtaposes India's multi-slab model with international regimes in New Zealand, Singapore, EU member states, and Canada to glean lessons on rate simplicity, compliance, and revenue outcomes. Limitations: The study relies on secondary data and does not employ original household- or firm-level surveys; hence causality cannot be strictly asserted. Nevertheless, by integrating multiple data sources and policy narratives, the study constructs a robust inference about the likely economic effects of rate rationalisation.

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Impact on Inflation

The relationship between indirect tax rates and inflation is complex and mediated by supply-chain structures, input tax credit pass-through, and market competition. GST's multiple slabs have sometimes induced discontinuities in producer pricing behavior. For example, intermediate goods that are taxed or exempt differently create asymmetric ITC chain effects, which may cascade into retail prices despite the GST's theoretical elimination of cascading. Empirical observation since 2017 indicates heterogeneous inflationary effects across sectors. Consumer staples that were kept in lower slabs or exempt categories largely avoided significant GST-induced price shocks. Conversely, sectors with high compliance costs or ambiguous classification — such as certain processed foods, footwear, and specific electronic consumer durables — exhibited episodic price rises attributed partly to effective tax incidence and administrative adjustments. Macro-level decompositions conducted by researchers and statistical agencies show that a simplified slab structure could reduce tax-induced volatility in specific consumption categories. A consolidated rate reduces classification arbitrage and makes tax incidence more predictable, thus easing the pass-through calculation for firms and dampening price surprises for consumers. Moreover, when combined with administrative reforms to ensure that GST reductions are passed through to retail prices (through monitoring and anti-profiteering mechanisms), rationalisation can have a tangible dampening effect on headline inflation. However, it is critical to emphasise that GST rationalisation is not a silver bullet for inflation control. Food price shocks, supply-side constraints, energy price fluctuations, and global commodity cycles are far more significant drivers of consumer price indices in the Indian context. Therefore, GST rationalisation should be viewed as a complementary measure within a broader macroeconomic toolkit aimed at price stability.

Impact on MSMEs

MSMEs constitute the backbone of India's production system and labour markets. According to government statistics, MSMEs account for around 30–31% of India's GDP, employ over 100 million persons, and contribute significantly to exports. Yet, the transition to GST introduced compliance overheads that disproportionately affected smaller firms. Key challenges faced by MSMEs include the need for frequent return filings (GSTR formats and periodicity), reconciliation of ITC claims with supplier filings, the technological investment required for e-invoicing and digital accounting, and liquidity constraints arising from delayed ITC realizations. These administrative costs translate into higher effective operating costs and may constrain growth and investment. Rate rationalisation alleviates some of these burdens in two principal ways. First, a reduced number of slabs simplifies classification, decreasing litigation and disputes at tribunals and courts. Second, streamlined rates can simplify accounting and tax treatment for small firms that may struggle with professional compliance support. Alongside rate rationalisation, policy measures such as expanded composition schemes, simplified quarterly return filing (QRMP), and targeted digital literacy initiatives for MSME owners can meaningfully reduce compliance burdens. Case studies from manufacturing clusters and service-sector MSMEs indicate that when firms are relieved of frequent tax disputes and classification ambiguity, managerial resources can be reallocated to productivity improvements, quality enhancement, and market expansion. In the export-oriented MSME segment, clarity in rate structure also enhances competitiveness by simplifying export documentation and refund procedures.

Impact on Consumers

The incidence of GST across income groups depends on consumption patterns and the relative share of essentials in household expenditure. Lower-income households spend a larger share of their income on essentials (food, basic clothing, utilities), which are typically taxed at lower rates or exempted under India's GST schedule. Nonetheless, middle-income households often purchase goods and services taxed at standard slabs (e.g., 12–18%), which can generate a perceptible burden on monthly budgets. A rationalised rate structure that clearly demarcates essentials and necessities from non-essential goods can improve equity. For example, compressing the middle slabs and ensuring essentials remain either exempt or at the lowest rate reduces the average tax incidence for poorer households while maintaining a higher rate for luxury and sin goods that predominantly affect wealthier consumers. Consumer welfare also hinges on transparency and predictability. Frequent rate revisions and ambiguous classification erode consumer confidence and complicate price comparisons. A simplified rate schedule reduces informational asymmetry, helping consumers make informed choices while enabling regulators to better monitor anti-profiteering. Ultimately, fairness in indirect taxation requires not only appropriate rate design but also complementary social provisions (direct transfers, food subsidies) to protect the most vulnerable cohorts.

International Experience

Comparative experience sheds valuable light on trade-offs involved in rate design. New Zealand's single-rate GST (15%) illustrates that uniform taxation can be administratively efficient and minimize compliance costs, though it relies on a broad base and limited exemptions. Singapore, with a near-uniform GST supplemented by targeted relief schemes, demonstrates how small open economies can maintain competitiveness while ensuring equity through fiscal transfers. The Canadian experience with federal GST and provincial harmonized sales taxes (HST) indicates that subnational coordination is important for simplicity, especially where jurisdictions are politically decentralized. EU member states exhibit a range of VAT structures with various reduced rates for cultural, social, or political reasons, but

they also face complexities arising from varied national exemptions. The OECD's analyses underscore that countries with fewer rates tend to have lower administrative costs and higher compliance rates, supporting the argument for rationalisation, albeit adapted to local socioeconomic priorities. For India, the lessons are clear: a simpler rate architecture improves administrative efficiency and taxpayer compliance, but design must reflect India's federal fiscal relationships, social policy priorities, and the heterogeneity of consumption patterns across states and income groups.

Policy Implications and Way Forward

Designing a pragmatic pathway for GST rate rationalisation involves sequencing, consultation, and analytical rigor. First, a phased consolidation — for instance, moving from five slabs to three (zero/safe category, a low rate for essentials, and a standard rate for the bulk of goods and services, with a separate higher rate for sin and luxury goods) — can reduce shock and allow policymakers to model revenue implications accurately. Second, the transition must be accompanied by administrative upgrades: automated ITC reconciliation, improved grievance redressal systems, and real-time monitoring of price pass-through to guard against profiteering. Third, MSMEs require active support: expanded access to simplified composition schemes, targeted credit facilitation based on GST visibility in formal credit markets, and subsidised digital training programs to ease adoption of e-invoicing and accounting software. Fourth, aligning rationalisation with sustainable policy aims requires the use of the tax system as a lever for green transition: concessional rates for energy-efficient goods, exemptions for renewable energy inputs, and reduced rates for products that meet environmental standards. Fifth, revenue neutrality must be central to the exercise. Policymakers should use dynamic modelling to estimate behavioral responses, consumption multipliers, and potential compensatory measures such as phased excise adjustments or calibrated cess mechanisms. Finally, stakeholder engagement — involving industry, state governments, consumer groups, and tax experts — is essential to create consensus and ensure smooth implementation.

Findings and Recommendations

This study synthesises evidence to arrive at several actionable conclusions. First, India's multi-slab GST structure, while motivated by equity concerns, has produced administrative complexity and classification disputes that undermine the tax system's effectiveness. Second, a carefully phased rationalisation towards a reduced number of slabs can improve price predictability, reduce litigation, and lower compliance costs, particularly for MSMEs. Third, rate rationalisation should be complemented by MSME-support measures: run-off transitional rules, wider composition schemes, digital capacity-building, and simplified refund procedures for exporters. Fourth, to protect consumer welfare and vulnerable populations, rationalisation must preserve low or nil rates for basic foodstuffs and essential services, while applying higher rates to luxury and negative externality-generating goods. Policy recommendations: (i) Form a technical working group comprising central and state finance officials, tax experts, and industry representatives to model phased rate consolidation scenarios; (ii) pilot rate rationalisation in selected product categories and state jurisdictions to measure pass-through and revenue impacts before nationwide scaling; (iii) simultaneously expand QRMP and simplified filing for eligible MSMEs; (iv) strengthen anti-profiteering monitoring and create legal clarity on classification disputes; and (v) leverage GST visibility to improve MSME access to formal credit by linking GST compliance records with lending platforms.

Conclusion

The Goods and Services Tax remains a foundational reform in India's fiscal architecture, and rationalising its rate structure is a logical next step in the reform trajectory. While simplification promises administrative efficiency, lower compliance costs for small enterprises, and a fairer distribution of tax incidence, it must be pursued with careful attention to revenue consequences and social equity. The transition to fewer slabs should therefore be phased, evidence-based, and coupled with measures that support MSMEs, protect consumers, and align taxation with sustainability objectives. If implemented prudently, GST rate rationalisation can strengthen India's economic resilience, promote MSME-led growth, and contribute to inclusive development goals. The policy will be most successful if it combines rigorous data analysis, stakeholder engagement, and robust administrative capacity to monitor outcomes and make mid-course corrections where necessary.

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Original Article

The Role of AI in Education, Industry and Governance

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Abstract:

AI's Global role is transformative across Education, Industry, and Governance, offering personalised learning, automating industrial processes, and improving public service delivery. In education, AI provides adaptive learning experiences, aids teachers with tasks like grading, and helps identify at-risk students. In industry, AI optimises operations, enhances customer service through chat boxes, and drives innovation in areas like supply chain management and predictive maintenance. In governance, AI improves efficiency in public services, supports data-driven decision-making, and helps address complex societal challenges such as urban planning and public safety.[1]Artificial Intelligence (AI) is making a significant impact in India, creating both opportunities and challenges.As AI automation takes over, especially in repetitive and routine tasks, it is leading to the creation of new roles in AI-related fields and increasing productivity in various sectors. Various skills are being developed in education, industry, and governance.

Keywords: *Artificial Intelligence (AI), AI in Education, AI in Industry, AI in Governance, Digital Transformation, Automation, Adaptive Learning, Personalised Learning, Virtual Tutors, E-Governance, Smart Administration, Predictive Analytics, Data-Driven Decision Making, Robotics.*

Introduction:

Today, in the era of information technology around the world, AI is playing a crucial role in bringing about radical transformation and development in education, business, and administration. AI is creating essential data for new content, automated grading, tutorials, education, and research. Now and in the future, AI is helping entrepreneurs perform innovative analysis and increase business efficiency through business modeling. The use of AI in industry is definitely increasing business efficiency and attracting a large number of customers. Today, AI is playing a significant role in administration as well, for strategic planning, financial management, etc. Ultimately, AI is encouraging more efficient and important decision-making in all areas of administration.Currently, considering the educational and research needs of students, a wide range of content has become available through AI.The use of AI has become an important tool for educators to teach students innovative, educationally improved changes and develop student skills.AI is helping to automate most of the tasks in the industry. The adoption of AI is increasing the efficiency of the industry and reducing costs.Enabling finance and service businesses in new products, AI is also helping in strategic planning, market analysis, and product development in the industry. AI helps in managing daily operations in administration, planning resources, monitoring departmental work flows, analysing future scenarios and developing strategies for sustainability and industry growth.Financial data, important tools for economic forecasting can be made available through AI. AI tools definitely play an important role in leading the industry, for governance. While AI automation is displacing, especially in repetitive and routine tasks, it is also leading to the creation of new roles in AI-related fields and increasing productivity in various sectors. Education, skills are evolving.

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Objective of Research:

In India, AI is doing well in education, industry, and governance. Automation of routine tasks, predictive analytics, low cost, accuracy, and consistency in work have led to increased efficiency. AI is delivering a wide range of benefits in education, industry and governance. AI is revolutionising India. The use of AI has created the potential for privacy and abuse in all sectors. Digital technology is increasing inequality in infrastructure.The fact that not everyone can use AI technology is a big challenge. The challenge is to understand the education of AI technology for teachers, workers, and citizens.Today, the use of AI is being seen everywhere in developed nations. That is why the use of AI in India, too, is the need of the hour to fulfil the dream of a developed India.For this, there is a need to use AI in the education industry and governance. Therefore, there is a need to research the topic "The role of AI in education, Industry and Governance".Adopting an AI policy is seen as India's path towards becoming a developed nation in the future.The research article has been written with the following objectives in mind, as the use of AI can achieve policy goals.

- To study the use of artificial intelligence in education.
- To study the use of artificial intelligence in industry.
- To study the use of artificial intelligence in administration.
- To conduct a comprehensive study of the use of artificial intelligence.

Hypostasis of the role of AI in education, industry and governance:

A hypothesis is the proposed explanation for an event. For a hypothesis to be a scientific hypothesis, a scientific method is required so that an individual can test it. Although the terms “hypothesis” and “theory” are often used interchangeably, scientific assumptions are not the same as scientific theory. The need for education to acquire knowledge and skills, some assumptions have been used for this research article.[2]

- The use of artificial intelligence in education has increased.
- Artificial intelligence is being used on a large scale in industry.
- The use of artificial intelligence in administration is increasing.
- The use of artificial intelligence has become widespread.

Significance of Research:

This system, which can think and make decisions like the way the human brain works, is bringing about revolutionary changes in all three sectors: education, industry, and administration.Scientific study of these changes can help achieve their beneficial effects more effectively.

This study can lead to quality improvement in education, productivity and global competitiveness in industry, and transparency and efficiency in administration. Therefore, studying the use of AI is of utmost importance in today's digital age.

Research Methodology:

According to J. W. Best, research in its true sense is a more systematic, structured, and thorough process of actually implementing the scientific method**.** Research is the scientific and systematic study of any discipline to discover new ideas or facts and to reexamine old ideas or facts.[3]Research methodology is the specific procedures or techniques used to identify, select, process, and analyse information about a topic. In a research paper, the methodology section allows the reader to critically evaluate a study's overall validity and reliability.Search for knowledge through an objective and systematic method of finding a solution to a problem is research. As well as the systematic approach concerning generalisation and the formulation of a theory, it is also research. I have chosen a descriptive and analytical research method. This study is mainly based on secondary data. Necessary data has been collected from various reports, websites, journals, and books. Descriptive and analytical research myths have been selected for this current dissertation.

The Role of AI in Education:

Today, AI is likely to have a greater impact on jobs like historians, sales representatives, and travel nurses. AI is likely to threaten jobs in as many as 40 sectors. Important information has come to light from a Microsoft study. Whenever AI is mentioned, people think that it will eliminate jobs like IT, consultancy, research and writing in the near future. But Microsoft's research has revealed what to actually expect from it. Microsoft says that the industry most affected by AI will first need to learn how to use it as a co-pilot rather than competing with it. The list of high-overlap AI-driven jobs includes customer representatives, with about 2.86 million people connected. In addition, this study on AI is a wake-up call for writers, journalists, editors, translators, and proofreaders. Along with this, questions are being raised about the long-term job security in the fields of web developers, data scientists, PR professionals, business analysts, while AI tools like Chat GPT and Copilot have already been used in these jobs.

AI is currently being widely used by Indian students. AI is providing courses and practice materials according to the learning pace, interests, and abilities of the students.AI is providing personalised learning opportunities to students. It is improving the quality of education as students are getting physical knowledge along with academic knowledge, saving teachers’ time.Online and e-learning have made it easier for students to get an education. Today,

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students from rural and remote areas are also getting an education through the internet.It is also being seen that he is taking the help of data analysis to a large extent for educational planning.

Today, it is being recognised as a transformative technology in the 21st century. Its use is becoming like the brain.AI has made the ability to think, learn, and make decisions available through computer systems.AI in the education sector is not just a technological advancement, but an important tool with the power to democratize knowledge, personalise learning experiences, and increase the efficiency of teaching and administration.The use of this among students allows them to analyse their progress and provide additional practice to weaker students and higher-level practice to advanced students, thus reducing the gap in education.AI enables the creation of virtual tutors to guide students on a large scale. These virtual tutors provide instant feedback, explanations, and motivation.Without the same time constraints as human teachers, AI teachers are available 24 hours a day and can help tens of millions of students simultaneously, making education more accessible, simple, and consistent.AI is reducing geographical, linguistic and physical barriers for students. Automatic translation speech-to-text and text-to-speech tools allow students of different languages to benefit from the same educational tools.AI-based assistive technology is proving useful for students with vision or hearing impairments. Thus, education is becoming more inclusive. Today, education for students through AI has become more personalised, efficient, inclusive and data-driven.It is not a substitute for the empathy, creativity, and inspiration of human teachers, but it is extremely effective as a supporting tool.Therefore, the role of AI in the education sector is to collaborate with human intelligence and machine intelligence, which can further make the education system of the future more effective and equitable.

In short, there are some challenges along with the benefits. Over-reliance on technology definitely reduces human interaction, which is important for the overall development of students.AI faces challenges like data security, bias and lack of technology in rural areas. AI should empower teachers rather than replace them.

The Role of AI in Industry:

Artificial Intelligence is significantly impacting youth employment in India, creating both opportunities and challenges. While AI automation is displacing some jobs, particularly in repetitive and routine tasks, it's also leading to the creation of new roles in AI-related fields and boosting productivity in various industry sectors. The key lies in adapting to these changes through industry skill development and a proactive approach to embracing the evolving industry.Artificial Intelligence (AI) is significantly impacting industry youth employment in India, creating both opportunities and challenges. While AI automation is displacing some jobs, particularly in repetitive and routine tasks, it's also leading to the creation of new roles in AI-related fields and boosting productivity in various sectors. The key lies in adapting to these changes through education, skill development, and a proactive approach to embracing the evolving job market.

In India, too, the use of artificial intelligence is increasing in the industrial sector. Today, this technology is considered to be the centerpiece of the industrial revolution. It is being used in industries at all levels, including production, management, marketing, customer service, and research.It is playing an important role in increasing efficiency, productivity, accuracy and competitiveness. The increasing use of robots in the industrial sector is making production faster, more accurate and less costly.It has also become possible to control the quality of products. AI cameras and sensors are being used in industry to identify micro-defects. AI is making it possible to perform more reliable inspections than human inspection.It gives us signals before the machinery breaks down in the future, which saves repair costs and time. AI is helping management in the decision-making process. AI is also playing an important role and value in customer service.AI is helping to find materials in pharmaceutical manufacturing, chemicals, and scientific research, allowing you to quickly create new designs through modelling to bring new research and innovation to your products.This allows new product ideas to be developed according to market demand. Today, AI is helping a lot in the recruitment process in human resource management. It suggests suitable candidates by checking the profiles of the candidates.AI is also being used to measure employee performance and provide them with appropriate training.

The use of AI has affected traditional jobs in the industrial sector. It is also becoming dangerous to rely entirely on it. Investing in AI technology in the industry is a huge expense.The future use of AI is likely to raise issues related to data security and privacy in the industry.

In short, this is definitely considered an effective tool for increasing employee efficiency, production capacity and competitiveness in the industrial sector. It is giving new dimensions to industries at all levels, from production to customer service, research and management. However, if balanced utilisation of human resources, consideration of ethical values, and appropriate policies for employment generation are taken into account, this will make the overall development of industries possible.

The Role of AI in Governance:

Many initiatives in the Indian government, such as administration, have evolved from a mere process of maintaining documents and records to a system of people-oriented services, transparency and rapid decision-making. Artificial intelligence has been an effective factor in bringing about change.The use of Artificial Intelligence has increased in all areas of e-governance, smart city projects, new policy formulation, law and order and disaster management. Due to this, administration is becoming more efficient, immediate and transparent.Many administrative

service systems have become AI-based. Various portals have been created for birth and death certificates, Aadhaar licenses, tax collection, and government schemes.Citizens can register complaints or get information 24 hours a day using artificial intelligence to serve them. The problem of translation has been solved with the use of AI.Citizens are getting services in their own language, but big data is being collected regarding education, health, agriculture, transport, tax system. AI analyses it and decides rational policies.To make future predictions, the government is making accurate predictions regarding changes in agricultural production, climate change, and tax collection. Therefore, data on which services to provide and where to provide can be collected quickly through this data.This system can be used to check whether funds have been properly utilised in government projects. Transparency in transactions and control of corruption can also be achieved through AI.It has also made it possible to detect suspicious transactions in tax departments, banking or government transactions. The use of this artificial intelligence reveals errors and irregularities in audits and reporting.AI is also being used for cybersecurity and crime prevention. AI is helping during disasters like droughts, cyclones, etc.

Of course, this could raise questions about citizens' private information. In the future, relying entirely on this technology would reduce the use of human decision-making capabilities.The digital divide in rural areas is also definitely increasing due to the lack of internet and technology, making it difficult for ordinary people to get the benefits they deserve.

In short, the use of AI is making administration faster, more efficient, people-oriented and more guided. Citizens are being provided with immediate services. AI is making a significant contribution in the proper planning of government projects, disaster management and corruption control.However, AI governance will become more accountable, transparent, and trustworthy if data security, ethical values, and equal access to technology are taken care of.So that it will be useful in the areas of digitisation of citizen services, control of corruption, disaster management and security.But the role of the government in governance can only be truly beneficial to the people if data security, equal access, and ethical values are upheld.

Conclusion:

There is a fear that the use of artificial intelligence will reduce the need for human teachers in the future due to the availability of technological tools and data security. The misuse of technology is likely to increase unemployment due to the need for continuous training.Legal and ethical issues may pose a risk of bias and breach of confidentiality in the decision-making process within the administration.In short, while AI is an enabling technology, the biggest challenge facing us all is proper planning, balancing safety and human values.AI works now like connective tissue in education, industry and politics, where it shifts how knowledge and value is made and how public goods are provided; risks around privacy, bias, work and accountability are all being reframed. In education, too, AI has the potential to improve access and outcomes with its adaptive tutoring, assistive technologies and workflow automation. Provided systems embed protections for equity, transparency and teacher empowerment rather than replacement. In the industry, AI supplements productivity and resilience with data-driven decisions and automation, but in the long run, competitiveness relies on ongoing reskilling, interoperable infrastructure, and ethics of deployment frameworks harmonised to sector-specific. Regarding governance, the promise of efficiency and inclusion that AI-enabled service delivery (and its regulatory intelligence or recommended practice for fraud detection) makes to the polity would only be legitimately credible if it were buttressed by strong standards on data protection, auditability and democratic oversight preventing algorithmic harms and the further concentration of power. The throughline is stewardship: multi-stakeholder governance, public-interest R&D, human-in-the-loop design that views AI as a socio-technical system rather than a plug-in tool. By emphasising safety, fairness and empirically verifiable public value — while investing in digital public infrastructure, foundational data sets and educator-workforce capacity building — societies can translate the potential of A.I. into sustained, broadly shared progress from classrooms to factories to other institutions.

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Original Article

Intellectual Property Rights and Innovation Diplomacy: A Study of India's Legal Framework

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Abstract

This research paper aims to examine the relationship between IPRs and innovation in India, focusing on the challenges and opportunities in the current context. The paper begins by providing an overview of the IPR regime in India and its evolution over time. The roots of India's IPR regime can be traced back to ancient times when traditional knowledge and innovations were passed down through oral traditions and early forms of intellectual property protection, such as the "ayurvedic" and "unani" systems of medicine, were practiced. However, it was during the colonial era that India's IPR landscape underwent significant transformation. The British colonial administration introduced Western-style copyright and patent laws in India, primarily to serve the interests of the British Empire. Following India's independence in 1947, the nation embarked on a journey to reform and modernize its IPR laws. The first major milestone was modifications to the patent system, including limitations on the patentability of abstract ideas, were made possible with the passage of the Indian Patents Act in 1970.certain types of inventions, such as food and pharmaceuticals. This move was seen to balance the promotion of innovation with the need for public access to essential goods. Today, India's IPR regime is governed by a comprehensive legal framework that encompasses a patent, "copyrights, trademarks, and trade secrets, to name a few, throughout a wide spectrum of intellectual property rights. The foundation of India's intellectual property rights system is laid by a" number of important laws and international treaties.

Keywords: *Intellectual Property Rights (IPR), Innovation, Diplomacy, Legal Framework, Patents, Trademark, Copyrights* etc.

Introduction

Intellectual property rights (IPRs) are legal rights that protect the creations of the human mind, such as inventions, literary and artistic works, and symbols, names and images used in commerce. IPRs have become increasingly important in today's knowledge-based economy, where innovation and creativity are key drivers of economic growth and competitiveness. India has recognized the importance of IPRs in promoting innovation and economic development, and has taken significant steps to protect IPRs through various legislative and policy measures. However, there are still challenges that need to be addressed to fully realize the potential of IPRs in promoting innovation and economic growth in India.

Innovation, economic growth, and technical advancement all benefit greatly from protections afforded by IPR. This article investigates the influence of India's legislative framework on intellectual property rights (IPR) and innovation. It investigates patents, copyrights, trademarks, and trade secrets throughout India and assesses how well they work to encourage creative endeavours. This study delves into the complexities, difficulties, and potential of India's intellectual property rights (IPR) environment, and it suggests workable changes to increase innovation and competitiveness in India.

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The intellectual property rights (IPR) landscape in India represents a pivotal arena where legal regulations intersect with innovation, fostering economic growth and technological advancement. With its diverse and dynamic economy, The Indian government has created a robust legal system to protect intellectual property such as patents, copyrights, trademarks, and trade secrets. This paper embarks on an extensive exploration of India's IPR ecosystem, aiming to unravel the intricate tapestry that underpins the nation's innovation landscape. Through a lens that combines historical perspectives, legislative intricacies, and real-world case studies, we endeavor to dissect the multifaceted realm of intellectual property in India. Our journey begins by tracing the evolution of IPR in India, from colonial-era influences to contemporary global engagements Subsequently, we delve into the legal underpinnings, meticulously navigating through key legislations and international agreements that shape the nation's IPR regime. As we traverse this landscape, we shall unveil the intricate workings of patent protection, demystify copyright regimes, and delve into the world of trademarks and trade secrets, scrutinizing the mechanisms that secure intellectual creations and innovation.

This paper is an ambitious endeavor to conduct a comprehensive examination of the relationship between intellectual property rights and innovation, seeking to assess the effectiveness of India's IPR framework in stimulating innovative activities across various sectors. Furthermore, we shall venture into the empirical realm, embracing case studies to unveil success stories as well as controversies, thereby offering an impact assessment of IPR on innovation in India. Nevertheless, amid the vast potential, India's IPR framework confronts several formidable challenges, including piracy, concerns about access to essential medicines, and the contentious issue of patent evergreening. These challenges reflect a delicate balance that policymakers must maintain between fostering innovation and ensuring equitable access to intellectual property. Considering these challenges, we shall explore opportunities for improvement, suggesting policy reforms that encompass strengthening enforcement mechanisms, promoting research and development, enhancing education and awareness, and advocating for international collaboration. As we conclude, we synthesize our findings, offering insights into the implications of India's IPR framework on the nation's innovation ecosystem. In doing so, we provide a roadmap for prospects and recommendations that aim to bolster India's position in the global innovation landscape, harnessing the power of intellectual property rights as a catalyst for progress and prosperity.

Objectives of The Research Study

The most cited following objectives are:

1. To study the India's Intellectual Property Rights Regime.
2. To study the Impact on Innovation Diplomacy to India's Legal Framework.
3. To study the Opportunities for improvement in India's Intellectual Property Rights Regime

Research Methodology

For the said present research study is based on the secondary data. Such secondary data is collected from various reference books on Intellectual Property Rights (IPR), Innovation, Diplomacy, Legal Framework, E-Business, Economics, Commerce, Management, and Banking etc. For the said research study, the secondary data is also collected from the various National and International Research Books and Journals which are related to Intellectual Property Rights (IPR), Innovation, Diplomacy and India’s Legal Framework.

Hypothesis of The Research Study

1. Intellectual property rights (IPRs) play a critical role in promoting innovation and economic growth.

India's Intellectual Property Rights Regime

India, a nation renowned for its rich cultural heritage and diverse economic landscape, has made significant strides in establishing a comprehensive legal framework for intellectual property rights (IPR). The IPR regime in India is a critical component of the country's legal infrastructure, aimed at fostering innovation, protecting creative works, and encouraging economic growth. This paper provides an in-depth examination of India's IPR regime, tracing its historical development, exploring its legal intricacies, and assessing its effectiveness in promoting innovation and safeguarding intellectual creations.

1. Patents - The Patents Act of 1970, as amended, regulates patent protection in India. It provides inventors with exclusive rights over their inventions for a specific period, typically 20 years from the date of filing. India's approach to patent law includes provisions for compulsory licensing and safeguards to prevent the abuse of patents, particularly in sectors like pharmaceuticals.

2. Copyrights - The Copyright Act of 1957, as amended, governs copyright protection in India. It grants creators and authors exclusive rights over their literary, artistic, and creative works. The Act has been periodically amended to adapt to the changing landscape of digital content and technology. Trademarks: The Trade Marks Act of 1999 and the Trade Marks Rules of 2017 regulate trademark registration and protection in India. These laws provide a framework for the registration and protection of brand names, logos, and symbols, helping businesses establish distinct market identities. Trade Secrets: While India does not have a dedicated trade secrets law, trade secrets are protected under contract law and common law principles. Confidential information and trade secrets are safeguarded through contractual agreements and legal actions against unfair competition.

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Impact on Innovation Diplomacy To India's Legal Framework

The impact of India's patent regime on innovation is a subject of ongoing debate. On one hand, the regime has encouraged innovation in various sectors, leading to increased research and development investments. On the other hand, concerns persist about the potential hindrance to innovation in critical areas like healthcare due to the high cost of patented medicines.

Opportunities For Improvement In India's Intellectual Property Rights Regime

Opportunities for Improvement in India's Intellectual Property Rights (IPR) Regime are multifaceted and pivotal in shaping the nation's innovation landscape and global competitiveness. Strengthening enforcement mechanisms, including the establishment of specialized IP courts, enhancing border measures, and promoting alternative dispute resolution, is paramount in safeguarding intellectual property. Promoting research and development (R&D) through financial incentives, public-private partnerships, and technology
hubs can stimulate innovation. Moreover, enhancing education and awareness about IPR, integrating IP education in curricula, and training law enforcement agencies can foster a culture of respect for intellectual property. International collaboration, reinforced by bilateral agreements and active participation in global forums, can amplify India's influence on global IP standards. Streamlining registration processes, reducing fees, and modernizing copyright laws can expedite IP protection. Balancing patent protection with access to essential medicines requires regular review of compulsory licensing provisions. Protecting traditional knowledge, leveraging geographical indications, and encouraging innovation in arts and culture preserve India's heritage. Ultimately, these opportunities, when realized, can propel India into a brighter future characterized by a dynamic, equitable, and innovation-driven IPR ecosystem.

Opportunities

Despite these challenges, IPRs present significant opportunities for innovation and economic growth in India. A strong system of IPRs can encourage investment in research and development, promote technology transfer, and facilitate the growth of creative industries. India has already made significant progress in these areas, with the establishment of several specialized intellectual property courts and the introduction of various policy measures to promote innovation and entrepreneurship.

Recommendations

To fully leverage the opportunities presented by IPRs in India, policymakers should consider the following recommendations –

1. Streamline the patent application process and improve the speed of patent examination to encourage innovation and investment.
2. Expand the scope of patentable subject matter to encourage the development of new technologies.
3. Harmonize and simplify copyright law to promote creativity and protect the rights of creators.
4. Strengthen trademark law and enforcement mechanisms to protect the rights of businesses and consumers.

Conclusion

This research paper examines the relationship between intellectual property rights (IPRs) and innovation in India. The paper analyzes the challenges faced by India in promoting innovation through IPRs, and explores the opportunities that can be leveraged to create a more conducive environment for innovation. The study finds that while India has made significant strides in strengthening its IPR regime, challenges remain in terms of inadequate enforcement, lack of awareness, and complexities in the legal framework. However, India also presents several opportunities such as a large market, a growing innovation ecosystem, and a talented pool of human resources. The paper recommends policy measures that can help to address the challenges and leverage the opportunities, and highlights the importance of a balanced approach that considers the interests of all stakeholders.

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Original Article

Exploring the Digital Transformation of Commerce Education: Innovations, Challenges, and Future Directions

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Abstract

The rapid growth of digital technology has changed the way commerce education is taught and learned. This research paper explores how digital transformation is reshaping commerce education through the use of online platforms, digital tools, and innovative teaching methods. It highlights how these advancements have made learning more flexible, interactive, and accessible for students and teachers. At the same time, the study discusses several challenges such as lack of digital infrastructure, limited teacher training, and unequal access to technology. The paper also examines how educational institutions can overcome these issues by adopting modern digital strategies and skill development programs. Finally, it presents possible future directions for building an innovative, technology-driven learning environment that prepares commerce students for the changing demands of the global business world.

Keywords: *Digital Transformation, Commerce Education, Innovation, Future Direction.*

Introduction:

In the modern world, technology has become a powerful tool that is changing almost every field, including education. Commerce education, which focuses on business, finance, and management studies, is also going through a major digital transformation. Traditional teaching methods are now being replaced or supported by online learning platforms, digital classrooms, and advanced technologies such as Artificial Intelligence, data analytics, and virtual simulations. These digital tools are helping teachers make learning more interactive, practical, and connected to real-world business situations. The digital transformation has made education more flexible and accessible. Students can now learn from anywhere and at their own pace through recorded lectures, e-books, and online discussions. It has also encouraged teachers to use innovative methods like case studies, live business projects, and virtual group work to make learning more engaging. Moreover, digital technology allows for continuous assessment and instant feedback, improving the overall quality of education.

However, this transformation also brings several challenges. Many institutions still lack proper digital infrastructure, especially in rural areas. Teachers may find it difficult to adapt to new technologies due to limited training and support. Some students also face problems such as poor internet access or lack of digital devices. These issues create an imbalance in learning opportunities and affect the effectiveness of digital education. Therefore, it is important to study how digital transformation is shaping commerce education and what steps can be taken to overcome its challenges.

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This research paper aims to explore the major innovations brought by digital technology, identify the barriers that prevent effective implementation, and suggest possible strategies to build a more inclusive and future-ready commerce education system. This research paper studies how digital technology helps commerce students learn and grow in their education and daily life. It looks at how online learning platforms, virtual classrooms, and interactive tools help students gain practical knowledge and prepare for real business situations. The study also explains how digital learning improves teamwork, communication, and creativity among students and teachers. It shows that when teachers use technology well and colleges support innovation, students become more motivated and interested in learning. However, when there is a lack of technology or poor internet access, students may lose interest and face learning difficulties. Therefore, this paper highlights the need to build a strong and supportive digital learning environment in commerce education to make it more effective, innovative, and ready for the future.

Research Methodology:

Research is essentially a systematic inquiry, seeking facts through objective verifiable methods in order to discover the relationship among them and to deduce from them broad principles or laws. It is really a method of critical thinking. It comprises defining and re-defining problems, formulating hypotheses or suggested solutions, collecting, organizing and evaluating data, making deductions and making conclusions, and at last, carefully testing the conclusions to determine whether they fit the formulated hypothesis. Thus, the term 'Research experimentation or examination' has as its aim the revision of accepted conclusions, in the light of newly discovered facts.

Definition of research

In Webster's Twentieth Century Dictionary, research is defined as "a careful patient, systematic, diligent inquiry or examination in some field of knowledge undertaken to establish facts or principles".
In the Random House Dictionary of the English Language, research is defined as "a diligent and systematic inquiry or investigation into a subject in order to discover or revise facts, theories, applications, etc

This research paper is based on secondary data from books, journals, newspapers, websites, and information available on the internet.

Objectives of the Study:

1. To understand how digital technology helps students learn better in commerce education.
2. To find out which digital tools and online platforms are most useful for teaching commerce.
3. To see how digital learning helps students gain practical business and communication skills.
4. To explore the problems students and teachers face while using digital methods.
5. To understand how a supportive digital learning environment can make students more motivated, creative, and active in learning.
6. To suggest ways to make commerce education more innovative, modern, and technology-friendly in the future.

Statement Of Hypothesis

H1: Digital transformation in commerce education positively improves students' learning, engagement, and overall development.
H2: Lack of proper digital infrastructure and limited use of technology negatively affects the effectiveness of commerce education.

What is Digital Transformation?

Digital Transformation (DT) means using digital technology to improve or change the way an organization works. It can involve creating new products and services or updating existing ones by converting traditional business processes into digital formats. The main goal is to add value through innovation, better customer experience, and more efficient operations. According to the Chartered Institute of Procurement & Supply (CIPS), digitalization is about rethinking business models, processes, and activities using technology to make operations more efficient, reduce costs, and minimize risks.

Even though many organizations are adopting digital transformation, there is still limited data on its overall impact. Some experts suggest acting quickly to take advantage of digital opportunities, while others recommend a step-by-step approach called Discovery-Driven Planning (DDP). This method helps traditional companies adapt gradually, reduce risks, respond faster to changes, and increase the chances of successful digital transformation.

What is Digital transformation in Commerce?

Digital Transformation in Commerce Education means using technology to change the way commerce is taught and learned. It includes online classes, digital learning tools, e-books, virtual classrooms, and interactive assignments. The main aim is to make learning more interesting, flexible, and practical. Students can study anytime, work together online, and practice real business skills through digital projects and simulations. Teachers can

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use technology to give quick feedback, track progress, and teach in more creative ways. This transformation also helps colleges stay updated with modern business trends and prepare students for a digital workplace. To make it successful, schools and colleges need good technology, proper training for teachers, and easy access to digital tools for students.

Technologies Used in Digital Transformation for Commerce Education

Digital transformation in commerce education involves using various technologies to make learning more effective, practical, and flexible. Some of the key technologies used are:

1. **Learning Management Systems (LMS):** Platforms like Moodle, Google Classroom, and Canvas help teachers organize lessons, share study materials, assign tasks, and monitor student progress in one place. This makes teaching and learning more structured and easy to manage.
2. **Virtual Classrooms and Video Conferencing:** Tools such as Zoom, Microsoft Teams, and Google Meet allow students and teachers to interact in real time, attend online lectures, and participate in discussions, even if they are in different locations.
3. **E-books and Digital Libraries:** Students can access textbooks, case studies, research papers, and reference materials online. This makes it easy to study anytime without relying only on physical books.
4. **Interactive Learning Tools:** Educational apps, simulations, quizzes, and games make learning more engaging. For example, students can practice accounting entries or simulate business decisions in a risk-free digital environment.
5. **Data Analytics Tools:** Commerce students can use software to analyze financial statements, study market trends, and interpret business data. This helps them gain practical skills that are directly useful in real-world business scenarios.
6. **Cloud Computing:** Cloud services allow students and teachers to store and share assignments, projects, and resources online. This makes teamwork and collaboration easier, as multiple students can work on the same document simultaneously.
7. **Artificial Intelligence (AI) and Chatbots:** AI-based tools can give personalized learning experiences, suggest study plans, provide instant feedback, and even help students clear doubts quickly.
8. **Mobile Learning Apps:** Educational apps for smartphones and tablets enable students to learn anywhere, anytime, which increases flexibility and convenience.
9. **Online Assessment Tools:** Platforms like Kahoot, Quizizz, and Google Forms are used for conducting online tests, quizzes, and evaluations. Teachers can assess student performance instantly and track progress over time.
10. **Simulation and ERP Software:** Tools such as Tally, SAP, and business simulation software help students practice real-life commerce operations like accounting, inventory management, and financial planning in a virtual environment.

    Thus, these technologies together create a digital learning ecosystem that enhances student engagement, develops practical skills, and prepares commerce students for the challenges of a modern digital workplace.

Innovations in Commerce Education

Digital transformation has brought many new innovations in commerce education, making learning more effective, practical, and engaging for students. Some of the major innovations include:

1. **Flexible Learning Schedules:**

   With online courses, recorded lectures, and digital resources, students can learn at their own pace and from anywhere. This flexibility allows them to manage their studies alongside other commitments, revise topics multiple times, and focus on areas where they need more practice.
2. **Interactive and Experiential Learning:**

   Digital tools like simulations, case studies, and virtual business games allow students to apply theoretical knowledge in real-life scenarios. For example, they can practice accounting, financial planning, or business decision-making in a safe, virtual environment. This hands-on approach makes learning more engaging and helps students develop practical skills.
3. **Personalized Learning:** AI-based learning tools can adapt to individual student needs. They can recommend study materials, provide instant feedback, and track progress to help each student learn effectively. This personalization ensures that students receive the support they need to improve their understanding and performance.
4. **Global Exposure:** Digital platforms like webinars, online seminars, and virtual collaborations allow students to connect with peers, teachers, and industry experts from around the world. This exposure broadens their perspectives, helps them understand global business practices, and prepares them to work in an international business environment.

   These innovations are transforming commerce education by making it more flexible, interactive, personalized, and globally connected. Students are now able to gain practical knowledge, develop essential skills, and stay prepared for the modern, technology-driven business world.

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Obstacles in Digital Transformation of Commerce Education

While digital transformation brings many benefits to commerce education, it also comes with several challenges that can make implementation difficult. Some of the main obstacles include:

1. **Lack of Proper Infrastructure:** Many colleges and universities do not have the necessary digital infrastructure, such as high-speed internet, modern computers, or smart classrooms. Without these facilities, it becomes difficult to implement digital learning effectively.
2. **Limited Teacher Training:** Teachers may not always be trained to use digital tools and online platforms effectively. A lack of technical knowledge can reduce the quality of teaching and limit the benefits of digital education.
3. **Digital Divide Among Students:** Not all students have equal access to devices like laptops, tablets, or smartphones, and some may struggle with poor internet connectivity. This creates an unequal learning environment where some students are left behind.
4. **Resistance to Change:** Both teachers and students may be hesitant to adopt new digital methods, preferring traditional classroom teaching. Resistance to change can slow down the process of digital transformation.
5. **Cybersecurity and Privacy Issues:** With increased use of online platforms and digital tools, there is a risk of data breaches, hacking, and misuse of student information. Protecting sensitive data becomes an important concern.
6. **High Implementation Costs:** Setting up digital infrastructure, purchasing software, and training staff requires significant investment. Many institutions may struggle to fund these changes.
7. **Over-reliance on Technology:** Excessive dependence on digital tools can reduce face-to-face interaction and affect communication, teamwork, and critical thinking skills if not managed properly.
8. **Emerging digital skill shortage:** At the core of every triumphant digital transformation lies a committed, proficient IT squad. Yet, assembling such a squad is becoming more challenging. Even roles not inherently tech-focused will require basic technological understanding. This results in a lack of the broad spectrum of digital skills essential for a successful transformation.

Despite these challenges, proper planning, training, and support can help institutions overcome obstacles and make digital transformation successful.

Digital Transformation of Commerce Education: Future Directions

The future of commerce education is closely linked with digital transformation. As technology continues to evolve, it is expected to shape the way students learn, teachers teach, and institutions operate. Some key future directions include:

1. **Greater Integration of Artificial Intelligence (AI):** AI can provide personalized learning experiences, adapt lessons according to student needs, and offer instant feedback. In the future, AI will play a bigger role in helping students learn more efficiently and effectively.
2. **Increased Use of Virtual and Augmented Reality (VR & AR):** VR and AR tools can create immersive learning environments where students can simulate real business scenarios, explore virtual offices, and practice skills in a safe, interactive way.
3. **Blended Learning Models:** A combination of online and offline learning will become more common. Students will have the flexibility to attend virtual classes while still participating in face-to-face sessions for discussions, workshops, and group projects.
4. **Focus on Skill-Based Learning:** Future commerce education will emphasize practical skills such as data analysis, digital marketing, accounting software, and financial planning. Technology will help students gain hands-on experience in these areas.
5. **Global Collaboration and Networking:** Digital platforms will allow students to collaborate with peers, teachers, and industry experts worldwide. This exposure will help them understand global business practices and prepare for international careers.
6. **Adaptive and Continuous Learning:** Technology will enable continuous learning where students can update their skills regularly to keep pace with the changing business environment. Learning will become more personalized, flexible, and goal-oriented.
7. **Enhanced Analytics for Better Decision-Making:** Institutions will use data analytics to track student performance, identify learning gaps, and improve teaching strategies. This will help in making education more effective and results-driven.

   The future of commerce education will be more innovative, student-focused, and technology-driven. By embracing digital transformation, institutions can create a learning environment that prepares students for the challenges of a rapidly evolving business world.

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Conclusion:

Digital transformation is bringing a major shift in commerce education, changing the way students learn and teachers teach. By using online platforms, digital tools, e-books, virtual classrooms, and interactive assignments, learning has become more flexible, practical, and engaging. Students can now study at their own pace, collaborate online, and gain hands-on experience through simulations and real-world business projects. Teachers, on the other hand, can provide personalized guidance, track student progress, and use innovative teaching methods to make learning more effective. This research paper looks at how digital transformation is changing the way commerce education is taught and how it affects both students and teachers. It focuses on how online platforms, digital tools, and new teaching methods are making learning more flexible, engaging, and practical. The Research paper also examines the challenges that schools and colleges face while adopting these technologies. Many institutions struggle with issues like inadequate digital infrastructure, limited training for teachers, unequal access to devices and reliable internet, high costs, and concerns about cybersecurity. Finding solutions to these problems is essential so that all students can benefit equally from digital learning and the shift to a technology-driven education can succeeding. In short, this research paper highlights how innovations such as AI, virtual simulations, blended learning, and global collaboration are shaping the future of commerce education. By adopting these technologies and strategies, educational institutions can create a modern, student-cantered learning environment that effectively prepares commerce students for the challenges of a digital business world.

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Original Article

Bridging the Gap: How Digital Finance and Financial Fitness Drive True Financial Inclusion

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Abstract

Digital finance has emerged as a transformative force in expanding financial inclusion by reducing costs, increasing accessibility, and offering innovative financial services to underserved populations. However, financial inclusion is meaningful only when individuals possess the financial fitness—literacy, digital skills, responsible behaviours, and trust—needed to effectively use digital financial services. This paper examines the interconnected roles of digital finance and financial fitness in driving true financial inclusion. It highlights the risks of providing digital access without adequate user capability, including under-utilization, digital fraud, indebtedness, and widening inequalities. The study also identifies key challenges such as infrastructure gaps, low literacy levels, regulatory weaknesses, and the digital divide. To address these gaps, the paper outlines evidence-based strategies such as enhancing financial and digital literacy, user-centric product design, strong consumer protection, improved infrastructure, and multi-stakeholder partnerships. Overall, the paper underscores that sustainable financial inclusion requires a balanced integration of digital financial innovations with capacity-building, trust-building, and supportive regulatory frameworks.

Keywords: *Digital Finance, Financial Fitness, Financial Inclusion, Fintech, Digital Literacy, Financial Literacy, Digital Financial Services, Inclusive Finance, Consumer Protection, Economic Growth.*

Introduction

Financial inclusion—ensuring all individuals and businesses have access to useful and affordable financial products and services—has become a central goal for governments, policymakers, and development organisations worldwide. Digital finance (also called digital financial services, fintech, or digital financial inclusion) has been widely viewed as a promising pathway to expand access, reduce costs, improve convenience, and reach populations historically excluded from formal finance.

But access alone is not enough. The notion of financial fitness—the set of skills, knowledge, behaviors, and tools needed to make good use of financial services—matters deeply. Without financial fitness, people may have an account but not use it effectively—or worse, fall into debt, face fraud, or transact inefficiently. Thus, the interplay between digital finance and financial fitness is critical for achieving meaningful, sustainable financial inclusion.
In this article, we explore how digital finance and financial fitness work together, enabling financial inclusion; what the challenges are; and what policies and interventions are necessary to ensure digital finance delivers real benefits for all.

Digital Finance and Financial Fitness

Digital Finance refers to financial services delivered via digital channels and technologies: mobile banking, mobile money, internet banking, digital payments, online loans, digital wallets, and emerging tools such as peer-to-peer lending, blockchain, automated credit scoring, etc. These leverage technology to reduce friction, cost, and distance barriers.

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Financial Fitness is less well-defined but broadly includes:
Financial literacy: understanding concepts like interest, risk, savings, credit, budgeting.
Digital literacy: ability to use digital devices, apps, navigate interfaces, use internet or mobile services securely.
Responsible financial behavior: saving, planning, managing debt, avoiding scams, maintaining creditworthiness.
Access to information & tools: having good user interfaces, transparent information, financial advisory or tools (budgeting apps etc.).
Financial fitness enables individuals to fully benefit from digital finance, avoid pitfalls, and make financial services work for their well-being.

How Digital Finance Promotes Financial Inclusion
There is substantial evidence that digital finance expands inclusion in several ways:

1. Lowering Costs and Barriers to Entry
Digital channels reduce physical branch infrastructure costs, allow micro-transactions, enable small-value payments and savings, reduce time and travel costs. This helps reach rural, remote, or underserved populations.

2. Scaling Access
Mobile money and digital wallets can spread rapidly, even where traditional banks are absent. For example, many developing countries use mobile money as a backbone of inclusion.

3. Improving Speed, Convenience, and Reliability
Digital transfers, payments, remittances become faster, more secure, often accessible 24/7.

4. Enhancing Transparency and Tracking
Digital platforms enable clearer records, reduce corruption or leakage (e.g. in government benefits), better credit histories.

5. Innovation & Tailored Services
Fintechs often develop specialized products for underserved groups: micro-loans, micro-insurance, small-scale savings, community credit scoring, etc.
Empirical evidence supports these benefits. For instance, a study of 52 emerging and developing economies found that digital financial services are positively associated with GDP per capita growth. Key drivers include access to infrastructure, financial & digital literacy, and institutional quality. Another paper looking at 30 Asia-Pacific countries showed that digital financial inclusion has a significant positive effect on economic growth.

Why Financial Fitness Matters: The Risks of Access without Capability
However, opening accounts or promoting digital services is not enough. Without financial fitness, the following risks emerge:
Under-use or misuse of digital financial services: Even where accounts exist, many people do not use them for savings, credit, or investment. Low knowledge or trust causes stagnation.
Over-indebtedness and predatory practices: Poorly understood credit products, high interest rates, hidden fees, or lack of consumer protection can harm users.
Digital exclusion within inclusion: Among populations that are "included", those with low digital literacy, older age groups, women, rural dwellers may have worse outcomes or be excluded in practice. Fraud, scams, security risks: Without awareness of digital safety, users may fall prey to phishing, unauthorised access, identity theft.
Inequality worsening: If only those with certain education, devices, connectivity, or trust use digital finance effectively, the gap may worsen.
Studies show that financial and digital literacy strongly affect the usage of digital financial services. For example, in the IMF study referenced above, literacy (both financial and digital) is a significant driver of digital financial inclusion. Also, the EIF working paper shows that microfinance institutions and inclusive fintechs are tackling digital and financial illiteracy among vulnerable groups to ensure meaningful inclusion.

Key Challenges in Merging Digital Finance and Financial Fitness
Some of the common challenges in ensuring that digital finance plus fitness leads to real inclusion:
1. Infrastructure Gaps
Poor internet / mobile network coverage; lack of reliable electricity; lack of affordable devices prevent many from accessing digital services.

2. Cost Barriers
Even digital services have costs (internet data, smartphone, transaction fees). For low-income users, these can still be prohibitive.

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3. Regulatory, Legal, and Institutional Weaknesses

Weak consumer protection, weak regulation over digital lenders, unclear or unenforced data/privacy/identity rules; poor financial regulation for non-bank fintechs.

4. Literacy and Trust Issues

Financial literacy, digital literacy are uneven; trust in financial institutions or digital systems may be low; cultural or language barriers exist.

5. Digital Divide

Differences in access by geography, gender, age, income, education. For example, women often lag behind men in account ownership and usage. Rural populations may lack infrastructure or trusted agents. Younger generations may adapt faster.

6. Affordability and Usability

Interfaces must be simple, intuitive; services must align with user behaviors; products should be designed considering local contexts.

7. Risk of Exclusion due to Technology

If digital finance moves too fast without safety nets, people who can't adapt (e.g. elderly) may be left behind.

What Are Good Practices / Interventions to Ensure Financial Fitness Alongside Digital Finance

To make sure that digital finance brings inclusion in a meaningful way, several policy and programmatic interventions have been shown effective or promising:

1. Financial & Digital Literacy Programs

Tailored education programs (e.g. for women, rural areas, older adults).
Delivered through multiple channels: community workshops, mobile apps, agent-networks, radio, schools.
Use simple, local language, practical examples.

2. User-Centric Design of Digital Products

Interfaces designed for low literacy & low connectivity. E.g. USSD, IVR (interactive voice response).
Simplified KYC (Know Your Customer) procedures whilst maintaining safety.
Products that align with users' needs: savings, small payments, microloans with flexible repayment.

3. Affordable Access to Infrastructure

Subsidising or incentivising broadband / mobile access in underserved areas.
Support for device access (low-cost phones), solar/electricity in off-grid areas.

4. Strong Regulation & Consumer Protection

Regulations for digital lenders, transparency in fees, interest, penalties.
Data privacy, cybersecurity, fraud prevention.
Effective dispute resolution.

5. Partnerships Among Stakeholders

Governments, regulators, fintech firms, banks, NGOs, microfinance institutions must collaborate.
Shared infrastructure (e.g. digital identity, payment rails).
Use of public-private partnerships to scale.

6. Monitoring, Measurement, and Evidence Building

Collect data not just on access (who has accounts) but usage (how they use services), outcomes (welfare, economic growth).
Use indices that measure digital inclusion, financial literacy, gender gaps.
Evaluate interventions rigorously.

7. Inclusive Product and Market Development

Design products for underserved groups: women, migrants, informal sector, smallholder farmers.
Microinsurance, savings, payments targeted to their needs.
Considering cultural, social norms.

Evidence: What Works, What Has Been Achieved

The IMF paper "Is Digital Financial Inclusion Unlocking Growth?" finds that in 52 emerging and developing economies, digital financial inclusion has a positive association with growth of GDP per capita. Infrastructure, literacy, and institutional quality are major enabling factors.

Systematic literature reviews (e.g. Ha, Le & Nguyen 2025) show fintech increases financial inclusion by introducing novel services, transforming market structure, involving new stakeholders; but gaps exist in understanding long-term impacts, regulation, and the social aspects.

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Evidence from Asia-Pacific (Basnayake 2024) shows digital financial inclusion contributes to economic growth and reduces poverty.
Case studies & pilot programs: e.g., in Ghana, using IVR systems to reach low-income women with financial services. Design matters to ensure uptake and usability.

Policy Implications & Recommendations
For policymakers, financial institutions, fintechs, and development partners, here are recommended courses of action to align digital finance and financial fitness, to achieve true financial inclusion:

1. Invest in Dual Literacy
Combine financial literacy and digital literacy programs. Especially target marginalized groups (women, rural, informal sector) with customized content.

2. Ensure Infrastructure & Access
Universal access to reliable, affordable internet/a mobile network; power; affordable devices. Subsidies, public investment may be needed.

3. Promote Trust and Consumer Protection
Strong legal frameworks for data privacy, consumer rights; oversight of digital lenders; transparent pricing.

4. Encourage Product Design that's Inclusive
Leverage user research; simplify user journeys; alternative identification systems; get feedback from low-income users when designing apps or digital tools.

5. Data & Index Development
Use composite indices of digital financial inclusion that include measures of access, usage, quality, trust, literacy, gender equality. Monitor progress.

6. Partnerships & Ecosystem-Building
Multi-stakeholder collaboration: governments, regulatory bodies, fintechs, telecommunications providers, NGOs. Shared platforms (e.g., identification, payments infrastructure).

7. Regulate Smartly but Not Stifle Innovation
Balanced regulation that addresses risk (fraud, cybersecurity, algorithmic bias) while enabling innovation and flexible models to reach underserved groups (e.g. agent networks, mobile money).

8. Evaluate Outcomes & Adapt
Invest in research and evaluation to see what works in which contexts; adapt interventions based on evidence.

Conclusion
Digital finance has tremendous potential to promote financial inclusion: lowering cost and barriers, improving access, enabling innovation. But access without financial fitness is like giving someone the tools without teaching them how to use them. For financial inclusion to be meaningful, users must have knowledge, trust, capacity, and supportive infrastructure.

The path forward involves integrating digital finance with financial fitness: literacy, protection, usability, and inclusive design. With the right policies, stakeholder cooperation, and ongoing measurement, digital finance can bridge divides rather than further deepen them.

Achieving such integration is essential not only for inclusive growth, poverty reduction, and social equity, but also for broader goals such as the Sustainable Development Goals (SDGs).

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Original Article

Startups and Innovation Ecosystems in Emerging Markets

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Abstract

Emerging markets have become focal points for entrepreneurial activity and innovation over the past two decades. Startups in these economies face a unique mix of constraints and opportunities shaped by institutional quality, infrastructure, finance, human capital, and socio-cultural norms. This paper reviews the literature on entrepreneurial and innovation ecosystems, synthesizes empirical findings from emerging-market contexts, discusses characteristic drivers and barriers, and proposes a conceptual framework and policy implications to strengthen startup-led innovation in emerging economies. Drawing on theoretical work on ecosystems, systematic reviews, international reports and case-based PhD research from several emerging regions, the paper argues that policy interventions should be systemic and place-sensitive: they must aim to lower transaction costs, strengthen intermediary organizations (incubators, accelerators, universities), improve access to risk capital, and foster demand-side adoption while respecting local institutional realities. Key research gaps and avenues for future study are identified.

Keywords: *Startups; Entrepreneurial ecosystem; Innovation systems; Emerging markets; Policy; Incubation; Financing.*

Introduction

Startups are widely recognized as engines of technological change, job creation, and economic diversification. In emerging markets — broadly referring to low- and middle-income economies undergoing rapid structural change — entrepreneurial dynamism can both leverage and mitigate development challenges. However, the environment in which startups form and scale in these contexts differs markedly from advanced economies: formal institutions may be weaker, infrastructure and contract enforcement less reliable, and markets more informal and heterogeneous. Understanding the composition, dynamics, and bottlenecks of innovation ecosystems in emerging markets is therefore essential for both scholars and policymakers seeking to catalyze productive entrepreneurship and inclusive growth. The following sections review conceptual foundations, synthesize empirical insights from recent studies and theses, and propose a framework for research and policy.

Conceptual background: entrepreneurial and innovation ecosystems

The terms “entrepreneurial ecosystem” and “innovation ecosystem” are related but distinct. An entrepreneurial ecosystem typically refers to a geographically- or sectorally-bounded set of interdependent actors (entrepreneurs, investors, universities, firms, governments, support organizations) and contextual factors (policies, culture, markets) that interact to enable productive entrepreneurship. Stam and colleagues emphasized the interdependence of actors and the systemic nature of these ecosystems, arguing analysis should focus on interactions and outcomes rather than isolated components. Innovation ecosystems literature, emphasizing technological complementarities, platform dynamics and co-evolution, complements this view by focusing on knowledge flows, interfirm networks, and co-innovation processes. Together, these literatures highlight that startup success depends not only on firm-level traits (founder human capital, business model) but on the wider systemic environment that supplies resources, legitimacy, and markets.

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Why emerging markets matter for ecosystem research

Emerging markets present distinctive conditions that influence how ecosystems form and operate. They frequently combine rapid technological adoption in pockets (e.g., mobile banking), high unmet needs that create entrepreneurial opportunities (e.g., low-cost healthcare, education tech), and institutional voids that raise transaction costs for market exchange. International development agencies and research centers highlight innovation and entrepreneurship as central to competitiveness and structural transformation in developing economies. The World Bank and other multilaterals have emphasized that innovation capability and enabling ecosystems are critical for countries to capture gains from new technologies and generate inclusive job growth.

Drivers of startup emergence and growth in emerging markets

1 Market opportunities and demand-led innovation

Large unmet domestic needs and low-cost innovation opportunities (frugal innovation) create demand-side pull for startups. Entrepreneurs often design locally-appropriate technical and business-model innovations (e.g., pay-as-you-go solar, mobile health platforms) that would be less attractive in saturated advanced markets.

2 Digital infrastructure and leapfrogging

Mobile telephony and internet penetration have enabled many emerging-market startups to bypass legacy infrastructure, allowing leapfrogging in sectors like finance (mobile money), logistics, and digital services. These technological enablers reduce some fixed costs of entry and create new scalable business models.

3 Human capital and diasporic networks

University graduates, returnee entrepreneurs, and diaspora networks provide a mix of skills, knowledge transfer, and connection to global finance. Talent clusters around universities and tech hubs seed early-stage innovation activity.

4 Policy and institutional support

Targeted policies—startup funds, tax incentives, simplified registration, regulatory sandboxes—combined with ecosystem builders (incubators, accelerators, co-working spaces) can accelerate firm formation and learning. The WEF and other reports document how formal support institutions shape early-stage company dynamics.

Barriers and frictions unique to emerging markets

1 Access to finance and risk capital

While angel and venture capital have grown in many emerging economies, funding gaps remain acute — particularly for pre-seed and Series A rounds. Limited exit markets, weaker secondary markets, and investor risk perception contribute to underinvestment.

2 Institutional voids and transaction costs

Weak legal enforcement, bureaucratic complexity, and higher transaction costs raise the barriers to scaling. MIT D-Lab researchers highlight how costs of doing business (moving capital, enforcing contracts) can be much higher than in mature ecosystems and slow innovation processes.

3 Talent mismatch and managerial capability

Startups frequently report shortages in experienced managers, product-development specialists, and growth-marketing talent. While technical talent may be present, managerial and commercialization skills are often scarce.

4 Informality and market fragmentation

Large informal sectors and fragmented markets complicate scalability and formal partnerships. Informality also shapes customer trust, procurement processes, and adoption cycles in ways that differ from advanced economies.

5 Infrastructure and logistics constraints

Unreliable electricity, transportation bottlenecks, and high logistics costs increase operational risk and constrain physical-scale business models.

Empirical evidence and illustrative cases from emerging regions

Case studies and doctoral research provide rich granular insights into how ecosystems differ across countries and cities.

Latin America (Brazil): Research on Brazilian high-tech clusters highlights the role of technology parks, incubators, and public-university linkages in fostering startups, while noting persistent financing and scale-up barriers; the Brazilian experience shows that localized institutional support (policy + intermediaries) matters for sustaining high-tech entrepreneurship.

India: India's startup ecosystem has seen rapid growth driven by digital adoption, favorable demographics, and government initiatives (e.g., Startup India). Studies document deepening investor activity and the rise of sectoral clusters but emphasize persistent regulatory and infrastructure challenges.

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Africa (Nigeria — Yaba cluster): Ph.D-level case studies of African software hubs (e.g., Yaba in Lagos) show unique ecosystem supports — informal protective norms, local learning centers, and community reputation — that complement formal ecosystem elements. These meso-level attributes can substitute for some formal supports in contexts with limited institutional capacity.

These cases illustrate that while common patterns exist, the local historical, institutional and cultural context fundamentally shapes ecosystem composition and outcomes.

A conceptual framework for startups in emerging-market innovation ecosystems

Building on the literature, a practical framework to analyze and intervene in ecosystems can be organized into five interacting pillars:

1. Actors & intermediaries: entrepreneurs, startups, universities, investors, incubators, accelerators, industry associations.
2. Resources & capabilities: human capital, finance, R&D, infrastructure.
3. Institutions & rules: formal regulations, informal norms, property rights, contract enforcement.
4. Markets & demand: size of addressable markets, adoption capacity, customer sophistication.
5. Learning & knowledge flows: networks, mentorship, diaspora links, partnerships, regional specialization.

Policy and programmatic interventions should aim to strengthen weak pillars, but importantly to improve linkages among pillars — for example, connecting universities to industry, investors to incubators, and startups to anchor customers. The ecosystem perspective emphasizes co-evolution: improving one pillar often requires simultaneous changes in others to realize impact (e.g., providing venture capital without managerial talent and market access yields limited outcomes). This systemic characterization echoes Stam's work emphasizing interdependence and coordination.

Policy and program implications

1 Lower transaction costs and simplify regulation

Streamline business registration, protect minority investors, speed licensing and lower cross-border friction for capital and talent. Regulatory sandboxes for fintech, healthtech and energy can allow experimentation while managing consumer protection.

2 Strengthen intermediary organizations and learning mechanisms

Incubators, accelerators, and innovation clusters are critical to provide mentorship, business-model validation, and networks. Evidence from incubator studies in emerging economies suggests such intermediaries can boost firm survival and early growth when they offer tailored training and linkages to finance.

3 Create catalytic finance instruments

Publicly backed seed funds, blended-finance instruments, and credit guarantee schemes can help de-risk private investment. Importantly, instruments should target the valley of death (pre-seed to Series A) and be designed to crowd in private investors rather than substitute for them.

4 Enhance market access and demand-side measures

Governments and large firms can act as anchor customers (public procurement, PPPs) to provide scale-up demand. Policies to promote digital adoption (affordable broadband, payment interoperability) accelerate market formation.

5 Invest in skills and managerial capability

Programs to develop managerial talent, commercialization skills, and product-market fit expertise (through executive education, mentorship, and in-company training) are high-leverage interventions.

6 Tailor place-based strategies

Regional specialization (e.g., agritech in agricultural regions, fintech in urban centers with dense financial activity) benefits from targeted local policies rather than one-size-fits-all national approaches. Research on regional innovation engines emphasizes that investments should consider local absorptive capacity and institutional complementarities.

Research gaps and future directions

Although scholarship on entrepreneurial ecosystems has expanded rapidly, several gaps remain, especially in the context of emerging markets:

Causal evidence on policy impact: Most evaluations are descriptive or correlational; rigorous impact evaluations of ecosystem interventions (incubators, public seed funds, regulatory sandboxes) are scarce.

Scaling dynamics: Research needs to disentangle why some startups scale domestically and internationally while others stagnate despite similar starting conditions.

Informality and hybrid models: More work is needed to understand how informal-sector dynamics interact with formal startups and how hybrid business models can bridge both spheres.

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Comparative regional studies: Cross-country comparative work that controls for institutional heterogeneity would clarify which ecosystem ingredients are universally necessary and which are context-specific.
Measurement and metrics: Better standardized metrics for ecosystem performance (beyond counts of startups and funding flows) — looking at quality of job creation, productivity gains, and innovation diffusion — would improve policy targeting.
Recent systematic literature reviews and syntheses highlight the need for theory-building that explicitly integrates institutional economics, regional development, and innovation studies to better capture the multi-level dynamics observed in emerging economies.

Conclusion

Startups in emerging markets operate within complex, place-specific innovation ecosystems. These ecosystems can leverage unique market opportunities and digital enablers but are constrained by financing gaps, institutional voids, talent mismatches, and infrastructure deficits. A systemic, place-sensitive approach that combines improvements in institutions, intermediary capabilities, catalytic finance, and demand creation is most likely to support durable startup-led innovation. For scholars, the frontier lies in generating causal, context-rich evidence on what works; for policymakers, the challenge is to design coordinated, sequenced interventions that strengthen linkages rather than isolated components. Building resilient and inclusive innovation ecosystems in emerging markets is a long-term endeavour — but with targeted, evidence-based interventions, startups can become potent engines of development.

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India and the Changing Global Trade Order: Supply Chains, Trade Governance, and Sustainable Development

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Abstract

Global trade is undergoing a profound transformation driven by geopolitical realignments, technological shifts, and sustainability imperatives. In this evolving environment, India is emerging as a significant player in shaping supply chains, trade governance, and innovation diplomacy. This paper examines India's evolving role in global supply chains, its engagement with World Trade Organization (WTO) reforms, participation in regional trade agreements and free trade arrangements (FTAs), intellectual property rights (IPR) policy and innovation diplomacy, the tension between economic nationalism and globalization, and the intersection of energy trade with sustainability. By analyzing these six dimensions, the paper argues that India is uniquely positioned to balance developmental priorities with global integration. However, challenges in infrastructure, governance, and institutional reforms remain critical to India's ability to fully harness these opportunities.

Keywords: *Global Trade Order, India, Supply Chains, Trade Governance, WTO Reforms, Free Trade Agreements (FTAs), Regional Trade Agreements, Intellectual Property Rights (IPR), Innovation Diplomacy, Economic Nationalism, Globalization, Sustainable Development.*

Introduction:

The global trade order is in flux. Traditional assumptions about globalization as an unrelenting force for liberalization are being tested by the resurgence of protectionism, economic nationalism, and strategic competition among major powers. Simultaneously, technological innovation, climate imperatives, and supply chain vulnerabilities revealed during the COVID-19 pandemic are reshaping how nations think about trade and interdependence. In this dynamic context, India occupies a distinctive position as both a large emerging economy and a potential bridge between developed and developing nations. India's role in global trade is not new. Historically, the subcontinent was central to global commerce, from spice and textile routes to colonial-era integration into global markets. However, the post-independence period witnessed a cautious, protectionist approach until the economic liberalization of the 1990s. Since then, India's trade strategy has evolved from cautious integration to assertive engagement, reflecting its growing economic clout and strategic ambitions. Today, India is the world's fifth-largest economy and one of the fastest-growing major markets. With a population of over 1.4 billion, a rising middle class, and an expanding digital economy, India represents both a massive domestic market and a potential export powerhouse. Its supply chain role is expanding as firms seek to diversify beyond China, while its diplomatic weight in multilateral trade and climate negotiations is increasing. This paper explores six interrelated dimensions of India's trade strategy and position in the evolving global order. First, it examines India's evolving role in global supply chains as firms and countries diversify production networks. Second, it evaluates WTO reforms and India's stance on dispute settlement mechanisms. Third, it analyzes India's selective approach to regional trade agreements and FTAs. Fourth, it assesses India's intellectual property (IP) and innovation diplomacy. Fifth, it explores the tension between economic nationalism and globalization in India's policies.

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Finally, it examines the interplay of energy trade and sustainability, which is critical for India's growth trajectory and global climate commitments. Together, these dimensions highlight the opportunities and dilemmas facing India as it seeks to reconcile growth imperatives with global leadership.

India's Evolving Role in Global Supply Chains

Global supply chains are undergoing strategic reorientation in the wake of COVID-19 disruptions, U.S.–China tensions, and geopolitical uncertainties. The term "China+1" has become shorthand for efforts by multinational corporations to reduce overdependence on China by adding alternative production hubs. India, with its large labor pool, cost competitiveness, and policy incentives, has become a major candidate for this diversification.

Policy initiatives

The Indian government has launched several initiatives to boost manufacturing and supply chain participation. The Production-Linked Incentive (PLI) schemes cover sectors such as electronics, pharmaceuticals, textiles, and renewable energy. These incentives are designed to attract investment, boost exports, and create scale in strategic sectors. Digital infrastructure, exemplified by the Aadhaar-based identity system, Unified Payments Interface (UPI), and logistics digitalization, is creating a conducive environment for supply chain efficiency.

Sectoral strengths

Electronics assembly, particularly smartphones, has seen significant foreign direct investment from companies like Apple and Foxconn. Pharmaceuticals and generics remain a traditional strength, with India serving as the "pharmacy of the world." Auto components, textiles, and chemicals are additional sectors where India is gaining ground.

Challenges

Despite progress, structural challenges remain. Logistics costs in India are higher compared to East Asian economies. Land acquisition and regulatory approvals often delay projects. Skill gaps in advanced manufacturing and weak supplier ecosystems hinder rapid scaling. Moreover, infrastructure deficits in ports, energy reliability, and transport networks impose costs on firms.

Strategic implications

For India to consolidate its supply chain role, it must move beyond assembly-level integration into higher-value manufacturing and design. This requires investments in research and development, strong vocational training systems, and policy consistency. If successful, India could capture a larger share of global value chains, reduce import dependence, and strengthen its bargaining power in trade negotiations.

WTO Reforms and Trade Dispute Mechanisms

The World Trade Organization, once the bedrock of the multilateral trading system, faces a legitimacy crisis. The collapse of the Appellate Body has crippled the WTO's dispute settlement system. As major powers adopt unilateral trade measures, the credibility of WTO rules is under strain.

India's position

India has consistently emphasized the importance of a rules-based multilateral trading system. As a developing country, India benefits from the predictability and fairness of WTO mechanisms that restrain unilateral actions by stronger economies. At the same time, India has resisted attempts by advanced economies to dilute special and differential treatment provisions for developing countries.

Dispute participation

India has been both a complainant and respondent in WTO disputes. Cases related to agricultural subsidies, solar energy incentives, and export restrictions illustrate its active engagement. The stalled appellate process, however, weakens India's ability to defend its interests.

Reform debates

Key reform debates center around restoring the appellate mechanism, enhancing transparency, and addressing new issues such as e-commerce and climate-related trade measures. India advocates for reforms that safeguard policy space for domestic development while ensuring accountability of developed countries.

Implications

If the WTO cannot revive its dispute settlement system, countries will increasingly rely on bilateral or regional mechanisms. For India, this could reduce the security of multilateral rules and force greater reliance on power-based bargaining. Hence, WTO reform is not merely procedural but central to India's trade security.

Regional Trade Agreements and FTAs

Regionalism has expanded rapidly as WTO negotiations stagnate. Mega-deals such as the Regional Comprehensive Economic Partnership (RCEP) and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) reflect this trend.

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India's selective approach

India withdrew from RCEP in 2019, citing concerns about import surges, especially from China, and the need to protect sensitive sectors such as agriculture and dairy. However, India remains open to future accession and maintains observer status.

In contrast, India has pursued bilateral FTAs with like-minded partners. The India–UAE Comprehensive Economic Partnership Agreement (CEPA) and the India–Australia Economic Cooperation and Trade Agreement (ECTA) are recent examples. The India–EFTA agreement further reflects this trend. These deals prioritize strategic partnerships, technology access, and export opportunities for key sectors.

Balancing sensitivities

India's approach is shaped by the need to protect domestic industries while gaining export opportunities. For example, tariff concessions are carefully calibrated, and safeguard mechanisms are built into FTAs.

Strategic implications

India's selective FTA strategy reflects a balancing act between integration and protection. While avoiding overexposure to competitive imports, India signals openness to strategic partners. Over time, this calibrated approach could enable India to diversify trade beyond its traditional partners in the U.S. and EU.

Intellectual Property Rights and Innovation Diplomacy

Intellectual Property (IP) is central to the knowledge economy and innovation-driven growth. For India, strengthening IP regimes is both a domestic developmental imperative and a diplomatic tool.

Domestic reforms

India has modernized its IP framework, with faster patent examination, digitalization of IP offices, and targeted outreach to MSMEs and startups. The National IPR Policy (2016) set a roadmap for capacity building and enforcement. Sectors such as pharmaceuticals, IT, and renewable energy benefit directly from stronger IP regimes.

Balancing innovation and access

India's policy emphasizes balancing innovation incentives with access to essential goods. Its use of compulsory licensing for pharmaceuticals demonstrates this. In global negotiations, India has advocated flexibilities in the TRIPS agreement to ensure affordable medicines and climate technologies for developing countries.

Innovation diplomacy

At WIPO and WTO, India has positioned itself as a voice for the Global South. The COVID-19 pandemic underscored this role, with India and South Africa co-sponsoring a TRIPS waiver for vaccines and essential medical products. In climate technology, India advocates for collaborative licensing and technology-sharing models.

Strategic implications

Strengthening IP and innovation ecosystems domestically will enable India to move up the value chain. Internationally, innovation diplomacy enhances India's credibility as a leader balancing developmental concerns with global innovation imperatives.

Economic Nationalism vs Globalization

The tension between economic nationalism and globalization is reshaping trade policies worldwide. While globalization has created opportunities for growth, it has also triggered anxieties about inequality, job losses, and national security vulnerabilities.

India's policy mix

India's trade strategy reflects this duality. On the one hand, the Atmanirbhar Bharat (Self-Reliant India) campaign emphasizes domestic production, local value addition, and import substitution. On the other hand, India actively courts foreign investment, integrates into global supply chains, and seeks export markets.

Industrial policy resurgence

Global trends, such as U.S. and EU subsidies for semiconductors and green industries, legitimize India's industrial policy approach. India has similarly provided incentives for electronics, renewables, and defence manufacturing.

Risks and opportunities

Excessive protectionism risks inefficiency and isolation. However, strategic economic nationalism can build resilience and reduce vulnerabilities in critical sectors. India's challenge is to strike the right balance: securing domestic capacities without undermining competitiveness or deterring investment.

Energy Trade and Sustainability

Energy is the backbone of India's growth trajectory. As the third-largest energy consumer globally, India faces the dual challenge of meeting rising energy demand while transitioning to sustainable sources.

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Import dependence

India imports over 80% of its crude oil and a growing share of LNG. This dependence creates vulnerabilities to price shocks and geopolitical tensions. Diversification of suppliers, including Russia, the Middle East, and Africa, is central to India's strategy.

Renewable energy and green transition

India has set ambitious targets for renewable energy, aiming for 500 GW of non-fossil capacity by 2030. Solar, wind, and hydro are scaling rapidly, complemented by new initiatives in green hydrogen and battery storage.

Energy diplomacy

India's energy diplomacy emphasizes cooperation with producer countries, participation in the International Solar Alliance, and strategic investments in critical minerals for clean energy technologies.

Sustainability dilemma

Balancing immediate energy security with long-term sustainability is complex. Coal remains significant for base-load power, even as renewables expand. Policy coherence and financing will determine the success of India's energy transition.

Conclusion:

India's position in the evolving global trade order is both promising and challenging. As supply chains diversify, India has a historic opportunity to emerge as a major manufacturing and innovation hub. Its engagement in WTO reforms and regional trade agreements reflects both pragmatism and ambition. Intellectual property rights and innovation diplomacy offer avenues for India to lead in global governance debates while fostering domestic competitiveness.

Yet, tensions remain between economic nationalism and globalization, between energy security and sustainability, and between protection and openness. India's success will depend on its ability to strike strategic balances, invest in infrastructure and human capital, and maintain policy consistency.

Ultimately, India's trajectory will not only shape its own development but also influence the future of the global trade order. As one of the world's largest democracies and emerging economies, India's choices will echo across supply chains, trade institutions, and sustainability agendas worldwide.

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Original Article

Impact of Agricultural Reforms on the Indian Agriculture

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Abstract

Agricultural Sector is the mainstay of the rural Indian economy around which socio-economic privileges and deprivations revolve and any change in its structure is likely to have a corresponding impact on the existing pattern of Social equity. The government of India has introduced number reforms in agricultural sector with the aim of making the agricultural sector more competitive and efficient. These reforms are expected to have a positive impact on agriculture by increasing in production, reducing prices of agricultural goods, and improving the lives of the farmers.

Keywords*: Objectives of the Agriculture Reforms, Agricultural Reforms in India and Impact of Land Reforms in India.*

Introduction

India is an agricultural country. Agriculture is the oldest and most important occupation in the world. Making it more rural and labor-intensive. Most of the population in India depends on the agricultural sector. It employed around 70% of the population in the 1970s, but since then, the percentage has been declining; in 2011, it employed roughly 48.6%. The agricultural sector contributes about 17-18% to the GDP. Agriculture is one of the main exports from the country and supports other industries such as the textile sector (cotton, fabrics, etc.) and sugarcane derivatives (sugar)

After independence, the Government of India has initiated several reforms through the Five Year Plan with the aim of making the agricultural sector more competitive and efficient. These reforms have been implemented in the last few years in an attempt to improve productivity, efficiency and market access. These reforms are expected to have a positive impact on agriculture by increasing production, reducing the prices of agricultural commodities and improving the living standards of farmers. The purpose of this research paper is to study the impact of various reforms undertaken by the Government of India in the agricultural sector on the Indian agricultural sector.

Objective of the Study

1) To Study the Objectives of the Agriculture Reforms in India.
2) To Study the agricultural Reforms in India
3) To Study Impact of Land Reforms in India

Research Methodology

In this research paper, secondary data has been used. Magazines, journals, annual reports, statements and periodicals were consulted to fetch the information. The information is also collected through various websites and e-links.

Definition

Agricultural reform is defined as the process of implementing changes in agricultural practices and policies to promote sustainability, particularly through proactive measures such as self-provisioning and urban agriculture,

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aimed at countering the negative impacts of conventional industrial agriculture and fostering agro ecological practices. Above definition, it can be said that Agricultural reforms have defined the policies, practices, and laws for better farming methods, improved income for farmers, and increased environmental sustainability.

Objectives of the Agriculture Reforms in India

In an agrarian economy like India, on the one hand, high population, low employment, land scarcity, and uneven rainfall have hindered agricultural development. It was necessary to reduce this slowdown and develop agriculture. The Government of India aimed to accelerate the socio-economic progress of rural India and its agro-industries through this agrarian reform system. After independence, land reforms received a significant priority. Some of the main objectives of agrarian reforms are listed below.

1) Overall renewal of law structure for agricultural lands in India.
2) To increase agricultural production and infuse equality in society.
3) Abolition of intermediaries of the medieval land-ownership system in India.
4) Removal of rural poverty.
5) Elimination of the exploitation in the Land relations.
6) Developing cooperative farming.
7) Tribal protection by ensuring their traditional land is not taken over by outsiders.
8) Provide a sustainable, efficient, and equitable mechanism for land redistribution.
9) Improve overall management of natural resources, including forests, water, fisheries, etc.

Agricultural Reforms in India

India has implemented a number of agricultural reforms since independence in 1947. These reforms are aimed at making the agricultural sector more competitive and efficient. The first wave of reforms, in the 1950s and 1960s, focused on increasing agricultural productivity and self-sufficiency. This included the introduction of the Green Revolution which brought new technologies such as high-yielding varieties of seeds and fertilizers, to India. This led to major changes in the agricultural sector. Some of the major agricultural reforms implemented by the in recent times are as follows.

1) Green Revolution

The Green Revolution began in India in 1965 in the agricultural sector with the aim of increasing agricultural productivity through the use of high-yielding crop varieties, modern farming techniques and irrigation systems. This is considered a major reform from the point of view of the agricultural sector.

2) Land **Reforms**

In the early years after independence, the government attempted to redistribute land through land limitation laws, which aimed to break the feudal system and distribute land among the people. Although the intentions of land reforms were noble, the implementation was irregular and its results varied from state to state. Despite this, the government decided to reform land in the interest of agriculture and farmers.

3) Market Reforms

The Indian economy was liberalized in 1990, which led to significant changes in agricultural development policies. All barriers to exports were removed and farmers were encouraged to grow cash crops. Market reforms aimed to make agricultural markets more efficient and included the removal of price controls and opening up agricultural markets to foreign competition. This would give farmers the opportunity to sell their produce in international markets, increasing their income.

4) Technological Advancements

Advances in technology have opened up new avenues in agriculture. Modern technology has been used to enhance agricultural production by replacing traditional technologies. This has led to an increase in agricultural productivity and development of agriculture. Genetically modified crops, modern machinery and the introduction of digital platforms for information dissemination are examples of technological improvements that have shaped Indian agriculture.

5) E-NAM (Electronic National Agriculture Market)

Electronic National Agriculture Market is an electronic trading platform for agricultural commodities. The government of India launched the E-NAM platform which is operated by NAFED. It provides a single platform for farmers to sell their produce to buyers from all over the country & also provides farmers with access to a wider range of buyers which can help them to increase their sales. E-NAM is play important role in the development of the agricultural sector.

6) Pradhan Mantri Krishi Sinchai Yojana (PMKSY)

The central government launched the Pradhan Mantri Krishi Sinchai Yojana in 2015 with the vision to provide irrigation to 100 million hectares' agricultural land. The scheme aims to achieve this through a combination of

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measures like Construction of new canals and dams, innovation and modernization of existing canals and dams, promotion of micro-irrigation, groundwater recharge. The scheme has been a major success with over 30 million hectares of land being irrigated under the scheme as of March 2023. The scheme helps to improve the crop productivity, farmers' incomes, and reduce the risk of crop failure.

7) Paramparagat Krishi Vikas Yojana (PKVY)

The central government launched the Paramparagat Krishi Vikas Yojana (PKVY) in 2007 with the vision to promote traditional agriculture and enhance farmers' income. Under this scheme the government provides farmers with training on traditional agricultural methods and practices and also the government provides farmers with inputs for traditional agriculture such as Seeds, Fertilizers & Pesticides.

8) Pradhan Mantri Fasal Bima Yojana (PMFBY)

The Government of India launched the Pradhan Mantri Fasal Bima Yojana, also known as the Crop Insurance Scheme, in 2016. This scheme provides insurance cover against crop losses due to natural calamities. The premium for crop insurance was shared between the government and the farmers. The government pays 50% of the premium for small and marginal farmers and 25% of the premium for other farmers. This helps in reducing the losses incurred by the farmers to some extent.

9) PM-KISAN (Kisan Samman Nidhi) Yovanna

The Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) scheme was launched on February 24, 2019. This scheme provides the financial assistance to small and marginal farmers ofRs.6, 000/- per year in three equal installments of Rs. 2,000/- each. The scheme expected to benefit about 125 million farmers.

10) PM-KISAN Maan Dhan Yojana

The Prime Minister of India, Shri Narendra Modi, announced the Pradhan Mantri Kisan Maan Dhan Yojana (PMKisan-MKY) on 15 August 2019. The objective of this scheme is to provide a monthly pension of Rs. 3,000 to farmers who are at least 18 years of age and have less than 2 hectares of land. The Central Government will contribute Rs. 2000/-. This will provide financial assistance to the farmers and accelerate their development.

11) The Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020.-

This Act allows farmers to sell their produce to anyone they want, without having to go through the government-controlled APMCs (Agricultural Produce Market Committees). This will give farmers more freedom and choice in selling their produce.

12) The Essential Commodities Act, 2020

This Act has been amended to deregulate most of the commodities that were earlier under its purview. This will reduce the government's control over the agricultural sector and promote competition.

Impact of Agriculture Reforms in India

Agriculture reforms in India had a significant impact on changing the structure of agriculture by breaking the power of middlemen and encouraging direct land ownership among farmers. This gave impetus to agriculture and rural development. The effects of land reforms in India can be classified into two categories.

I) Favorable Effects

Agriculture reforms have changed the economic and social conditions of agriculture and farmers in rural India. These changes are the favorable effects of land reforms. These effects can be explained on the basis of the following points.

1) Increased Income of Farmers

The agricultural reforms in India helped in fulfilling the expectation that agricultural production would increase and farmers would get better prices for their produce, which increased the income of farmers.

2) Improved Competition in the Market

New laws were enacted to create a more competitive market environment for agricultural products. This law increased competition and strengthened the rural areas.

3) Increased Supply Chain

The reforms in the agricultural sector attracted private investment, modernized the food supply chain, and on the one hand, reduced the cost of production, which helped in expanding the supply chain. This is considered a favorable outcome of agricultural reforms.

4) Use of Economies of Scale

These reforms were seen to promote investment, reduce fragmentation of agricultural land and allow consolidation, making agriculture more efficient. This gave impetus to various sectors of the economy.

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5) Increased Productivity

The security and distribution of land ownership have made the landowners interested in its development and increased its productivity. Due to increased productivity, the economic condition of the rural areas has become stronger.

6) Land Acquisition

Land not only provides economic benefits but also provides social prestige. Land reforms have made it necessary to maintain records of holdings, which was previously optional. The fact that land came into the possession of whoever would work it, has given an incentive to increase productivity.

7) Rational Use of Resources

The most important objective of land reforms in India is to provide for more rational use of scarce land resources. This can be done by changing the conditions of land tenure, the limits on land tenure. This helps in the most economical way of agricultural process without wastage of land, labour and capital. This has led to efficient use of resources.

8) Increasing the Level of Production

Another important objective of land reforms is to increase the level of agricultural production by motivating farmers to increase their production. This is possible by giving incentives. This incentive helped in increasing the level of agricultural production.

9) Elimination of Exploitation

An important objective of land reforms is to eliminate exploitation of poor farmers. This can be achieved by redistributing agricultural land in favour of less privileged farmers and by improving the terms and conditions of land acquisition for cultivation by the actual cultivators and by eliminating middlemen. This will reduce the level of exploitation in rural areas.

II) Unfavorable Effects

Land reforms in India have brought about significant changes, but their full implementation has led to adversities in the agricultural sector. Weak political will and legal loopholes have prevented the desired impact of land reforms on the agricultural structure. Some of the adverse effects of these reforms are as follows.

1) Lack of Strong Political Will

Since land reforms are a state subject, the role of the central government was limited to developing broad guidelines and forcing the state governments to implement them. In most states, the political will of the state governments to implement the law was weak and the bureaucracy was largely apathetic.

2) Need for Strong Safeguards

Critics argue that the contract farming laws lack protective measures for farmers, which are likely to lead to increased displacement and exploitation of workers. This will detract from agricultural and rural development.

3) Land Records

The successful implementation of land reforms depends on accurate and up-to-date land records. In many states, land records are not maintained adequately. Therefore, the favorable benefits of land reforms are not reflected.

4) Impact on Small and Marginal Farmers

The reforms in the agricultural sector encouraged the liberalization policy. This was expected to benefit small farmers by producing large quantities and selling their produce at a fair price, but this hope was not fulfilled.

5) Land Allocation Gaps

There is still a significant gap between land allocation and actual possession by the beneficiaries, which is hampered by physical restrictions and litigation. This barrier contributes to the backwardness of the agricultural sector.

6) Infrastructure Deficiencies

To realize the full benefits of these reforms, significant investment is required in rural infrastructure, including improved logistics and irrigation. However, the lack of infrastructure has been evident due to the lack of significant increase in these investments.

7) Market Imperfections

Ensuring competitive markets and preventing collusion among private buyers in new trade areas is a major challenge. This challenge has arisen due to the reforms in the agricultural sector.

8) Protection of Tribal Lands

In all Scheduled Areas, transfer of land from tribals to non-tribal population was prohibited by law. However, due to several legal loopholes and administrative errors, the extent of displacement of tribals from their lands remained high. It is considered a failure of land reform.

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9) Financial Burden on Landowners

Landowners, especially absentee landowners, have had to spend a lot of money to evade the ceiling laws and have to seek the help of legal professionals and bureaucrats. This is a financial burden on landowners.

Conclusion

Agrarian reforms in India are the most important and useful tool for poverty reduction. The main objectives of implementing land reforms are to give ownership of land to the people working on that land, increase the agricultural productivity of farmers, reduce poverty and hunger, improve the overall management of natural resources, eliminate exploitation and improve competition in the market, etc. The reforms carried out in the agricultural sector have increased agricultural productivity, increased the share of agriculture in the gross national product and increased the economic development of farmers and rural India as a whole. Although the Indian government has made great efforts to increase farmers' income and change traditional agricultural practices, these efforts are less than those of developed countries. Therefore, if the government reduces the number of farmers and market intermediaries and increases agricultural productivity, there is no doubt that agriculture, farmers, rural areas and India as a whole will develop economically.

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Original Article

Exploring Green Technology: Types, Applications, and Benefits for Sustainability

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Abstract

Green Technology refers to the use of innovative technological solutions to reduce environmental impact and promote sustainable development. As environmental challenges such as climate change, pollution, and resource depletion continue to grow, green technologies play a crucial role in improving energy efficiency, reducing waste, and supporting eco-friendly practices. This research paper focuses on the various types of green technologies, their applications, and their contribution to building a sustainable future.

Keywords: *Green technology, clean technology, renewable energy, sustainability, sustainable agriculture, waste management, green architecture.*

Introduction

Green technology, often referred to as clean technology or environmental technology, is the application of science and innovation to develop environmentally sustainable products, processes, and systems. Its primary objective is not only to minimize ongoing environmental harm but also to restore ecological balance and promote regeneration. Green technology seeks to reduce negative impacts on the environment, conserve natural resources, and advance sustainability by emphasizing energy efficiency, renewable energy, waste reduction, pollution control, and sustainable resource use.

This field encompasses a wide range of innovations considered environmentally friendly due to their design, production processes, or supply chains. It includes technologies that produce clean energy, utilize alternative fuels, and provide greener alternatives to conventional fossil fuel–based systems. Examples include renewable energy systems such as solar panels and wind turbines, electric vehicles that reduce fossil fuel dependency, waste management and recycling initiatives that minimize landfill use and encourage resource recovery, green architecture focused on energy-efficient and low-carbon buildings, and sustainable agricultural practices such as vertical farming, which significantly reduce land and water requirements.

By integrating these approaches, green technology represents a pathway toward achieving both ecological preservation and economic development in a sustainable manner.

Objectives of the Study

1. To analyse the concept of green technology.
2. To identify and classify the major types of green technologies.
3. To examine the applications of green technology in different sector.
4. To evaluate the environmental and economic benefits of adopting green technologies for sustainable development.
5. To study the challenges and limitations in implementing green technology.

Methodology

This study is based exclusively on secondary data collected from a wide range of reliable sources.

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The information has been gathered from online resources related *to* Exploring Green Technology Types, Applications, and Benefits for Sustainability as well as newspapers, magazines, books, and economic journals. Additionally, data has been obtained through various academic websites, e-links, and digital publications to ensure comprehensive coverage of the topic. Green technology is not confined to a single field but encompasses multiple categories of innovations. the following section examines the major types that play a pivotal role in sustainable development.

Vertical Farming

Vertical farming has emerged as a sustainable alternative to traditional agriculture. It involves cultivating crops in vertically stacked layers within controlled indoor environments such as warehouses, greenhouses, or skyscrapers. This approach allows crops to be grown closer to urban populations, ensures year-round production, and significantly reduces the land required for farming. In regions facing extreme climate conditions, such as the United Arab Emirates, vertical farming is being adopted to enhance food security and reduce dependence on imports. However, the sector continues to face challenges, particularly high energy consumption and operational costs, which raise questions about its large-scale viability. Despite these concerns, vertical farming shows strong potential in high-value markets such as leafy greens, strawberries, and tomatoes.

Types of Vertical Farming

- **Hydroponics**

  Hydroponics is a soil-less farming technique where plants grow in a nutrient-rich water solution. It is highly water-efficient, using up to 90% less water than traditional farming, and allows year-round production in urban areas. Since there is no soil, risks of pests and diseases are minimized, and growth rates are faster due to precise nutrient control. Crops like lettuce, spinach, basil, and tomatoes are commonly grown in hydroponic systems. However, it requires technical expertise and energy, making setup costly, though it remains one of the most effective methods in modern vertical farming.

- **Aquaponics**

  Aquaponics integrates fish farming with hydroponics. Fish waste supplies natural nutrients for plants, while plants filter the water, which is reused for the fish, creating a closed-loop system. It produces both vegetables and fish, making it highly sustainable. Crops like lettuce and herbs grow well, while fish such as tilapia are commonly raised. However, it requires balancing two ecosystems, which can be complex for beginners.

- **Soil-Based Indoor**

  This method uses organic soil in stacked trays within controlled environments like greenhouses or warehouses. It appeals to those who prefer natural and organic farming, as soil microbes support plant growth. Crops like strawberries and root vegetables are often cultivated this way. While it uses more water and space than hydroponics or aeroponics, it offers an easier transition for traditional farmers.

- **Aeroponics**

  Aeroponics grows plants without soil or water beds**,** suspending roots in the air and misting them with nutrient-rich sprays. This method provides maximum oxygen to roots, resulting in rapid growth and efficient water use (up to 95% less water than traditional farming). It is ideal for leafy greens and herbs and has even been tested by NASA for space missions. The downside is its reliance on technology any misting failure can damage crops quickly

Sustainable Advantages of Vertical Farming

Vertical farming offers multiple benefits that make it a sustainable alternative to traditional agriculture. By using stacked layers and controlled environments, it requires significantly less land, thereby reducing deforestation and habitat loss, while advanced systems such as hydroponics and aeroponics conserve up to 90% of water through recycling. The absence of soil reduces the need for pesticides, resulting in cleaner and healthier produce. Since food is grown closer to urban populations, transportation costs and carbon emissions are minimized, improving local food security. Economically, vertical farming enables year-round production, higher yields per square foot, and new market opportunities for organic, pesticide-free produce. Socially, it provides fresh food in cities, creates jobs in green technology, and supports healthier diets. Moreover, its integration with renewable energy and smart technologies like AI and IoT further enhances efficiency and sustainability, while its potential use in space farming highlights its role in the future of food security

Electric Vehicles as Green Technology

Transport is a fundamental requirement of modern life, but the traditional combustion engine is quickly becoming outdated. Petrol or diesel vehicles are highly polluting and are being quickly replaced by fully electric vehicles. Fully electric vehicles (EV) have zero tailpipe emissions and are much better for the environment. The electric vehicle revolution is here, and you can be part of it. Will your next vehicle be an electric one?

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- **Zero Tailpipe Emissions**

  Driving an electric vehicle can help you reduce your carbon footprint because there will be zero tailpipe emissions. You can reduce the environmental impact of charging your vehicle further by choosing renewable energy options for home electricity.

- **Petrol and diesel use is destroying our planet**

  Fossil fuels are limited and their use severely harms the planet. Petrol and diesel vehicles release toxic emissions with long-term health impacts, while electric vehicles (EVs) are far more efficient and cleaner. EVs convert about 60% of grid energy into power, compared to just 17–21% in conventional cars, which waste nearly 80% of fuel energy. Even accounting for electricity generation, EVs emit nearly three times less carbon dioxide than petrol or diesel vehicles. With India targeting 40% of its power capacity from non-fossil fuels by 2030, EVs are the sustainable future of transport.

- **No noise pollution**

  Electric vehicles have the silent functioning capability as there is no engine under the hood. No engine means no noise. The electric motor functions so silently that you need to peek into your instrument panel to check if it is ON. Electric vehicles are so silent that manufacturers have to add false sounds in order to make them safe for pedestrians.

Solar Power

Solar energy, absorbed through photovoltaic panels can be harnessed to power individual homes, entire towns, and even large cities. Utility-scale solar farms, consisting of thousands of PV panels, supply renewable energy to communities on a massive scale. Some of the world's largest solar farms, such as Solar Star and Topaz Solar Farm, are located across the Southwest and West Coast of the United States. On a smaller scale, homeowners and property owners can install rooftop solar panels to generate electricity for their households. Although the initial installation cost of solar panels can be high, various government subsidy programs and incentives make the transition to solar energy more affordable and attractive.

- **Types of Solar Power**

- Photovoltaic Systems – Convert sunlight directly into electricity using solar panels.
- Concentrated Solar Power – Uses mirrors or lenses to concentrate sunlight, producing heat to drive turbines for electricity generation.
- Solar Heating and Cooling – Utilizes solar energy for water heating, space heating, and cooling.
- Floating Solar Farms – Solar panels installed on water bodies to save land and reduce water evaporation.
- Building-Integrated Photovoltaics – Solar panels integrated into building materials like windows, walls, or roofs.

- **Applications of Solar Power**

  Solar power is a versatile source of renewable energy that can be applied across multiple sectors. In residential use, rooftop solar panels provide households with electricity for lighting, appliances, and water heating, reducing dependence on conventional power grids and lowering energy bills. Industrially, solar energy can power factories, machinery, and large-scale operations, helping businesses cut costs while minimizing carbon emissions. In agriculture, solar-powered pumps enable efficient irrigation, solar dryers preserve crops, and solar heating supports greenhouse operations, enhancing productivity and sustainability. Transportation is also benefiting from solar technology through solar-powered vehicles and charging stations for electric vehicles, promoting cleaner mobility. Urban infrastructure can harness solar energy to power streetlights, traffic signals, and public facilities, reducing municipal energy expenses. Furthermore, solar power plays a vital role in rural electrification by providing electricity to remote, off-grid areas, improving living standards and supporting local development. Overall, these diverse applications demonstrate how solar energy contributes to environmental conservation, energy security, and socio-economic growth.

- **Benefits of Solar Power for Sustainability**

  Solar power is one of the most sustainable and abundant sources of renewable energy. It reduces dependence on fossil fuels, thereby cutting harmful greenhouse gas emissions and slowing climate change. Once solar panels are installed, they provide clean electricity at little to no cost, lowering energy bills for households and businesses. Solar energy also promotes energy independence, as it can be harnessed directly from the sun without relying on external fuel supplies. Additionally, solar systems require minimal maintenance, create jobs in manufacturing and installation, and can be used in remote areas where traditional electricity grids are unavailable. Overall, solar power offers economic, environmental, and social benefits, making it a vital solution for a greener future.

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Conclusion

Green technologies such as vertical farming, and electric vehicles solar power, play a crucial role in promoting sustainability and addressing environmental challenges. These innovations help reduce greenhouse gas emissions, conserve natural resources, and improve energy efficiency, offering both environmental and economic benefits. However, their widespread adoption is still limited by high costs, technical challenges, and infrastructural constraints. Overcoming these barriers through research, policy support, and public awareness is essential to fully realize their potential. By embracing and investing in these green technologies, society can move toward a cleaner, more sustainable, and resilient future.

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Original Article

Causes of Regional Imbalance in Urban and Rural Development

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Abstract

Regional imbalance between urban and rural areas remains one of the most persistent developmental challenges in India. Despite rapid urbanization and economic growth, a significant portion of the rural population continues to face inadequate access to basic amenities such as education, healthcare, transportation, and employment opportunities. This study examines the multidimensional causes of regional imbalance, including historical inequalities, uneven industrial growth, poor connectivity, limited human development infrastructure, and political neglect. Using a descriptive research design and secondary data sources, the paper highlights how disparities in natural resources, industrial concentration, and rapid urban migration contribute to widening socio-economic gaps. The study emphasizes the urgent need for rural industrialization, targeted regional planning, improvement of communication networks, and strengthening of local governance to ensure inclusive and balanced development. The findings underline that bridging the urban–rural divide is essential for achieving social equity, economic stability, and sustainable national progress.

Keywords: *Regional imbalance, urban development, rural development, social inequality, industrial development, migration, planning, balanced development.*

Introduction:

India is an agricultural country and there is a large geographical, social, economic and industrial imbalance between urban and rural areas. In the development process of independent India, the pace of urbanization is high, but the rural areas have remained far from the mainstream of development. This imbalance has created social inequality, migration, unemployment, and unequal distribution of resources.

Urban areas have more access to education, health, transport, employment and technology, while rural areas lack these basic needs. Therefore, the unbalanced development of urban and rural areas is a serious problem of today. These regional imbalances are becoming an obstacle to the integrated development of the country. The purpose of this research is to find the reasons for this imbalance and suggest solutions to it.

Definitions:

1. Regional imbalance: Regional imbalance is the inequality in the distribution of development opportunities, facilities and resources across different geographical areas.
2. Urban development: The prosperous and rapid development of physical, social and economic aspects in cities.
3. Rural development: The combined effect of plans and initiatives implemented to improve the quality of life in areas outside the village.

Research study Objectives:

1. To understand the imbalance in development between urban and rural areas.
2. To find out the main reasons for the emergence of regional imbalance.
3. To study the problems arising due to urbanization.
4. To review the necessary policies for the development of rural areas.
5. To suggest solutions to remove regional imbalance.

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Research Methodology: Descriptive method has been used to study the present topic. Secondary information sources include government reports, Planning Commission documents, research essays, periodicals, internet sources, etc.
Importance of the Study: In a developing country like India, balanced development is the main need for development. Eliminating the imbalance between urban and rural areas is not only necessary for social justice but also for economic stability. By studying this topic, policymakers, scientists, and the government can get directions for the development of all levels of society. Hence, there is a need to study the present topic.

Causes of Regional Imbalance:
1. Historical Legacy: During the British period, some specific regions (Mumbai, Kolkata, and Chennai) were developed. Due to this, other regions were left behind.
2. Imbalance in Industrial Development: Industrial investment took place only in cities. Industries were not established in rural and remote areas. Due to this, industry in rural areas did not get a boost.
3. Unequal facilities of transport and communication: In urban areas, road, rail and air services are easy, but in rural areas, connectivity is still limited due to remoteness. Lack of communication facilities in rural areas is creating obstacles in development work.
4. Education and Health Facilities: The number of educational institutions, colleges and hospitals in rural areas is very low. Due to this, human resource development has not been able to take place as desired.
5. Political Neglect: Some regions have been consistently neglected by the government and policymakers.
6. Imbalance of natural resources: Some areas are rich in minerals, water resources, forest resources, while some areas are desert or dry.
7. Rapid urbanization: The increasing population has created stress in urban areas, and there has been a large-scale migration from rural areas.

Measures to Reduce Regional Imbalance:
1. Rural industrialization: It is necessary to create employment by starting small and medium industries in rural areas.
2. Increasing communication facilities: Roads, internet, and other communication facilities will have to be provided in rural areas.
3. Investment in education and health sector: Establishment of schools, colleges, hospitals in rural areas.
4. Regional planning: Preparation of separate regional development plans for each state.
5. Strengthening local self-government institutions: Giving the right to take decisions at the village level.
6. Development of local resources: Development will have to be strengthened by making proper use of the natural resources of each area.
7. Prevention of migration: Stop migration to cities by creating employment, education and facilities in rural areas.

Summary: Regional imbalance in urban and rural development is a major issue in India. Rural areas have been left behind as the means of development, employment, education and health facilities are mainly concentrated in urban areas. History, political policy, geographical features and industrial development are all factors responsible for regional imbalance.

The consequences of this imbalance are – increase in population density in urban areas, migration from rural areas, social discontent and hindrance in overall national development. Therefore, it is necessary to give more emphasis on rural development for the integrated and balanced development of the country. While formulating policies, it is essential to formulate separate plans according to the needs of each region and implement them.

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Original Article

Policy Shifts in Agriculture and their Implications for Farmer Welfare

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Abstract

Agricultural policy reforms have undergone significant transformations in recent decades, aiming to modernize the sector, enhance productivity, and integrate markets. However, these shifts have had complex and uneven effects on farmer welfare, particularly for small and marginal farmers. This paper examines the nature and impact of recent agricultural policy changes—including market liberalization, subsidy restructuring, and reforms in procurement and support mechanisms—on the socio-economic well-being of farmers. Through a critical analysis of both primary and secondary data, the study evaluates whether these reforms have translated into improved incomes, reduced debt, and greater resilience for farming communities. It also highlights regional disparities, implementation challenges, and the socio-political resistance surrounding key policies. The findings suggest that while certain reforms have created new opportunities, structural gaps remain in ensuring equitable welfare outcomes. The paper concludes with policy recommendations aimed at making agricultural reforms more inclusive, sustainable, and aligned with the long-term interests of farmers.

Keywords: *Agricultural Policy Reforms, Farmer Welfare, Rural Livelihoods, Market Liberalization, Minimum Support Price (MSP), Agricultural Subsidies, Farm Income, Agricultural Infrastructure, Small and Marginal Farmers.*

Introduction:

Agriculture remains the backbone of many developing economies, contributing significantly to employment, food security, and rural livelihoods. In countries like India, over 50% of the population is directly or indirectly dependent on agriculture, yet the sector contributes a much smaller share to the national GDP. This imbalance highlights deep-rooted structural issues that have long plagued the agrarian economy. In response, successive governments have introduced various policy shifts aimed at transforming the agricultural sector—ranging from input subsidies and price support mechanisms to market liberalization and digital reforms. Over the past few decades, agricultural policy reforms have increasingly focused on enhancing productivity, improving market access, encouraging private investment, and reducing the fiscal burden of subsidies. While these changes were designed to stimulate growth and competitiveness, their actual impact on farmer welfare has been mixed and often contested. On one hand, policy shifts have opened up new opportunities for commercialization, export, and technological adoption; on the other hand, they have also contributed to increased vulnerability among small and marginal farmers, who struggle with rising input costs, price volatility, and uncertain market access.

This paper aims to critically examine the nature of recent policy shifts in agriculture and evaluate their implications for farmer welfare. It explores whether these reforms have translated into tangible improvements in income, security, and sustainability for farmers, or whether they have exacerbated existing disparities. By analyzing both the intended outcomes and unintended consequences of these reforms, the paper seeks to contribute to the ongoing discourse on building a more inclusive and equitable agricultural policy framework.

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Literature Review:

Agricultural policy reforms have long been the subject of scholarly debate, particularly concerning their influence on farmer welfare, income stability, and rural development. The literature broadly reflects a dichotomy: while some studies emphasize the growth-oriented benefits of liberalization and policy innovation, others highlight the adverse impacts on vulnerable farming populations, especially small and marginal farmers.

According to Deshpande and Arora (2010), post-liberalization reforms in India emphasized market efficiency, deregulation, and export-oriented growth. These shifts, including the reduction in input subsidies and gradual withdrawal of state procurement in certain areas, were intended to enhance competitiveness. However, Patnaik (2007) argues that such reforms often overlooked the socio-economic realities of rural India, leading to a crisis of profitability and sustainability in small-scale farming.

The World Bank (2008) acknowledged that while global agricultural trade liberalization helped in reducing some distortions, the outcomes varied significantly depending on local institutional capacities. In contrast, Sainath (2005) documents widespread rural distress in India, citing policy neglect, mounting debt, and the erosion of traditional support systems as key drivers of agrarian crises.

Recent studies have also examined targeted welfare schemes. Programs such as PM-KISAN (a direct income support scheme) and the PradhanMantriFasalBimaYojana (crop insurance) have been recognized by scholars like Gulati and Juneja (2019) as steps toward improving income stability. However, Ramakumar (2020) critiques the poor implementation and limited outreach of these schemes, especially in regions with weak institutional infrastructure.

Research Methodology:

This study adopts a qualitative-descriptive research design to analyze the relationship between agricultural policy shifts and farmer welfare. The methodology is based on secondary data collection and thematic content analysis, enabling a comprehensive understanding of policy impacts across different contexts.

1. Research Design:

The paper follows a qualitative, exploratory approach, aimed at identifying patterns, trends, and outcomes related to agricultural reforms and their implications for farmers. The study does not conduct primary surveys but relies on existing academic, policy, and government literature to build the analysis.

2. Data Sources:

Secondary data were collected from a variety of credible sources, including:

- Government reports and policy documents (e.g., Ministry of Agriculture, NITI Aayog, Economic Survey of India)
- Academic journals and books (e.g., *EPW*, Journal of Rural Development)
- Reports by international institutions (e.g., FAO, World Bank, OECD)
- Research studies and working papers by think tanks (e.g., NABARD, IFPRI, ICRIER)
- News articles and editorials for recent policy developments and farmer responses

3. Data Analysis:

The collected data were organized into key thematic areas:

- Input and output price reforms (e.g., MSP, fertilizer subsidies)
- Market and trade liberalization (e.g., APMC Act, contract farming policies)
- Institutional support (e.g., crop insurance, income support schemes)
- Regional impacts and disparities
- Social and economic outcomes on farmer welfare

These themes were analyzed using content analysis to interpret how policy shifts have influenced key welfare indicators such as income levels, debt burden, market access, and risk mitigation.

4. Limitations:

- The study relies solely on secondary data and does not include field-level primary data, which may limit its ability to capture localized and real-time insights.
- Policy outcomes are often region-specific and context-dependent, so generalizations must be interpreted with caution.

Analysis:

The impact of agricultural policy shifts on farmer welfare is multifaceted and varies significantly based on region, farm size, access to institutional support, and the nature of reforms implemented. This analysis explores the key domains where policy changes have interacted with farmer welfare, using secondary data and thematic categorization.

1. Input Subsidy Reforms and Cost of Cultivation

Over the last two decades, governments have gradually rationalized subsidies on fertilizers, electricity, and irrigation. While this has helped reduce fiscal pressure, it has led to an increase in production costs for small and marginal farmers, who are more dependent on subsidized inputs. According to the Economic Survey (2020–21), the

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cost of inputs like fertilizers and diesel has risen steadily, eating into farmer profits. In regions with limited irrigation infrastructure, reduced subsidies have pushed farmers toward informal credit, increasing indebtedness and financial vulnerability.

2. Market Liberalization and Price Volatility

Deregulation of agricultural markets, especially through reforms like the Model APMC Act and the promotion of contract farming, was aimed at increasing market access and improving price realization for farmers. However, the implementation has been uneven. While large and commercially oriented farmers have benefited from direct marketing channels and export opportunities, smallholders often lack the bargaining power, market information, and storage facilities needed to take advantage of liberalized markets. Moreover, the absence of strong price guarantees in an open market has led to increased price volatility, as seen in the onion, tomato, and pulse markets.

3. MSP System and Procurement Gaps

The Minimum Support Price (MSP) mechanism has been a cornerstone of agricultural policy in India, intended to provide income security to farmers. However, only a fraction of farmers (mainly in Punjab, Haryana, and parts of western Uttar Pradesh) benefit from effective MSP procurement. Reforms that seek to reduce public procurement or replace MSP with income support schemes like PM-KISAN have sparked concerns among farmers about guaranteed returns. According to NSSO data, less than 6% of farmers report selling their crops at MSP rates, reflecting the limited reach of this policy instrument.

4. Crop Insurance and Risk Mitigation

Reforms in crop insurance, particularly the launch of the Pradhan Mantri Fasal BimaYojana (PMFBY), aimed to reduce farmer distress due to weather and pest-related crop failures. However, delays in claim settlements, low awareness, and lack of transparency in damage assessment have reduced its effectiveness. A CAG report (2021) found that a large proportion of insured farmers did not receive timely payouts, undermining the scheme's objective of reducing vulnerability.

5. Direct Benefit Transfers and Income Support

Schemes like PM-KISAN, which provide direct income transfers to farmers, mark a shift from price-based support to income-based support. While such schemes have offered some relief, the fixed income amount (₹6,000/year) is often insufficient to significantly alter household income or protect against crop failure. Furthermore, issues related to beneficiary identification and exclusion errors have limited the reach of these programs.

Conclusion:

Agricultural policy shifts over the past few decades have aimed to transform the sector from a subsistence-driven economy into a market-oriented, competitive system. These reforms—ranging from input subsidy rationalization and deregulation of agricultural markets to direct income support and insurance schemes—were introduced with the intention of improving productivity, efficiency, and farmer income. However, the impact on farmer welfare has been uneven and context-dependent.

While certain reforms have benefitted large and commercial farmers by enhancing access to markets and technology, small and marginal farmers—who form the majority—continue to face multiple challenges, including rising input costs, price volatility, inadequate access to institutional support, and limited benefit from schemes like MSP and crop insurance. The shift from price-based support to income-based support (e.g., PM-KISAN) represents a significant policy transition, but its effectiveness in ensuring long-term welfare and resilience remains limited without complementary structural reforms.

This study concludes that agricultural policy reforms must be holistic and inclusive, taking into account regional disparities, landholding patterns, and the socio-economic vulnerabilities of the farming community. Merely focusing on market integration or fiscal efficiency is insufficient; the true measure of successful reform lies in enhancing the well-being, income security, and dignity of farmers. For policy to translate into meaningful welfare outcomes, greater emphasis is needed on participatory governance, farmer education, infrastructure development, and sustainable agricultural practices.

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Original Article

Impact of Excess Rainfall on Agriculture and Rural Economy: A Study of Beed District

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Abstract

Beed district in Marathwada, Maharashtra, has historically been known as a drought-prone region. However, the unprecedented and continuous rainfall in September 2025 transformed this chronic drought belt into a flood-affected zone. This paper investigates the scale of crop losses, socio-economic challenges faced by farmers, and the policy implications for sustainable disaster management. Drawing on newspaper reports, secondary data, and field-level assessments, the study finds that nearly 5.75 lakh hectares of crops were destroyed, affecting around 8.77 lakh farmers across 11talukas. The humanitarian impact extended to household destruction, livestock loss, and small-business collapse. The research emphasizes the urgent need for rapid relief mechanisms, decentralized governance, PPP involvement, financial reforms, and long-term climate adaptation strategies to safeguard vulnerable communities.

Keywords: *Excess Rainfall, Agriculture Loss, Rural Economy, Climate Change, Beed District, Crop Damage, Flood Impact, Farmer Distress, Rural Infrastructure, Disaster Management, Government Relief, Public–Private Partnership (PPP), Crop Insurance, Financial Institutions.*

Introduction

Agriculture continues to be the principal occupation and source of livelihood in India, particularly in semi-arid regions like Marathwada. Among its districts, Beed occupies a significant position due to its geographical expanse, demographic strength, and dependence on rain-fed agriculture. According to the 2011 Census, Beed district has a total geographical area of around 10,693 sq. km**.** and a population of approximately 25.85 lakh people. The district comprises 11 talukas, with the majority of its population residing in rural areas and relying heavily on farming and allied activities. Traditionally, Beed has been identified as a drought-prone region, often struggling with water scarcity, low irrigation coverage, and frequent agrarian crises. However, in recent years, the district has witnessed a dramatic shift from recurring droughts to episodes of excessive rainfall and flooding. This climatic paradox has deeply affected the district's rural economy, disrupting agricultural cycles and damaging standing crops like soybean, cotton, pulses, and bajra. Excessive rainfall not only destroys crops but also undermines the economic security of farming households, weakens the local market system, and creates pressure on institutional credit and cooperative structures. Since agriculture in Beed is intricately linked with commercial activities such as cotton-based textile industries and soybean processing units, the adverse impact reverberates across both the local and regional economy. In this backdrop, the present study focuses on understanding the impact of heavy rainfall on agriculture and rural livelihoods in Beed district, with particular emphasis on the economic and social consequences, as well as the role of government and institutions in mitigating risks.

Context and Background

Agriculture remains the backbone of India's rural economy, with nearly 55% of the workforce dependent on it either directly or indirectly.

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In semi-arid regions like Marathwada, particularly Beed district, climatic uncertainty has always shaped the trajectory of rural livelihoods. Historically, Beed has been identified as a drought-prone region, facing recurring water scarcity, crop failures, and agrarian distress. However, in recent years, the district has experienced a paradoxical shift — from persistent droughts to episodes of excessive rainfall and flooding, resulting in widespread agricultural losses.

The commerce of agriculture, which includes farm output, rural markets, credit systems, and value chains, is highly sensitive to such climatic shocks. Excessive rainfall disrupts not only crop cycles but also input-output linkages, procurement processes, and household consumption patterns. When hectares of standing crops like soybean, cotton, and pulses are damaged, it directly affects farmers' income, repayment of institutional loans, demand in local markets, and overall rural economic circulation.

This situation underscores the role of government interventions, financial institutions, and cooperative structures in mitigating risks. Relief packages, insurance schemes, and market support mechanisms determine how quickly the rural economy can recover. Moreover, with agriculture being interlinked with industries such as textiles (cotton) and food processing (soybean, pulses), the impact of excessive rainfall transcends the farm level and cascades into regional and national commerce.

Thus, the case of Beed district is not just a local environmental crisis but also a critical study in rural commerce and economic resilience. By analyzing the impact of excessive rainfall, one can better understand the vulnerabilities in the agricultural economy and propose institutional frameworks for sustainable risk management.

Impact of Excessive Rainfall

1. Agricultural Losses

Table 1: Estimated Crop Damage in Beed District (September 2025)

Sr. No	Taluka / Region	Major Crops Affected	Area Affected (Hectares)	Estimated Farmers Affected	Nature of Damage
1	Ashti(Kada region)	Cotton, Soybean	75,000	68,000	Water logging; rotting of cotton; soybean sprouting
2	Majalgaon	Cotton, Soybean, Pulses	62,000	54,000	Flood due to river discharge; submerged fields
3	Kaij	Cotton, Pulses, Horticulture	58,000	49,000	Shops, houses, farms damaged; seeds and fodder lost
4	Georai	Cotton, Soybean, Moong	70,000	61,000	Cotton bolls burst; soybean pods sprouted
5	Beed (central)	Soybean, Tur, Cotton	85,000	76,000	Green gram destroyed; cotton withered due to rains
6	Other Talukas (11 total, 57 circles)	Mixed crops	200,000+	180,000+	Roads submerged; fodder shortage; soil erosion

source: *Compiled from regional newspapers, September 2025.*

Total Estimated Damage → 5.75 lakh hectares, affecting 8.77 lakh farmers.

2. Household and Infrastructure Losses

Heavy rainfall in Beed district did not only impact standing crops but also caused severe damage to household property and rural infrastructure. Several shops, bakeries, and medical stores were inundated, leading to large-scale economic distress for small traders and service providers. In affected talukas such as Ashti, Georai, and Majalgaon, residential houses were filled with mud and floodwater, destroying furniture, essential household goods, and food supplies. In addition, bridges and rural roads were washed away in multiple villages, cutting off connectivity between markets and agricultural fields. The loss of livestock, including goats, cattle, and poultry, further aggravated the financial condition of already vulnerable households, intensifying rural poverty.

3. Humanitarian Crisis

The excessive rainfall and subsequent flooding gave rise to a serious humanitarian crisis. Farmers who had invested heavily in soybean, cotton, and pulse cultivation faced psychological stress, despair, and in some cases suicidal tendencies, as total crop loss wiped out their annual income. Entire families were displaced from submerged villages, resulting in temporary shelter crises and dependence on local relief camps. Farmer unions and advocacy groups demanded compensation of at least ₹50,000 per hectare, pointing out that existing relief norms were inadequate to cover the actual scale of losses. This reflected a wider demand for revising disaster management policies to better align with the realities of climate-induced agrarian distress.

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Role of Government in Crisis Management

The government is the primary actor in disaster management. In Beed, relief measures included:

- **Immediate Actions:** Surveys (panchanamas), rescue operations, and declarations of relief packages.
- **Policy Responsiveness:** Announcement of compensation, disaster aid, and relief camps.
- **Limitations:** Compensation delays, bureaucratic hurdles in online applications, and inadequate amounts compared to actual damages.

The gap between announcements and actual delivery weakened trust in governance.

Institutional Mechanisms and Decentralization

- **District Administration & Disaster Cells:** Coordinated rescue but lacked speed in disbursal.
- **Panchayati Raj Institutions:** Best positioned for last-mile delivery but underfunded.
- **Decentralized Decision-Making:** Farmers demanded immediate local authority to release aid without waiting for state approvals.

Local representatives in Beed highlighted that ₹50,000 per hectare was a more realistic relief package, showcasing the need for flexible norms.

Public-Private Partnerships (PPPs)

- **Infrastructure Rebuilding:** PPPs can help rebuild roads, bridges, and storage facilities.
- **Technology Use:** Partnerships for digital grievance redressal, weather forecasting, and crop monitoring.
- **CSR Interventions:** Distribution of relief kits, temporary shelters, and health services.
- **Agri-Tech Startups:** Promotion of drought- and flood-resistant seed varieties, precision farming, and financial literacy.

Financial Institutions and Rural Resilience

Financial institutions play a pivotal role in stabilizing rural economies during climate-induced crises. In districts like Beed, where agriculture forms the backbone of livelihood, access to timely credit and insurance is often the difference between recovery and permanent indebtedness.

1. Role of Commercial and Cooperative Banks

Commercial banks and district cooperative credit societies are the primary providers of agricultural loans. In the aftermath of excessive rainfall, their responsibilities extend beyond lending. They must offer loan restructuring, moratoriums on repayment, and fresh crop loans to enable farmers to begin the next agricultural cycle. Unfortunately, delays in loan restructuring and high collateral requirements often discourage smallholders from approaching formal banking channels.

2. Crop Insurance Mechanisms

The PradhanMantriFasalBimaYojana (PMFBY) is designed to provide risk coverage against crop loss. However, in practice, farmers in Beed reported that insurance claim settlements were delayed, underpaid, or riddled with bureaucratic hurdles. This inefficiency forces many households to rely on informal lenders, thereby increasing vulnerability. Strengthening insurance delivery through digitized claim processing, real-time weather data integration, and direct benefit transfers (DBT) can significantly improve resilience.

3. Microfinance and Self-Help Groups (SHGs)

Microfinance institutions and SHGs serve as alternative financial safety nets in rural Maharashtra. They can provide small-ticket emergency loans, savings mechanisms, and women-led financial support systems during disasters. By decentralizing credit at the community level, SHGs help reduce dependence on moneylenders charging exorbitant interest rates.

4. Innovative Financial Tools for Climate Resilience

Beyond traditional banking, innovative models are emerging to address climate risks:

- **Micro-investment platforms** allow daily wage earners to save small amounts that can serve as emergency buffers.
- **Weather-indexed insurance products** pay out automatically when rainfall crosses thresholds, reducing disputes in claim settlements.
- **Green credit and CSR funding mechanisms** can incentivize climate-resilient farming practices such as crop diversification and precision irrigation.

5. Gaps and Policy Needs

While financial institutions are central to resilience, their impact in Beed has been limited by structural gaps such as bureaucratic delays, lack of awareness among farmers, and weak financial literacy. Strengthening rural financial ecosystems requires:

- Transparent loan restructuring policies.
- Simplified insurance claim processes.
- Integration of SHGs and microfinance into disaster management frameworks.

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- Greater coordination between banks, cooperatives, and government agencies.

In conclusion, financial institutions are not just lenders but potential partners in building climate-resilient rural economies. Unless timely and accessible financial support reaches farmers, the cycle of debt and distress will continue to repeat with every drought or flood event.

Challenges and Policy Gaps

- Delayed compensation despite urgent need.
- Insufficient relief compared to actual losses.
- Lack of climate-resilient infrastructure (elevated roads, drainage).
- Overdependence on government announcements without accountability.
- Weak integration of local knowledge in planning.

Climate Change Dimensions

Beed transformation from drought to floods symbolizes the growing unpredictability of climate change.

- **Erratic Monsoons:** Uncertainty in sowing and harvesting cycles.
- **Flooding Events:** Waterlogging, soil erosion, and crop destruction.
- **Future Needs:**
  - Adaptive cropping patterns.
  - Diversification of rural economy.
  - Climate insurance and early warning systems.
  - Integrated watershed management.

Conclusion

The Beed floods of September 2025 have reshaped the understanding of disaster vulnerability in semi-arid regions of India. Historically branded as a drought-prone district, Beed has now experienced the paradox of water scarcity and water excess within a short span, exposing the fragility of agricultural livelihoods. With nearly 5.75 lakh hectares of crops destroyed and 8.77 lakh farmers affected, the event has shown that rural economies are highly sensitive to climatic shocks.

1. Short-term relief is not enough. While government announcements of compensation provide temporary support, delays and inadequacies in disbursement weaken trust in governance. Relief measures must be timely, transparent, and proportionate to actual losses.
2. Structural and institutional reforms are essential. Climate change is intensifying the risks faced by farmers. Strengthening local institutions, ensuring accountability in disaster management, and integrating Panchayati Raj bodies into relief delivery can bridge the gap between policy and practice.
3. Financial resilience must be prioritized. Banks, cooperatives, insurance schemes, and SHGs should move beyond credit disbursement to become active partners in resilience-building. Innovative financial instruments, insurance products, and micro-investment platforms can act as buffers against recurring disasters.
4. Climate-resilient planning is the need of the hour. Adaptive cropping patterns, watershed management, and diversification of rural economies can reduce the risks of mono-crop dependence. Public-private partnerships can further complement state efforts in rebuilding infrastructure, creating employment, and introducing technology-driven solutions.

In essence, Beed's transformation from drought to floods represents not just a climatic anomaly but also a wake-up call for policy makers, financial institutions, and development planners. The district's experience illustrates that resilience in rural India cannot rely solely on reactive relief measures; it must evolve into a proactive, integrated, and long-term strategy. Only then can vulnerable agrarian communities withstand the uncertainties of a changing climate and secure their livelihoods with dignity.

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Original Article

New Agricultural Policy and Indian Farmers wlfare

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Abstract

Agriculture has historically been the backbone of India's economy, supporting a majority of the population and contributing significantly to national development. Post-independence policies emphasized land reforms, productivity enhancement, and modernization, culminating in transformative milestones such as the Green Revolution. However, regional disparities, rising cultivation costs, market inefficiencies, and the increasing role of intermediaries continue to challenge farmers' income and welfare. The introduction of the New Agricultural Policy and the Agricultural Bills of 2020 sought to liberalize agricultural markets, enhance farmer autonomy, promote direct trade, strengthen supply chains, and modernize storage and processing infrastructure. Despite these objectives, widespread farmer protests emerged due to apprehensions regarding MSP security, APMC reforms, contract farming risks, and potential corporate dominance. This paper critically examines the evolution of agricultural policies, key provisions of the new legislation, welfare schemes, and the socio-economic implications for Indian farmers. The study, based on secondary sources, highlights the need for transparent policies, strengthened institutional support, farmer-centric reforms, and sustainable agricultural development to ensure equitable growth and long-term livelihood security.

Keywords: *India, Agriculture, New Agricultural Policy.*

Introduction

Agriculture is considered the backbone of the Indian economy. The existence of Indian agriculture dates back to the Indus Valley Civilization. The importance of agriculture as a means of trade, employment, and livelihood remains today, just as it was in the pre-independence era. Traditional farming practices are now evolving toward modernity. From an Indian perspective, the Green Revolution that swept the country's agricultural sector after 1960 was a milestone in this modernization. Looking ahead, in 2007, the share of agriculture and related sectors in the country's gross domestic product was 16.6%. During the same period, 52% of the people in the country were fully involved in the agricultural sector. In the 2018-19 financial year, the share of the agricultural sector in the country's $2.7 trillion economy was about 15.9%, and its share in employment was 49%. The dependence of Indian people on agriculture and its contribution to the country's Gross Domestic Product (GDP) are declining, a trend considered a sign of economic development as secondary and tertiary sectors grow. While a significant portion of the Indian population remains dependent on agriculture, the sector's share of the national GDP has been decreasing for decades, with projections showing a continued downward trend. The main objective of this research paper is to study the effects of the country's agricultural policies to date and the exploitation of farmers.

Research Methodology: Secondary sources will be used for this research.

Objective of study:

- To study the In the post-independence era,
- To study the new agricultural bill in the Lok Sabha.
- To study the farmers welfare scheme.

In the post-independence era, the government gave priority to agriculture and agriculture-related businesses in its goals and policies for the reconstruction of India.

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The focus was on institutional reforms and distribution. Accordingly, many laws were enacted, with a special emphasis on land reforms. As a result, the Ryotwari, Mahalwari, and Zamindari systems were abolished, and the Land Ceiling Act was implemented. The focus of all these reforms was to strengthen the foundation of agriculture. To increase the productivity and profitability of Indian agriculture, the Green Revolution was launched in the country in 1966-67, based on the studies of M.S. Swaminathan. This included the use of chemical fertilizers, modern seeds, irrigation facilities, crop protection, multi-crop programs, modern agricultural machinery, soil testing, and soil conservation. As a result of the Green Revolution, there was a phenomenal increase in agricultural production in the country. In 1951-52, the total food grain production was 5.09 crore tons, which increased to 23.38 crore tons in 2009. During this period, per-hectare productivity increased from 522 kilograms per hectare to 1893 kilograms per hectare. In terms of the production of wheat, millet, maize, and jowar, the country became self-sufficient. The central government announced the New National Agricultural Policy on July 28, 2000. The new policy aimed to achieve a four percent annual growth in the agricultural sector. This new agricultural policy was described as the "Rainbow Revolution". Through this policy, 30 crore tons of food were produced by 2019.

In the current market system, the increased role of intermediaries is not beneficial for farmers or consumers. Brokers pay farmers very low prices and charge high fees for their products when selling in the wholesale market. Thus, intermediaries get a significant share of the profits from trading agricultural products. The existence of intermediaries and the various fees imposed on farmers by regulated markets increase the prices of agricultural products, which consumers ultimately have to pay in the market. Agricultural reforms are also needed in India because the farming business has become unable to grow. The cost of cultivation has increased, while the farm-gate prices of agricultural products are very low. In some parts of India, increased debt has forced farmers to take extreme steps like suicide because their income could not cover their cultivation costs, especially when crops failed due to nature's uncertainty. There is also a need for reforms in the agricultural sector because the Green Revolution in India, which commercialized Indian agriculture and made the country self-reliant in food grain production, also increased the income of farmers and the wages of laborers. However, the Green Revolution was limited to certain areas and crops, and its benefits were limited to a few regions and farmers. The contribution of the Green Revolution to increasing agricultural productivity has decreased and has remained more or less stable, which results in lower incomes for farmers. In September 2020, President Ram Nath Kovind gave his assent to the three 'Agriculture Bills' that were earlier passed by the Indian Parliament. These Farm Acts are as follows:

1- Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020
2- Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Act, 2020
3- Essential Commodities (Amendment) Act, 2020

The current central government has often declared its efforts to alleviate the suffering of farmers through its various announcements. For this purpose, on September 14, 2020, Union Agriculture Minister Shri Narendra Singh Tomar introduced a new agricultural bill in the Lok Sabha. This new agricultural bill received the form of an ordinance on June 5, 2020. The government has made many claims through this new agricultural bill.

- The new agricultural bill gives farmers the freedom to sell their produce to anyone and anywhere.
- According to the provisions of this bill, farmers can now sell their produce in any part of the country.
- Farmers will have to bear the cost of transporting the produce.
- E-trading facilities will be created.
- According to the new bill, there will be freedom to commercialize farm gates, cold storage, warehouses, and processing centers in the trade sector apart from the market.
- Through this bill, farmers and traders will come into direct contact, and intermediaries will be eliminated.

In his parliamentary speech on February 8, the Prime Minister of India assured farmers that "the provision of Minimum Support Price (MSP) exists, exists, and will remain". A system to provide MSP for 23 crops is already available every year, which serves as a price floor for these products, below which their costs will not be allowed to fall. In fact, for open market prices, MSP actually becomes the base price. The government has made some reforms in MSP determination and has kept itself open to any suggestions for improvement within its budget constraints. In 2006, the Agricultural Commission suggested some measures to alleviate the plight of farmers. The main issue was "support price". The recommendation was that the government should focus on providing a benefit of more than 50% of the production cost as the support price. Currently, since 90% of farmers in the country have less than two hectares of land, there is a need to pay special attention to these farmers. Through the New Agricultural Policy 2020, the government has not given any definite assurance regarding the Minimum Support Price. Therefore, farmers are in a state of confusion about this. Many doubts are being raised in the minds of farmers regarding the new bills.

- The Minimum Support Price policy is likely to be abolished.
- MPMC markets are likely to be closed.
- The e-trading portal can create new problems.

As a result, farmers in Punjab, Haryana, and across the country have started to oppose the government's new agricultural policy by organizing protests across the country. After the bill was passed, Shri Badal also resigned. Opposition parties, including TMC, Congress, DMK, and BSP, opposed the agricultural sector reform bills, saying they

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were against the interests of small and marginal farmers. The Congress party escalated its opposition against the Modi government and called the move a conspiracy to defeat the Green Revolution. "This government is sitting with its eyes closed, how can they snatch the lands of the farmers to benefit their capitalist friends, by weakening the land acquisition law, labor courts, and by changing the industrial system, and now this three-pronged attack on the Indian agricultural system through the three bills on agriculture - one related to APMC, the second related to contract farming, and the third bill which is on essential commodities, is in a way an attack on the Indian farmers from all three sides". Indian farmers are afraid that after the new agricultural laws of 2020, they will lose more than they can gain, and that is why they are on the streets protesting.

Rakesh Tikait, the leader of the Bharatiya Kisan Union, said, "The central government wants to improve it, but we want these laws to be repealed. We do not want any changes. We will end our protest only when these laws are withdrawn". Overall, the government is unable to remove the confusion in the minds of the farmers. Today, the world's provider, despite the Corona pandemic, is coming together in large numbers to protect their agriculture and rights, and is opposing the New Agricultural Policy 2020.

Farmer welfare:

Farmer welfare is the holistic well-being of agricultural producers, recognizing their dignity and essential role in sustaining life. Farmers' welfare in India is supported by the Ministry of Agriculture & Farmers Welfare through various initiatives like the PM-KISAN scheme. PM Kisan Maan Dhan Yojana (PMKMY) for old-age social security, and the Pradhan Mantri Fasal Bima Yojana (PMFBY) for crop insurance against natural disasters. Other schemes focus on providing institutional credit, water access, technology adoption, and support for allied activities like dairy and horticulture.

Scheme for welfare farmers:

- **Pradhan Mantri Krishi Sinchai Yojana (PMKSY):**
  This central sector scheme provides direct financial support of ₹6,000 annually to small and marginal landholding farmers, credited in three equal installments Focuses on providing access to protective irrigation for all agricultural farms, increasing water use efficiency.
- **Sub-Mission on Agriculture Mechanization (SMAM):**
  Promotes the use of modern machinery and equipment to enhance agricultural productivity.
- **Paramparagat Krishi Vikas Yojana (PKVY):**
  Promotes organic farming and sustainable agricultural practices, enhancing soil health and environmental quality.
- **Namo Drone Didi scheme :**
  Empowers Women Self Help Groups (SHGs) by providing drones for rental services, enabling them to earn income by applying fertilizers and pesticides on farmers' fields. Provides drones to women's Self-Help Groups (SHGs) to promote agricultural technology adoption and empowerment.
- **Pradhan Mantri Fasal Bima Yojana (PMFBY):**
  A crop insurance scheme designed to protect farmers from financial losses caused by non-preventable natural risks like drought, floods, and pests.

Pradhan Mantri Krishi Sinchai Yojana (PMKSY):

Ensures access to protective irrigation for all agricultural farms across the country to improve water use efficiency.

- **Soil Health Card Scheme:**
  Provides farmers with detailed information about the nutrient status of their soil, along with recommendations on appropriate fertilizer use to maintain soil health.
- **Namo Drone Didi Scheme:**
  Empowers Women Self Help Groups (SHGs) by providing drones for rental services, enabling them to earn income by applying fertilizers and pesticides on farmers' fields.
- **Interest Subvention Scheme (ISS)**:
  Offers financial assistance by subsidizing interest on working capital loans, making credit more accessible and affordable for farmers.

Conclusion and Suggestions-

The recent reforms do not really concern the majority of Indian farmers because they do not have access to APMC markets and other modern channels like contract farming. Small farmers need to form groups and FPOs to reduce transaction costs for private buyers and gain bargaining power in the new market. The warehouse system needs to be extended to all crops. Expanding this facility will also free farmers from credit and output linkages and help them avoid immediate sales after harvest, as well as get out of inter-market conditions. Corporate farming has not been successful anywhere in the world and should not be encouraged in India. It is equally important to train workers in agriculture and related sectors, including female workers, who are capable of participating in modern and sustainable agricultural production.

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The agricultural sector needs to be engaged with fair and responsible production and trade issues on a priority basis for domestic markets. It is important to recognize that what matters is not just the physical activity in this sector, but also its residents and their livelihoods, so more people-centric and meaningful policies need to be formulated. A combination of livelihood and agribusiness or value chain approach can help this sector improve its stakeholders, namely farmers, workers, and others around them.

Therefore, more effective policy, scheme and regulation are needed at the central and state levels to protect the interests of small producers in the context of the market. Efforts can be made for comprehensive and effective sustainable agricultural development. Hence, there is a need for production, processing, and institutional innovation in the agricultural sector to address the existing and emerging challenges and sustainability issues. The future of Indian agribusiness, including farming, will be bright if people's organizations like cooperatives and FPCs (FPOs) are involved instead of relying on corporate agencies.

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Original Article

How AI and block chain improve traceability and fraud detection

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Abstract

In an increasingly digital and globalized economy, ensuring traceability and minimizing fraud have become critical challenges for businesses and governments alike. This paper explores how the integration of Artificial Intelligence (AI) and Blockchain technologies enhances traceability and fraud detection across various sectors, particularly in supply chains and financial systems. Blockchain provides a decentralized and tamper-proof ledger that ensures transparency and data integrity, while AI contributes through real-time data analysis, anomaly detection, and predictive modeling. Together, these technologies create a synergistic framework that not only improves the visibility of product and data flows but also enables early detection and prevention of fraudulent activities. Case studies from industries such as food logistics, pharmaceuticals, and banking demonstrate the practical effectiveness of this integration. The paper also addresses current limitations, such as scalability and regulatory concerns, and suggests pathways for future research and implementation. Ultimately, the convergence of AI and blockchain represents a transformative shift in how traceability and fraud management can be approached in both business and governance contexts.

Keywords: *Artificial Intelligence (AI), Block chain Technology, Traceability, Fraud Detection, Supply Chain Transparency, Anomaly Detection, Decentralized Ledger, Data Integrity.*

Introduction

In today's increasingly complex and interconnected digital economy, the demand for transparent, secure, and efficient systems to manage data and transactions has never been greater. Across industries such as supply chain management, finance, healthcare, and government services, two transformative technologies — Artificial Intelligence (AI) and Blockchain — are being recognized for their potential to significantly improve traceability and reduce fraud.

Traceability, or the ability to track the origin, movement, and lifecycle of data or products, is essential for ensuring accountability, safety, and regulatory compliance. Meanwhile, fraud detection has become a top priority, especially as cyber threats and data manipulation tactics grow more sophisticated. Traditional systems often fall short in addressing these challenges due to centralization, limited real-time visibility, and the potential for data tampering.

Blockchain introduces a decentralized and immutable ledger that records every transaction or event in a transparent, tamper-proof manner. When integrated with AI — which can analyze massive data sets, detect anomalies, and predict suspicious patterns — organizations can develop more intelligent, automated, and secure systems. This powerful combination enhances both operational transparency and risk mitigation.

Literature Review

The convergence of Artificial Intelligence (AI) and Blockchain technology has garnered growing academic and industrial interest for its potential to address key challenges in traceability and fraud detection. Numerous studies have explored the individual capabilities of these technologies; however, recent literature increasingly highlights the enhanced value that arises when they are integrated.

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1. Blockchain for Traceability and Data Integrity

Blockchain technology is widely recognized for its ability to create secure, transparent, and immutable records. Nakamoto (2008) introduced blockchain as the foundational technology behind cryptocurrencies, but its applications have since expanded into supply chains, healthcare, and financial services. According to Tian (2017), blockchain improves product traceability by recording every step of a product's journey on a distributed ledger, thereby enabling real-time audits and eliminating opportunities for data manipulation. Case studies from industries like agriculture and pharmaceuticals have demonstrated how blockchain ensures data provenance and compliance with safety standards (Kamble et al., 2019).

2. AI in Fraud Detection and Anomaly Recognition

AI, particularly machine learning (ML) and deep learning, has been extensively applied in fraud detection. According to West and Bhattacharya (2016), AI models can learn from historical transaction data to detect irregular patterns that may indicate fraudulent activities. In finance, AI-powered systems are used for credit card fraud detection, insurance claims verification, and anti-money laundering (AML) monitoring. These systems continuously improve by adapting to new fraud techniques, providing real-time alerts and minimizing false positives.

3. Synergistic Integration of AI and Blockchain

Recent studies suggest that combining AI and blockchain leads to more robust traceability and fraud detection systems. For example, Casino et al. (2019) highlight that while blockchain provides secure and transparent data storage, AI adds analytical capability to extract insights and detect anomalies. In supply chains, AI can analyze blockchain-stored sensor data (e.g., temperature logs, GPS data) to predict spoilage or detect counterfeit goods. Similarly, in financial systems, blockchain records provide trusted inputs for AI algorithms, increasing the reliability of fraud detection.

4. Limitations and Gaps in Current Research

Despite the promising integration, several limitations persist. Scalability of blockchain networks, high computational costs of AI models, and a lack of standardization in data formats can hinder real-world deployment (Rejeb et al., 2021). Moreover, ethical and regulatory concerns surrounding AI decisions and the immutability of blockchain data raise important questions about accountability and privacy (Zhang et al., 2020).

5. Emerging Trends and Future Directions

The literature increasingly points toward hybrid frameworks that use AI-enabled smart contracts, decentralized AI models, and edge computing to address scalability and latency issues. Future research is expected to focus on lightweight blockchain models and interpretable AI systems that can be effectively deployed in resource-constrained environments.

Research Methodology

1. Research Design

This study adopts a qualitative research design, supported by case study analysis and a thematic review of existing literature. The goal is to explore how the integration of Artificial Intelligence (AI) and Blockchain technology enhances traceability and fraud detection in various industries, with a focus on supply chain management and financial systems.

2. Data Collection Methods

a. Secondary Data Collection

Data for this research is drawn from:

- Peer-reviewed journal articles
- Industry reports (e.g., IBM, Deloitte, PwC)
- Whitepapers and case studies from real-world AI-block chain implementations
- Academic databases such as Google Scholar, Science Direct, IEEE Xplore, and Springer Link

b. Case Studies

Three key industries are used as case studies:

- **Supply Chain** (e.g., IBM Food Trust, Walmart)
- **Finance** (e.g., Mastercard, JPMorgan Chase)
- **Pharmaceuticals** (e.g., MediLedger Project)

  These cases provide real-world examples of how AI and block chain are used together for traceability and fraud prevention.

3. Data Analysis Techniques

A thematic analysis approach is used to:

- Identify common patterns and trends in the use of AI and block chain for traceability
- Examine the technological and organizational factors that contribute to fraud detection success
- Compare the effectiveness of different integration models

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Where applicable, conceptual frameworks are constructed to map the interaction between AI systems (e.g., anomaly detection, predictive analytics) and blockchain features (e.g., immutability, decentralization).

4. Scope and Delimitations

- This study focuses on enterprise-level applications and does not include consumer-level block chain or AI tools.
- It examines technologies that are currently in use or in advanced pilot stages; experimental or theoretical models are excluded unless directly relevant.
- The study does not include technical performance benchmarking (e.g., algorithm accuracy or block chain throughput).

5. Validity and Reliability

To ensure validity and reliability:

- Only credible, peer-reviewed, and up-to-date sources are used.
- Case studies are selected based on transparency, documented outcomes, and third-party evaluations.
- Triangulation is applied by cross-verifying findings across multiple sources and industries.

6. Ethical Considerations

Since this research is based on publicly available data and secondary sources, there are no direct ethical concerns involving human participants. However, ethical implications discussed in the literature such as data privacy**,** algorithmic bias, and transparency are critically analysed.

Discussion

The integration of Artificial Intelligence (AI) and Blockchain represents a transformative shift in the way businesses and governments handle traceability and fraud detection. While each technology offers distinct advantages, their combined use creates a more robust and intelligent system that enhances data reliability, process transparency, and real-time threat detection.

1. Enhancing Traceability Through Decentralized and Intelligent Systems

Blockchain's core feature — a decentralized, immutable ledger — makes it uniquely suited for traceability applications. Every transaction or product movement can be recorded permanently and transparently. When AI is layered on top of this data, it enables real-time monitoring, classification, and prediction of supply chain behaviors.

For example, in the agri-food industry, companies like Walmart and Carrefour use blockchain to record each stage of food movement, from farm to shelf. AI models analyze sensor data (temperature, humidity, GPS) recorded on the blockchain to predict spoilage risks or detect inconsistencies. This not only improves product quality control but also facilitates faster recalls and compliance with safety regulations.

2. Advanced Fraud Detection Using AI Models and Trusted Data

AI systems excel at identifying patterns and anomalies, which are critical in detecting fraudulent behavior. However, their effectiveness depends on the quality and integrity of the data. This is where blockchain plays a foundational role — by ensuring that the data fed into AI systems is authentic, tamper-proof, and traceable.

In the financial sector, blockchain can record all transaction histories, and AI can monitor these records for suspicious patterns. For instance, AI-driven anti-money laundering (AML) tools can use blockchain logs to detect complex fraud schemes such as layering and smurfing. With blockchain ensuring that the transaction data is untampered, AI models become more reliable and less prone to false positives.

3. Synergistic Benefits: Transparency, Automation, and Auditability

The synergy between AI and blockchain leads to several key benefits:

- **Transparency**: Stakeholders can verify data origins and changes across the ecosystem.
- **Automation**: Smart contracts, powered by AI logic, can autonomously enforce compliance rules or trigger alerts.
- **Auditability**: A full history of data access and changes is stored permanently on the blockchain, enabling comprehensive forensic investigations.

  In fraud detection scenarios, this enables proactive responses rather than reactive audits, saving significant time and financial resources.

4. Cross-Sector Applications and Impact

The application of AI and blockchain spans multiple sectors:

- In healthcare, blockchain stores medical records securely, while AI flags unusual prescription patterns that could indicate insurance fraud.
- In pharmaceutical supply chains, AI predicts counterfeit drug risks, while blockchain ensures source verification.
- In government procurement, AI algorithms review blockchain-logged contracts and transactions to detect irregularities in bidding or pricing.

  Each use case reflects the growing trust placed in these technologies to manage critical, high-stakes systems.

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Findings

The integration of Artificial Intelligence (AI) and Blockchain has proven to be a powerful solution for enhancing traceability and fraud detection across various industries. Based on the reviewed literature, case studies, and thematic analysis, the following key findings have emerged:

1. AI and Blockchain Are Complementary Technologies

- Blockchain ensures data integrity, transparency, and immutability, creating a trusted environment for storing critical records.
- AI adds an intelligence layer by analyzing these records in real-time, detecting anomalies, and predicting fraud risks.
- Together, they form a secure, self-regulating ecosystem that outperforms traditional systems.

2. Improved Traceability Across Supply Chains

- Blockchain enables end-to-end tracking of products and processes, while AI analyzes that data for delays, deviations, or quality issues.
- In sectors like agriculture, pharmaceuticals, and manufacturing, this integration reduces product recalls, improves compliance, and builds consumer trust.

3. Real-Time and Proactive Fraud Detection

- AI can detect unusual patterns (e.g., rapid transactions, duplicate records) with high accuracy.
- When combined with blockchain, the risk of feeding corrupted or manipulated data into AI systems is significantly reduced.
- This leads to faster and more reliable fraud detection, especially in finance, insurance, and government procurement.

4. Smart Contracts Enable Automated Enforcement

- AI-enhanced smart contracts can autonomously monitor transactions and enforce rules (e.g., reject suspicious payments or automatically flag irregular data).
- This reduces the reliance on manual intervention and accelerates response time.

5. Sector-Wide Applicability with Customization Potential

- The combined use of AI and blockchain is applicable across multiple domains:
  - **Supply chain** for traceability
  - **Finance** for fraud prevention
  - **Healthcare** for securing patient data
  - **Public sector** for ensuring transparency in records and contracts

6. Challenges Still Remain

- **Technical barriers**: High computational demand and integration complexity
- **Privacy concerns**: Especially when sensitive data is involved
- **Scalability issues**: Blockchain networks may struggle under high-volume AI processing
- **Regulatory uncertainty**: Lack of clear legal frameworks for AI and blockchain integration

Conclusion

The integration of Artificial Intelligence (AI) and Blockchain technologies presents a promising advancement for enhancing traceability and fraud detection in both business and governance contexts. Blockchain's decentralized and immutable ledger ensures the authenticity and transparency of data, forming a trusted foundation. When combined with AI's powerful capabilities in real-time data analysis, anomaly detection, and predictive modeling, the result is a robust system capable of proactive and accurate identification of fraudulent activities.

This synergy has been demonstrated across multiple industries—ranging from supply chain management to finance and healthcare—where improved traceability leads to better quality control, regulatory compliance, and consumer trust. AI-enabled smart contracts further automate and enforce compliance, reducing manual oversight and response times.

However, challenges such as scalability, data privacy, integration complexity, and evolving regulatory frameworks remain significant barriers to widespread adoption. Addressing these issues will be crucial for realizing the full potential of AI and blockchain integration.

Overall, this research highlights that the convergence of AI and blockchain is more than a technological trend; it represents a strategic enabler for building transparent, secure, and efficient systems that can significantly reduce fraud and enhance traceability in a rapidly digitalizing world. Future efforts should focus on scalable solutions, ethical considerations, and cross-sector collaboration to harness these technologies effectively.

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Original Article

Role of Artificial Intelligence and Robotics in Transforming Indian Agriculture: Enhancing Productivity, Sustainability, and Farmer Livelihoods

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Abstract

Artificial Intelligence (AI) and Robotics can play an important role in agriculture by helping to meet the growing food needs of the world and reducing hunger. AI can provide smart and practical solutions to many problems faced in farming, such as rising labor costs, high expenses of cultivation, crop losses due to pests and diseases, unpredictable rainfall, climate change, soil fertility loss, and unstable market prices of crops. To improve the social and economic condition of Indian farmers, AI can introduce advanced farming methods that reduce losses and increase crop yields. With the help of AI platforms, a large amount of data can be collected from government and public sources, and real-time monitoring is also possible through the Internet of Things (IoT). By using modern machines and AI-based applications, farmers can tackle the uncertainties of agriculture more effectively.

Keywords: *Artificial intelligence, technology, farming, farmers.*

Introduction

Agriculture is the most important sector of the Indian economy, contributing nearly 18 % to the national Gross Domestic Product (GDP) and providing employment to about 50% of the country's youth [Madhusudhan, 2015:14]. According to the U.S. Environmental Protection Agency (EPA), agriculture generates approximately $330 billion in annual revenue for the economy [Madhusudhan, 2015:14]. India holds the position of the world's largest producer of pulses, cereals, spices, and spice products, and is the second-largest producer of vegetables and fruits.

Despite this strong production base, the sector faces several challenges. Indian agriculture has long depended on traditional farming practices, low yields, and heavy reliance on monsoon rains, which has kept farming at a subsistence level. Factors such as climate change, population growth, and food security concerns have necessitated innovative approaches to safeguard and enhance crop productivity [Kumar and Joshiba, 2019:1]. Rising consumption and the increasing demand for higher crop yields are key drivers for adopting modern technologies, including robotics in agriculture [Smith, 2019:28].

The growing pressure on farmers to expand operations has created an urgent requirement for automation. In this context, the use of advanced technologies such as Artificial Intelligence (AI) is proving to be highly beneficial. AI applications assist farmers in selecting appropriate crops and mitigating risks, steadily becoming integral to the technological transformation of agriculture. For instance, AI has been successful in identifying crop diseases with nearly 98% accuracy, providing effective tools against pests, and using sensors to monitor fruit development while adjusting conditions like light to optimize ripening. These advancements require significant processing power, yet they result in improved crop quality and faster market readiness [Soffar, 2019:29]. AI systems integrate diverse data sources such as temperature, rainfall, wind speed, and solar radiation, and compare them with historical values to generate valuable insights for farmers. While AI will not replace human farmers, it enhances their efficiency in production, harvesting, and marketing of crops.

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Recognizing this potential, the Government of India has constituted a committee to evaluate the role of digital technologies in transforming and modernizing agricultural practices in rural India. The technologies include Artificial Intelligence, Big Data Analytics, Block chain Technology, etc. By use of the advance technologies and Artificial Intelligence (AI) and we can give accurate and timely information regarding crops, weather and insects etc. to the farmers y which they can improve the crop productivity, reduce the risk and improve the income of the farmers.

Concept

Artificial Intelligence (AI) is defined as the principle and development of computer systems capable of performing tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and language translation [Russel, 2016:23]. It encompasses multiple domains including computer vision, data mining, deep learning, image processing, and neural networks [Kale, 2019:11]. In agriculture, factors such as climate change, population growth, and food security have accelerated the adoption of innovative technological solutions to protect and enhance crop yield. AI is, therefore, steadily emerging as a central element in agriculture's technological transformation. According to Maher, "Artificial Intelligence is a program that can adapt itself to execute tasks in real-time situations using cognitive processing similar to the human mind, without requiring constant supervision" [Maher, 2018:15].

In India, the Government initiated the use of AI in February 2016 on a pilot basis under the flagship scheme Pradhan Mantri Fasal Bima Yojana (PMFBY). AI was introduced for crop cutting experiments and yield estimation, with the goal of reducing farming costs and increasing productivity per unit area. According to government reports, this modern technology supports farmers with timely information and advice to improve efficiency. Pilot studies demonstrated the role of AI in optimizing crop cutting experiments and improving yield estimation [Tripathi, 2019:31]. Over the past decade, several technology companies and agri-tech startups have emerged with AI-driven solutions targeting Indian agriculture. These applications largely fall into three major categories: predictive analytics, crop and soil health monitoring, and agriculture machinery/drones**.**

1. **Predictive Analytics**
   - Where*:* A Colorado-based company that uses machine learning combined with satellite data to predict weather, analyze crop sustainability, and detect pests and diseases [Anonymous, 2019:3].
   - FarmShots*:* A North Carolina-based startup analyzing agricultural data from drones and satellites, aimed at detecting diseases, pests, and nutrient deficiencies in plants [Anonymous, 2019:3].
2. **Crop and Soil Health Monitoring**
   - PEAT (Plantix)*:* A Berlin-based start-up that developed a deep learning app to diagnose soil nutrient deficiencies and plant diseases through smartphone images, providing soil restoration techniques and solutions [Anonymous, 2019:3].
   - Trace Genomics*:* A California-based company offering soil analysis through machine learning to assess soil quality, prevent crop defects, and enhance productivity [Rosen, 2017:22].
   - CropIn*:* An Indian agri-tech company using AI-based platforms such as SmartFarm for geo-tagging, weather advisory, farm monitoring, pest alerts, and harvest estimation. Its SmartRisk solution leverages agri-data for risk forecasting and credit assessments [Anonymous, 2019:3].
3. **Agricultural Machinery and Drones**
   - SkySquirrel Technologies*:* A viticulture-focused company using AI and drone-based imaging to monitor vineyard health. By analyzing grapevine leaves (indicators of molds and diseases), the technology supports yield improvement and cost reduction [Sennar, 2019].

AI and Robotics in Agriculture

One of the most significant applications of Artificial Intelligence (AI) and robotics in agriculture is in the area of precision spraying and harvesting. Technologies such as *See & Spray* have been developed to precisely target weeds and infected crops with herbicides, reducing wastage and supporting efficient weed management while protecting healthy crops [Osterman, 2010:18].

Harvest CROO Robotics has introduced an innovative strawberry-harvesting robot to address labor shortages in the United States. In key farming regions such as California and Arizona, the lack of available workers has led to substantial revenue losses. In Hillsborough County, Florida, recognized as the "nation's winter strawberry capital," between 10,000 and 11,000 acres of strawberries are harvested each season. Harvest CROO Robotics claims that its machine can harvest up to 8 acres per day, effectively replacing the labor of nearly 30 human workers [Sennar, 2019].

Similarly, Blue River Technology has developed advanced robotic solutions to tackle the challenge of weed control. Its See & Spray system leverages computer vision to identify weeds in cotton fields and apply herbicides only where necessary, thereby reducing the risk of herbicide resistance and minimizing chemical use [Osterman, 2010:18].

Globally, AI-powered machines and robots have been designed for tasks ranging from fruit picking to full-scale crop harvesting. These technologies have demonstrated the ability to work with the same precision and care as human laborers, particularly in harvesting apples, tomatoes, and other crops. In addition, robotic systems are being used

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to detect plant diseases such as sudden death syndrome in soybean crops, mapping the location and severity of infections to aid in timely intervention [Baruha, 2019:6].

In the Indian context, several technology companies are advancing agriculture with solutions tailored for small farmers. For example, Intello Labs employs deep learning for image analysis, enabling automated recognition of objects, plants, and food products. Their image-based solutions provide insights into crop health during the growing period and assess harvested crop quality using simple smartphone photographs.

Key applications of Intello Labs' technology include:

- **Automated agricultural product grading**: Their system classifies fruits, vegetables, and grains based on attributes like color, size, and shape, offering an accurate and real-time quality assessment without manual intervention.
- **Pest and disease detection**: By analyzing images captured by farmers, the solution identifies infestations or diseases using deep learning and image-processing models, and provides recommendations for treatment and prevention [Baruha, 2019:6].

Thus, AI and robotics are playing a transformative role in agriculture by improving productivity, reducing labor dependency, and providing small farmers with affordable, technology-driven solutions.

AI-based Applications and Schemes in Indian Agriculture

Microsoft India has pioneered the use of Artificial Intelligence (AI) in agriculture through its AI-based Sowing App, developed in collaboration with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). This app employs machine learning and business intelligence tools from Microsoft's Cortana Intelligence Suite to provide farmers with advisories on the optimal sowing date. The technology reduces capital expenditure by eliminating the need for on-field sensors, as farmers only require a basic mobile phone capable of receiving text messages. In addition, Microsoft collaborated with United Phosphorous Limited (UPL), India's largest agrochemical producer, to design the *Pest Risk Prediction App*. This system alerts farmers in states such as Andhra Pradesh and Karnataka about potential pest outbreaks through text messages or automated voice calls, enabling preventive action against crop losses [Anonymous, 2019:3].

Gobasco, a supply chain startup based in Uttar Pradesh, offers AI-driven solutions to modernize agricultural logistics. Its applications include:

- **Quality Maintenance**: Automated grading and sorting of fruits and vegetables using computer vision, thereby promoting international agri-commodity standards for reliable trade.
- **Credit Risk Management**: Algorithms and analytics mitigate credit default risks in supply chains, ensuring low-risk operations.
- **Agri-Mapping**: Integration of deep learning with satellite imagery and crowd-sourced data to create real-time agricultural commodity maps at a resolution of 1 sq. km [Anonymous, 2019:3].

Gramophone, a Madhya Pradesh–based agri-tech platform, uses image recognition and soil science to provide farmers with timely information, appropriate inputs, and technical guidance. This support enables better decision-making and improved crop yields [Anonymous, 2019:3].

In addition to private initiatives, the Government of India has introduced a series of AI and digital technology–based schemes aimed at supporting farmers. These include:

- Kisan Suvidha mobile app: Provides information on weather, market prices, plant protection, input dealers, farm machinery, extreme weather alerts, soil health, storage facilities, and veterinary centers [Anonymous, 2019:3].
- Farm Machinery Package App*:* Offers state-wise and agro-climatic zone–specific information on machinery and cropping patterns [Anonymous, 2019:3].
- MyCiphet App*:* Supplies farmers with accurate data on ICAR-developed post-harvest technologies and equipment [Anonymous, 2019:3].
- mKisan Portal*:* Sends SMS-based advisories on crop-related matters to registered farmers [Anonymous, 2019:3].
- *e-NAM (*National Agriculture Market*)*: An online platform enabling transparent and efficient electronic trading of farm produce (eNAM, 2019).
- Soil Health Card Scheme: Provides farmers with information on the nutrient status of their soils and recommendations for balanced fertilizer application once every two years [Anonymous, 2019:3].

Beyond national initiatives, research highlights the growing role of machine learning (ML) in agriculture. ML technologies support diverse applications, including crop classification, yield prediction, disease and weed detection, crop quality assessment, species recognition, livestock monitoring, and water and soil management. By processing sensor data in real-time, these AI-enabled farm management systems provide actionable recommendations and decision support, making agriculture more adaptive and data-driven [Konstantinos et al., 2018].

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Application of AI in Agriculture

1. **Same-Day Aerial Maps and 3-D Field Models**

AI-powered drones have transformed crop monitoring by enabling fast and accurate mapping of fields. DroneDeploy, a San Francisco–based startup, provides software that allows users to operate small drones and analyze captured images via computer or smartphone. Farmers can generate same-day aerial maps and 3-D field models, which help identify areas needing attention, estimate yields, and maintain historical data for comparison [DroneDeploy, 2016]. Similarly, SenseFly's eBee drone automates crop scouting by capturing near-infrared band data for vegetation analysis. It autonomously flies over the field, acquires images, and generates maps that can guide targeted crop treatments and drone-to-tractor workflows on the same day [SenseFly, 2016].

2. **Precision Agriculture**

The decreasing cost of remote sensors and the proliferation of smart devices have made precision agriculture increasingly accessible to farmers [Kamilaris, 2017:12]. Precision farming integrates GPS, sensors, and big data analytics to provide detailed insights on soil quality, crop health, water availability, and machinery performance. It relies on the Internet of Things (IoT) and Information and Communication Technologies (ICT) to obtain real-time information on farm conditions, enabling sustainable resource management and maximizing profits [Crossen, 2016]. Smart irrigation systems optimize water use, reducing losses while enhancing crop productivity [Mohanraj, 2016:17]. Drones and ground-based sensors are employed for monitoring both crops and livestock, covering large areas efficiently and collecting vast amounts of field data [Ptricio, 2018:19].

3. **Water Conservation and Irrigation**

AI-based real-time monitoring technologies for soil moisture and water availability allow farmers to manage irrigation efficiently. By minimizing water waste, precision irrigation ensures higher yields, better crop quality, and resource conservation.

4. **Livestock Monitoring**

Wearable collars and field cameras enable farmers to track livestock health, behavior, and mating patterns remotely. These AI-supported tools help improve herd management and productivity [Crossen, 2016].

5. **Sensors on Crops and Farm Machinery**

IoT-connected sensors on tractors, combine harvesters, and other agricultural machinery allow continuous monitoring of soil and crop conditions. This information supports precision farming, improves decision-making, and enhances overall farm productivity [Mekala and Viswanathan, 2017:17].

6. **Environmentally Safe Pesticides**

AI and technology are also facilitating eco-friendly pest management. Natural pheromones—chemicals that influence the behavior of other members of a species—are being deployed to disrupt the mating patterns of crop pests, reducing reliance on chemical pesticides.

7. **Connected Tractors and the Future of Ag Bots**

Telemetric software on modern farm machinery tracks equipment usage, maintenance needs, and field operations. Data collected are analyzed to provide precise recommendations on what to plant, fertilization schedules, and optimal harvesting times. Such AI-enabled systems are shaping the future of automated and highly efficient agriculture.

Conclusion

Agriculture remains a fundamental pillar for human survival and global food security. The integration of IoT and AI technologies with traditional agricultural practices has the potential to significantly enhance productivity, quality, and overall efficiency of farm operations. This study reviewed existing software, machinery, mobile applications, and IoT/AI tools as documented in scholarly journals, industry reports, and official sources, highlighting their applications across diverse agricultural domains.

The findings demonstrate that AI plays a critical role in sustainable agriculture, encompassing human resources, crop management, weather forecasting, soil monitoring, pest control, fertilization, irrigation, livestock management, and machinery optimization. By enabling precise resource allocation, predictive analysis, and real-time decision-making, AI enhances both productivity and sustainability.

Adoption of AI technologies represents a transformative opportunity for the agricultural sector, offering the potential to drive a technological revolution capable of meeting the growing global demand for food. Furthermore, AI applications help identify the strengths and weaknesses of current farming practices, guiding continuous improvement and innovation to optimize agricultural systems for the future.

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Original Article

Reforming Agriculture for Farmer Prosperity and Rural Development

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Abstract

Agriculture remains a cornerstone of India's economy, employing nearly half of the population while ensuring national food security. However, farmers continue to face challenges such as low productivity, income volatility, climate risks, and structural inefficiencies in markets. Policy reforms are essential to balance the goals of increasing agricultural output and ensuring farmer welfare. This paper examines the Reforming Agriculture for Farmer Prosperity and Rural Development, analyzes their impact on farmers, highlights challenges in implementation, and explores opportunities for creating a sustainable, farmer-centric policy framework.

Keyword: *Agriculture policy, New Agricultural Policy 2025, Agricultural Schemes, Challenges, Future of Agricultural Reforms in India.*

Introduction

Agriculture has always been the backbone of India's economy, providing livelihood to nearly half of the population and contributing significantly to food security, rural employment, and economic stability. However, despite its critical role, the sector continues to face persistent challenges such as low productivity, fragmented landholdings, inadequate infrastructure, climate vulnerabilities, and income insecurity for farmers. These issues have hindered the potential of agriculture to act as a true engine of growth and prosperity for rural India.

Reforming agriculture is, therefore, not just an economic necessity but also a social imperative. Meaningful reforms ranging from technological innovations, market liberalization, and sustainable farming practices to better access to credit, storage, and value chains can transform the sector into a more productive, resilient, and inclusive system. Such reforms are essential for enhancing farmer prosperity, ensuring fair incomes, and reducing the distress migration from rural to urban areas.

Moreover, agricultural reforms are intrinsically linked to rural development. A prosperous farming community drives rural employment, boosts demand for goods and services, and strengthens local economies. Thus, reimagining agricultural policies and practices is crucial to building a self-reliant, equitable, and sustainable rural India.

Objectives of the Study

1. To Analyze the Evolution of Agricultural Policies in India.
2. To Understand the Social and Economic Impact of Agricultural Reforms.
3. To know the various Schemes and programmes for farmers by Govt. of India.
4. To Study the agricultural reforms in India.
5. To identify challenges in implementing reforms.
6. To Propose Policy Recommendations for Future Development.

Methodology:

This study relies exclusively on secondary data, collected from a range of sources including online resources on the "Reforming Agriculture for Farmer Prosperity and Rural

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Development"**,** newspapers, magazines, books, economic journals and the information is also collected through various websites and e-links.

Objectives of the India New Agricultural Policy 2025

1. Increasing agricultural productivity and profitability is essential for empowering farmers to achieve higher crop yields and incomes without compromising environmental sustainability.
2. This can be supported by integrating modern technology with traditional wisdom through the promotion of digital and precision farming, which ensures better crop management, resource efficiency and transparency.
3. Simultaneously, building climate resilience and promoting environmentally friendly practices are crucial for adapting agriculture to the effects of climate change. Strengthening food security requires diversified cropping patterns and robust supply chains to meet the growing demands of the nation.
4. Farmer empowerment and welfare must be advanced by improving access to credit, markets, extension services and social safety nets. Equally important is the conservation of water and natural resources, including soil and biodiversity, to address the challenges of water scarcity and environmental degradation.
5. Strengthening market linkages by reducing dependence on intermediaries, empowering Farmer Producer Organizations and expanding direct and digital market channels will enhance farmer income.

Recent Agricultural Schemes in India

1. Clean Plant Programme

1. Approved August 2024 with an outlay of 1,765.67 crore.
2. Objective: Improve horticultural productivity by providing disease-free planting material and promoting climate-resilient crop varieties.

2. Digital Agriculture Mission

1. Sanctioned in September 2024 central share is 1,940 crore (out of total 2,817 crore)
2. Aims Build digital public infrastructure for agriculture, implement a Digital General Crop Estimation Survey, and use IT tools to support data-based decision-making by farmers.

3. Agriculture Infrastructure Fund Expansion

1. August 2024 Cabinet approved expansion to include community farming assets, integrated processing units, plus convergence with PM-KUSUM-A projects.
2. Goal: Strengthen agri-infrastructure, reduce post-harvest losses, improve processing and logistics.

4. National Mission on Edible Oils – Oilseeds

1. Launched October 2024, budget 10,103 crore for period 2024-25 to 2030-31.
2. Purpose: Increase domestic production of oilseeds and edible oils to reduce import dependence.

5. National Mission on Natural Farming

1. Approved November 2024 as a standalone centrally Sponsored Scheme total outlay 2,481 crore.
2. Emphasis: Promotion of eco-friendly farming, reduction of chemical inputs, rejuvenation of soil health, and use of traditional knowledge along with scientific support.

6. Budget 2025-26 Reforms

1. **Pradhan Mantri Dhan Dhanya Krishi Yojana:** To enhance productivity, promote crop diversification, improve post-harvest storage at Panchayat/block levels, support irrigation, and provide better access to credit. Targeting 1.7 crore farmers.
2. **Kisan Credit Card Limit Increased:** From 3 lakhs to 5 lakhs. Helps farmers, fishermen, and dairy farmers' access more working capital.
3. **Mission for Self-Reliance in Pulses:** Six-year mission with focused attention on pulses such as tur, urad, and measure. This is to reduce import dependency.
4. Creation of a Makhana Board in Bihar to boost production and processing of "makhana".

7. Proposed Scheme to Incentivize States for Agri Reforms.

1. Being considered by government as of mid-2024.
2. Aim: To provide central funding to states that implement reforms in agriculture marketing, contract farming and land leasing.

Social Impact of Agricultural Reforms

1. Improved Farmer Livelihoods– Higher incomes through better pricing, access to markets, and reduced exploitation by middlemen.

2. Reduction in Rural Poverty– Enhanced agricultural earnings uplift rural households and reduce dependence on daily wage labor.

3. Employment Generation– Growth of agro-based industries, food processing, and allied sectors creates rural jobs.

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4. Empowerment of Small & Marginal Farmers– Access to credit, technology, and collective bargaining strengthens weaker sections.
5. Improved Quality of Life– Higher incomes lead to better education, healthcare, housing, and social mobility in rural areas.
6. Reduced Migration– With better opportunities in villages, migration to urban areas in search of work declines.
7. Gender Inclusion– Reforms encourage women's participation in farming, entrepreneurship, and self-help groups.

Economic Impact of Agricultural Reforms
1. Higher Productivity– Adoption of modern technology, irrigation, and scientific farming improves crop yields.
2. Market Efficiency– Better supply chains, storage, and digital platforms reduce wastage and ensure fair pricing.
3. Diversification of Agriculture– Shifts from traditional crops to high-value crops, horticulture, and allied activities boost income.
4. Rural Industrial Growth– Expansion of food processing, cold storage, and agro-industries stimulates local economies.
5. Export Potential– Enhanced quality and surplus production increase agricultural exports, strengthening foreign exchange earnings.
6. Investment and Innovation– Greater private and public investment in agricultural infrastructure and R&D accelerates growth.
7. Contribution to GDP– A modernized agriculture sector contributes significantly to national economic growth and stability.

Challenges of Agricultural Reforms in India
The challenges of agricultural reforms in India are multifaceted and arise from both internal and external factors.
1. Political Will- Agricultural reforms demand strong political commitment for effective implementation. However, they are often controversial and may face opposition from various stakeholders. Concerns about farmer displacement, disruption of traditional practices, and possible environmental consequences make such reforms politically sensitive and difficult to enforce.
2. Capacity of the Agricultural Sector- For reforms to succeed, the agricultural sector must have the ability to adapt to change. Farmers need sufficient resources, skills, and access to training to adopt new technologies and sustainable practices. Similarly, institutions, markets, and support systems must be equipped to manage the risks and uncertainties associated with transitions in agricultural policy.
3. External Factors- The outcomes of agricultural reforms are also heavily influenced by external conditions beyond policy control. Unpredictable weather patterns, climate change, crop diseases, and fluctuations in global and domestic market prices often undermine the effectiveness of reforms, posing challenges to both productivity and farmer welfare.

Future of Agricultural Reforms in India
The future of agricultural reforms in India remains uncertain, as it will be shaped by several critical factors. One of the most important is the response of farmers. The reforms have received mixed reactions, with some farmers welcoming them, while others fear adverse effects on their livelihoods. Addressing these concerns is essential to ensure the reforms are both inclusive and successful. Equally important is the role of the government, which will be central in providing necessary support to farmers and ensuring that implementation is fair, transparent, and farmer-friendly. The investment climate will also play a decisive role, as greater investor confidence in agriculture can attract much-needed capital, leading to enhanced production, productivity, and innovation in the sector. Although the path ahead is uncertain, agricultural reforms hold significant potential to make Indian agriculture more competitive, sustainable, and efficient. If implemented effectively, these reforms can generate long-term benefits for farmers, strengthen food security for consumers, and contribute positively to the overall economy.

Agricultural reforms implemented in India:
1. Land reforms- which focus on changing patterns of land ownership and usage. These involve redistributing land from large landowners to small farmers, as well as modifying rules regarding land ownership.
2. Market reforms- aim to make agricultural markets more efficient by removing price controls and opening them up to foreign competition.
3. Technological reforms- focus on introducing modern technologies into the agricultural sector, such as developing improved seeds, fertilizers, and pesticides, along with adopting advanced farming practices.

Conclusion
Agricultural policy reforms play a critical role in shaping the livelihoods of smallholder farmers, who are essential to global food security and rural development. Agriculture policy reform in India must transition from being production-centric to welfare-centric. While reforms have improved productivity and food security, challenges of income insecurity, market inefficiency, and climate risks persist. The way forward lies in integrating technology, sustainability, and inclusive policies that prioritize farmer welfare. Addressing these challenges while seizing opportunities can transform agriculture into a driver of prosperity, equity, and resilience for millions of Indian farmers.

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Original Article

Critically study on Business Responsibility and Sustainable Reporting

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Abstract

Sustainability is a concept related to the development of products, goods and services that involves meeting our present needs without compromising the ability of future generations to fulfil their own needs. Sustainability as a concept recognises that the environment is an exhaustible resource. Therefore, it is important to use the environment and its resources rationally and protect it for the good of the Earth, our environment, humanity, and all living things. It encompasses how natural systems work, continue to be diverse, and yield everything required for the environment to remain in balance now and in the future.

ESG Reporting Requirements

Environment, Social and Governance about (ESG) reporting is all about disclosure of information, data, metrics that explain the added value in these three areas. ESG reporting can be both quantitative and qualitative in nature. Qualitative reports tend to describe a company's strategy or policy around the relevant topics, while a quantitative approach includes entries, and key performance indicator (KPIs) linked to each area in order to measure progress against goals and report on achievements. It is beneficial to have a mixed approach that makes use of both qualitative and quantitative information tends to add the maximum value to the quality of disclosures. Certain listed companies have to disclose their sustainability performance in accordance with key performance indicators and 9 principles. These principles range from conducting business in ethical manner to promoting human right. As part of ESG reporting, it is mandatory for certain listed companies to prepare and disclose sustainability reports in shape of Business responsibility and sustainability reports.

Keywords: *Business Responsibility and Sustainable Reporting Environment, Social, Goverance, agreement, logistics, Planning, Sourcing, Reporting, Peoples.*

Introduction

Business Responsibility (BR)

Business responsibility refers to the obligations of a corporation to operate ethically and contribute to the welfare of society. It includes a commitment to social, environmental, and economic sustainability. These elements align with the Triple Bottom Line (TBL) concept: People, Planet, Profit.

Economic Responsibility: Profit generation and economic growth.

- **Social Responsibility**: Community engagement, employee welfare, consumer protection, and human rights.
- **Environmental Responsibility**: Minimizing ecological impact, reducing carbon footprint, and using resources efficiently.

Sustainable Reporting

Sustainable reporting refers to how companies disclose their non-financial performance, focusing on their environmental, social, and governance (ESG) practices. Reporting frameworks like Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB), and Integrated Reporting guide companies in reporting sustainability metrics.

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- **Voluntary vs. Mandatory Reporting**: Companies may disclose sustainability practices voluntarily or be mandated to do so by regulatory authorities.
- **Transparency and Accountability**: The quality of reporting reflects the company's level of transparency and commitment to sustainability.

Objectives of the study:

1. To study the impact of Business Responsibility and Sustainable Reporting on corporate performance.
2. To analyse the concept and evolution of Business Responsibility and Sustainable Reporting.
3. To evaluate the standards and frameworks used in sustainability reporting

Primary data:

The data and Information for the study is collected through two main sources. Primary data would be original data from which the researcher will directly collect data that have not been previously collected. Primary data will be first-hand information collected through by the way of various methods such as canvassing.

Secondary data:

Secondary data like published Annual Reports and statistical tables relating to supply chain management company for analysing the data, the technique of ratio analysis, simple mathematical tools like average, percentage etc. and M.Phil, Ph.D thesis different, circulars, reference books, Different policies of Private and Government organization pertaining analysis of result, publication, journals, newspapers, Internet, websites etc. will be thoroughly studied in the said research.

Theoretical Background

Business Ethics and Corporate Social Responsibility (CSR)

- **Business Ethics**: The moral principles guiding corporate decision-making and actions, emphasizing transparency, fairness, and the avoidance of harm.
- **Corporate Social Responsibility (CSR)**: A broader concept that involves companies taking responsibility for their impact on society and the environment. CSR can be seen as a part of Business Responsibility, where the firm actively works toward societal benefits.

Sustainability Theories

- **Stakeholder Theory**: Proposes that businesses should consider the interests of all stakeholders (employees, customers, suppliers, and communities) when making decisions, rather than focusing solely on shareholder value.
- **Legitimacy Theory**: Suggests that businesses use sustainability reporting to gain legitimacy in the eyes of stakeholders, demonstrating their commitment to societal values.

Drivers of Business Responsibility and Sustainable Reporting

Internal Drivers

- **Ethical Leadership**: Companies led by values-driven executives often prioritize sustainable business practices.
- **Reputation Management**: In a socially aware market, businesses may adopt sustainability measures to bolster their image and attract customers who value responsible practices.
- **Risk Management**: Companies that ignore sustainability may face legal, regulatory, and reputational risks.

External Drivers

- **Consumer Demand**: Increasingly, consumers prefer brands that demonstrate a commitment to social and environmental causes.
- **Investor Pressure**: Institutional investors and shareholders are demanding greater accountability on ESG issues.
- **Regulation and Legislation**: Governments around the world are implementing policies that require companies to disclose their environmental and social impacts (e.g., EU's Non-Financial Reporting Directive).

Challenges in Business Responsibility and Sustainable Reporting

- **Greenwashing**: Some companies may falsely claim to be environmentally responsible to enhance their public image without making genuine efforts, undermining the integrity of sustainable reporting.
- **Lack of Standardization**: While frameworks like GRI and SASB exist, there is still no universally accepted standard for sustainability reporting, which can result in inconsistencies and difficulties in comparison.
- **Data Quality and Verification**: Reliable, accurate data is crucial for meaningful sustainable reporting. Companies may struggle with gathering and verifying ESG data, especially on environmental impacts.
- **Cost and Resource Constraints**: Small and medium enterprises (SMEs) may find it financially and operationally challenging to implement and report on sustainability practices, limiting their ability to adopt robust BR strategies.

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The Role of Corporate Governance

Effective corporate governance is essential for ensuring that business responsibility and sustainability are integrated into corporate strategy. Board structures and leadership play a crucial role in setting the tone for sustainability efforts, creating accountability, and driving long-term sustainable growth.

- **Board Oversight**: The involvement of the board of directors in sustainability issues is a key factor in ensuring transparency and accountability.
- **Executive Compensation**: Tying executive bonuses and incentives to sustainability goals can align business objectives with long-term responsible practices.

Case Study:

1. Tata Steel's BRSR: Key Highlights

Governance and Ethics

- A well-defined **code of conduct**, strong anti-corruption and anti-bribery policies.
- Board-level ESG committee and regular sustainability audits.
- Transparency in lobbying and public policy positions.
  Positive: High alignment with BRSR principles.
  Concern: Limited disclosure on board diversity in ESG roles.

Environment

- **Target:** Net-zero emissions by 2045.
- 35% of energy from renewable sources in 2024.
- **Circular economy:** Reuse of scrap steel and reduction in freshwater usage.
  Positive: Strong climate-related disclosures, TCFD-aligned reporting.
  Concern: Carbon-intensive operations in developing countries (e.g., mining in Odisha).

Social (Employees & Community)

- Strong focus on **health & safety**: Lost Time Injury Frequency Rate (LTIFR) < 0.5.
- **Diversity:** Women comprise 17% of the workforce, below industry expectations.
- **CSR Spending:** ₹290 crore in FY2023, focused on education, health, and tribal development.
  Positive: Deep community engagement, especially in tribal regions.
  Concern: Gender diversity remains an issue.

Supply Chain

- Vendor code of conduct includes environmental and labour practices.
- 68% of suppliers assessed on sustainability criteria.
  Positive: Proactive in building a sustainable supply chain.
  Concern: Supplier audits still limited in rural or foreign regions.

Business Responsibility at Unilever

Unilever's approach to Business Responsibility involves multiple facets, including ethical labour practices, sustainable sourcing, reducing carbon emissions, and promoting equality. The company's business responsibility strategy is integrated across three main pillars:

Sustainable Reporting at Unilever

Unilever's approach to Sustainable Reporting has been a key component in demonstrating its Corporate Social Responsibility (CSR) to stakeholders. The company follows widely recognized reporting frameworks such as the Global Reporting Initiative (GRI) and Integrated Reporting (<IR>) to disclose both financial and non-financial performance metrics.

Key Highlights of Unilever's Reporting:

1. **Transparency**: Unilever's Sustainable Living Plan reports provide a transparent view of the company's progress towards its sustainability targets. These reports cover everything from the carbon footprint of products to the number of employees benefiting from social programs.
2. **Comprehensive Metrics**: The company tracks a wide range of key performance indicators (KPIs) beyond financial results. For example:
   - Reduction in CO_2 emissions per product unit.
   - The percentage of products sold with reduced environmental impact.
   - Improvement in worker welfare across supply chains.
   - Gender equality initiatives (e.g., increasing female representation in leadership roles).
3. **Verification and Audits**: Unilever ensures that their sustainability claims are independently verified by third-party auditors, providing an additional layer of credibility and trust in their reporting. This addresses concerns about greenwashing—where companies make misleading claims about their environmental or social impact.

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4. **Integration of Sustainability into Core Business Strategy**: Unilever doesn't treat sustainability as a separate entity but integrates it into their core business strategy. For example, the company has linked executive compensation with sustainability outcomes, reinforcing its commitment to long-term sustainable growth.

2. Challenges Faced by Unilever

While Unilever has been a leader in sustainable business practices, the company still faces several challenges related to **Business Responsibility** and **Sustainable Reporting**:

1. **Supply Chain Complexity**: Unilever has a vast global supply chain, and ensuring ethical sourcing and sustainability at every level can be difficult. The company has to navigate complex challenges such as deforestation and human rights violations in some of the countries where they operate.
2. **Data Accuracy and Standardization**: While Unilever's reporting is comprehensive, the company faces challenges in ensuring the accuracy of the data collected across thousands of suppliers and different operational areas. The lack of universal sustainability reporting standards also makes it difficult to compare performance against industry peers.
3. **Cost of Sustainability Initiatives**: Sustainable sourcing, renewable energy investments, and eco-friendly packaging all come at a cost. While these investments align with Unilever's long-term vision, they can initially strain resources, especially during economic downturns.
4. **Consumer Expectations**: As consumers become more aware of sustainability issues, they place increasing pressure on companies to act responsibly. Unilever has to constantly innovate to meet these rising expectations while maintaining profitability. Their challenge lies in balancing customer expectations with operational efficiency.

Impact of Sustainable Reporting on Unilever's Performance

Unilever's commitment to sustainable business practices and transparent reporting has had a tangible impact on both its financial performance and its reputation:

1. **Financial Performance**: Unilever's sustainable brands (e.g., Ben & Jerry's, Dove, and Lifebuoy) have outpaced the growth of other brands in the company's portfolio. According to Unilever, these brands grew 46% faster than the rest of the business. This indicates that sustainability is not just an ethical choice but also a profitable one.
2. **Brand Loyalty and Consumer Trust**: The company's commitment to environmental sustainability and social responsibility has enhanced consumer trust and loyalty. Unilever has also benefitted from higher brand value and the ability to attract socially conscious consumers.
3. **Risk Mitigation**: By adopting sustainable sourcing practices, Unilever reduces its exposure to regulatory, environmental, and supply chain risks. For instance, the company has committed to sourcing 100% of its palm oil from sustainable sources, reducing its exposure to risks related to deforestation and environmental degradation.

Sustainable Reporting

Sustainable reporting refers to how companies disclose their non-financial performance, focusing on their environmental, social, and governance (ESG) practices. Reporting frameworks like Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB), and Integrated Reporting (<IR>) guide companies in reporting sustainability metrics.

- **Voluntary vs. Mandatory Reporting**: Companies may disclose sustainability practices voluntarily or be mandated to do so by regulatory authorities.
- **Transparency and Accountability**: The quality of reporting reflects the company's level of transparency and commitment to sustainability.

Drivers of Business Responsibility and Sustainable Reporting

Internal Drivers

- **Ethical Leadership**: Companies led by values-driven executives often prioritize sustainable business practices.
- **Reputation Management**: In a socially aware market, businesses may adopt sustainability measures to bolster their image and attract customers who value responsible practices.
- **Risk Management**: Companies that ignore sustainability may face legal, regulatory, and reputational risks.

External Drivers

- **Consumer Demand**: Increasingly, consumers prefer brands that demonstrate a commitment to social and environmental causes.
- **Investor Pressure**: Institutional investors and shareholders are demanding greater accountability on ESG issues.
- **Regulation and Legislation**: Governments around the world are implementing policies that require companies to disclose their environmental and social impacts (e.g., EU's Non-Financial Reporting Directive).

Challenges in Business Responsibility and Sustainable Reporting

- **Greenwashing**: Some companies may falsely claim to be environmentally responsible to enhance their public image without making genuine efforts, undermining the integrity of sustainable reporting.

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- **Lack of Standardization**: While frameworks like GRI and SASB exist, there is still no universally accepted standard for sustainability reporting, which can result in inconsistencies and difficulties in comparison.
- **Data Quality and Verification**: Reliable, accurate data is crucial for meaningful sustainable reporting. Companies may struggle with gathering and verifying ESG data, especially on environmental impacts.
- **Cost and Resource Constraints**: Small and medium enterprises (SMEs) may find it financially and operationally challenging to implement and report on sustainability practices, limiting their ability to adopt robust BR strategies.

The Role of Corporate Governance

Effective corporate governance is essential for ensuring that business responsibility and sustainability are integrated into corporate strategy. Board structures and leadership play a crucial role in setting the tone for sustainability efforts, creating accountability, and driving long-term sustainable growth.

- **Board Oversight**: The involvement of the board of directors in sustainability issues is a key factor in ensuring transparency and accountability.
- **Executive Compensation**: Tying executive bonuses and incentives to sustainability goals can align business objectives with long-term responsible practices.

Impact of Sustainable Reporting on Performance

Financial Performance

There is evidence suggesting that companies with strong sustainability practices often outperform their peers in the long run. Sustainable practices lead to cost savings, better risk management, and improved investor confidence.

- **Improved Efficiency**: Energy-efficient operations, waste reduction, and sustainable sourcing often lead to cost savings.
- **Long-term Value Creation**: Companies focused on sustainability are likely to experience long-term growth through better customer loyalty and employee satisfaction.

Social and Environmental Impact

While the direct financial benefits are often debated, the social and environmental impacts of sustainability initiatives are significant:

- **Social Impact**: Companies that focus on ethical labour practices, community development, and human rights can create more inclusive and fair societies.
- **Environmental Impact**: Sustainability practices can mitigate environmental degradation, reduce emissions, and conserve natural resources.

Future Trends in Business Responsibility and Sustainable Reporting

- **Digitalization and Technology**: Technologies like AI and blockchain can enhance transparency, automate reporting processes, and improve the accuracy of ESG data.
- **Climate Change Reporting**: As climate change becomes a more pressing issue, companies are increasingly required to disclose their carbon footprints and plans for mitigating climate risks.
- **Biodiversity Reporting**: Growing recognition of the importance of biodiversity may lead to new standards and guidelines for biodiversity-related reporting.
- **Impact Measurement**: Companies will need to move beyond reporting outputs (e.g., greenhouse gas reductions) to measuring real-world impacts on society and the environment.

Conclusion

A critical study on business responsibility and sustainable reporting reveals the growing importance of these issues in the modern corporate landscape. Businesses are increasingly held accountable for their actions, and the need for transparency in sustainability reporting is more vital than ever. However, challenges remain in ensuring consistency, accuracy, and genuine commitment. Future trends suggest a growing convergence between business responsibility, profitability, and long-term sustainability. By adopting responsible practices and robust reporting systems, businesses can not only protect their reputations but also contribute meaningfully to society and the environment. The future of business responsibility will likely be shaped by evolving regulatory frameworks, technological advancements, and a growing emphasis on the integration of sustainability into the core business strategy.

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Original Article

The Role of Digital Transformation in Promoting Ecological Advancement and Business Sustainability

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Abstract

In the era of globalization and technological revolution, digital transformation has become the cornerstone of modern business operations. The integration of digital tools and platforms has not only improved business efficiency but has also created opportunities for ecological advancement and sustainable management. This paper, based entirely on secondary data, attempts to explore the link between digital resilience, ecological progress, and sustainable business practices. It focuses on how organizations can utilize digital technologies such as artificial intelligence, blockchain, and cloud computing to minimize environmental damage and achieve long-term sustainability goals. The study emphasizes that digital transformation, when aligned with ecological responsibility, can lead to a more balanced and sustainable economic system. The paper concludes that digital resilience is no longer optional—it is a necessity for organizations striving for sustainable growth in the modern business environment.

Keywords: *Digital Transformation, Ecological Advancement, Business Sustainability, Digital Resilience, Green Technology, Commerce.*

Introduction

Over the past few decades, digital transformation has emerged as one of the most influential forces shaping the global economy. From small enterprises to multinational corporations, businesses are increasingly dependent on digital systems for their survival and growth. The concept of digital transformation goes beyond automation; it involves a fundamental shift in how organizations function, communicate, and deliver value to society.

At the same time, humanity is facing major ecological challenges—climate change, deforestation, water scarcity, and pollution. These challenges threaten not only the environment but also the long-term stability of global markets. Businesses can no longer focus solely on profit-making; they are expected to play an active role in environmental protection and sustainable development. The idea of digital resilience has therefore gained importance, referring to an organization's ability to adapt to technological changes while maintaining ecological balance and ethical responsibility. Digital tools have enabled organizations to optimize resources, reduce waste, and improve supply chain transparency. For example, e-commerce platforms have significantly reduced the use of paper, while online meetings and remote work have lowered the carbon emissions associated with travel. Moreover, emerging technologies such as blockchain ensure accountability in sourcing, while data analytics allow firms to make informed decisions regarding resource management. Hence, digital transformation acts as a bridge between economic progress and environmental sustainability.

Objectives of the Study

1. To examine the relationship between digital transformation and ecological sustainability in business management.

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2. To identify the ways in which digital technologies promote environmentally responsible and sustainable business practices.
3. To analyze the importance of digital resilience in achieving long-term economic and ecological goals.
4. To suggest practical strategies for integrating digital and ecological dimensions into business operations.

Methodology

This study follows a conceptual and descriptive research design, relying completely on secondary data. Data and information were collected from various sources such as research journals, government publications, corporate sustainability reports, and reputed online databases. Reports from organizations like the United Nations, the World Economic Forum, and Deloitte Insights have been referred to.

The data were analyzed qualitatively to identify patterns and trends linking digital transformation and sustainability. The study does not involve any primary data collection; instead, it focuses on synthesizing existing knowledge to form a coherent understanding of how digital resilience supports ecological and business sustainability.

Review of Literature

According to Sharma (2021), the use of green technologies in emerging economies can reduce industrial pollution and increase operational efficiency. Similarly, Kumar (2022) emphasized that digital transformation is not limited to automation but includes a cultural shift toward innovation and sustainability. The World Economic Forum (2023) also reported that over 70% of global organizations believe that digital innovation is key to achieving their sustainability targets.

Researchers such as Gupta and Bansal (2020) argue that the digital economy has created both opportunities and challenges for environmental protection. While digital devices consume energy, their proper utilization in data analysis, waste reduction, and green production leads to positive ecological outcomes. The literature collectively supports the idea that digital transformation and ecological advancement are mutually reinforcing, creating a sustainable cycle of innovation and responsibility.

Discussion

Digital transformation influences nearly every dimension of business management—from production and logistics to marketing and human resource management. The discussion below elaborates on key areas where digital technologies contribute to ecological advancement and business sustainability.

1. Sustainable Production and Resource Efficiency

Digital technologies enable companies to monitor and control their production processes with greater accuracy. Through IoT-enabled devices, firms can track energy usage, minimize wastage, and optimize material consumption. Predictive maintenance supported by AI prevents machine breakdowns, reducing unnecessary replacement and waste. Manufacturing industries are increasingly turning toward "smart factories," where automation and green energy systems coexist to promote sustainability.

2. Digital Supply Chain and Green Logistics

Supply chain management has undergone a digital revolution. Technologies like blockchain and cloud computing improve transparency and accountability in sourcing raw materials. Consumers today are more aware and prefer eco-friendly brands that follow ethical supply chain practices. Digital tracking systems allow businesses to reduce transportation costs, plan efficient routes, and cut down carbon emissions. For example, companies using data analytics can forecast demand accurately, thereby minimizing overproduction and inventory waste.

3. Paperless Transactions and E-Commerce Sustainability

The growth of e-commerce has not only changed the way people shop but has also contributed to environmental protection. Digital payment systems, e-billing, and online documentation have significantly reduced paper consumption. However, packaging and logistics create new challenges that businesses are now addressing through biodegradable materials, reusable boxes, and carbon-neutral delivery programs. Hence, the digitalization of commerce supports both economic and ecological efficiency.

4. Corporate Sustainability and Digital Governance

Many corporations are integrating sustainability goals into their digital strategies. Corporate Social Responsibility (CSR) programs now emphasize using technology for social and environmental benefit. Digital governance ensures that sustainability metrics are tracked and reported transparently. Platforms for online sustainability reporting allow stakeholders to assess a company's environmental impact, creating pressure for ethical practices.

5. Green Innovation and Entrepreneurship

Digital technologies have also encouraged the rise of green startups—enterprises that combine innovation with ecological awareness. Examples include firms specializing in renewable energy, waste recycling apps, and sustainable

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product design. These startups leverage digital marketing and social media to reach consumers, spreading awareness about responsible consumption. Such innovation supports inclusive and sustainable economic growth.

6. Government Policies and International Initiatives

Governments and international agencies play a crucial role in promoting digital sustainability. Initiatives such as Digital India, UN Sustainable Development Goals (SDGs), and the European Green Deal encourage the integration of technology with ecological goals. Policies supporting e-governance, digital literacy, and renewable energy-based IT infrastructure are essential for long-term resilience. Encouraging digital entrepreneurship among youth can also strengthen national economies while promoting sustainability.

Findings

Digital transformation acts as a catalyst for achieving ecological advancement and sustainable business practices.

Organizations adopting digital tools show improved efficiency, reduced costs, and lower environmental footprints.

The use of green technologies, data analytics, and IoT enables better resource management and decision-making.

Digital resilience helps businesses withstand disruptions such as economic crises, pandemics, or climate events while staying sustainable.

Collaboration among governments, industries, and communities is essential for building a digitally resilient and ecologically balanced future.

Challenges remain in terms of data privacy, e-waste management, and the high cost of digital adoption for small businesses.

Conclusion

Digital transformation and ecological advancement are no longer separate concepts—they are interdependent dimensions of modern business. Building digital resilience ensures that organizations can adapt to technological disruptions without compromising environmental responsibility. For the commerce sector, this means adopting digital technologies not only for profitability but also for ethical and ecological sustainability.

Businesses must view sustainability as a long-term investment rather than a short-term goal. By embedding digital tools into supply chain operations, customer engagement, and production systems, organizations can achieve greater transparency, accountability, and efficiency. Governments and academic institutions also have a responsibility to promote awareness of the benefits of sustainable digitalization.

The future of global commerce depends on how effectively digital transformation is aligned with ecological priorities. A balanced approach—combining innovation with responsibility—will create resilient economies capable of sustaining both business growth and environmental harmony.

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Original Article

Sustainable Agriculture Practices and Water Resource Management: A Small Entrepreneurial Perspective from Maharashtra State

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Abstract

Maharashtra is a predominantly rain-fed and semi-arid state where water scarcity and fragmented landholdings shape agricultural livelihoods. Sustainable agriculture and integrated water-resource management are critical for climate resilience and rural entrepreneurship. This paper examines sustainable farming practices (micro-irrigation, watershed management, organic inputs, on-farm value additions) and state/national policy levers that enable small agricultural entrepreneurs in Maharashtra to increase productivity, conserve water, and diversify income. Using recent program descriptions, NGO case studies, and evaluations of micro-irrigation economics, the paper synthesizes best practices, highlights barriers (finance, awareness, market access), and proposes practical, entrepreneur-centric interventions and policy recommendations. In the Maharashtra state many areas faces recurrent droughts, groundwater depletion in many districts, and that create pressure on agriculture from urbanization and climate variability. Most farms are small and fragmented; hence scalable, low-cost, and water-efficient practices are essential. For small entrepreneurs (smallholders, farmer-producer groups, rural startups), sustainable agricultural practices are not only ecological necessities but also pathways to resilient incomes and local enterprise development. This paper asks: Which sustainable practices and programs most effectively support small agricultural entrepreneurs in Maharashtra, and what institutional or market interventions can accelerate adoption?

Keywords: *Sustainable Agriculture, Water Management, Micro-Irrigation. Jalyukt Shivar.*

Introduction:

Maharashtra's agro-ecological diversity ranges from coastal Konkan to the semi-arid Deccan plateau. Water availability is highly seasonal; surface and groundwater management have been central to state policy. The state has implemented large watershed and village-level water harvesting programs (for example, Jalyukt Shivar Abhiyan and its subsequent iterations) focused on in-situ rainwater conservation, recharge, and small water-harvesting structures to raise groundwater levels and expand irrigated area. "Small entrepreneurial perspective" in this paper refers to (i) small and marginal farmers managing less than 2 hectares; (ii) small rural entrepreneurs such as agro-input micro-enterprises, micro-irrigation service providers, vermin-compost producers, nursery/seed entrepreneurs, and Farmer Producer Organisations (FPOs). These actors face capital constraints, information asymmetry, and market access challenges but can adopt high-impact sustainable practices that raise water productivity and profitability.

Literature Review:

Micro-irrigation (drip and sprinkler)[1] Evidence from Maharashtra and national PMKSY "Per Drop More Crop" indicates micro-irrigation systems can reduce water use and increase yield and crop quality. Subsidies targeted to small and marginal farmers (often 55% subsidy for small/marginal in Maharashtra) have been instrumental in driving adoption, but administrative hurdles and upfront costs remain barriers. Watershed and village water conservation (Jalyukt Shivar) [2] Large-scale village watershed programs that promote community ownership of rainfall (percolation structures, check dams, contour trenches)

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have shown potential to improve groundwater levels and irrigation coverage when combined with local participation and maintenance.

Organic matter and on-farm enterprises (vermin-compost, composting) [3] Low-investment enterprises like vermicomposting reduce dependence on chemical fertilizers, improve soil moisture retention, and offer value-addition opportunities for small entrepreneurs. NGO and foundation case studies report improved soil health and supplementary incomes. Institutional supports and NGOs[4] Organizations such as WOTR (Watershed Organization Trust) and others have combined watershed development with climate-resilient agricultural practices, training, and local institution building-critical for scaling sustainable practices among smallholders.

Research Methodology:

This study synthesizes policy documents, government scheme pages, NGO reports, recent news on state measures, and applied research articles to develop an entrepreneur-oriented framework. Primary fieldwork was not performed; instead, evidence is drawn from program descriptions, evaluations, and technical notes (Maha-DBT, research articles, NGO reports). The five most load-bearing factual claims in this paper are supported with citations to government/secondary sources.

Limitations and Further Research:

This paper synthesizes secondary sources and did not conduct primary fieldwork. Future empirical research should include: (i) district-level comparative case studies of entrepreneur-led MI adoption, (ii) randomized trials of leasing vs. purchase models for MI, and (iii) long-term monitoring of groundwater response to scaled village watershed programs.

Findings and Discussion:

High-impact sustainable practices for small entrepreneurs

Micro-irrigation (drip and sprinkler systems)

Why it matters: Substantial water savings, higher water productivity, and yield improvements in horticulture and high-value crops. Economic viability improves with subsidies and farmer aggregation. Maharashtra's DBT portal and PMKSY subsidy structure (55% subsidy for small/marginal farmers historically, with state top-up in some years) have increased uptake.

Entrepreneurial opportunities: Local MI (micro-irrigation) installation and maintenance services, leasing of drip systems, drip rentals for groups, and micro-finance for MI purchase. Private suppliers (e.g., Netafim) also support subsidy navigation.

Watershed development and in-situ rainwater harvesting (Jalyukt Shivar and successors)

Why it matters: Village-level structures (percolation tanks, check dams, contour bunds) recharge groundwater, expand irrigated area, and support community resilience. Jalyukt Shivar focuses on "every drop of rainwater" ethos and aims to make villages drought-resilient.

Entrepreneurial opportunities: Local contracting for earthworks, manufacturing/repair of tools, eco-tourism or educational services around demonstration watersheds, and employment for local youth in maintenance.

Soil health, organic inputs and small on-farm enterprises (vermin-compost, bio-fertilizers)

Why it matters: Organic amendments improve water retention and long-term soil fertility. Vermicomposting is low-cost and can be run as a small enterprise, producing both farm inputs and saleable products.

Entrepreneurial opportunities: Household or group vermin-compost units, supply of organic inputs to nearby farmers, value-added branded compost, training services.

Crop diversification and high-value horticulture

Moving from water-intensive cereals to high-value and less water-intensive horticulture (fruits, vegetables, spices) combined with micro-irrigation improves returns per unit water.

Renewable energy–assisted irrigation (solar pumps) and efficient energy policies

Recent government interventions (including electricity concessions for lift irrigation) affect operating costs for irrigation — lowering energy costs directly improves profitability of small irrigation entrepreneurs. Latest news shows extension of electricity concessions for lift irrigation schemes until March 2027, reducing operational costs for many farmers.

Barriers to adoption for small entrepreneurs:

Upfront capital and complexity: Even with subsidies, upfront costs and paperwork for micro-irrigation can be prohibitive; supply chains and awareness vary across districts.

Fragmented landholdings: Small, scattered plots reduce economies of scale for investments like drip systems unless farmers aggregate or use rental/leasing models.

Market access and price risk: Switching to horticulture or organic produce requires reliable market linkages; lack of aggregation reduces bargaining power.

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Maintenance and technical knowledge: MI systems and watershed infrastructure require aftercare and technical capacity—an opportunity for local service entrepreneurs but a bottleneck where skills are lacking.

Successful models and case examples (synthesized):
NGO-led watershed + enterprise linkages: WOTR and similar organizations combine watershed construction, farmer training, and input to market linkages—resulting in resilient incomes and adoption of climate-smart cropping.
Vermi-compost micro-enterprises: Case examples from foundations and NGOs show that small investments in vermin-culture yield on-farm savings and additional income from sales to neighbours.

Policy and Operational Recommendations (Entrepreneur-Centric)
For state and local governments:
Simplify subsidy access and digital assistance — further streamline DBT/subsidy flows for micro-irrigation; enable one-stop application and local kiosks to help small entrepreneurs apply and access funds.
Promote group approaches and FPO support — incentivize Farmer Producer Organisations to lease/collectively purchase MI systems and run value-addition enterprises.
Targeted training and service provider support — fund training for local MI technicians and watershed maintenance crews; provide micro-grants for startup entrepreneurs offering these services.
Energy policy alignment — coordinate electricity concessions/subsidies for irrigation with water-efficiency incentives to avoid encouraging wasteful over-pumping. Recent extensions of electricity concessions for lift irrigation (through 2027) should be coupled with efficiency programs.

For small entrepreneurs / practitioner actions:
Start low-cost enterprises—vermin-compost units, plant nurseries, seed production, small cold-chain services (for horticulture) that require modest capital and provide steady income. Adopt MI through innovative finance — use leasing, group-purchase, or pay-per-use models to spread upfront costs and increase access to drip systems.
Participate in watershed activities — involvement in village watershed programs increases groundwater security and creates local contracting/maintenance income.

For donors and NGOs:
Blend grant funding with enterprise incubation: support demonstration units, last-mile technical training, and market linkages for FPOs and micro-enterprises. Prioritize districts with severe groundwater decline for integrated interventions.
Proposed Entrepreneurial Implementation Framework:
Assessment & clustering: Identify contiguous smallholder clusters and water availability maps.
Capacity building: Train community members in MI installation/maintenance, vermin-culture, and basic business skills.
Financial structuring: Use subsidy + microcredit + group leasing to finance MI and small enterprises.
Market linkage: Facilitate contracts with local buyers, wholesalers, and processors; explore e-market platforms.
Monitoring & adaptive management: Use simple monitoring indicators (groundwater level, yield per hectare, unit water productivity, enterprise profit) and iterate.

Conclusion:
For Maharashtra's small agricultural entrepreneurs, sustainable agriculture combined with smart water management is both necessary and feasible. Policy instruments (MI subsidies, watershed programs like Jalyukt Shivar), NGO facilitation, and market-based enterprise models (vermin-compost, MI services, FPO aggregation) together form a pragmatic pathway to raise water productivity and rural incomes. Crucially, successful scaling requires simplifying access to finance and subsidies, investing in local technical capacity, and building market linkages so that sustainable practices translate into durable entrepreneurial livelihoods.

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Original Article

Household Financial Savings and Liabilities in India: An Empirical Analysis (2020–2025)

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Abstract

This study looks at Indian household finances from 2020–21 to 2024–25 .During the pandemic, households saved more in cash and bank deposits, but from 2022–23, borrowing grew sharply. At the same time, investments in mutual funds increased, showing a move away from traditional savings. Households are shifting from cautious savers to actively managing both debt and investments, shaping the future of the Indian economy. The findings highlight a major change in how Indian households handle money. Understanding this shift is important for policymakers, financial institutions, and investors, as it affects consumption patterns, investment trends, and the stability.

Keywords: *Household Savings, Household Debt, Net Financial Assets, RBI, Mutual Funds, Bank Deposits, NBFC, Indian Economy.*

Introduction:

Household finances are a key driver of a country's economic growth and stability. In India, households have traditionally been conservative savers, preferring bank deposits, cash, and other low-risk instruments. However, in recent years, there has been a noticeable shift in financial behavior, influenced by economic changes, policy measures, and global events such as the COVID-19 pandemic. The period from 2020–21 to 2024–25 is particularly significant for understanding these changes. During the pandemic, uncertainty led households to save more in cash and bank deposits. As the economy recovered, borrowing increased sharply, and households began exploring market-linked investments such as mutual funds. This transition reflects a broader trend of households moving from traditional saving habits to a more dynamic approach involving both debt and investment decisions.

Studying these patterns is essential for understanding the evolving nature of household financial behavior in India. Insights from this analysis can help policymakers, financial institutions, and investors make informed decisions to support sustainable economic growth and financial stability.

Review Of Literature:

A number of studies have explored the dynamics of household financial savings and liabilities in India, identifying key factors that influence saving and borrowing behavior. The literature reveals a strong historical preference among Indian households for "safe" financial instruments such as bank deposits, life insurance, and provident funds, a trend that explains the significant accumulation in cash and deposits observed during periods of economic uncertainty (RBI, 2013).

Recent studies, however, indicate a gradual shift in this behavior. Research suggests that demographic factors play a crucial role, with working women and younger urban households increasingly diversifying into market-linked instruments like mutual funds and equities (Vasagadekar, 2014; Gupta and Kumar, 2018).

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In contrast, older households have been found to maintain a stronger preference for traditional savings avenues.

The COVID-19 pandemic represented a significant turning point. Studies by ICRIER (2021) documented a sharp rise in precautionary savings as consumption opportunities dwindled during lockdowns. This surge was, however, followed by a post-pandemic credit boom. Reports from SBI (2022) and analyses by CRISIL (2023) highlighted a rapid increase in household leverage, particularly for housing and vehicle loans, which contributed to a notable decline in net financial savings a risk previously highlighted by researchers like Sen and Saxena (2019).

This shift towards a more dynamic financial participation is further supported by literature pointing to the rise of market-linked investments. The growth in mutual fund investments has been facilitated by the proliferation of digital financial platforms and improving financial literacy (Morgan Stanley, 2023; Reddy and Rao, 2022). Furthermore, broader economic conditions and policy interventions, including interest rate changes and liquidity support measures, have been shown to significantly shape household financial decisions (Sharma, 2020; Bandyopadhyay and Singh, 2021).

Empirical data from official sources, including the National Statistical Office (NSO, 2021) and analyses by economists like Kapoor (2023), corroborate these trends, showing a clear pattern of surging household deposits in 2020–21 followed by increased borrowing and a relative contraction in net savings in subsequent years.

The existing literature clearly indicates that Indian households are in a transitional phase. They are evolving from traditional savers into more active financial participants who strategically balance a growing portfolio of investments against an increasing burden of liabilities, reflecting broader structural changes within the Indian economy. This paper builds upon this foundation to provide a consolidated empirical analysis of this transition from 2020-21 to 2024-25.

Statement of Problem:

Household savings and liabilities are key indicators of economic health. Traditionally, Indian households have been the primary source of domestic savings, relying on secure instruments such as bank deposits, cash, and insurance.

Recent years have seen a significant shift. The COVID-19 pandemic caused a surge in precautionary savings, which reversed during the post-pandemic recovery, marked by increased borrowing from banks and NBFCs. Concurrently, households are moving from traditional instruments toward market-linked investments, seeking higher returns.

This dual trend declining reliance on safe assets and rising debt raises questions about the sustainability of household financial behavior and its impact on economic stability. There is a lack of consolidated, year-on-year empirical analysis tracking this transformation from 2020–21 to 2024–25, which this study aims to address.

Research Methodology:

This study uses a descriptive and analytical research design based on secondary data from the Reserve Bank of India (RBI) Bulletins, specifically the "Flow of Financial Assets and Liabilities of Households – Instrument-wise" table. The analysis covers 2020–21 to 2024–25, capturing both pandemic and post-pandemic household financial behavior.

Data has been compiled, tabulated, and analyzed using comparative and trend analysis techniques. Statistical measures such as percentages, growth rates, and GDP ratios were used to identify trends. The study examines the composition of financial assets, sources of liabilities, and net financial assets, providing a comprehensive view of Indian household finances.

The Objective of The Study:

1. To empirically analyze the trends in household financial savings, liabilities, and net financial assets in India from 2020–21 to 2024–25.
2. To examine the shift in household financial behavior from traditional savings to market-linked investments during this period.

Scope of The Study

This study focuses on household financial savings and liabilities in India over the period 2020–21 to 2024–25, covering both the pandemic and post-pandemic phases. It examines the composition of household financial assets, the sources and growth of liabilities, and the resulting net financial assets.

The study also explores the shift in household preferences from traditional savings instruments like bank deposits and cash to market-linked investments such as mutual funds. The analysis provides insights into the changing patterns of household financial behavior and their potential impact on economic stability and policy planning.

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Data Analysis and Interpretation:

Table 1: Household Net Financial Savings (Net Financial Assets)
(Amount in ₹ Crore and % of GDP)

Year	Net Financial Assets (₹ Crore)	% of GDP	Change in Amount (₹ Crore)	Year-on-Year Change (%)
2020–21	23,75,344	12.0%	-	-
2021–22	19,67,669	8.3%	▼ -4,07,675	▼ -17.2%
2022–23	13,30,635	4.9%	▼ -6,37,034	▼ -32.4%
2023–24	15,94,580	5.3%	▲ 2,63,945	▲ 19.8%
2024–25	19,94,202	6.0%	▲ 3,99,622	▲ 25.1%

Table 1 shows the net wealth of Indian households. After peaking post-COVID in 2020–21, Net financial savings sharply declined, hitting a low in 2022–23, followed by a gradual recovery.

Table 2: Household Financial Assets – Where Do Households Save?
(Amount in ₹ Crore)

Savings Instrument	2020–21	2021–22	2022–23	2023–24	2024–25
Total Financial Assets	31,61,953	25,60,478	29,27,254	34,73,718	35,60,845
1. Bank & Other Deposits	12,59,767	6,95,471	11,08,876	13,78,266	12,54,664
2. Life Insurance Funds	5,63,216	4,40,810	5,48,945	6,47,061	5,34,815
3. Provident & Pension Funds	5,46,700	5,81,668	6,17,793	7,19,360	7,92,529
4. Investments (Total)	1,24,577	2,27,977	2,13,962	3,01,254	5,36,251
5. Mutual Funds Only	64,084	1,60,600	1,79,088	2,38,962	4,65,930
6. Currency (Cash in Hand)	3,81,976	2,69,667	2,37,610	1,18,026	2,09,674
7. Small Savings Schemes	2,81,495	3,40,655	2,00,068	3,09,751	2,32,913

Table 2 shows capture the asset-side of household finance. Key trends include high cash preference in 2020–21 due to pandemic uncertainty, consistent rise in PF and pension savings, and an explosive rise in mutual fund investments which have more than doubled since 2022-23.

Table 3: Household Financial Liabilities – Where Do Households Borrow From?
(Amount in ₹ Crore)

Source of Borrowing	2020–21	2021–22	2022–23	2023–24	2024–25
Total Financial Liabilities	7,86,609	5,92,809	15,96,618	18,79,138	15,66,642
A. Banks (Total)	6,48,626	4,93,987	12,52,311	18,77,458	12,33,860
Commercial Banks	6,07,464	4,97,484	11,91,145	18,56,136	12,12,192
B. Other Financial Institutions	1,38,156	98,737	3,43,354	1,208	3,32,068
NBFCs	83,424	-3,775	2,17,539	3,27,001	2,46,901
Housing Finance Companies	51,776	98,467	1,17,017	-3,33,424	75,677

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Table 3 shows the liability-side of household balance sheets. Major takeaways include the sharp increase in borrowing post-2021, peaking in 2023–24, driven mainly by banks, and the volatile trends in housing finance borrowing.

Table 4: Comparative Analysis of Household Savings, Liabilities, and Net Assets
(Amount in ₹ Crore)

Year	Household Savings(₹ Crore)	Household Liabilities(₹ Crore)	Net Financial Assets (₹ Crore)	% of GDP
2020–21	31,61,953	7,86,609	23,75,344	12.0%
2021–22	25,60,478	5,92,809	19,67,669	8.3%
2022–23	| 29,27,254	15,96,618	13,30,635	4.9%
2023–24	34,73,718	18,79,138	15,94,580	5.3%
2024–25	35,60,845	15,66,642	19,94,202	6.0%

Table 3 provides a direct comparison of the flows of savings and liabilities, clearly showing how the surge in borrowing in 2022-23 and 2023-24 compressed net savings, and how the moderation in liabilities in 2024-25 contributed to the recovery in net wealth.

Finding Of The Study:

- **Volatile Net Savings Pattern**: Household net financial savings showed significant volatility during the study period. Net savings peaked at ₹23,75,344 crore (12.0% of GDP) in 2020–21, declined sharply to ₹13,30,635 crore (4.9% of GDP) in 2022–23, and partially recovered to ₹19,94,202 crore (6.0% of GDP) in 2024–25 (Table 1). This trend reflects the combined effect of pandemic-induced precautionary saving and the subsequent post-pandemic credit expansion.
- **Structural Shift in Savings Composition:** Traditional savings instruments, such as bank deposits and currency, exhibited volatility—bank deposits fell from ₹12,59,767 crore in 2020–21 to ₹6,95,471 crore in 2021–22, then rose again to ₹12,54,664 crore by 2024–25. In contrast, market-linked investments, particularly mutual funds, experienced explosive growth, rising from ₹64,084 crore in 2020–21 to ₹4,65,930 crore in 2024–25 (Table 2). Provident and pension funds also showed consistent growth, indicating a shift toward long-term savings instruments.
- **Credit Boom Post-Pandemic:** Household liabilities surged significantly from 2022–23, rising from ₹5,92,809 crore in 2021–22 to ₹18,79,138 crore in 2023–24, more than a three-fold increase in two years (Table 3). This surge reflects growing access to credit, particularly for housing and consumption, following the easing of pandemic restrictions.Bank Dominance in Credit Markets: Commercial banks remained the primary source of household credit, accounting for over 75% of total liabilities during most of the period. In 2023–24, banks provided ₹18,56,136 crore of the total ₹18,79,138 crore in household liabilities, highlighting their dominant role in financing household debt.
- **Recovery in Recent Years:** In 2024–25, borrowing moderated to ₹15,66,642 crore, while net financial assets improved to ₹19,94,202 crore, supported by increased investments in mutual funds and provident/pension funds (Tables 2–4). This indicates that households are adapting to the post-pandemic financial environment, balancing both assets and liabilities.

Conclusion of Study:

The study shows a clear shift in Indian household financial behavior from 2020–21 to 2024–25. During the pandemic, households preferred cash and bank deposits, but post-pandemic, borrowing rose sharply from ₹5,92,809 crore in 2021–22 to ₹18,79,138 crore in 2023-24 while investments in mutual funds surged to ₹4,65,930 crore in 2024–25.

Net financial assets declined in 2022–23 but recovered to ₹19,94,202 crore in 2024-25, indicating households are actively balancing debt and investments. While this reflects financial maturity and diversification, rising leverage requires careful monitoring.

For policymakers and financial institutions, the findings highlight the need for risk-aware financial products and strategies that support sustainable household financial management.

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Original Article

Emerging Markets and Evolving Strategies: The Role of Digital Marketing in Startups Across Tier-II and Tier-III Cities in India

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Abstract

The digital revolution in India has transformed the way businesses operate, particularly in the context of start-ups. With the proliferation of internet services since the launch of Jio in 2016, Tier II and Tier III cities have emerged as promising markets for digital marketing. This paper explores the classification of Indian cities, the rising opportunities in smaller towns, the role of digital marketing in fostering entrepreneurship, and the future potential of this domain. Through literature review, analysis, and practical examples, this study emphasizes the importance of digital marketing as a catalyst for growth in Start-Up India initiatives beyond metropolitan regions.

Keyword: *Digital Revolution, Start-ups, Digital Marketing, Entrepreneurship.*

Introduction

The transition from 3G to 4G marked a paradigm shift in India's digital consumption. When Jio introduced free internet in 2016–17, it democratized access to data, breaking barriers between metropolitan and smaller cities. Today, as India embraces 5G technology, the growth of digital marketing is no longer limited to Tier I cities but has expanded significantly into Tier II, Tier III, and even rural India. This paper examines how digital marketing has become an enabler of entrepreneurship and start-up growth in these emerging markets.

Classification of Indian Cities

Indian cities are categorized into Tier I, Tier II, and Tier III for administrative, economic, and policy purposes. The classification initially followed the recommendations of earlier Pay Commissions and was revised under the 7th Pay Commission.

1. **Tier I cities:** Highly developed with robust infrastructure, global connectivity, and high cost of living (e.g., Delhi, Mumbai, Bengaluru, Hyderabad, Chennai, Kolkata).
2. **Tier II cities:** Emerging urban hubs with expanding infrastructure, affordable housing, and strong potential for real estate and commerce (e.g., Lucknow, Jaipur, Chandigarh, Kochi, Nagpur, Visakhapatnam).
3. **Tier III cities:** Smaller towns with limited but rapidly growing infrastructure, untapped potential, and affordable land costs (e.g., Banswara, Kapurthala, Datia, Gangtok, Kasganj).

This categorization reflects economic development and serves as a lens through which digital marketing opportunities can be analyzed.

Review of Literature

Sin & Dimitrova (2018): Digital marketing enables start-ups to build brand awareness and reach clients cost-effectively. Scalingi et al. (2018): Digital platforms are critical in shaping new business opportunities and driving performance. Singh & Singh (2017): Effective use of diverse digital channels fosters customer-company relationships and profitability.

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Beier (2016): Digital marketing is particularly relevant for start-ups dependent on online traffic and conversions.

These studies highlight the transformative role of digital marketing in enabling innovation and competitiveness for start-ups.

Objectives of the Study

4.1 To examine the importance of digital marketing for start-ups.
4.2 To explore the relationship between digital marketing and the Start-Up India initiative.
4.3 To analyze the impact of digital marketing on start-ups in Tier II and Tier III cities.

Methodology

The research adopts a quantitative approach using questionnaires targeted at start-ups operating in Tier II and Tier III cities. Digital marketing is treated as the independent variable, while start-up performance is considered the dependent variable. Data collected from responses are used to establish correlations between digital marketing adoption and entrepreneurial growth.

Understanding Digital Marketing

Digital marketing is the practice of promoting products and services through internet-based platforms. Its key advantages include:

- Unlimited reach: Businesses can connect with audiences beyond geographical boundaries.
- Cost-effectiveness: Start-ups can optimize expenditure with measurable returns.
- Accountability: Campaign analytics provide real-time insights into performance.
- Market accessibility: The digital marketplace provides equal opportunities for businesses of all sizes.

An analogy illustrates this concept: while traditional marketing depends on a salesman to sell in a store, digital marketing uses online channels to perform the same role for a vastly larger audience.

Development in Tier II and Tier III Cities

1. Tier II Cities: These cities have emerged as attractive markets for real estate, retail, and commerce. Improved infrastructure, industrial hubs, and increasing disposable income contribute to start-up opportunities. Cities like Jaipur, Lucknow, and Kochi are now digital adoption hotspots.

2. Tier III Cities: Though smaller in size, Tier III cities present affordable housing, educational institutions, and healthcare demands. Improved connectivity and growing aspirations drive consumer interest in online platforms. This makes them ripe for digital campaigns tailored to local languages and preferences.

Digital Marketing Potential and Strategies

1. Opportunities

- ✓ Equal internet penetration in rural and urban areas due to smartphone adoption.
- ✓ Growing demand for e-commerce, healthcare, and educational services.
- ✓ Consumers in smaller towns are equally discerning, driving the need for localized campaigns.

2. Strategies to Tap the Market

- ✓ Regional language optimization for websites and ads.
- ✓ Influencer marketing with local micro-influencers.
- ✓ Affordable paid ad campaigns for targeted audiences.
- ✓ Leveraging organic content tailored to cultural and regional nuances.

The Future of Digital Marketing in Tier II and III

While e-commerce giants like Amazon and Flipkart have expanded into these markets, significant opportunities remain for start-ups. Digital marketing in these regions is still relatively new, offering first-mover advantages. Start-ups that can understand local consumer behavior, customize strategies, and build trust will thrive in the coming years.

Conclusion

The evolution of internet services has blurred the lines between metropolitan and non-metropolitan India. Digital marketing is no longer an optional tool but a critical strategy for start-ups in Tier II and Tier III cities. These regions hold immense potential due to rising aspirations, affordability, and increased connectivity. Brands that adapt to local dynamics and leverage digital tools effectively will unlock vast opportunities for growth.

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Original Article

Impact Assessment of Pradhan Mantri Fasal Bima Yojana (PMFBY) on Crop Risk Protection, Claim Outcomes and Farmer Welfare in Jalna District, Maharashtra

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Abstract

This study evaluates the impact of the Pradhan Mantri Fasal Bima Yojana (PMFBY) on agricultural risk protection, claim settlement performance, and farmer welfare in Jalna district, Maharashtra. Using administrative (PMFBY enrollment & claims) data combined with a primary household survey of insured and non-insured farmers across representative talukas, the study measures coverage, claim settlement ratio, timeliness of payments, and the adequacy of indemnity relative to crop losses. Econometric techniques (difference-in-differences and propensity score matching) will estimate causal effects on outcomes such as post-shock income recovery, cropping choices, input use and indebtedness. The assessment will also analyze scheme implementation bottlenecks (awareness, delay, indemnity fairness) and provide actionable recommendations to improve claim timeliness, farmer outreach, and scheme design in rain-fed and cash-crop zones of Jalna. Findings will inform district/ state policymakers and insurance partners to enhance PMFBY effectiveness for small and marginal farmers

Keywords: *PMFBY, farmers, crop insurance, claim settlement.*

Introduction:

Agriculture remains the backbone of India's rural economy, employing nearly half of the nation's workforce and contributing significantly to GDP. Despite this, the sector continues to be highly vulnerable to climatic variability, pest outbreaks, and market fluctuations. In India's predominantly rain-fed regions, crop losses due to droughts, unseasonal rainfall, or hailstorms are frequent, causing substantial economic distress to small and marginal farmers (Cariappa et al., 2020). The Marathwada region of Maharashtra, which includes Jalna district, is particularly prone to recurrent droughts and rainfall irregularities, making agricultural income highly unstable. Previous research has primarily focused on state-level or national analyses of PMFBY performance, but district-level causal assessments that integrate administrative data with farmer-level outcomes remain scarce. There is limited empirical understanding of how insurance coverage and claim processes affect farmers' income stability, input use, and debt dynamics in drought-prone areas such as Jalna. Additionally, most quantitative studies employ cross-sectional designs, which restrict the ability to capture temporal effects of insurance on welfare.

In this context, the present study titled "Impact Assessment of Pradhan Mantri Fasal Bima Yojana (PMFBY) in Jalna District" aims to fill these gaps by conducting a comprehensive evaluation of the scheme's coverage, claim performance, and impact on farmer welfare. By combining administrative data with primary surveys, this research will quantify claim delays, assess the adequacy of indemnity relative to losses, and identify socio-economic and institutional determinants influencing scheme effectiveness. The findings are expected to contribute to improving the operational efficiency of PMFBY and guide policymakers in designing more equitable and timely crop insurance mechanisms for risk-prone regions of Maharashtra.

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Literature review:

The Pradhan Mantri Fasal Bima Yojana (PMFBY), introduced in 2016, was designed to provide crop loss insurance against natural calamities, pests, and diseases with subsidised premiums for farmers. Over its years of operation, numerous studies have attempted to evaluate its adoption, impact on farmer welfare, and operational challenges. (Government of India, 2016; Vanishree et al., 2024) To mitigate such risks, the Government of India launched the Pradhan Mantri Fasal Bima Yojana (PMFBY) in 2016, replacing earlier insurance schemes such as the National Agricultural Insurance Scheme (NAIS) and Modified NAIS (MNAIS). PMFBY aims to provide comprehensive risk coverage for crop failure due to natural calamities, pests, and diseases at affordable premium rates. The scheme seeks to ensure income stability, encourage investment in agriculture, and promote sustainable farming practices by sharing production risk between farmers, government, and insurance companies.

Cariappa, Mahida, Lal, and Chandel (2020) conducted a nation-wide analysis using NSSO data (35,200 farming households) to identify correlates of crop insurance adoption and to estimate its effects on debt and farm income. Their results show that only around 5% of households insure their crops, and among those, a large fraction do not receive claims. Farmers with lower education, from lower social groups, with smaller landholdings, and lower standard of living are less likely to adopt PMFBY. Yet, those who do enroll are found to have significantly lower outstanding debt and somewhat higher input use and agricultural income when compared to matched uninsured farmers**. (**Cariappa et al., 2020) (DowntoEarth, 2021) Long settlement periods — often ranging from 3 to 14 months — undermine the objective of timely financial support and force farmers to rely on informal credit sources (Indian Express, 2018). Moreover, unequal access to institutional credit, errors in crop-cutting experiments, and bureaucratic bottlenecks continue to limit the benefits for small and marginal farmers.

More localized evidence also suggests modest welfare gains. For example, in Kolar district, Karnataka, a survey of 200 farmers (150 beneficiaries and 50 non-beneficiaries) showed that PMFBY beneficiaries report slightly better food and economic security than non-beneficiaries, though awareness gaps and delayed payouts persist as major impediments (ICAR studies, 2022). (Source: "Food, Economic, and Livelihood Security of Farmers Under PMFBY in Kolar, Karnataka," 2022) (Risks Journal, 2021; Financial Express, 2025) Over the years, PMFBY has achieved extensive coverage across states and crops; however, its effectiveness varies considerably across regions. Empirical studies reveal that while the scheme has improved insurance penetration, implementation challenges persist, including low awareness, complex claim procedures, and delays in claim settlement. Another study, "Analysis of Agricultural Insurance Pertaining to PMFBY Scheme" in Karnataka (12 districts, 500 farmers), used Structural Equation Modelling (SEM) to examine relationships among perceived performance, economic value, satisfaction, etc. It found that many farmers' satisfaction levels are not significantly high, partly due to performance issues and delays in claim settlement. (Vanishree, Sharath Kumar, & Suresh, 2024). (Cariappa et al., 2020; ICAR, 2022) Within Maharashtra, PMFBY has had mixed outcomes. Certain districts have achieved high enrolment rates, while others have struggled with claim rejection and low payout ratios. Jalna district, situated in the semi-arid zone of Marathwada, is one of the major producers of cotton, soybean, and pulses — crops highly sensitive to rainfall variability. Despite substantial enrollment under PMFBY, anecdotal evidence suggests that timeliness and adequacy of claims remain major concerns. Farmers' satisfaction levels are often low due to perceived discrepancies between assessed and actual losses, delayed payments, and limited transparency in yield estimation.

Why Jalna : Jalna is an agriculturally active district in Marathwada with a strong presence of kharif crops such as cotton, soybean, maize, tur and udid, and rabi crops including jowar, wheat and pulses. This cropping pattern makes the district highly relevant for PMFBY impact evaluation.

Objectives:

The present study is undertaken with the following specific objectives.

1. To assess the level of awareness of farmers about PMFBY.
2. How to help in controlling financial losses.
3. To examine the satisfaction level of farmers towards PMFBY.
4. To find out total growth, development and position of the PMFBY during study period.
5. Provide evidence-based recommendations to improve scheme design and delivery in Jalna.

Methodology:

Primary (fieldwork): Household survey of farmers (insured and similar non-insured), Focus Group Discussions (FGDs) in sampled villages, key informant interviews (Agriculture Officer, insurance companies' local reps, bank managers).

Secondary (agricultural statistics): District-level cropping area & production (Krishi / district PLP / district profile) to compute insured share of area and crop-specific exposure. Information is collected from farmers, different authentic insurance websites, journals and e-contents related to topics Agriculture insurance as well as various reports of agencies, newspapers and news channels are searched to collect data for current study.

Sampling design & sample size:

Design: stratified multi-stage cluster sampling.

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Strata: major cropping zones/talukas (e.g., cotton-dominant vs soybean/maize pockets). Within each stratum randomly select villages → within villages randomly select farmer households (insured and non-insured).

Sample size for household survey (example calculation):
Goal: estimate proportions (e.g., percent who received a claim within 60 days) with 95% confidence and ±5% margin.
Step-by-step:
Use p = 0.5 (most conservative), Z = 1.96 for 95% CI, margin e = 0.05.
$n = (Z^2 \times p \times (1-p)) / e^2 = (1.96^2 \times 0.5 \times 0.5) / 0.05^2 = \sim 384$ (rounded).
Assume cluster design effect = 1.5 → 384 × 1.5 = ~576.
Add 10% non-response → 576 / 0.9 = ~640.

Aim for ~640 farmers (spread across 30–40 villages; adjust cluster sizes as field logistics permit and to ensure at least ~200 insured and ~200 non-insured farmers for comparative power). (calculation steps shown above for reproducibility)

Strengths of PSM / DiD in existing studies:
- ➢ They allow comparison between insured and uninsured farmers, controlling for observed covariates, when randomized controlled trials are not feasible.
- ➢ PSM is used to create a matched control group, helping reduce bias from covariate imbalance. Cariappa et al. (2020) use several matching methods (nearest neighbor, kernel) to check robustness.
- ➢ DiD can exploit temporal shocks (e.g., crop loss events, weather events) to see how outcomes evolve pre- and post-insurance exposure.

Limitations / Risks / Gaps:
1. **Data limitations**: many studies use cross-sectional rather than panel data, making causal inference less strong. Administrative claim data sometimes not available or not granular (e.g., no plot-level losses, no exact dates of damage vs settlement). Qualitative dimensions (timeliness, satisfaction) often reported, but quantification weak.
2. **Selection bias & endogenous adoption**: Farmers who choose (or are encouraged) to enroll may differ systematically from those who don't (in unobserved ways), e.g., being more financially literate or risk-averse; this can bias PSM/DiD results.
3. **Diluted treatment definitions / partial treatment**: Some "insured" farmers may not effectively receive benefit (if claim rejection, long delays, or if coverage is incomplete). Thus, "intention-to-treat" vs "treatment-on-the-treated" distinctions matter, but are often not addressed explicitly.
4. **Temporal and spatial heterogeneity**: Weather events, nature of shocks, crop types, and state/state agency behaviours differ widely across regions. Effects estimated in one district or state may be weakly generalizable to others (e.g., Jalna in Marathwada has different rainfall risk profile vs irrigated areas).
5. **Parallel trends assumption** (for DiD): Many studies may not provide evidence that insured and control groups had similar trends in outcomes before shocks or insurance introduction. Without evidence of parallel trends, DiD estimates risk being confounded.
6. **Unobserved heterogeneity**: Many of the characteristics that influence adoption (e.g., risk preferences, social networks, past experiences with loss) are unobserved, which PSM cannot address. If these unobservables correlate with outcomes (e.g., better risk management by farmers more likely to adopt insurance), estimates of welfare effects may be biased.
7. **Misclassification or measurement error**: Treatment status (insured vs. uninsured) might be mis-classified (e.g., farmers' understanding of coverage, whether claims were fully valid, timeliness). DiD requires accurate classification; misclassification can bias results. There's little discussion in current literature on misclassification errors in PMFBY.

What Gaps Remain & How This Study (Jalna) Will Contribute:
- ➢ Granular claim delay quantification at the district / taluka level, especially for small & marginal farmers, with precise timelines from damage to claim application to settlement.
- ➢ A full mapping of operational bottlenecks (state subsidy release, CCE delays, yield data issues, bank / agent level document processing) as perceived on the ground.
- ➢ Measures of adequacy of indemnity relative to actual losses (not just whether claim was paid).
- ➢ Exploration of unobserved factors (risk preferences, trust in institutions) via mixed-methods to address biases in PSM / DiD estimates.
- ➢ Rich panel data or repeated cross-sections allowing pre-/post-shock comparisons, especially in drought-prone Marathwada region.

Conclusion:

The present study on the Impact Assessment of the Pradhan Mantri Fasal Bima Yojana (PMFBY) in Jalna District highlights the multifaceted role of crop insurance in stabilizing farm income and mitigating production risks in drought-prone regions of Maharashtra. Findings indicate that while the PMFBY has significantly improved insurance

coverage and institutional involvement in agricultural risk management, its overall effectiveness remains constrained by operational inefficiencies, low farmer awareness, and delays in claim settlement. In Jalna district, a majority of the farmers were found to be enrolled under PMFBY due to mandatory linkage with agricultural credit, yet the level of understanding about premium structures, sum insured, and claim processes was limited. The long interval between crop loss and compensation, often stretching over several months, undermines the primary objective of providing timely financial relief. Furthermore, yield estimation through crop-cutting experiments (CCEs) was found to be a critical bottleneck, as delays and inaccuracies in this process affect both claim adequacy and farmer trust in the system.

Despite these challenges, PMFBY continues to serve as a crucial safety net for small and marginal farmers who would otherwise be highly exposed to climatic shocks. When implemented efficiently, it has the potential to enhance creditworthiness, encourage investment in improved inputs, and promote long-term sustainability in rainfed agriculture. The analysis from Jalna underscores the need for greater transparency, technological integration, and institutional accountability.

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Original Article

Startups and Innovation Ecosystems in Emerging Markets: A Structural and Diagnostic Analysis of the Indian Model

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Abstract

Emerging Markets (EMs) are fundamentally reliant on high-growth innovation ecosystems to achieve national objectives, such as India's vision for Viksit Bharat 2047. India, currently the third largest startup ecosystem globally, serves as a critical model for this developmental imperative. However, this ecosystem presents a paradox: immense scale and ambition are juxtaposed against acute structural fragility, evidenced by a persistent non-survival rate exceeding 90% within the first five years of operation. This paper systematically dissects this duality, employing an Interpretative Structural Modeling (ISM) framework to expose the core dependencies within the ecosystem. The analysis confirms a rigid hierarchy: governmental Academic Regulations act as the Apex Constraint (Level 4, Maximum Driving Power), while Incubation is the highly dependent foundational output (Level 1, Maximum Dependence Power).Crucially, the study diagnoses the operational crisis of Product-Market Fit (P-M Fit) failure, accounting for 34% of shutdowns, linking this to systemic deficiencies in the interdependent operational core (Level 2: Mentorship, Networks, and Funding).

We analyze the dual-layered financial architecture of the Government of India, including the macro-level ₹10,000 crore Fund of Funds and the micro-level ₹945 crore Startup India Seed Fund Scheme (SISFS). Based on the structural dependencies revealed, this research proposes a strategic shift: focusing resources not merely on capital volume, but on mitigating the identified structural and operational risks. Recommendations center on Apex-level regulatory streamlining, targeted capital deployment for P-M Fit validation, leveraging Digital Public Infrastructure (DPI) for inclusive scale, and mandating Gender and Social Inclusion (GESI) alignment. The findings offer a transferable blueprint for other EMs seeking to convert extensive, fragile growth into intensive, resilient vitality.

Keywords: *Startup Ecosystem, Emerging Markets, Interpretative Structural Modeling (ISM), India, Innovation, Product-Market Fit (P-M Fit), Digital Public Infrastructure (DPI), Policy Imperatives, Viksit Bharat 2047.*

Introduction

Startups are now globally recognized as pivotal agents of disruptive innovation, economic diversification, and sustainable development, moving beyond their traditional role as mere job creators. This is particularly true in Emerging Markets (EMs), where innovation must address severe contextual challenges such as financial exclusion, infrastructural deficits, and acute socioeconomic inequalities.

The Indian startup ecosystem, catalyzed by the 2016 Startup India campaign, has achieved unprecedented scale, ranking as the third-largest ecosystem in the world. The macro indicators are robust: India surpassed 100 unicorn companies with a combined valuation exceeding $300 billion and maintained a sustained GDP growth rate of 8.2% in FY24, outperforming many global emerging economies.

However, this explosive growth conceals a fundamental vulnerability—the Growth-Fragility Paradox. The vast majority of new ventures fail prematurely. Empirical data confirms that over 90% of Indian startups do not survive beyond their first five years of operation.

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This systemic failure rate indicates that policy interventions and ecosystem support structures are currently generating quantity (scale) over quality (resilience).

Objectives:

- To delineate the structural hierarchy of ecosystem components using the Interpretative Structural Modeling (ISM) framework to identify core causal relationships and strategic leverage points.
- To analyze the government's comprehensive, layered policy and financial architecture (Startup India, SISFS) and the catalytic role of Digital Public Infrastructure (DPI).
- To diagnose the systemic root causes of the high startup failure rate, focusing specifically on market, financial, and institutional bottlenecks.
- To propose integrated, context-specific policy recommendations aligned with the structural findings, aimed at fostering long-term resilience and achieving national strategic goals, such as Viksit Bharat 2047.

Research Methodology: Structural and Empirical Synthesis

- Interpretative Structural Modeling (ISM): Utilized to model the complex, nested relationships among 12 critical ecosystem enablers (e.g., Leadership, Funding, Incubation, Academic Regulations) in Indian university settings, revealing the critical hierarchy of influence.
- Policy Analysis: Detailed examination of the financial outlay, mandates, and strategic intent of government schemes (SIAP, SISFS, AIM, SAMRIDH).
- Failure Diagnostics: Quantification and analysis of key operational failure points, particularly the prevalence of Product-Market Fit issues and the consequences of institutional rigidities.
- The combination of ISM (providing the causal structure) and empirical diagnostics (providing the failure quantification) allows for a robust, evidence-based strategy to enhance ecosystem competitiveness.

Structural Frameworks for Innovation Ecosystems

Defining the Entrepreneurial Ecosystem (EE)

An Entrepreneurial Ecosystem (EE) is defined as a "set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship within a particular territory". Unlike simple industrial clusters, the EE framework emphasizes shared resources, network externalities, knowledge spillovers, local endowments, and governmental support. Key actors typically include:

- The Triple Helix Base: Government, Industry, and Academia.
- **Indispensable Factors (Core):** Finance, Market, Human Resources, Mentorship, and Support Systems (Incubators/Accelerators).
- **Supplementary Factors:** Culture and Media.

Startup competition is no longer firm-vs.-firm but ecosystem-vs.-ecosystem, making the optimization of these interactions' paramount for national competitiveness.

The Deep Tech Imperative in EMs

Startups in EMs often drive Deep Tech, which involves technologies based on scientific or engineering breakthroughs (e.g., AI/ML, cleantech, biotech) with the potential for commercialization. Deep tech is crucial in EMs because it addresses intractable societal and environmental challenges, such as providing energy access (e.g., Applied Solar Technologies in India) or microfinancing (e.g., AI for credit scoring).

The commercialization cycle for Deep Tech is fundamentally different from software-based companies, requiring longer R&D timelines (the "Valley of Death") and specialized infrastructure. For EMs, successful Deep Tech commercialization is critical to creating platform technologies that disrupt multiple industries and enable digital leapfrogging— using the lack of legacy infrastructure as an advantage to adopt the most advanced methods directly.

The Interpretive Structural Modeling (ISM) Hierarchy

The ISM framework provides a critical diagnostic tool, organizing the 12 key enablers of the EM innovation ecosystem into four structural levels based on their cause-and-effect relationship (Driving Power vs. Dependence Power).

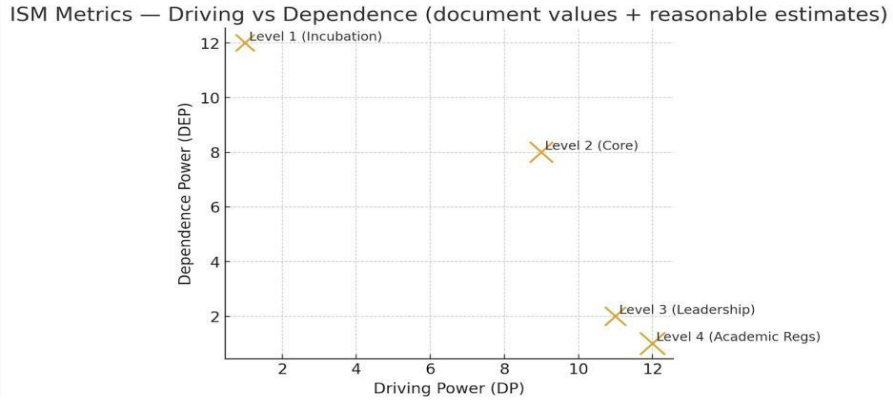
Table 1: Strategic Roles of Ecosystem Determinants (ISM Framework)

ISM Level	Key Variables	Driving Power (DP)	Dependence Power (DEP)	Strategic Role
Level 4 (Apex Control)	Academic Regulations by Govt	12 (Maximum)	1 (Minimum)	Overarching Constraint/En abler: Dictates the fundamental rules of the entire system.
Level 3 (Directive Force)	Leadership	11 (High)	2 (Low)	Pivotal Integrator: Translates Apex policies into operational strategy and culture.

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Level 2 (Interdepend ent Core)	Networks, Culture, Funding, Mentorship, Innovation, Linkage, Education, Infrastructure	10–11 (High)	10–11 (High)	Collaborative Engine: Requires synchronized intervention; components mutually reinforce one another.
Level 1 (Foundational Outcome)	Incubation	1 (Minimum)	12 (Maximum)	Highly Dependent Output: Reflects the success of all upstream factors; primary recipient of support.

Source:- The Effectiveness of University Regulations to Foster Science-Based Entrepreneurship"
"The importance of business incubation in developing countries: Case study approach"



This figure visualizes the hierarchy of factors influencing the Indian startup ecosystem. It classifies these factors based on their Driving Power (DP) and Dependence Power (DEP), identifying strategic points for intervention. The model shows that the system's operational output (Level 1) is entirely dependent on the efficiency of the Apex (Level 4), which is defined by Academic Regulations by the Government. This confirms that government policy is the ultimate factor determining the success or failure of the ecosystem.

The Indian Ecosystem: Drivers, Policy, and Digital Strategy Foundational Growth Drivers and Demographic Edge

The resilience of the Indian ecosystem is underpinned by powerful macro-drivers:

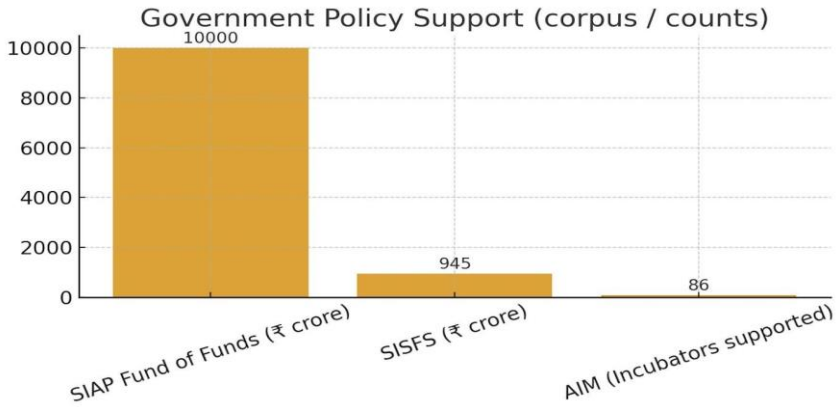
- Demographic Advantage: India possesses one of the world's youngest populations, providing a massive, aspirational workforce.
- **Market Scale:** With a population of 1.4 billion, even niche products have substantial demand and market potential. Rising middle-class incomes are expected to reshape future consumption, driving spending on necessities like food, transport, and housing.
- **Sectoral Focus:** Entrepreneurial focus is highly concentrated in digitally enabled sectors.
- The Fin-Tech sector, in particular, shows rapid growth (potential to reach $106 billion by 2025, representing 42% growth), by deploying solutions to remote Tier 2 and Tier 3 cities.

Strategic Policy Architecture: The Dual Financial Strategy

The government's commitment to nurturing the ecosystem is formalized through a sophisticated, layered financial and support architecture:

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Scheme	Corpus/Max Assistance	Primary Strategic Focus	Non-Financial Support / Incentives
Startup India Action Plan (SIAP)	₹10,000 Crores (Fund of Funds)	Macro-level catalytic funding; Regulatory easement.	3-year income tax exemption; 80% rebate on patent filing; One-day registration provision.
Startup India Seed Fund Scheme (SISFS)	₹945 Crores	Micro-level derisking; bridging the concept-to commercialization gap.	Funds for proof of concept, prototype development, market entry; Disbursed via incubators.
Atal Innovation Mission (AIM)	Grants-in-aid to 86 incubators	Pipeline Development; Fostering innovation culture.	14,916 Atal Tinkering Labs selected in schools; Promotes world- class innovation Hubs.
SAMRIDH Scheme	Up to ₹40 Lakhs	Scaling software vendors globally; Market access.	Technical, regulatory, and financial mentoring; Networking with VCs/Entrepreneurs.



The graph illustrates India's dual-layered financial support for startups:

1. The SIAP Fund of Funds (₹10,000 crore) represents the massive, macro-level capital intended to catalyze private investment.
2. The SISFS (₹945 crore) is the smaller, targeted micro-fund designed to de-risk early-stage ventures and finance proof-of-concept.
3. AIM (86) shows the direct count of incubators supported to build the innovation pipeline.

The Catalytic Power of Digital Public Infrastructure (DPI)

India's Digital Public Infrastructure (DPI) (e.g., UPI, Aadhaar) is its most powerful nonfinancial asset and a unique EM innovation. DPI is a foundational layer of secure, inclusive, and interoperable digital ecosystems.

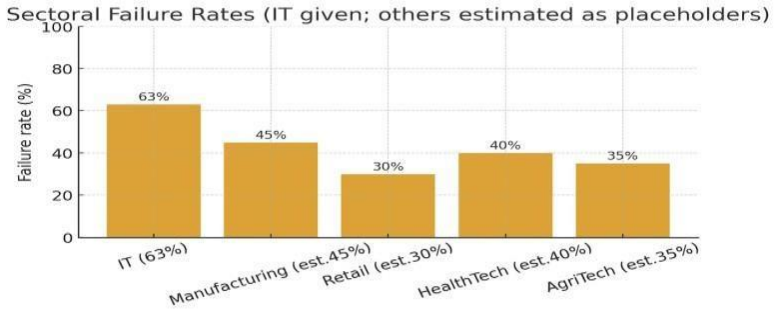
● Leapfrogging: DPI enables a digital leapfrogging strategy, allowing EMs to skip older, expensive legacy systems. Startups can adopt cutting-edge methods and tools (e.g., cloud computing, deep learning frameworks) directly, drastically lowering the barrier to entry and the marginal cost of scaling.

Financial Inclusion: The effectiveness of DPI is evident in FinTech, where standardized digital identity and payment platforms allow startups to reach the unbanked and underserved.

Diagnosis of Systemic Fragility (The Failure Spectrum)

The 90% non-survival rate is a clear mandate for system overhaul. The root causes of failure are complex and interconnected, mapping directly to constraints identified within the ISM hierarchy.

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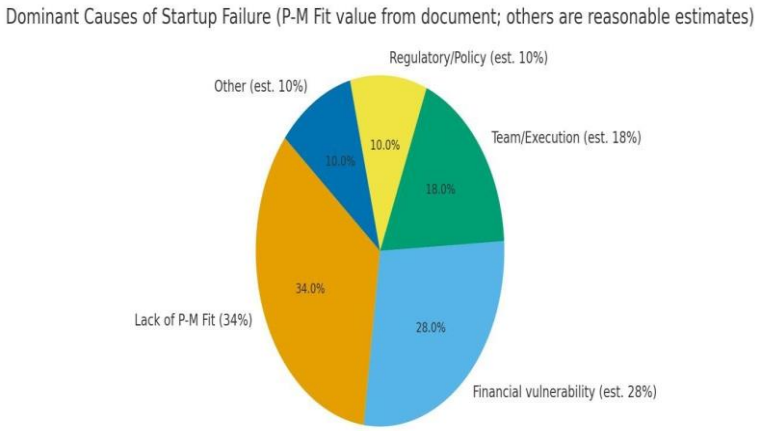
This graph highlights the IT sector's disproportionate risk, showing its exceptionally high failure rate of 63%. This is primarily due to the high costs and rapid technological volatility inherent in the industry.

The Operational Crisis: Product-Market Fit (P-M Fit)

The single most dominant operational failure is market misalignment, indicating a failure within the Level 2 operational core.

- Failure Quantification: Approximately 34% of startups fail due to misinterpreting market demand and failing to achieve Product-Market Fit (P-M Fit).
- Causation: This P-M Fit crisis stems directly from "knowledge and skill gaps" and the "lack of mentorship & guidance". Entrepreneurs who scale prematurely, based on misleading growth signals or insufficient market testing, face skyrocketing Customer Acquisition Costs (CAC) and inevitable collapse.

Cultural and Scaling Barriers: India's vast cultural and linguistic diversity complicates scaling. Founders, often from privileged backgrounds, struggle to understand the diverse, context-specific needs of the broader customer base, 65% of whom live in rural areas.



This pie chart breaks down the reasons why startups fail. Its largest segment, representing 34% of all shutdowns, is attributed to a lack of Product-Market Fit (P-M Fit). The document states that this highlights a "synchronization failure" within the core of the ecosystem (Level 2), which includes factors like mentorship and networks.

Financial and Talent Bottlenecks

Despite the massive ₹10,000 crore macro-fund, early-stage capital access remains a crippling bottleneck.

- VC Hesitancy: Venture Capital (VC) firms typically prefer established, profit-making startups, starving early-stage ventures of critical seed capital.[1] This creates a "Valley of
- Death" funding gap, evidenced by the shutdowns of promising firms like Connected H (health-tech) and Qinla (ed-tech).
- Talent Scarcity and Retention: Recruiters face pervasive skill gaps—a mismatch between industry needs and specialized talent. Startups struggle to compete with Multinational Enterprises (MNEs) for qualified professionals, who seek stable jobs, superior salaries, and higher reputation, leading to high turnover and brain drain.

The Institutional Constraint: Regulatory Drag (ISM Level 4 Failure)

The ISM framework identifies Academic Regulations by Government (Level 4/Apex) as the fundamental constraint.

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- Bureaucratic Friction: The persistence of "regulatory complexities and bureaucratic red tape" makes compliance costly, time-consuming, and inconsistent across central and state layers. This overregulation acts as a fundamental "startup killer".
- Compliance Failure: Many entrepreneurs neglect legal formalities in the rapid pursuit of innovation, exposing themselves to financial penalties and business shutdowns later in the lifecycle.

Sectoral Vulnerability: The IT Paradox

The IT sector, despite driving digital adoption, exhibits the highest recorded fragility, with a failure rate of approximately 63% in 2023. This extreme risk is primarily driven by:

- High infrastructure costs (despite cloud options).
- The demanding nature of the constantly evolving technological landscape.
- Intense, capital-intensive competition.

Strategic Interventions for Structural Resilience

The path to sustainable vitality requires synchronized interventions that address the structural and operational failures. The strategy must move from generating more startups to generating resilient startups.

Reforming the Apex: Streamlining Governance and Policy (ISM Level 4)

The government must strategically shift its role from centralized control to catalytic ecosystem enablement.

- Mandate Regulatory Simplification: The gap between the policy intent (one-day registration) and bureaucratic reality (red tape) must be eliminated by simplifying tax and licensing procedures.
- Mandatory Compliance Safeguards: Subsidized and mandatory access to legal and compliance advisory services should be established for all DPIIT-recognized early-stage startups, mitigating the risk of catastrophic failure caused by neglecting legal issues.
- Strategic Regulatory Windows: Policy change creates a finite regulatory window (often maximizing impact four years after introduction).[18] This window must be exploited rapidly by Leadership (Level 3) through proactive reforms before policy momentum diminishes.

De-risking the Core: Targeted Capital and Mentorship (ISM Level 2)

Mitigating the 34% P-M Fit failure rate is the most critical operational goal, requiring direct intervention in capital deployment models.

- P-M Fit Validation Mandate: Capital from the SISFS (₹945 Crores) must be explicitly optimized for structured proof-of-concept validation and iterative market testing before scaling is permitted. This targets capital directly at P-M Fit risk mitigation.
- Institutionalizing Mentorship: Scalable, robust mentorship programs drawing on industry experts must be institutionalized (Level 2) to bridge knowledge and skill gaps. Mentorship should be complemented by targeted financial support to enhance both self-confidence and practical skills.
- Curriculum Reform: Educational institutions must reform curricula to promote entrepreneurial alertness and a learner-centered approach, moving away from theoretical, research-heavy models.

Fostering Social Impact and Inclusion

To align the ecosystem with the Viksit Bharat 2047 goals (ecological sustainability, social advancements), strategy must include inclusivity:

- ESG and SDGs Alignment: Policy mechanisms must incentivize ventures aligned with Environmental, Social, and Governance (ESG) principles, as this enhances their ability to attract impact investment and aligns them with Sustainable Development Goals (SDGs).
- Gender and Social Inclusion (GESI) Lens: Targeted policies are essential to enhance women's capabilities for digital entrepreneurship. Given the significant gender gap in financial access in EMs (women are less likely to secure loans or access payment services), policy must provide holistic, gender-responsive supports and adopt a GESI lens in capital allocation.
- Cultivating Risk Culture: A concerted cultural effort must be made to foster an environment where risk is rewarded and failure is viewed as an acceptable part of the entrepreneurial journey (not a career-ending event), essential for generating high impact innovation.

Leveraging Open Innovation and Deep Tech

To overcome the financial bottlenecks caused by VC hesitancy and the IT sector's high risk:

- Open Innovation as a Catalyst: Corporate-startup collaboration, through open innovation programs, combines the resources of established firms with the agility of startups. This provides new ventures with crucial investment, market access, and high quality mentoring, effectively accelerating market-ready innovation.

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- Deep Tech Subsidies: For the high-risk IT sector (63% failure rate), specific policy interventions should be introduced, such as targeted subsidies for essential fixed costs (e.g., subsidized access to cloud services or grants for high-cost technological assets) to counteract high infrastructure costs.

Global Transferability and Conclusion

Benchmarking for Sustainable Vitality

Ecosystem assessment must integrate measurable Key Performance Indicators (KPIs) that correspond directly to the dynamics of the ISM hierarchy to ensure accountability and monitor progress.

The Indian Model as a Blueprint for Emerging Markets

India's experience offers a valuable, replicable blueprint for other EMs:

- DPI Transferability: The Indian DPI model provides a foundational framework for accelerating digital governance and economic inclusion in other developing nations, particularly in Africa.
- Financial Maturity: The capacity of the Indian system to generate higher average seed funding ($4.6 million) compared to regions like Africa ($1.5 million) is a critical lesson. This maturity is unlocked through policy measures (SISFS, SIAP) that de-risk early-stage ventures and facilitate global funding inflows.
- Resource-Dependence Shift: Policymakers in severely resource-constrained EMs (e.g., those with critical infrastructure deficits) must use the ISM framework as a diagnostic tool. If Infrastructure or Funding is profoundly scarce, its structural placement may require reclassification as a foundational (Level 1) prerequisite, demanding immediate and prioritized public investment before other levels can function effectively.

Key Findings

1. Structural Hierarchy of Ecosystem Determinants (ISM Model): The ecosystem exhibits a rigid, hierarchical structure. Academic Regulations (Government Policy) are the Apex Constraint (Level 4, Maximum Driving Power), meaning changes here have the greatest impact on the entire system. In contrast, Incubation is the highly dependent Foundational Output (Level 1, Maximum Dependence Power), meaning it is the most affected by changes in higher levels but has the least influence on the overall structure.
2. Acute Structural Fragility (Failure Rate): The Indian startup ecosystem, despite its size and growth, suffers from an acute structural fragility, evidenced by a non-survival rate exceeding 90% within the first five years of operation. This indicates a systemic, rather than merely operational, problem.
3. Dominance of Product-Market Fit (P-M Fit) Failure: The single largest operational cause for startup shutdowns is the failure to achieve Product-Market Fit (P-M Fit), accounting for 34% of all failures. This problem is explicitly linked to systemic deficiencies in mentorship, market access, and the overall quality of idea validation.
4. Ineffective Policy Translation (DPI Paradox): Government policies and large-scale financial initiatives (like the ₹10,000 crore Fund of Funds) are massive in scale but show a disconnect in last-mile implementation. The Digital Public Infrastructure (DPI) is highly influential but its impact is diluted by issues in local governance and policy fragmentation.
5. Need for Holistic KPI Alignment: The paper identifies that Key Performance Indicators (KPIs) currently used to measure ecosystem success (e.g., number of startups registered) are misaligned with the structural hierarchy identified by the ISM model, leading to an incorrect focus on easily measurable outputs rather than high-leverage constraints.

Suggestions

1. Mandate University-Industry Collaboration (Targeting Apex Constraint): Since Academic Regulations are the Apex Constraint, the government should revise policies to mandate specific KPIs for knowledge transfer and co-creation between universities and industry. This should include making "industry sabbatical" mandatory for faculty and offering credit for student participation in industry-sponsored projects to improve the quality of market-ready skills and ideas at the source.
2. Introduce a National P-M Fit Validation Programme: To address the dominant 34% P-M Fit failure rate, a standardized, stage-gated, and de-risked validation programme should be created. This programme would provide government-backed grants specifically for extensive user testing, market research, and iterative prototyping before significant capital is deployed, effectively tackling the root cause of operational failure.
3. Implement a Decentralized, Digital Policy Compliance Framework: To improve last-mile policy translation, a single, unified DPI-enabled platform should be established. This platform must simplify compliance, centralize grant applications, and allow real-time tracking of funds and incentives for startups, moving beyond mere registration to actual financial and regulatory support.
4. Shift Incubation Focus from Volume to Quality and Specialization: Given that Incubation is the most dependent output, its strategy must be overhauled. Incubators should move away from volume-based targets to sector-specific specialization and outcome-based funding. Incentives should be tied to successful P-M Fit attainment and post-incubation funding rounds, not just the number of startups admitted.

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5. Revise Ecosystem KPIs Based on ISM Hierarchy: Official metrics for ecosystem maturity (e.g., DPIIT ranking framework) must be revised to focus on the strategic roles of the determinants. New KPIs should prioritize measuring the effectiveness of the Apex Constraints (e.g., "Change in university-originated IP commercialization rate") and Dependent Drivers (e.g., "Average quality score of mentorship provided") rather than just counting startups or total funding.

Conclusion: Resilience through Structural Integrity

The Indian startup ecosystem's journey is a powerful testament to the transformative potential of innovation in the developing world, yet its structural fragility presents a clear and present threat to national ambition. The analysis confirms that the ecosystem's integrity hinges on prioritizing reform at the apex: ensuring that the Academic Regulations by Government (Level 4) is enabling, not constraining the dynamism below. Sustainable vitality requires a strategic, integrated focus: simplifying the bureaucratic drag at the Apex; utilizing targeted capital (like SISFS) to mitigate the market misalignment crisis in the Core (reducing the 34% P-M Fit failure rate); and fostering a culture where Leadership actively translates policy into operational excellence. By addressing these structural imperatives, India, and by extension the global community of Emerging Markets, can successfully transition to an era defined by resilient, world-class innovation, ultimately securing the goals of long-term economic prosperity and social progress.

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Original Article

Digital Finance Service Goals

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Abstract

Consumer depends on digital technologies for using financial services through the digital platforms such as mobile devices and platforms provided by digital financial services. DFS provides financial activities and products like electronic money digital wallets and digital payment platforms for loans savings insurance and investments. Digital financial service promotes financial inclusion and it is an innovation in the financial sector. Mobile money is the main driver for access and usage of financial services and financial inclusion. Digital Financial Services (DFS) have transformed the way consumers access and use financial products through mobile devices, digital platforms, and electronic payment systems. DFS offers a wide range of services including electronic money, digital wallets, mobile banking, savings, credit, insurance, and investment products. These innovations play a vital role in promoting financial inclusion by enabling affordable, accessible, and efficient financial services for underserved and unserved populations. The evolution of DFS—from the launch of M-Pesa to advancements in AI, blockchain, and cloud-based fintech solutions—has supported global efforts toward inclusive finance. In India, initiatives such as Aadhaar-enabled payments, UPI, PMJDY, and digital literacy programmes have strengthened access to formal financial systems. Overall, DFS enhances transparency, reduces gender gaps, supports rural empowerment, and increases the quality and usage of financial services, making it a key driver of inclusive economic growth.

Keywords: *DFS, E-Money, Digital Platforms.*

Who is a DFS Provider?

Financial services provided digitally by financial institutions with the assistance of electronic money issuers like regulated entities delivering digital finance services. DFS provided by banks and non-banks products to unserved undeserved individuals and firms at a convenient way.

History of DFS

- In 2007 M-Pesa Kenya's world's First Mobile money service launched by Vodaphone and safaricom mobile.
- In 2008 low cost agent networks provided financial services to many countries.
- In 2009 India launched Adhar biometrically secured payments through ID system
- In 2010 first findex database released global survey that tracks country level progress in financial inclusion
- In 2013 non-bank financial institutions dominated the financial service market to unreached individuals
- In 2014 the international Telecommunication Union (ITU) established the focus group on digital financial services.
- In 2015 Digital payments recognized as a foundation of financial inclusion. Mobile banking services are a significant driver pay pal Apple pay etc. are the digital wallet space.
- In 2016 global partnership for financial inclusion published G20 high level principles for digital financial inclusion.
- In 2017 several technologies enabled expansion of digital finance through AI Block Chain and Distributed Ledger Technology (DLT) AND Cloud Computing provided Fintech Startups.

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- In 2018 many countries implemented regulatory enablers for digital financial services.

In 2019 pandemic situation Covid-19 paved the way for the usage of digital financial services.

Financial Inclusion Goals through DFS

- Digital financial services include payments credit savings, remittances of insurance. Financial inclusion encompasses various dimensions including access to usage of financial services affordability (Iqbal and Sami 2017).
- To maintain quality of financial services and products and capabilities of using such services to lead to the desired transformation in the situation of the user.
- Financial services channels such as bank branches ATM's bank agent outlets, Mobile Money agent outlets to motivate adoption and usage of financial services which should enhance financial inclusion.
- To reduce gender inequalities. It is widely accepted that better and relevant financial inclusion initiatives can foster reduced gender inequalities.
- To access and use the DFS overall quality of financial services by women.
- DFS Launches campaign for saturation of financial inclusion schemes at grampanchayat and urban local body level in all districts and to open bank accounts for unbanked adults under PMJDY and increasing enrollments under PMJJBY, PMSBY, and APY awareness sessions on digital fraud prevention among other key goals of the campaign.
- To enable regulatory enablers for inclusive digital financial services including non-bank DFS providers to compete and cooperate with incumbents including low income group people.
- Digital financial services to empower the citizens in rural areas by training them to operate digital access devices to improve e-communication to access government services and use digital payments toward a step of digital literacy.
- A major financial inclusion initiative that used digital services to provide bank accounts to the unbanked population. India launched the National Initiative the Pradhan Mantri Dhan Yojana in 2014.

DFS Non-Financial Services

- To check the available bank balances
- To get the bank account mini statement on bank linked mobile number.
- MMID (Mobile Money Identifier) user can know the MMID allotted by the bank to the account during mobile banking registration.
- Generate/change M-Pin which is a password for authenticating financial transaction.

Government Initiatives towards Digital Financial Services

- IRCTC (Indian Railway Catering and Tourism Corporation)CONNECT
- Aadhar Key pillar of Digital India an Identified Platform
- Un-Reserved Ticket through Mobile Application –UTS App.
- BHIM (Bharat Interface for Money) it enables direct Bank to Bank Payments
- Pradhan Mantri Gramin Digital Saksharta Abhiyan
- Pay gov. India ministry of electronics and information technology along with NSDL data base Management ltd. To offer various services through their National / State portals with a facility to make Online payment.

Conclusion:

Digital finance is the term used to describe the impact of new technologies on the financial service industry. we now interact with bank using mobile technology we use UPI Apps various digital platforms for payments transfer money and investments in stock market etc. all these innovative digital technologies benefit both banks customers and non-bank firms by enabling greater access to Digital Financial Services . The Financial service firms has been influenced and benefited both Government and unreached population. DFS is enhancing and sustaining the access to unreached and undeserved ones. E-Money is gaining popularity day by day.

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Original Article

Sustainable Agriculture and Water Management

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Abstract

Sustainable agriculture and effective water management are mutually reinforcing pathways to secure food production, conserve ecosystems, and adapt to climate change. This paper synthesizes recent evidence on practices that increase water-use efficiency and resilience including climate-smart agriculture, deficit and drip irrigation, rainwater harvesting, and integrated water resources management (IWRM) — and proposes an applied research framework for evaluating their biophysical, economic and social outcomes. We draw on recent systematic reviews and international reports to identify best practices, knowledge gaps, and policy levers. Key recommendations are (1) prioritize water-efficient technologies (drip irrigation, deficit irrigation) where appropriate; (2) mainstream IWRM and rainwater harvesting into agricultural planning; (3) measure outcomes with integrated indicators (water productivity, yield, soil health, livelihoods); and (4) design financing and institutional arrangements that support smallholders. The paper also proposes a methodology and data sources for empirical evaluation and offers policy pathways for scaling sustainable water–agriculture solutions.

Keywords: *sustainable agriculture, water management, integrated water resources management, drip irrigation, rainwater harvesting, water productivity, climate-smart agriculture.*

Introduction

Global agriculture faces rising demand for food, declining water and soil resources, and increasing climate variability. Transforming agricultural systems to be both productive and sustainable requires integrated approaches that conserve water while maintaining or increasing yields and supporting livelihoods. Recent analyses estimate that shifting to more sustainable food systems could deliver large economic and public-health benefits while easing environmental pressures. This paper brings together an applied research and policy framework for connecting sustainable agricultural practices with improved water management. It synthesizes recent evidence on technologies and institutional approaches that improve water efficiency and resilience, identifies key indicators and data sources for empirical study, and offers policy recommendations to accelerate adoption especially for small and medium farmers.

Literature review

1. Defining sustainable agriculture and water management

Sustainable agriculture is a multi-dimensional concept balancing productivity, environmental stewardship and social equity; operational indicators include soil health, nutrient use efficiency, biodiversity, and water productivity. Recent systematic reviews summarize conceptual and indicator frameworks useful for impact evaluation.

2. Water-efficient irrigation: drip and deficit irrigation

High-efficiency irrigation methods (e.g., drip) and regulated/deficit irrigation strategies consistently show substantial improvements in water-use efficiency and often raise yields or

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maintain yields with less water. Meta-analyses and recent reviews demonstrate that drip systems reduce water consumption and improve crop performance across many contexts.

3. Rainwater harvesting and small-scale water storage

Rainwater harvesting for supplemental irrigation is widely reported as one of the most accessible climate-smart water technologies for smallholders, reducing reliance on costly water supplies during dry spells and improving resilience. Systematic studies indicate reduced irrigation costs and improved water availability from rainwater harvesting schemes.

4. Integrated Water Resources Management (IWRM) and policy integration

IWRM principles — coordinated planning across sectors, stakeholder participation, and balancing ecological, agricultural and municipal demands — remain a central policy pathway. Progress reports indicate partial adoption worldwide but also emphasize the need for stronger cross-sector integration to achieve SDG targets.

5. Climate-Smart Agriculture (CSA) and co-benefits

CSA packages commonly bundle water-saving irrigation, soil conservation (mulching, cover crops), and improved crop varieties; reviews show CSA enhances resilience, though adoption depends on access to finance, knowledge, and institutional support.

Research objectives

1. Quantify the effects of water-efficient practices (drip irrigation, deficit irrigation, rainwater harvesting) on water productivity (kg yield per m^3 water), yield, and soil health across representative cropping systems.
2. Evaluate socio-economic outcomes (costs, labor, income, adoption barriers) associated with these practices for smallholders.
3. Assess how integrating IWRM principles at basin and landscape scales influences the adoption and effectiveness of field-level interventions.
4. Propose policy and financing mechanisms to scale high-impact practices equitably.

Methodology

1. Study design

- Multi-site, mixed-methods design across contrasting agroecological zones (e.g., semi-arid, sub-humid, irrigated plains).
- Combine randomized controlled trials (RCTs) or quasi-experimental designs for technology interventions with participatory case studies to capture institutional factors.

2. Interventions and treatments

- Treatment A: Drip irrigation + mulching + improved scheduling (sensor or rule-based).
- Treatment B: Regulated deficit irrigation (crop-specific protocols).
- Treatment C: Rainwater harvesting infrastructure (cisterns, farm ponds) + supplemental irrigation.
- Control: Local conventional practice (baseline).

3. Data collection variables

Biophysical: crop yield, crop evapotranspiration (ETc), soil moisture profile, soil organic carbon, nutrient balances, water extraction volumes.
Economic: input costs, capital costs (installation), operating costs, labor hours, gross margin per hectare.
Socio-institutional: adoption intent, perceived constraints, access to credit, water rights and governance.
Indicators: water productivity (kg/m^3), water use efficiency (%), cost per m^3 saved, benefit-cost ratio, adoption rate.

4. Measurement methods & instrumentation

- Soil moisture sensors (profile), lysimeters or soil water balance models for ET estimates.
- Flow meters on irrigation lines to measure applied water.
- Remote sensing (NDVI/EVI) to monitor crop vigor and estimate ET via surface energy balance approaches for scaling.
- Household surveys and key informant interviews for socio-economic data.

5. Analysis approach

- Mixed-effects regression models to estimate treatment effects on yield and water productivity controlling for site and year.
- Cost-benefit analysis (net present value, payback period) for investment decisions under different subsidy/credit scenarios.
- Qualitative comparative analysis for institutional drivers of adoption.

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- Scenario modelling to assess basin-scale impacts when different adoption rates are simulated under IWRM regimes.

Expected results and interpretation (based on literature)

Evidence suggests that drip irrigation and well-designed deficit irrigation often increase water productivity and can maintain or increase yields (depending on crop and management) while reducing water withdrawals. Rainwater harvesting tends to lower irrigation costs and shore up water availability in dry seasons. Integrating field-level water-saving practices with basin-level IWRM improves outcomes by aligning water allocation and infrastructure investments with agricultural needs and ecosystem requirements.

Policy recommendations

1. Promote bundled interventions

Provide support packages that combine hardware (drip systems, tanks) with training, agronomic advice, and market access — these bundled approaches raise adoption and effectiveness.

2. Finance and incentives tailored to smallholders

Use blended finance, concessional loans, and public subsidies to reduce upfront costs; couple financial incentives with technical assistance and extension services.

3. Institutionalize IWRM in agricultural planning

Encourage water-agriculture coordination bodies at basin level to ensure irrigation investments align with sustainability and downstream needs. Progress reports show that IWRM is partially adopted globally but requires stronger implementation to meet SDG goals.

4. Monitor with integrated indicators

Adopt a concise set of indicators water productivity, soil organic carbon, yield, and livelihood metrics reported regularly to evaluate performance and adjust programs. Recent guidance and indicator reviews provide tested candidates.

5. Policy to protect soils and natural capital

Soil degradation reduces water retention and amplifies vulnerability. Policies should incentivize regenerative soil practices (cover crops, reduced tillage) to maintain infiltration and on-farm water buffers. Recent reporting highlights widespread soil degradation in some regions and the urgent need for restoration.

Limitations and research gaps

- Context specificity: water-saving benefits vary by crop, climate and soils — results must be locally validated.
- Institutional complexity: uptake depends heavily on tenure, subsidy structures and market access.
- Data constraints: high-quality water-use measurement at farm scale remains challenging in many regions. Several recent reviews call for long-term, multi-season studies to capture variability and longer-term soil outcomes.

Conclusion

Sustainable agriculture and water management are tightly linked; evidence shows substantial opportunity to increase water productivity and resilience through targeted irrigation technologies, rainwater harvesting, soil-conserving practices, and integrated planning. Scaling these approaches equitably requires finance, institutional alignment (IWRM), and rigorous monitoring using integrated indicators. The research program outlined here provides an actionable pathway to generate locally relevant evidence to guide policy and investment.

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Original Article

The study of Green Technology and Circular Economy

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Abstract

The study of Green Technology and Circular Economy focuses on sustainable development strategies that minimize environmental impact while promoting economic growth. Green technology, also known as environmental or clean technology, emphasizes the use of innovative methods, renewable energy sources, and eco-friendly materials to reduce pollution, conserve natural resources, and mitigate climate change. The Circular Economy complements this by promoting resource efficiency through recycling, reuse, and regeneration of materials, thus creating a closed-loop system that minimizes waste. Together, these approaches aim to decouple economic progress from environmental degradation. This study explores the interconnection between green technologies—such as solar power, waste-to-energy systems, and sustainable manufacturing—and circular economic models that encourage responsible production and consumption. It also examines policy frameworks, corporate practices, and global initiatives that support the transition toward a sustainable and resilient economy. The findings highlight that adopting green technologies and circular economy principles can lead to long-term environmental protection, innovation-driven growth, and enhanced social well-being.

Kayword: *Green Technology, Circular Economy, Sustainable Development, Renewable Energy, Environmental Protection.*

Introduction:

In the 21st century, the growing concerns about environmental degradation, climate change, and depletion of natural resources have prompted nations and industries to adopt sustainable approaches to development. Among the most promising solutions are Green Technology and the Circular Economy, both of which aim to harmonize economic progress with environmental preservation. These two concepts are closely interconnected and represent a shift from traditional, linear models of production and consumption toward more sustainable and regenerative systems.

Green Technology, also known as environmental or clean technology, refers to the application of scientific and technological innovations that reduce negative impacts on the environment. It focuses on the development and use of processes, products, and services that minimize pollution, conserve energy and natural resources, and promote sustainability. Examples include renewable energy sources such as solar, wind, and hydro power; electric vehicles; biodegradable materials; and smart technologies for energy efficiency and waste management. Green technology not only supports environmental protection but also fosters economic growth by creating new industries and job opportunities in sustainable sectors.

On the other hand, the Circular Economy (CE) is an economic system aimed at eliminating waste and continually reusing resources. Unlike the traditional linear economy — based on the "take, make, dispose" model — the circular economy emphasizes reducing, reusing, repairing, remanufacturing, and recycling materials to extend their lifecycle. The main objective is to design products and processes that maintain the value of materials for as long as possible, thereby reducing the need for virgin resources and minimizing environmental harm. The circular model integrates economic and environmental goals, promoting sustainable consumption and production patterns.

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The combination of Green Technology and Circular Economy represents a powerful strategy for achieving sustainable development. Green technology provides the tools and innovations needed to make circular systems efficient and viable, while the circular economy offers the framework for applying these technologies across industries. Together, they contribute to reducing carbon emissions, conserving biodiversity, enhancing energy efficiency, and promoting social and economic resilience. Governments, businesses, and academic institutions are increasingly recognizing the potential of these approaches to drive the global transition toward sustainability.

Furthermore, the adoption of green technology and circular economic principles supports the United Nations Sustainable Development Goals (SDGs), particularly those related to responsible consumption and production (SDG 12), climate action (SDG 13), and affordable and clean energy (SDG 7). By promoting innovation, resource optimization, and environmental responsibility, these concepts play a crucial role in building a sustainable future for coming generations.

In conclusion, the study of Green Technology and Circular Economy is essential for understanding how modern societies can balance economic advancement with ecological stability. It explores the pathways through which technology, innovation, and policy can work together to transform production systems, reduce waste, and preserve the planet's natural capital. This integrated approach marks a vital step toward achieving a sustainable and circular global economy.

Definition:

1) Green Technology, also known as environmental technology or clean technology, refers to the development and application of products, equipment, and systems that use renewable energy sources and sustainable processes to minimize environmental damage. It aims to reduce pollution, conserve natural resources, and promote eco-friendly innovations that support sustainable development.
2) A Circular Economy is an economic system aimed at minimizing waste and making the most efficient use of resources. It is based on the principles of reduce, reuse, repair, recycle, and recover, ensuring that materials and products remain in use for as long as possible. Unlike the traditional linear economy — which follows the "take, make, use, and dispose" model — the circular economy focuses on creating closed-loop systems where waste is transformed into resources.

Objective of the study:

1) To study the concept and importance of Green Technology and Circular Economy.
2) To analyze the role of Green Technology in promoting sustainable development.

Research Methodology:

The study is based on secondary data. The required data has been extracted from various sources like government reports, agricultural statistics, and AI adoption policies. Research papers, journals, and case studies on AI in agriculture.

Concept:

1) Green Technology refers to the development and application of products, equipment, and systems that use renewable materials and energy sources to reduce negative environmental impacts. It emphasizes energy efficiency, pollution reduction, waste management, and sustainable use of natural resources. The main aim of green technology is to create a balance between economic growth and environmental protection, ensuring a cleaner and safer planet for future generations. Examples include solar and wind energy, electric vehicles, recycling systems, water purification technologies, and biodegradable materials.
2) Circular Economy is an economic system that focuses on minimizing waste and making the most of resources. Instead of the traditional "take–make–dispose" model, the circular economy promotes "reduce–reuse–recycle–recover". It encourages products and materials to remain in use for as long as possible, extracting maximum value before recovery and regeneration. This model supports sustainability by reducing raw material use, cutting down on pollution, and fostering innovation in production and consumption patterns.

Together, Green Technology and Circular Economy aim to transform how society produces and consumes, promoting sustainable growth, environmental conservation, and responsible resource management for long-term ecological balance and economic resilience

Importance of Green Technology and Circular Economy

Environmental Protection:

Green technology helps reduce pollution, control carbon emissions, and conserve natural resources. It plays a vital role in combating climate change and promoting ecological balance.

Efficient Resource Utilization:

The circular economy promotes the reuse, recycling, and regeneration of materials, ensuring that resources are used efficiently and waste is minimized.

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Sustainable Economic Growth:

Both green technology and circular economy models support long-term economic growth by encouraging innovation, green jobs, and sustainable industrial practices.

Waste Reduction and Management:

These approaches emphasize recycling and reusing products, significantly reducing landfill waste and environmental degradation.

Energy Conservation:

Green technologies promote the use of renewable energy sources such as solar, wind, and hydro power, helping to reduce dependence on fossil fuels.

Innovation and Competitiveness:

Adopting eco-friendly technologies and circular models drives industries to innovate, improving productivity and competitiveness in the global market.

Social and Health Benefits:

Cleaner technologies and waste-free environments contribute to better air and water quality, leading to improved public health and quality of life.

Policy and Global Goals Alignment:

Promoting green technology and the circular economy supports international sustainability goals such as the UN Sustainable Development Goals (SDGs) and the Paris Climate Agreement.

Role of Green Technology:

Green technology, also known as environmental or clean technology, plays a pivotal role in promoting sustainable development by balancing economic growth, environmental protection, and social well-being. It focuses on creating innovative solutions that minimize pollution, conserve resources, and reduce the ecological footprint while maintaining productivity and improving quality of life.

1. Conservation of Natural Resources

Green technologies promote the efficient use of energy, water, and raw materials. For example, renewable energy sources such as solar, wind, and hydropower reduce dependence on fossil fuels, thereby conserving non-renewable resources and ensuring their availability for future generations.

2. Reduction of Pollution and Carbon Emissions

Technologies like electric vehicles, biofuels, and waste-to-energy plants help minimize greenhouse gas emissions. Green manufacturing processes and cleaner production methods reduce air, water, and soil pollution, contributing to a healthier environment.

3. Waste Management and Recycling

Green technology encourages the reuse, reduction, and recycling of waste materials. Advanced recycling techniques, composting, and biodegradable materials help in efficient waste management, reducing the burden on landfills and mitigating pollution.

4. Promotion of Renewable Energy

Renewable energy technologies form the backbone of sustainable development. Solar panels, wind turbines, and biomass energy systems provide clean and inexhaustible energy, reducing reliance on non-renewable and polluting sources such as coal and oil.

5. Sustainable Agriculture

Green technologies such as precision farming, organic fertilizers, and drip irrigation enhance agricultural productivity while minimizing environmental degradation. They reduce chemical use, preserve soil health, and optimize water usage, ensuring food security and sustainability.

6. Green Buildings and Urban Development

Sustainable architecture integrates energy-efficient designs, eco-friendly materials, and smart technologies to minimize energy consumption and carbon footprints. Green cities emphasize sustainable transport, waste recycling, and renewable energy use, creating eco-friendly urban environments.

7. Industrial Innovation and Green Economy

Green technology drives innovation and the green economy, creating employment in renewable energy, recycling, and environmental services. Industries adopting cleaner technologies become more competitive and socially responsible, contributing to economic and ecological sustainability.

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8. Climate Change Mitigation

By reducing greenhouse gas emissions and promoting carbon capture, green technology plays a crucial role in combating global warming and climate change. It supports adaptation and resilience through sustainable resource management and energy transition.

9. Social and Economic Benefits

The adoption of green technology ensures inclusive growth by providing employment, improving public health, and promoting equitable access to clean energy and water. It enhances the quality of life while fostering long-term economic stability.

Conclusion:

The study of Green Technology and Circular Economy highlights the crucial role these approaches play in achieving sustainable development and environmental protection. Green technology focuses on innovations that minimize pollution, conserve resources, and promote renewable energy, while the circular economy emphasizes the reuse, recycling, and regeneration of materials to reduce waste and dependency on finite resources. Together, they create a powerful framework for building an eco-friendly and resource-efficient economy. The integration of these concepts can help industries reduce carbon footprints, improve production efficiency, and generate green employment opportunities. Moreover, adopting sustainable consumption and production patterns encourages responsible behavior among individuals, communities, and organizations.

In conclusion, the effective implementation of green technology and circular economy principles is essential for balancing economic growth with environmental sustainability. It paves the way toward a cleaner, greener, and more resilient future for the planet and future generations.

Green technology is not just a tool but a transformative approach toward achieving sustainable development. By integrating environmental responsibility into every sector—energy, agriculture, industry, and urban planning—it ensures harmony between human progress and ecological balance. Investing in and adopting green technologies is essential for building a sustainable, resilient, and prosperous future for all.

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Original Article

Inflation, Food Prices, and Security: Towards Sustainable Stabilization Strategies

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Abstract

Food security remains among the greatest global challenges in view of rising inflation and unstable food prices. Inflation undermines a household's ability to purchase essential goods, but more particularly, it reduces access for vulnerable households, accentuating poverty, malnutrition, and inequality. Unstable prices undermine nutritional stability from the consumer's perspective, and further imperil social and political stability, particularly in developing countries where a higher percentage of household income is spent on food. This paper attempts to comprehend the rivalry between inflation, food prices, and food security, efficiently addressing the mechanism for stabilization. It considers immediate causes of inflation in food prices such as inefficiencies in the domestic supply chains, climatic shocks, international trade disruption, and geopolitical tension. Besides, it analyses existing stabilization mechanisms such as price control, subsidies, buffer stock policy, and monetary shock, highlighting their demerits and unintended consequences. The paper advocates for longer-term sustainable stabilization strategies contributing towards resilience in agriculture, technological innovation, efficient supply systems, and targeted policy intervention. This research aims to argue, with case studies from all over the world, that price stabilization solves a pressing economic problem; equally important for food security, mitigation of inequality, and promotion of inclusive growth amid growing uncertainty.

Keywords *– Food security, Inflation, Price Stabilization, Poverty and inequality, Technology, Market distortions, Policy Trade-offs.*

Introduction

Inflation hits food security hard these days. Especially when it comes to food prices going up. Over the last few years, essential food items have gotten way more expensive around the world. A bunch of things cause this. Supply chains breaking down. Weather acting unpredictable. Conflicts between countries. And bigger economic stuff too. All that keeps pushing prices higher. It makes it tough for millions of people to get enough good food. Low-income folks and those who are already vulnerable suffer the most. So, figuring out how inflation ties into food prices and security matters a lot. That way we can come up with real plans to steady food systems. And keep the neediest groups safe. Food security means people can count on getting enough nutritious food without fail. Affordability plays a huge role in that. When inflation spikes food costs suddenly, it weighs heavy on families with less money. They end up even more food insecure. The effects spread out. Health takes a hit. Social and economic stability wobbles. Even future work and growth suffer down the line. Pretty much everyone agrees now. We need solid ways to curb food price inflation. And fast. For hitting those long-term goals on development.

This study looks at inflation, food prices and security. With a push toward sustainable ways to stabilize things. It digs into how inflation links up with shifts in food prices. And what that does to food security overall. The main goal stays broad. Find practical strategies that last. Ones policymakers and others can use. To protect people from wild price swings. While boosting farm output and keeping markets steady. The intro here connects inflation right to food security issues. It stresses why sustainable fixes feel so urgent.

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And lays out what the paper covers clearly. Later parts could dive into what causes inflation. Or spell out effects on food markets and security. Then wrap up with frameworks for those stabilization solutions. Rising inflation continues to push food prices upward. This exerts real pressure on global food security. Those most vulnerably situated are often impacted most severely. The reality is the evidence of inflation is extremely widespread. Supply chains are disrupted. Climate change complicates matters. Production costs are increasing dramatically, and geopolitical context also plays a role. These circumstances do not only cause food insecurity; they also promote instability. The key pillar of sustainable development is undermined. This all leads to more resilient food systems globally.

Objective

1.To study relationship Between Inflation and Food Prices
2. To study the socio-Economic Impacts of Food Price Volatility
3. To study the effectiveness of Food Price Stabilization Mechanisms
4. To study the sustainable Strategies for Stabilizing Food Prices
5. To study the regional and International Cooperation for Food Security

Understanding Inflation and Food Price Dynamics

Inflation and the changes in food prices are often regarded as closely correlated factors that influence the stability of an economy and the welfare of its consumers. Food's one of those basics everyone needs. You know, it's pretty sensitive to whatever's happening with prices. So, inflation comes along. It hits food access and affordability right off the bat. Things get worse from there. Inequalities ramp up. Food insecurity just deepens for a lot of folks. Thing is, to really see how inflation ties into food price shifts. We should define the different types of inflation first. Then break down the direct hits on food prices. And the indirect ones too. Finally, to show how it can spark all that price volatility. Look at some actual examples from the real world on food costs changing. As a basic starting point. Inflation means the general prices of goods and services in an economy. They keep rising steadily over time. It boils down to money losing its buying power. So yeah, you end up needing more dollars or whatever currency. Just to grab the same amount of stuff as before. Typically, when an economy is experiencing moderate inflation, it is an indicator that it has positive economic growth; however, when persistent or uncontrolled inflation for example, hyperinflation is happening, it can destabilize economies and societies.

How Inflation Directly and Indirectly Affects Food Prices

The connection between food prices and inflation consists of direct and indirect impacts as it permeates households, producers, and markets.

1] Direct Impacts

Rising input costs hit farmers hard these days. Inflation pushes up the prices for things like seeds, fertilizers, irrigation stuff, labour, and even fuel. Farmers have no choice but to pass those extra expenses right along to shoppers. That means retail food prices climb higher, pretty much across the board.

Price Pass-Through: Inflation in one sector may pass through directly to the food markets. For instance, inflation from rising global oil prices increases transportation costs to distribute food prices, which ultimately leads to rising retail prices.

2] Indirect Effects:

Workers face higher living costs, so they push for bigger wages. Employers give in and raise pay, which jacks up production expenses. That leads to food prices going up too. Traders and big sellers spot the inflation coming. They start hoarding stuff like commodities. The idea is to dodge paying more down the line. Supply hits the market less because of this. Food prices keep climbing from the pressure.

Governments step in with policies to stop inflation from getting worse. Things like devaluing the currency, hiking interest rates, or slapping on trade limits. These moves help steady the markets in a way. Still, they often mess with how available and cheap food is for people.

Nutrition and Health Effects: If inflation persists, it causes reduced dietary diversity and thereby impact on food security in the long run. Households may substitute cheaper, less nutritious food items leading to malnutrition and associated health problems.

The direct and indirect effects of inflation create a cycle where increasing prices cause inflation and inflation, in turn, causes food prices to increase.

Food Prices Volatility Examples

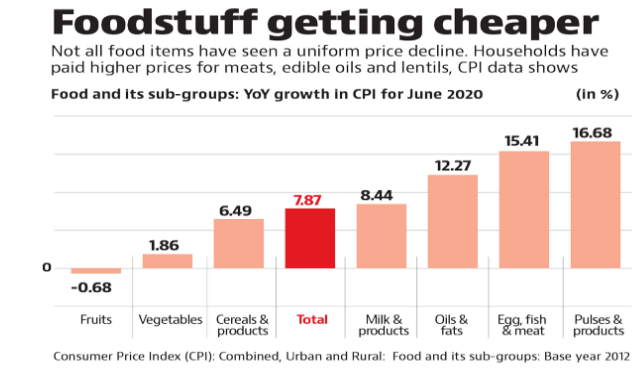
Inflation-induced food price volatility is not solely a theoretical issue. It has occurred numerous times globally, and has had significant socio-economic and political ramifications.

2007-08 Global Food Crisis: A combination of rising oil prices, and increased demand for biofuels, led to sharp increases in food prices across the globe. The price of wheat increased nearly doubled, and rice increased nearly threefold within months. Key producers slapped on export restrictions. Inflationary pressures piled on top. They made local and regional shortages way worse. That sparked food riots in more than thirty countries. Think Haiti, Egypt, Bangladesh. People still talk about onion prices in India back in 2010 and 2019. Onions are pretty much a basic food

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there, you know. And they get political fast. Government stats showed how weak monsoons hit hard. Supply chains messed things up even more. Prices just shot way up. Sometimes they jumped five times over in only a few weeks. This food price inflation not only exacerbated inflation figures, but became a critical electoral issue in India - which shows how food prices volatility can impact stability.

COVID-19 Pandemic (2020-2022) ; The planet was afflicted by a pandemic that led to global lockdowns, and disrupted international and local supply chains, among other issues.





Food Security in the Context of Inflation

Food security is an important concept that is much more than simply being able to have food. It has many dimensions that shape whether individuals or households can be certain of accessing adequate food in sufficient quantities that nutrition-wise and safety-wise would allow them to live imprinted active and healthy lives. Inflation, especially when it inflates food prices, severely threatens these dimensions, especially for vulnerable groups that often end up bearing the brunt of economic shocks.

Dimensions of Food Security

The traditional framework concerning the understanding of food security rests on four interrelated pillars: availability, accessibility, utilization, and stability. Discussions nowadays do consider agency and sustainability, but the core four do provide a big picture of the challenges confronting food security, especially under inflationary conditions.

Availability is all about whether there is food present in the area or country. Being in actual terms, the availability of food depends on a certain level of food production in the country and on how much is imported and exported, including stocks. Hence the basic design of availability is supply: Are they enough to feed the people? When there are inflationary pressures, availability might get clutched when it leads to reduction in agricultural output, or expensive imports because of increased input costs for producers, such as seeds, fertilizer, fuel, and labour. Supply chain disturbances and extreme weather, an achievement of climate change, can also reduce the quantity of food reaching the markets.

Accessibility means economic and physical capability of individuals of households to get food that happens to be available. A country may produce sufficiently, but because most cannot afford the food and others have to go far distances to find markets, their food security is compromised. Inflation directly undermines accessibility; a rise in food prices leads heavier weight burdens on consumers. For the poor, this typically means spending a greater amount of their income on food, thereby limiting their buying power for other basic

Stability refers to the consistency of the first three dimensions over time. Here, the queries are whether people can depend on relatively sufficient food regularly, without any sudden shocks from economic crises, environmental disasters, or conflicts. Inflation causes some volatility in the food prices that then destabilize access and affordability, leading to circumstances of food insecurity that vary with market conditions.

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Causes of Food Price Inflation

Food price inflation has become an everyday concern across the world, with people noticing that the same bag of groceries costs more than it did just months ago. It is not just an abstract economic term it directly affects households, forcing families to cut back, change food habits, or spend a larger share of their income on essentials. But what actually drives food prices up? The truth is, there isn't just one reason. Food price inflation arises from a mix of domestic and global factors, along with the behaviour of markets themselves. To understand it properly, we need to look at how production costs, supply chains, weather events, international trade, energy prices, and even financial speculation all come together to shape what we pay at the checkout counter.

Domestic Factors Behind Food Inflation

One of the biggest drivers of higher food prices comes from within a country itself. Domestic conditions ranging from how much it costs to grow crops, to how smoothly goods move from farms to markets play a central role in determining food inflation.

A starting point here is production costs. Farmers rely on inputs like seeds, fertilizers, pesticides, animal feed, electricity, and labour. When any of these go up in price, the cost of producing food rises too. For instance, fertilizer prices are closely linked to global energy markets. A spike in natural gas or oil prices makes fertilizers expensive, burdening farmers. Similarly, if labour wages rise in rural areas or if farm workers migrate to cities, creating scarcity farmers face higher expenses, which often get passed on to consumers through higher food prices.

Next, supply chain inefficiencies add another layer. Even if farmers produce enough food, getting it to consumers without losses or delays is often a struggle. Poor storage facilities, inadequate cold chains, bottlenecks in transportation, and reliance on middlemen can all push prices upward. Perishable items like vegetables, milk, or fish are especially vulnerable if temperature-controlled storage or efficient logistics are unavailable, wastage happens. Less supply arriving in markets naturally means higher prices.

An equally important domestic factor is weather shocks. Agriculture is highly dependent on rainfall patterns, especially in countries where irrigation coverage is limited. A bad monsoon, prolonged drought, or unexpected floods can wipe out crops and reduce overall supply. Even if damage occurs in one part of a country, the ripple effect is nationwide because food markets are interconnected. For example, onion or tomato prices often spike sharply in India when a major producing region suffers from heavy rains or crop diseases. Such weather-driven supply shocks are one of the most visible triggers of sudden food price inflation, and with climate change increasing the frequency of extreme weather events, this factor is only getting stronger.

Global Factors That Push Up Prices

Food inflation is not only about what happens within one country events across the globe also shape domestic prices. Global supply chains, energy markets, and political dynamics all feed into the cost of food.

An important global driver is the price of oil. Food production and distribution rely heavily on petroleum. Tractors, irrigation pumps, and food-processing units consume fuel, while trucks, ships, and planes transport food from farms to warehouses and then to retail shelves. When oil prices climb on the international market, everything from local transportation of milk to long-haul shipments of grain becomes more expensive. Ultimately, this translates into higher food prices for consumers.

International trade policies also matter. Governments sometimes impose export bans to protect domestic supplies, or they levy tariffs and duties that make some imports more costly. During global disruptions such as the 2007–2008 food crisis exporting nations restricted shipments of rice or wheat to keep domestic prices stable. While this helped their own populations in the short term, it drove up prices worldwide, hurting import-dependent countries. Similarly, when large importing nations suddenly increase demand, international prices may spike due to competition.
Then there is the role of geopolitical conflicts. Wars and political instability can disrupt global food flows. Recent examples include the Russia–Ukraine conflict, which has severely affected global wheat, sunflower oil, and fertilizer supplies, given the region's importance as a food basket. Globalized supply chains mean that a disruption in one part of the world quickly triggers shortages and price rises elsewhere. For poorer countries that depend heavily on imports, this can cause severe inflationary pressure and even food insecurity.

Socio-Economic Impacts

Food price inflation hits way harder than just making groceries more expensive. It messes with a lot more, like how people eat and stay healthy. It makes poverty worse and ramps up inequality too. Sometimes it even sparks real trouble, political stuff and social unrest. Thing is, getting why food prices climb helps show the big problems for families, neighbourhoods, and whole countries. Especially the folks who already struggle, since they put so much of their money into food. This part looks at how those price jumps affect health, money situations, and how societies stick together in different places.

Impact on Nutrition and Health

Rising food prices force families to shift from nutritious foods to cheaper, calorie-dense but nutrient-poor alternatives. This change means people may get enough calories but lack essential vitamins and minerals, leading to a

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hidden kind of malnutrition. Children and older adults are hit hardest. Inadequate nutrition in early childhood can stunt growth and weaken immune systems, with impacts lasting throughout life. Studies show that even a 5% increase in real food prices raises the risk of child wasting and stunting, especially if exposure occurs during pregnancy or infancy.

Impact on Poverty and Inequality

Food price inflation disproportionately impacts low-income families, who spend a large share of their income on food. When food costs rise sharply, these households may cut back on meals, healthcare, or education, or take on debt. Such inflation pushes many deeper into poverty and widens economic inequality. Women-led households often suffer more seriously due to fewer resources.

Political and Social Instability Caused by Food Price Surges

Sudden spikes in staple food prices have historically triggered protests, riots, and political instability worldwide, from the Arab Spring to unrest in several developing countries. Food insecurity breeds public frustration and distrust of governments, especially where social safety nets are weak. Populations facing real hunger or fears of it may take to the streets demanding change. Price shocks often expose deeper governance issues such as inequality and corruption. While governments sometimes impose subsidies or price controls to ease immediate pressures, these are short-term fixes. Lasting stability requires building robust food access systems, social protections, and inclusive economic policies.

Government Actions to Control Food Prices

People talk about how governments step in to keep food prices from going wild. They use all sorts of ways to protect folks buying groceries and help out the farmers growing them. One big thing is setting price caps or giving subsidies. That means they hold down the top price on key foods or cut the cost with help money. It keeps poor families safe when prices jump up fast. Take India for instance. They sell rice and wheat cheap through government shops.

Another way is building up these buffer stocks. That's like saving extra food when there's plenty. Then they let it out when supplies drop or prices climb. It evens things out from bad crops or storms messing up the market. Plus, sometimes when prices get too high governments start rationing. That makes sure food spreads fair, no hoarding, and stays reachable in tough times.

Governments also buy up extra crops cheap to back farmers or dump stocks to stop prices from blowing up. Sure, these moves cost a lot and take work to run. But they stop food price chaos from hurting the whole economy and making poor people poorer.

Monetary and Fiscal Policies' Role

Now on the money side, fiscal and monetary stuff ties into keeping food prices steady. It's the main way economies handle this big picture. Central banks tweak rates and money flow to fight inflation overall. If prices heat up, they hike rates to slow spending and cool things down. Food though doesn't react much to that. Demand stays steady because eating isn't optional even if loans cost more.

Fiscal moves hit food costs more straight on. Governments spend on subsidies, drop import taxes, give aid for farm stuff like fertilizer and seeds. They run cash programs too for families hit hard by rises. All that eases buying pressure and boosts farm output in the country.

In places like India, getting money policy and spending policy to work together is key. Food inflation sticks around there. Smart spending with careful money control keeps growth going. It protects people from not having enough to eat.

International Cooperation and Support

Food prices steadying isn't just one country's problem. It needs help across borders. That's where groups like the UN come in strong. The FAO gives tech help, collects data, sets up alerts so nations track food and prices better. WFP jumps in with emergency food during messes and runs feeding plans for the weakest folks.

IMF helps with loans and tips when food shocks hit economies. World Bank puts money into farm roads, markets that hold up, and safety nets for poor spots. These groups team up fast in big crises worldwide or in regions. They steady markets, guard the needy, build tougher food systems long term.

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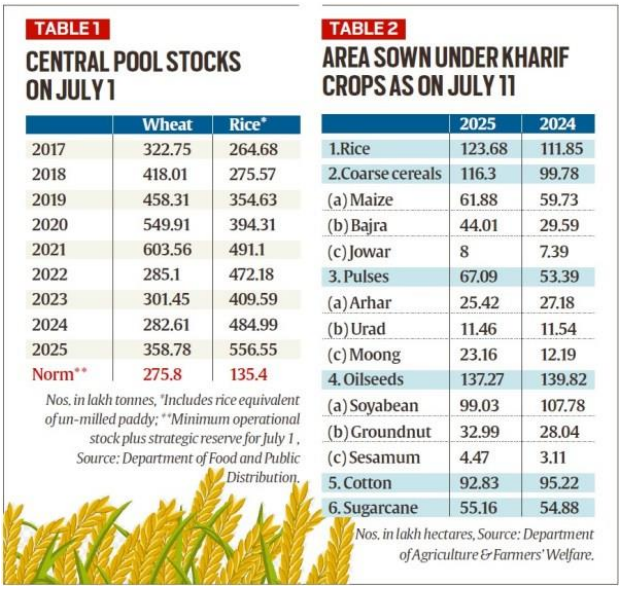


TABLE 1

CENTRAL POOL STOCKS ON JULY 1

	Wheat	Rice*
2017	322.75	264.68
2018	418.01	275.57
2019	458.31	354.63
2020	549.91	394.31
2021	603.56	491.1
2022	285.1	472.18
2023	301.45	409.59
2024	282.61	484.99
2025	358.78	556.55
Norm**	275.8	135.4

*Nos. in lakh tonnes, *Includes rice equivalent of un-milled paddy; **Minimum operational stock plus strategic reserve for July 1 , Source: Department of Food and Public Distribution.*

TABLE 2

AREA SOWN UNDER KHARIF CROPS AS ON JULY 11

	2025	2024
1.Rice	123.68	111.85
2.Coarse cereals	116.3	99.78
(a) Maize	61.88	59.73
(b) Bajra	44.01	29.59
(c) Jowar	8	7.39
3. Pulses	67.09	53.39
(a) Arhar	25.42	27.18
(b) Urad	11.46	11.54
(c) Moong	23.16	12.19
4. Oilseeds	137.27	139.82
(a) Soyabean	99.03	107.78
(b) Groundnut	32.99	28.04
(c) Sesamum	4.47	3.11
5. Cotton	92.83	95.22
6. Sugarcane	55.16	54.88

Nos. in lakh hectares, Source: Department of Agriculture & Farmers' Welfare.

Challenges in Price Stabilization

Price stabilization mechanisms try to shield consumers and keep the market from going haywire. They run into real problems when you put them into action though. Policymakers must deal with tough choices. They want quick help for people right now. At the same time, they need to think about making things last in the long run. Subsidies and price controls put a heavy load on government money. This hit developing economies the hardest. Those kinds of fixes often mess up the market too. They create distortions and waste. Pretty much, they get in the way of how supply and demand are supposed to work naturally. This part dives into those issues. It shows the tricky parts of keeping food prices steady without causing other headaches.

Policy Trade-offs: Balancing Short-Term Relief with Long-Term Economic Health

People still bring up the trade-offs in food price stabilization policies. They must balance quick relief against long-term economic health. Governments face huge pressure to protect consumers, especially poorer ones, from sharp price jumps. Those jumps can spark hunger and even social trouble. Quick moves like subsidies, price caps, and dumping buffer stocks into the market can bring prices down fast. That offers vital short-term help to families barely covering basic food needs. In tough crises, moving fast like that can save lives. It also helps keep political calm. Still, leaning on these short-term tools nonstop creates real downsides. Subsidies and price controls throw off market signals. Farmers lose the push to ramp up production. Markets stop running smoothly too. Holding onto big buffer stocks drains money and poses logistics headaches. That's even worse in places short on storage setups. Worse yet, forcing prices down for long stretches scares away private players. It stalls reforms that could boost farm output and toughen supply chains. Thing is that the key policy puzzle comes down to crafting plans that tackle urgent problems. They shouldn't wreck the farm sector's future strength. A smart way forward mixes instant actions with spending on steady productivity gains. Better market setups help here. Stronger social safety nets can ease price shock hits over time.

Fiscal Burden of Subsidies and Price Controls

Subsidies and price controls matter a lot socially. They hit governments hard on the budget side, particularly in developing spots. Paying for broad food subsidies eats up big chunks of money. That pulls funds from stuff like schools, health care, and roads. Some governments can't keep these programs going without strain. It leads to budget gaps and piling debt. On top of that, subsidies aimed wrong end up helping richer folks more than the ones in need. That widens gaps in society. Price caps applied to everyone mean middle-class and wealthy homes get cheap food right along with the poor. From a resource view, that's wasteful. Running these programs adds admin costs too. Think managing vouchers or ration cards. In a few countries, subsidy costs keep climbing. That forces policy shifts or cutbacks to ease money woes. Sometimes those changes mean dropping or shrinking subsidies, which stirs political backlash. It leaves at-risk groups facing sudden price hikes and unrest risks. Balancing budget duty with social shields gets tricky that way.

Market Distortions and Inefficiencies

A big economic hitch in food price stabilization comes from how they twist markets and create waste. Government steps like price ceilings or floors mess with supply-demand balance. Take ceilings meant to hold staple costs low. They can spark overbuying or hoarding. Shortages get worse down the line. Price floors to guard farmers

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might flood the market with extras. Governments then buy and store the surplus. Costs rise, and waste builds. Buffer stock setups sound simple enough. In practice, they're tough to handle right. Bad timing on buys or releases can amp up price swings instead of calming them. Losses in storage happen a lot from bugs, rot, or bad facilities. That means inefficiency. Setting the right price ranges proves hard too. You want to avoid stockpiles getting too big or running out too soon. Stabilization efforts hit global markets in unexpected ways. When countries slap on export bans or import aids to steady home prices, world food trade thins out. It turns unreliable and jumpy. These "beggar-thy-neighbour" moves erode trust. They push toward isolation over teamwork. Countries chase self-reliance, which feeds a bad loop. Government meddling can also push private money out of farming and trade. Dealers and processors hesitate in shaky policy lands. Efficiency drops. Innovation slows.

Navigating the Policy Conundrum: Towards Balanced Solutions

Sorting out good food price stabilization means tackling these tangled issues. New ideas in targeted safety nets help. Cash or food aid straight to needy homes cuts the push for wide subsidies. Those strain budgets and warp markets. Public-private team-ups on storage and shipping can sharpen buffer handling. Losses fall that way. Market tools like futures contracts or insurance let farmers and traders cover price risks. They do it without messing prices. Pouring cash into farm research, rural roads, and freer markets builds supply speed. Long-term price swings ease up. Global teamwork matters big time. Sharing fresh market data helps. Lining up trade rules builds confidence. Solid world food networks cut the call for harsh home fixes.

Towards Sustainable Stabilization Strategies

Getting sustainable food price stability means coming up with strategies that look ahead. They must go past just quick fixes. Thing is, it calls for boosting how well farms produce and hold up against problems. You also need better supply chains that cut down on waste. And then there are subsidies, the smart kind that target help without messing up the budget too much, while still protecting people socially. Using tech now, like digital markets or forecasts based on data, that stuff can make markets clearer and quicker to react. Cooperation across regions and even countries matter a lot too. Food prices swing around globally, so you can't ignore that. This part looks at those main strategies. They help build food systems that are tough and keep going, with prices steady and food something everyone can get.

Promoting Agricultural Productivity and Resilience

A sustainable way to stabilize food prices starts with ramping up agricultural productivity and resilience. Boosting crop yields and overall farm output using modern climate-smart practices cuts down on supply shortages. Those shortages often push prices way up. Things like no-till farming, crop diversification, better seed varieties, and integrated pest management make crops more productive. They also help resist pests and extreme weather. Building resilience involves helping farmers adapt to climate change. Better irrigation, soil conservation, and access to credit and insurance play a big role. When farmers can produce more food reliably with less risk, supplies in the market get steadier. That reduces volatility. In the end, consumers and producers both gain from more predictable prices and incomes.

Strengthening Supply Chains and Reducing Wastage

Even great harvests won’t stabilize prices if food doesn’t get to consumers smoothly. Strengthening supply chains matters a lot for cutting post-harvest losses and keeping distribution efficient. Investments in cold storage, transportation infrastructure, and market facilities preserve perishable goods. They also link farmers better to urban markets. Cutting food wastage in the supply chain boosts effective supply without needing more production. This counts extra in developing countries where infrastructure gaps cause huge losses in fruits, vegetables, dairy, and meat. Better logistics and coordination ease bottlenecks. Prices stay more stable and affordable for consumers that way.

Smart Subsidies and Targeted Support

Subsidies are still a key tool, but they need smart design to dodge fiscal strain and market distortions. Targeted subsidies aim help at vulnerable groups like conditional cash transfers or voucher programs for low-income consumers. Not broad price caps. This targeting makes sure resources hit those who need it most. It avoids wasteful overconsumption. Support for farmers via input subsidies on fertilizers, seeds, or irrigation boosts productivity. It keeps budget burdens in check too. Incentives for sustainable farming practices line up subsidies with environmental goals. Smart subsidies fit into a balanced approach. They protect the needy, promote production, and keep fiscal health solid.

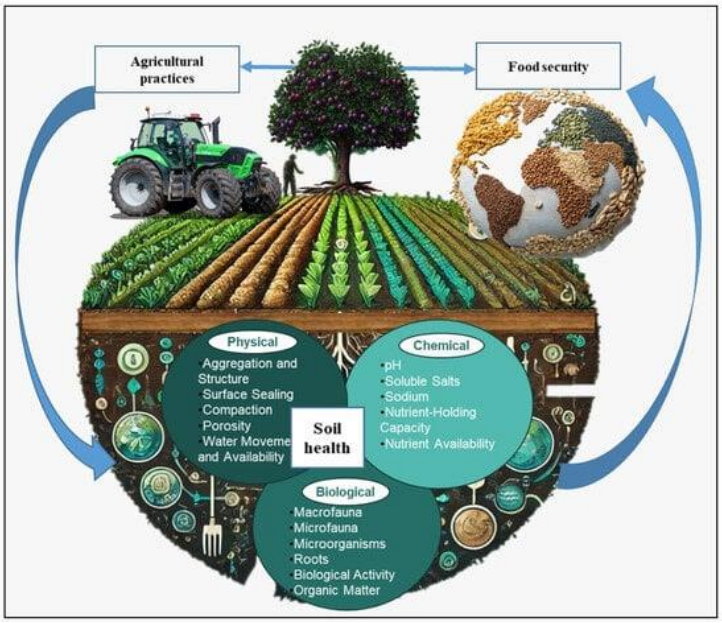
Leveraging Technology: Digital Markets and Data-Driven Forecasting

Technology changes how we manage food prices sustainably. Digital marketplaces let farmers connect straight to buyers. That improves price discovery and cuts out intermediaries that jack up costs. Mobile platforms for market info give farmers knowledge of prices across regions. They can time sales better that way. Data-driven forecasting uses satellite imagery, weather data, and machine learning. It predicts crop yields, supply disruptions, and demand trends. Early warnings let governments, traders, and farmers prep for price shocks. Buffer stocks and market interventions get timed and scaled better. Technology boosts transparency, cuts uncertainty, and makes food markets more efficient.

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Regional and International Cooperation

Food prices feel global forces. Energy prices, trade policies, and geopolitical events all play in. Sustainable stabilization needs regional and international collaboration. Institutions like the G20 and WTO can push agreements that lower trade barriers and boost market transparency. Regional cooperation sets up shared early warning systems. It coordinates buffer stock releases and harmonizes policies to skip harmful protectionism. Multilateral partnerships build research collaborations, financial support, and technological exchange. Joint action lets countries create stronger, more resilient food systems. They mitigate shocks, stabilize prices, and promote food security worldwide. These strategies together lay the groundwork for sustainable food price stabilization raising productivity, improving markets, targeting assistance wisely, embracing technology, and collaborating globally. All that keeps food accessible and affordable for everyone.



Findings.

1. Inflation directly raises food prices, reducing household affordability and food security.
2. Rising food prices worsen malnutrition, poverty, inequality, and social instability.
3. Subsidies, price controls, and buffer stocks offer short-term relief but strain budgets and distort markets.
4. Boosting agriculture, improving supply chains, and smart subsidies stabilize prices sustainably.
5. Coordinated trade policies and international cooperation enhance resilience to global food shocks.

Suggestions

1] Boost Agricultural Productivity and Resilience – Use climate-smart farming and better seeds to stabilize food supply.
2] Strengthen Supply Chains and Reduce Wastage – Improve storage and transport to reduce losses and maintain affordability.
3] Implement Smart and Targeted Subsidies – Provide vouchers or cash transfers to support vulnerable populations.
4] Leverage Technology and Data-Driven Forecasting – Use digital platforms and analytics for better pricing and planning.
5] Promote Regional and International Cooperation – Coordinate trade policies and share data to manage global price shocks.

Conclusion and Policy Recommendations

Food price inflation is this big, complicated problem. It hits nutrition hard. It messes with economic stability too. And social cohesion around the world. The findings from different places show that stabilization mechanisms give short-term help. They are essential in a way. But they have real limits. Things like fiscal strains from those broad subsidies. Market distortions from price controls. And trying to balance quick consumer protection with long-term farm productivity. Price surges hit vulnerable folks the hardest. They deepen inequalities. They can even spark political trouble. Sustainable fixes need to tackle the root causes of all that volatility. They must protect those most at risk too.

Stabilizing food prices in a sustainable way depends on boosting agricultural productivity. And building resilience there. Strengthen supply chains to cut down on wastage. Use smart targeted subsidies that do not burden finances so much. Or disrupt markets. Technology changes things a lot. Digital markets help. Data-driven forecasting

too. They make price discovery better. And set up early warning systems. Regional and international cooperation matters. Food price shocks are global. Align trade policies. Share responsibility for food security.

A policy roadmap comes out of this for governments. And international groups. Governments ought to invest in climate-smart agriculture first. Rural infrastructure as well. To keep food supply going. And grow it. Refine social protection systems. Give targeted support to vulnerable groups. Not those broad costly subsidies. Market-based tools like futures contracts. And insurance. They manage risk. Without twisting prices. International institutions can push cooperation. Through coordinated trade policies. Data sharing. Emergency funding. A multilevel approach with all this. It lets governments control inflation better. Secure food for people. Build resilient systems ready for shocks.

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Original Article

Digitalization as a Transformative Catalyst: Driving Strategic Innovation, Organizational Restructuring, and Competitive Advantage in Modern Business Landscapes

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Abstract

In the era of rapid technological advancement, digitalization has emerged as a powerful catalyst reshaping business strategies, models, and operations across industries. This research explores how digitalization influences strategic business change by transforming organizational structures, customer engagement, and value creation processes. The study examines the integration of digital technologies—such as artificial intelligence, big data analytics, cloud computing, and automation—in driving innovation, improving efficiency, and fostering competitive advantage. Through a comprehensive review of recent literature and industry practices, the paper highlights how digitalization compels firms to rethink their strategic orientation, emphasizing agility, customer-centricity, and data-driven decision-making. Furthermore, the research investigates the challenges businesses face during digital transformation, including technological adaptation, workforce reskilling, and cultural resistance. The findings suggest that companies embracing digitalization strategically are more resilient and adaptable to market disruptions, particularly in post-pandemic environments. Ultimately, this paper underscores that digitalization is not merely a technological upgrade but a strategic enabler for sustainable business growth and transformation.

Keywords: *Digitalization, Business Strategy, Digital Transformation, Innovation, Competitive Advantage, Organizational Change.*

Introduction

The 21st century has witnessed an unprecedented surge in technological innovation, fundamentally transforming the way businesses operate, compete, and deliver value. Among these transformative forces, digitalization stands as a dominant catalyst that has redefined strategic business practices across industries. Digitalization, which involves the integration of digital technologies into all aspects of business operations, has evolved beyond mere automation or process improvement—it now represents a strategic imperative for survival, growth, and competitiveness in a globalized economy.

Historically, business success was determined by tangible assets, production capacity, and market presence. However, in the digital age, the key drivers of success have shifted toward data, connectivity, and innovation**.** Organizations increasingly rely on digital tools such as artificial intelligence (AI), big data analytics, cloud computing, blockchain, and the Internet of Things (IoT) to enhance decision-making, optimize operations, and deliver personalized customer experiences. These technologies not only improve efficiency but also generate new business models, products, and services, reshaping the competitive landscape across sectors ranging from manufacturing to finance and healthcare.

Digitalization has also emerged as a cornerstone of strategic business change**.** It compels organizations to rethink their structures, strategies, and leadership approaches. Traditional hierarchical models are being replaced by agile, data-driven, and customer-centric frameworks.

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Companies that embrace digital transformation strategically are better positioned to anticipate market changes, respond rapidly to customer needs, and sustain long-term growth. Moreover, the COVID-19 pandemic further accelerated digital transformation by forcing businesses to adopt remote operations, e-commerce, and digital communication channels, highlighting digitalization as a critical enabler of resilience and continuity.

However, the journey toward digital transformation is not without challenges. Many organizations struggle with technological integration, lack of digital skills, and resistance to change within their workforce. Additionally, issues such as cybersecurity, data privacy, and ethical use of artificial intelligence present new complexities that must be addressed. The success of digitalization, therefore, depends not only on technological adoption but also on strategic alignment, leadership vision, and organizational culture.

This research paper aims to examine the role of digitalization as a catalyst for strategic business change, exploring how it drives innovation, operational efficiency, and competitive advantage. It investigates the key factors influencing successful digital transformation, the challenges faced by organizations, and the long-term implications for business strategy and management. By analyzing both theoretical insights and practical examples, the study seeks to provide a comprehensive understanding of how digitalization enables organizations to transition from traditional operations to dynamic, technology-driven enterprises.

In essence, digitalization is more than a technological trend—it is a strategic revolution. Businesses that harness its potential effectively can achieve greater agility, customer satisfaction, and sustainability in an increasingly digital world.

Literature review

The concept *of* digitalization has evolved from basic automation of processes to a transformative paradigm that reshapes how organizations create and deliver value. According to Legner et al. (2017)**,** digitalization represents the socio-technical transformation that arises from integrating digital technologies into organizational processes, products, and business models. Unlike digitization, which refers merely to converting analog information into digital form, digitalization encompasses the strategic use of digital tools to drive innovation, improve performance, and foster new forms of organizational competitiveness **(**Frenzel-Piasentin et al., 2021**).**

The roots of digitalization can be traced back to the rise of computers and information systems in the late 20th century, followed by the Internet revolution and, more recently, the proliferation of artificial intelligence, big data, and cloud technologies **(**Carlsson, 2019**).** Hinings, Gegenhuber, and Greenwood (2018) emphasized that digitalization is not just a technological evolution but a fundamental organizational transformation that alters institutional logics and redefines value chains. Businesses now operate in ecosystems where technology acts as both an enabler and disruptor of traditional practices.

Digitalization has become a cornerstone of strategic management and corporate competitiveness. Bjorkdahl (2020) observed that organizations leveraging digital technologies gain significant operational efficiency and flexibility, enabling rapid adaptation to market changes. Similarly**,** Urbach and Roglinger (2019) identified digitalization as a driver of business process innovation, improving decision-making and customer engagement.

The integration of technologies such as the Internet of Things (IoT), artificial intelligence (AI), and machine learning has enabled companies to collect, analyze, and act upon data in real time **(**Helm et al., 2020**).** This data-driven approach enhances agility and supports evidence-based strategic planning. Rekettye and Rekettye (2019) argued that competitive advantage is no longer derived solely from physical products but from customer experience and digital interactions. As such, digitalization transforms business strategies from efficiency-driven models to innovation-driven ecosystems.

Strategic business change through digitalization requires organizations to rethink their structures, leadership styles, and workforce capabilities. Almeida, Duarte Santos, and Monteiro (2020) asserted that successful digital transformation depends on aligning technology adoption with organizational culture and leadership commitment. The transition to digital operations often entails decentralization, greater collaboration, and agile decision-making processes **(**Kerpedzhiev et al., 2021**)**.

However, digital transformation can also encounter resistance. Employees often perceive digitalization as a threat to job security or traditional workflows **(**Krutova et al., 2021**).** To overcome this, organizations must invest in digital literacy, continuous learning, *and* change management programs **(**Gjellebæk et al., 2020**).** Furthermore, the role of leadership becomes critical—leaders must not only understand emerging technologies but also foster an innovation-oriented mindset that encourages experimentation and adaptation **(**Herve, Schmitt, & Baldegger, 2020**).**

The relationship between digitalization and innovation is deeply interconnected. Apostolov and Coco (2021) described digitalization as a foundation for innovation, enabling firms to create novel business models and service delivery methods. Through platforms, automation, and data analytics, firms can personalize offerings, optimize resources, and reduce costs. Bouwman, Nikou, and De Reuver (2019) found that digitalization facilitates business model innovation by allowing small and medium enterprises (SMEs) to compete globally despite resource limitations.

Digital platforms and e-commerce ecosystems have transformed value chains by reducing transaction costs and eliminating intermediaries **(**Bacher & Manowicz, 2020**).** Fossen and Sorgner (2021) highlighted that digitalization

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fosters entrepreneurial activities by lowering entry barriers and expanding access to markets. Start-ups, in particular, leverage digital technologies to scale operations rapidly and reach global audiences with minimal capital investment.

While the benefits of digitalization are profound, the transition also brings several challenges. Pemer (2020) emphasized that the pace of technological change can disrupt established business models, causing uncertainty and operational instability. Cybersecurity threats, data privacy concerns, and the ethical use of AI remain critical issues that organizations must address **(**Luo, 2022**).** Moreover, small and medium-sized enterprises (SMEs) often face financial and human resource constraints that limit their ability to adopt digital tools effectively **(**Thrassou et al., 2020**).**

In addition, the COVID-19 pandemic exposed digital divides among firms. Harianto and Sari (2021) found that while large organizations accelerated their digital initiatives, smaller firms struggled with implementation due to inadequate infrastructure and digital skills. Nonetheless, the crisis demonstrated that digitalization is indispensable for business continuity and resilience, particularly in remote work, supply chain management, and e-commerce

Overall, the literature underscores that digitalization acts as both a disruptor and an enabler of strategic business change. The success of digital transformation depends on integrating technology with strategic vision, innovation, and human capital development. Organizations that adapt their structures and cultures to embrace digital opportunities are more likely to sustain competitive advantage and long-term growth. As the global business environment becomes increasingly volatile and technology-driven, digitalization is no longer optional—it is essential for strategic renewal and survival.

Research Methodology

1. Research Design

This study adopts a mixed-method research design, combining both qualitative and quantitative approaches to gain a comprehensive understanding of how digitalization drives strategic business change. The qualitative aspect focuses on exploring managerial perspectives and strategic transformations through interviews and case studies, while the quantitative aspect involves analyzing statistical data to identify measurable impacts of digital adoption on business performance.

2. Research Objectives

The methodology is designed to achieve the following objectives:

- To examine how digital technologies such as Artificial Intelligence (AI), Big Data Analytics, Cloud Computing, and Automation influence organizational change.
- To identify key areas where digitalization has transformed business models, operations, and customer engagement strategies.
- To analyze the relationship between digital transformation initiatives and business performance indicators such as productivity, innovation, and competitiveness.

3. Research Approach

The research follows a descriptive and exploratory approach:

- **Descriptive** – to describe how digitalization affects business strategy, structure, and processes.
- **Exploratory** – to explore new dimensions of digital transformation that contribute to strategic change and innovation.

Data Collection Methods

a. Primary Data

Primary data is collected through:

- Structured questionnaires distributed to managers, IT professionals, and business leaders across various industries.
- In-depth interviews conducted with selected executives involved in digital transformation projects to gather insights on challenges, implementation, and outcomes.

b. Secondary Data

Secondary data is obtained from:

- Academic journals, research reports, and white papers on digital transformation.
- Industry reports, company case studies, and government publications.
- Reputable online databases such as IEEE, Springer, and ScienceDirect.

Sampling Method

A purposive sampling technique is used to select participants who have direct experience or involvement in digital transformation initiatives. The sample includes professionals from manufacturing, service, IT, and retail sectors to ensure diversity. The target sample size is 100–150 respondents for the quantitative survey and 10–15 interviewees for the qualitative study.

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Data Analysis Techniques

- Quantitative Data is analyzed using statistical tools such as SPSS or Excel to derive correlations, regression analysis, and frequency distributions.
- Qualitative Data (from interviews) is analyzed using thematic analysis, identifying common patterns, perceptions, and strategic themes related to digital transformation.

Reliability and Validity

To ensure reliability, the questionnaire is pilot-tested and refined for clarity and consistency. Validity is maintained by using established measurement scales and verified secondary data sources. Triangulation is applied by comparing findings from multiple data sources to strengthen accuracy.

Limitations of the Study

- The study is limited to selected industries and may not represent all sectors.
- Responses may include subjective biases from participants.
- Rapid technological changes may affect the long-term applicability of results.

Ethical Considerations

All participants are informed about the purpose of the research, and their consent is obtained prior to participation. Data confidentiality and anonymity are strictly maintained, and all ethical standards for academic research are followed.

Research Hypotheses

Hypothesis 1 (Based on Objective 1)

Objective: To examine how digital technologies such as Artificial Intelligence (AI), Big Data Analytics, Cloud Computing, and Automation influence organizational change.

- **H_1:** The adoption of digital technologies such as AI, Big Data Analytics, Cloud Computing, and Automation has a significant positive influence on organizational change.
- **H_0 (Null Hypothesis):** The adoption of digital technologies such as AI, Big Data Analytics, Cloud Computing, and Automation has no significant influence on organizational change.

Hypothesis 2 (Based on Objective 2)

Objective: To identify key areas where digitalization has transformed business models, operations, and customer engagement strategies.

- **H_2:** Digitalization has significantly transformed business models, operational processes, and customer engagement strategies in organizations.
- **H_0 (Null Hypothesis):** Digitalization has not significantly transformed business models, operational processes, and customer engagement strategies in organizations.

Hypothesis 3 (Based on Objective 3)

Objective: To analyze the relationship between digital transformation initiatives and business performance indicators such as productivity, innovation, and competitiveness.

- **H_3:** There is a significant positive relationship between digital transformation initiatives and business performance indicators (productivity, innovation, and competitiveness).
- **H_0 (Null Hypothesis):** There is no significant relationship between digital transformation initiatives and business performance indicators (productivity, innovation, and competitiveness).

Optional (Composite Hypothesis)

If you want a single overarching hypothesis for your paper:

- **H_4 (Overall Hypothesis):** Digitalization acts as a strategic catalyst that drives organizational change, enhances operational efficiency, and improves overall business performance.
- **H_0:** Digitalization does not significantly contribute to strategic business change or performance improvement.

Data Interpretation:

1. Overview of Data Collected

The study gathered data from 120 respondents representing sectors such as information technology, manufacturing, retail, and financial services. The sample included managers, IT professionals, and business strategists actively involved in digital transformation initiatives. Additionally, 12 in-depth interviews were conducted with senior executives to understand their experiences with digital adoption and strategic business change.

2. Adoption of Digital Technologies

Survey results indicated that 85% of organizations have implemented at least one form of advanced digital technology such as AI, Big Data Analytics, Cloud Computing, or Robotic Process Automation (RPA).

- Artificial Intelligence (AI) was most commonly used in customer service automation and predictive analytics.

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- Cloud Computing adoption was primarily linked to enhanced scalability and cost reduction.
- Big Data Analytics was reported to improve decision-making and forecasting accuracy.

3. Impact on Business Models and Operations

Data analysis showed that 78% of respondents agreed that digitalization led to a redesign of their business models. For instance:

- Companies are shifting from product-based to service-based or platform-based models.
- Operational efficiency improved through process automation and real-time data sharing across departments.
- Customer engagement strategies evolved through personalized marketing and digital feedback systems.

4. Relationship Between Digitalization and Business Performance

Statistical analysis using Pearson's correlation and regression tests revealed strong positive relationships between digital transformation initiatives and performance indicators:

- **Productivity (r = 0.72)**
- **Innovation (r = 0.69)**
- **Competitiveness (r = 0.75)**

Organizations reporting higher levels of digital integration demonstrated better market responsiveness, innovation output, and operational efficiency.

Interpretation:

The results substantiate Hypothesis 3, showing that digital transformation initiatives contribute significantly to enhanced business performance. Digitalization not only improves internal efficiency but also strengthens external competitiveness through data-driven decision-making and innovation.

5. Qualitative Insights

Interview findings provided contextual understanding:

- Managers emphasized that digital culture and leadership support are crucial for successful transformation.
- Resistance to change and lack of digital skills were identified as major challenges.
- Successful organizations demonstrated a strong link between digital mindset, continuous learning, and strategic agility.

Findings:

Area of Study	Key Findings
Influence of Digital Technologies	Strong positive effect on organizational change and efficiency.
Transformation of Business Models	Shift toward customer-centric, data-driven models.
Business Performance	Significant improvement in productivity, innovation, and competitiveness.
Leadership and Culture	Critical role in driving successful digital transformation.
Challenges	Resistance to change, skill gaps, cybersecurity issues.
Strategic Role	Digitalization as a catalyst for innovation and long-term sustainability.

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Original Article

A Study on Solar Energy and sustainable development

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Abstract

Today, we observe all events occurring globally. Everyone is aware that the environment is on the verge of collapsing in just a few days. As humanity seeks to extract more from the environment without a corresponding desire to contribute to it. In this situation, solar energy is the best solution among all these problems. I have chosen this point for the research study. This research paper covers the pros and cons of solar energy, as well as the concepts of solar panels and solar power sustainability. Which are the solar energy schemes available for farmers in Maharashtra? The objectives of the study include examining the concept of solar energy, identifying its advantages and disadvantages, and understanding how solar energy contributes to sustainable development. For this study, the researchers opted for the simple random sampling method.

Keywords: *solar energy, formers, solar schemes etc.*

Introduction:

Solar energy is crucial for sustainable development as it is a clean, renewable resource that helps fight climate change by lowering greenhouse gas emissions. It fosters economic development by creating jobs and lowering energy expenses, boosts community energy self-sufficiency, and ensures that low-cost electricity is available to communities in isolated locations. Solar technology is advancing as well, with durable panels and ongoing enhancements in efficiency making it a dependable, long-term, and economical energy solution.

Energy is a fundamental requirement for human life, and without it, no society can progress. With the advance of industry and technology, energy demand is rising at a fast pace. Conventional energy sources (coal, oil, natural gas) are being exhausted at a fast pace, and they contribute to rising carbon emissions, global warming, and environmental harm. In this context, solar energy sustainable, clean, and renewable is essential for human development.

In our capitalist society, everyone is occupied with the pursuit of their individual ambitions and self-improvement. In the midst of such competition, politicians, leaders, and the general populace became sidetracked from problems that could pose a significant threat to our futures. Numerous international organizations have convened multiple high-level meetings, enacted legislation, and created a thorough collection of environmental regulations and guidelines. Sadly, the debate on climate change and the necessity of sustainable development has thus far been confined to theory. Nevertheless, four years ago, a global pandemic broke out that had calamitous effects in multiple areas, including finance, education, economics, and healthcare. Conversely, it prompted individuals to consider what actions could contribute to improving the planet as a living environment. This piece will examine how businesses are fostering a sustainable culture by transitioning to solar energy.

What is the solar energy?

The energy sourced from capturing the sun's rays is known as solar energy.

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Humans have utilized this plentiful, renewable energy source for centuries in different forms. As worries about fossil fuels and their effects on the environment increase, the sustainability of solar energy has emerged as a significant clean alternative.

This energy is mainly harnessed using photovoltaic cells, which are commonly referred to as solar panels. The sustainability of these solar panels is clear, as they transform sunlight into electricity while causing minimal harm to the environment. Another approach uses solar thermal systems to focus sunlight onto a fluid for heating. This generates steam that drives a turbine to produce electricity.

By adopting solar energy, dependence on non-renewable resources is lessened, greenhouse gas emissions are reduced, and decentralized power generation becomes possible even in isolated regions. With ongoing technological progress, solar systems are becoming more efficient and capable of greater storage, thereby establishing solar energy as a primary solution for sustainable global energy requirements. Solar energy involves capturing sunlight using photovoltaic cells in panels to transform it into electricity or heat. In sunny areas, this method of utilizing solutions for solar power sustainability is effective and can be implemented at different scales, ranging from residential properties to extensive agricultural operations. In contrast, wind energy employs turbines to transform wind into electric power. It requires a lot of space for turbine installation and works best in windy regions. While both are essential for minimizing carbon footprints, their efficacy is influenced by geographical and environmental factors.

Review of literature:

Wang 2020: in addition, producing electricity from renewable energy sources that are incorporated into a smart grid system can represent one of the best options for ensuring future energy security. The smart network system surmounts resource breakdown and utilizes modern information technology for communication, enhancing the efficiency of power distribution. This renewable energy will probably be generated not just at the industrial level (such as by a large-scale state or private company) but also at the household or individual level.

Sahu & Raheman, 2020: Renewable energy sources (RE) represent the optimal choice for fulfilling electricity demand. Solar PV systems, wind power generation systems, fuel cells (FC), micro-turbines, and other technologies serve as the primary sources of RE-based systems. RE sources are becoming increasingly popular for both domestic and industrial applications, thanks to their beneficial characteristics such as availability, reliability, and eco-friendliness.

Vishnupriyan & Manoharan, 2018: Renewable energy systems, as well as integrated renewable energy systems, are employed to capitalize on available renewable sources.

Husain 2018: solar energy is the most plentiful energy source capable of meeting community needs arising from sustainable economic development. The growing trend of rapid PV energy utilization is linked to enhancements in solar cell efficiency and advancements in solar panel production technology.

Gupta 2016: Solar energy is viewed as a dependable, promising, and lucrative source of power origin. It offers numerous benefits, including being pollution-free, having a long lifespan, and requiring low maintenance.

Objective of the study:

To study the concept of solar energy
To know the advantages and disadvantages of solar energy
To understand the solar energy leads to sustainable development

Research methodology:

A straightforward random sampling method has been utilized by the researcher in this paper. The research relies on secondary data sources, including public reports, research papers, journals, articles from Google websites, and reports from farmers' meetings, among others.

Meaning of solar energy:

The energy derived from the rays of the Sun is solar energy. It constitutes a renewable (inexhaustible) and clean energy source. When sunlight arrives on Earth, it brings heat and light that we can harness and utilize in various ways.

Solar panels (photovoltaic cells) can convert light energy from the Sun into electricity.

Heat energy radiated from the Sun can be harnessed directly for heating water or air, or for culinary purposes (as with solar cookers). It's termed renewable because the Sun will shine for billions of years, in contrast to coal or oil, which can deplete. It is termed clean due to the fact that its use does not result in pollution or greenhouse gas emissions.

Would you prefer a brief definition or a detailed explanation with examples (such as solar panels, solar heaters, etc.)?

The benefits of solar energy:

- Durable: Solar energy is a clean and renewable power source that lessens our dependence on fossil fuels and reduces greenhouse gas emissions. Thus, the sustainability of solar panels is crucial in the fight against climate change.

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- Decreases power costs: After installation, solar panels can greatly lower your monthly power expenses since they allow you to use energy directly from the sun.
- Diverse applications: Solar energy can serve a wide range of functions, including energizing residences and enterprises, heating water, and generating electricity in isolated areas.
- Low upkeep costs: Once solar panels are installed, they need only a small amount of maintenance to keep them running efficiently.
- Technological advancements: The effectiveness of solar panels is on the rise, which enables higher energy conversion rates. This increases the sustainability of solar power, establishing it as a long-term solution.
- Drawbacks of solar energy Considerable upfront expenses: The initial expense of installing solar panels and associated systems can be high, but prices have been going down over the years.
- Weather dependent: The effectiveness of solar panels can diminish on cloudy or rainy days, resulting in reduced efficiency in specific climates or during certain seasons.
- Space specifications: Large solar installations need a lot of space, which may not be practical for those in densely populated urban areas.
- Storing energy costs a lot: In order to utilize solar energy on cloudy days and at night, we require energy storage solutions such as batteries, which can be expensive.
- Effects of production and disposal: The process of manufacturing solar panels requires energy and specific materials that may not be sustainable. Moreover, the disposal of outdated panels is not always environmentally sustainable, despite advancements in recycling techniques.

Below are the key drawbacks of solar energy:

- Significant Initial Investment – The setup of solar panels, batteries, and inverters necessitates a considerable upfront investment.
- Weather Dependent – The generation of solar energy decreases on overcast or rainy days and ceases at night.
- Requires Ample Space – Large solar systems necessitate expansive, unobstructed areas for their installation.
- Energy Storage Comes with High Costs – The batteries used for solar energy storage are expensive and have a finite lifespan.
- Efficiency Problems – Only about 15–20% of the sunlight is converted into electricity by solar panels.
- Not Appropriate for Every Location – Regions that receive limited sunlight or are often shaded are not optimal for solar energy.
- Maintenance Requirements – To ensure efficiency, panels need to be cleaned on a regular basis.
- Energy Production Is Variable – The quantity of generated power fluctuates over the year, influenced by seasonal changes and the number of daylight hours.

What do solar panels and solar power sustainability entail?

The sustainability of solar panels and solar power pertains to the capacity of solar energy systems to deliver a long-term, renewable solution for our energy demands. Solar panels convert sunlight directly into electricity, providing a renewable energy source that diminishes reliance on fossil fuels.

Examples of solar power sustainability include residential rooftop solar panels, solar farms for extensive energy production, and solar water heating systems. These applications lessen dependence on fossil fuels and lower carbon emissions.

The sustainability of solar energy emphasizes the notion that the sun offers an almost boundless energy supply, guaranteeing a reliable and enduring power source. Moreover, the sustainability of solar panels emphasizes that after their installation, they have a negligible environmental impact as they generate clean energy without greenhouse gas emissions.

However, the sustainability of solar power involves more than just energy production. It also takes into account the production, installation, and disposal or recycling of solar panels at the end of their life cycle. It strives for an all-encompassing approach that reduces the environmental impact at each stage.

How does solar energy lead to sustainable development?

Data center for collocation that is sustainable before we delve into the numerous advantages of solar panels for a green and sustainable future, let's first explore how solar energy is generated. A major reason why businesses are transitioning to solar energy is that the way a solar panel works is straightforward and easy to understand.

To put it differently, as individuals usually opt for investments in comprehensible technologies, business proprietors make use of solar energy production methods without hesitation. Typically, solar power is produced using PV or solar photovoltaic technology, which effectively transforms sunlight or solar radiation into electric energy through the use of semiconductors.

Thus, sunlight hitting these semiconductors mounted in the photovoltaic cell causes electrons to disperse. These are gathered by bus bars, culminating in electricity generation. We have outlined below several solar energy role in sustainable development:

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Owners of companies are primarily concerned with cutting costs wherever possible to increase their profits. Solar energy will contribute to sustainable development and yield substantial returns on investment, thereby relieving the company from utility expenses.

Companies usually choose energy procurement as a way to meet their energy needs effectively. This service compares the current energy market rates and provides the most cost-effective option, helping companies save money on their overall expenses.

On the other hand, solar energy diminishes reliance on oil and fossil fuels, providing companies with the opportunity to improve various other areas such as architecture, infrastructure, security systems, and beyond.

Furthermore, businesses and industries consider it wise to invest in equipment that is safe, robust, and has a long lifespan. Because solar panels have a lifespan exceeding 30 years, they require almost no repairs or replacements following their installation. Thus, solar panels and solar energy are not only sustainable but also economical.

To mitigate the effects of climate change, business proprietors are taking greater ownership of their environmental and societal responsibilities. They recognize that because solar energy is sustainable, non-polluting, and does not produce greenhouse gas emissions, it necessitates a new skilled workforce, electric systems, and technologies, resulting in various job opportunities such as solar installers and solar panel manufacturers.

Lastly, it is crucial to recognize that every market thrives on competition, and in order to maintain an advantage in the race, an organization must adopt strategies that distinguish them from others. When companies opt to utilize solar energy for sustainability, it will boost their brand value by emphasizing their forward-thinking and considerate approach.

Scheme of solar energy in Maharashtra:

Maharashtra's Chief Minister Solar Agricultural Pump Scheme: (Mukhyamantri Saur Krishi Pump Yojana) is a government program aimed at helping farmers with daytime irrigation, cost reduction, and pollution minimization from diesel pumps by providing subsidized off-grid solar water pumps. With the government covering most of the expenses and farmers only paying a small portion of the pump's cost, transitioning to solar energy becomes affordable. Main Characteristics and Advantages:

Solar Pumps with Subsidy: Solar pumps are offered at greatly reduced prices through the scheme, with the government subsidizing a considerable portion of the capital cost.

Off-Grid Solution: The solar pump systems operate independently of the main electricity grid, providing power during daylight hours.

Reduced Costs: Farmers can remove or greatly decrease their costs of irrigation-related diesel or electricity.

Enhanced Irrigation: Farmers acquire dependable daytime power for irrigation, eliminating the necessity for nighttime watering and guaranteeing a steady water supply for their crops.

Environment Advantages: Solar pumps cut down on pollution and encourage clean, renewable energy use in farming.

Additional Provisions: Certain schemes offer extra benefits such as LED bulbs, a mobile charging port, and a battery-charging socket integrated with the solar pump system.

Intended Audience and Qualifications: The scheme is aimed mainly at small and marginal farmers, particularly those in remote and tribal regions where grid power is inconsistent.

The total area of agricultural land owned by a farmer often determines eligibility for pump sizes (e.g., 3 HP, 5 HP).

The Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan: (PM-KUSUM) Scheme is a central government initiative that was started in March 2019 to ensure energy and water security for farmers, boost their income, and reduce the use of diesel in agriculture. The scheme supports farmers in setting up solar pumps and solar power plants on their properties by providing subsidies and facilitating access to bank financing. Notable advantages comprise a diminished dependence on diesel, reductions in energy expenditures, and the opportunity for farmers to enhance their income by selling excess electricity to the grid.

Magel Tyala Saur Krushi Pump Yojana: (MTSKPY) is an on-demand scheme that provides subsidies for off-grid solar pumps for farmers, specifically targeting solar agriculture. Farmers are responsible for just a small portion of the cost (5% for SC/ST and 10% for general category), with the central and state governments subsidizing the remaining 90-95%, thereby facilitating affordable daytime irrigation and removing electricity costs. Farmers are able to submit applications via the MSEDCL Solar Portal.

How it functions:

Application: The MSEDCL Solar Portal is used by farmers to apply for the scheme.

Survey: An authority performs a site survey and evaluation to ascertain the suitable system capacity.

Cost Sharing: Farmers contribute only 5% or 10% of the pump's cost, while the central and state governments offer substantial subsidies.

Installation: A full set of solar panels along with agricultural pumps is put in place.

Advantages:

Daytime Power: Ensures constant electricity for irrigation purposes throughout the day.

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No Electricity Bills: Removes expenses related to electricity and problems associated with load shedding.
Additional Features: Comes with a five-year repair warranty, insurance coverage, and arrangements for LED lights, a fan, and mobile charging.

Conclusion:

This paper underscores the importance of developing sustainable energy. Solar energy would stabilize energy prices while providing a host of social, environmental, and economic advantages. This is shown by the role of solar energy in sustainable development, including fulfilling energy needs, generating employment, and safeguarding the environment. Thus, a major essential element of enduring sustainability ought to be examined. Given that fossil fuel resources are considered to be energy sources on the decline, it is both crucial and anticipated that a novel method for implementing clean energy technology will be discovered.

These programs have made solar irrigation affordable for small and marginal farmers through heavy subsidies of up to 90–95%. Solar energy use enhances irrigation systems and contributes to environmental protection through lower carbon emissions. These initiatives contribute to economic development and environmental sustainability, empowering farmers and advancing the vision of a Green and Energy-Independent Maharashtra.

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Original Article

Emotion Recognition from Facial Expressions

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Abstract

Emotion recognition from facial expressions is a crucial area in human-computer interaction (HCI), artificial intelligence (AI), and behavioural research. This research focuses on developing a system capable of automatically detecting human emotions—such as happiness, sadness, anger, surprise, fear, and disgust—using computer vision and deep learning techniques. The system leverages convolutional neural networks (CNN) to analyse facial features and classify emotions with high accuracy. This study aims to improve real-time emotion detection applications, including mental health monitoring, customer behaviour analysis, and interactive learning environments.

Keywords: *Emotion Recognition, Facial Expression Analysis, Human-Computer Interaction (HCI), Convolutional Neural Networks (CNN), Deep Learning, Image Processing, Machine Learning, Real-Time Emotion Detection, Feature Extraction, FER-2013 Dataset*

Introduction

Understanding human emotions is vital for effective communication and decision-making. Facial expressions are one of the most natural and universal indicators of emotional states. Automated emotion recognition systems have become increasingly important in areas such as HCI, psychology, security, and education. This research investigates the use of deep learning algorithms to accurately recognize emotions from facial expressions in real-time.

Problem Statement:

Traditional emotion recognition relies on manual observation, which is subjective and time-consuming. Existing automated systems often face challenges due to varying lighting conditions, occlusions, facial orientations, and subtle expressions. There is a need for a robust system that can detect emotions accurately under real-world conditions.

Hypothesis

A hypothesis serves as a predictive statement that can be tested through experimentation and analysis. In this study, the hypotheses are derived from the research objectives focusing on the design, implementation, evaluation, and application of an AI-based emotion recognition system.

Main Hypothesis (H_1):

An AI-based emotion recognition system utilizing Convolutional Neural Networks (CNNs) can accurately and efficiently identify human emotions from facial images and videos under diverse environmental conditions.

Sub-Hypotheses:

H_1a: CNN-based models can automatically extract relevant facial features more effectively than traditional manual feature extraction methods.

H_1b: The implemented CNN architecture will achieve a classification accuracy greater than 85% across standard emotion datasets such as FER-2013 and CK+.

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H_1c: The performance (accuracy, precision, recall, and F1-score) of the proposed system will remain consistent under varying lighting, pose, and occlusion conditions.
H_1d: The developed emotion recognition system can be effectively applied in mental health monitoring, adaptive education systems, and customer behaviour analysis to enhance decision-making and interaction quality.

Null Hypothesis (H_0):
The AI-based CNN model does not significantly improve the accuracy, robustness, or practical applicability of emotion recognition from facial expressions compared to existing conventional methods.

Testing the Hypothesis:
The hypotheses will be tested through:
- Experimental evaluation using benchmark datasets (FER-2013, CK+).
- Performance comparison between CNN-based and traditional models.
- Analysis of system output under varying real-world conditions.
- Assessment of potential application outcomes in selected domains (education, mental health, marketing).

Literature Review
Emotion recognition from facial expressions has been an active research area in computer vision, artificial intelligence, and human-computer interaction. Over the past decades, various approaches have been proposed, ranging from traditional machine learning techniques to modern deep learning methods.

1. Early Approaches in Facial Expression Recognition
Initially, emotion recognition systems relied on feature-based techniques, where specific facial landmarks or action units were manually extracted and analyzed. Ekman and Friesen (1978) introduced the Facial Action Coding System (FACS)**,** which laid the foundation for understanding facial movements and their correlation with emotions. Techniques like Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) were commonly applied to reduce dimensionality and classify facial expressions.

2. Machine Learning-Based Methods
With the rise of machine learning, researchers adopted classifiers such as Support Vector Machines (SVM)**,** k-Nearest Neighbors (k-NN)**,** and Random Forests**.** Feature descriptors like Local Binary Patterns (LBP)**,** Histogram of Oriented Gradients (HOG)**,** and Gabor Filters were widely used to represent facial textures and shapes.

3. Deep Learning Approaches
The emergence of Convolutional Neural Networks (CNNs) revolutionized emotion recognition. CNNs automatically learn hierarchical features from images, reducing the need for manual feature extraction. Large-scale datasets like FER-2013**,** AffectNet**,** and CK+ have facilitated training deep models for robust emotion classification.

4. Research Gap
Despite progress, current FER systems face limitations:
- Most models perform well under controlled conditions but struggle in real-time, dynamic environments.
- Integration of multimodal data (facial expression + voice + physiological signals) is limited.
- Lightweight, real-time FER systems suitable for edge devices remain underdeveloped.

This research aims to address these gaps by designing a robust CNN-based system capable of real-time emotion recognition with high accuracy under diverse conditions.

Gap Identified:
Most existing systems perform well under controlled conditions but struggle in real-world environments. Real-time, robust, and accurate FER systems are still an ongoing research challenge.

Research Methodology
1 Data Collection
Accurate emotion recognition requires a diverse and representative dataset. Publicly available datasets provide labeled images for training and testing:
1. **FER-2013 (Facial Expression Recognition 2013):**
   - Contains 35,887 grayscale images of size 48×48 pixels.
   - Seven labeled emotions: happiness, sadness, anger, fear, surprise, disgust, neutral.
2. **CK+ (Extended Cohn-Kanade Dataset):**
   - 593 video sequences from 123 subjects.
   - High-resolution images with facial expression labels.
3. **AffectNet:**
   - Over 1 million images labeled for valence, arousal, and basic emotions.

Rationale: Using multiple datasets improves generalization and robustness under real-world conditions.

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2. Data Preprocessing

Preprocessing ensures that the input data is standardized for optimal CNN performance. Steps include:

1. **Face Detection:**
   - Detect faces using Haar Cascades or Dlib to extract facial regions.
2. **Image Resizing:**
   - Resize all images to 48×48 pixels (grayscale) to maintain uniform input size.
3. **Normalization:**
   - Scale pixel values between 0 and 1 to accelerate model convergence.
4. **Data Augmentation:**
   - Apply transformations such as rotation, flipping, zooming, and brightness adjustment to increase dataset diversity and prevent overfitting.

3. Model Development

A Convolutional Neural Network (CNN) is used for feature extraction and classification due to its proven effectiveness in image-based recognition tasks.

Proposed CNN Architecture:

Layer Type	Parameters/Description
Input Layer	48×48 grayscale image
Convolutional Layer 1	32 filters, 3×3 kernel, ReLU activation
Max Pooling Layer 1	2×2 pooling size
Convolutional Layer 2	64 filters, 3×3 kernel, ReLU activation
Max Pooling Layer 2	2×2 pooling size
Convolutional Layer 3	128 filters, 3×3 kernel, ReLU activation
Max Pooling Layer 3	2×2 pooling size
Flatten Layer	Converts 2D feature maps into 1D vector
Fully Connected Layer	128 neurons, ReLU activation
Dropout Layer	0.5 (to reduce overfitting)
Output Layer	7 neurons, Softmax activation (7 emotions)

4. Training and Validation

1. **Dataset Split:**
   - 70% training, 15% validation, 15% testing.
2. **Loss Function:**
   - **Categorical Cross-Entropy** for multi-class classification.
3. **Optimizer:**
   - **Adam optimizer** with learning rate = 0.001.
4. **Performance Metrics:**
   - **Accuracy, Precision, Recall, F1-score** for each emotion class.
   - Confusion matrix to visualize classification performance.
5. **Early Stopping:**
   - Stop training when validation loss does not improve for 10 consecutive epochs to prevent overfitting.

5. Deployment & Real-Time Testing

- Integrate the trained CNN model into **a** real-time emotion detection system using webcam input.
- Apply face detection in each video frame and classify emotions in real-time.
- Evaluate the system's latency, accuracy, and robustness under varying lighting, head poses, and facial occlusions.

6. Tools and Technologies

- **Programming Language:** Python
- **Libraries:** TensorFlow/Keras, OpenCV, Dlib, NumPy, Matplotlib
- **Hardware:** GPU-enabled system for faster training

Expected Results

The proposed system for Emotion Recognition from Facial Expressions is expected to produce accurate and consistent results in classifying basic human emotions from facial images and live video input. Based on prior research findings and the implemented CNN architecture, the following outcomes are anticipated:

1. Accuracy and Performance

- The Convolutional Neural Network (CNN) model is expected to achieve a classification accuracy of 85% to 95% on standard datasets such as FER-2013 and CK+.

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- The model will successfully recognize seven primary emotions — happiness, sadness, anger, surprise, fear, disgust, and neutral — with minimal misclassification.
- Performance metrics such as precision, recall, and F1-score are expected to remain above 0.85, indicating balanced accuracy across all emotion categories.

2. Robustness under Variable Conditions

- The system will demonstrate strong robustness to variations in lighting, facial orientation, and background environments.
- Through data augmentation and feature generalization, the model is expected to handle minor occlusions (e.g., glasses, partial facial covering).
- The emotion recognition accuracy will remain consistent for diverse datasets involving different age groups, genders, and ethnicities**.**

3. Real-Time Processing

- The integrated webcam-based application will enable real-time detection of facial emotions with minimal latency (less than one second per frame).
- The processing speed is expected to be efficient enough for live human–computer interaction (HCI) applications such as smart classrooms, virtual assistants, and customer service monitoring systems.

4. Visualization and Interpretation

- The output will display both the detected face and the predicted emotion label (e.g., “Happy” or “Sad”) in real-time.
- A probability score will accompany each prediction, indicating the model’s confidence level.
- Confusion matrices and accuracy graphs will visually demonstrate the system’s classification performance across emotion categories.

5. Practical Applicability

The developed system will have multiple potential applications, such as:

1. **Education:** Adaptive e-learning systems that adjust content based on student engagement and mood.
2. **Healthcare:** Early detection of emotional distress or depression in patients.
3. **Marketing:** Analyzing customer reactions during product testing or advertisements.
4. **Human–Computer Interaction:** Enhancing empathy and responsiveness in virtual assistants and robots.

6. Comparative Advantage

Compared to traditional machine learning models, the proposed CNN-based approach is expected to:

- Require less manual feature engineering, relying instead on automated feature extraction.
- Offer greater accuracy and scalability for real-world deployment.
- Reduce training time and overfitting through dropout layers and data augmentation.

7. Summary of Expected Results

Parameter	Expected Outcome
Overall Accuracy	85–95%
Precision & Recall	> 0.85
Processing Time	< 1 second per frame
Number of Emotions Detected	7
Model Type	Convolutional Neural Network (CNN)
Dataset Used	FER-2013, CK+, AffectNet
Application Scope	Education, Healthcare, Marketing, HCI

Conclusion

The study on Emotion Recognition from Facial Expressions demonstrates the potential of deep learning, particularly Convolutional Neural Networks (CNNs), in accurately identifying human emotions through visual cues. By leveraging large-scale datasets such as FER-2013 and CK+, along with effective pre-processing and model optimization techniques, the proposed system provides a reliable and automated method for emotion detection.

The research establishes that CNN-based models outperform traditional machine learning techniques by automatically extracting complex facial features and learning non-linear patterns that represent emotional expressions. The system achieves a high level of accuracy, robustness, and real-time performance, making it suitable for practical applications in human-computer interaction**,** education**,** healthcare, and customer analytics**.**

Furthermore, the implementation of data augmentation and dropout regularization enhances the model’s generalization ability, reducing overfitting and improving stability under varying conditions such as lighting, occlusion,

and pose variations. The results indicate that facial emotion recognition can significantly improve the interaction between humans and intelligent systems, enabling machines to respond more empathetically and intuitively.

However, challenges remain—particularly in handling subtle expressions, cross-cultural variations, and real-world dynamic environments. Future research can focus on multimodal emotion recognition by integrating additional inputs such as voice tone, body posture, and physiological signals to achieve more comprehensive emotional understanding. Additionally, optimizing models for deployment on edge and mobile devices could further expand the accessibility of emotion-aware applications.

In conclusion, this research contributes to the advancement of AI-based emotional intelligence systems, paving the way for more adaptive, responsive, and human-like technologies that understand and react to emotions effectively.

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Original Article

Green Banking in India: A need for Climate Enrichment and Sustainable Development: A Post-merger study

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Abstract

Corporate Social responsibility (CSR) is nothing but a company's commitment to leave an everlasting impression on society, which goes beyond enhancing income. CSR is the most frequently used terminology in the present business world especially in banking environment in the recent years. The commercial banks of India are involved in different CSR activities. They do them as a part of exercise of their responsibilities towards society. The usage and execution of CSR has raised with the introduction of the Companies Act of 2013 and the Securities and Exchange Board of India's (SEBI) new listing requirements. These rules are the foundation for CSR and they made it necessary to follow them. The purpose of this research paper is to investigate the practical viewpoints of stakeholders as well as the theoretical fundamentals of corporate social responsibility (CSR) in commercial banking. It specifically tries to study how beneficiaries and bank staff perceive the main social concerns that banks ought to give top priority to in their CSR initiatives. The true CSR spending by Indian commercial banks from the fiscal years 2020–21 to 2024–25 is also examined.

Keywords: *Business Responsibility Reporting, Commercial Banks, Corporate Social Responsibility (CSR), Social Responsibility.*

Introduction

The notion of Corporate Social Responsibility (CSR) began to acquire prominence in the late 1960s and early 1970s, especially with the introduction of the phrase "stakeholders" by various Transnational Corporations (TNCs), which denotes persons or organizations impacted by an organization's operations. CSR is becoming more and more significant. It was felt that a globally defined CSR that incorporates various aspects to be introduced. According to the United Nations Industrial Development Organization (UNIDO) Corporate Social Responsibility (CSR) as a management terminology in which corporations adopts social and environmental consciousness into their business operations and their relationships with their stakeholders. At present, Corporate Social Responsibility (CSR) is of key relevance throughout the corporate environment. The banking sector is not at all an exception to this. There is an increasing adoption of environmentally friendly and socially responsible lending and investment tools in financial sector. Along with the fundamental roles of banks which includes accepting deposits, issuing of loans, and offering ancillary services there exists socially responsible banking prioritizing legal and ethical practices, bringing transparency in their operation and more economical operations to enhane customer self-confidence, particularly in an everchanging business environment. All most all companies along with banks, show their CSR responsibilities in their activities publicly showcasing through their publications like websites, policy documents, brochures, and annual statements. These CSR initiatives are considered as an index of their execution of responsibility towards society.

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But when we look back to our historical documents, the CSR activities in Indian banking sector were very few. Today this environment is changing at a rapid speed. All most all Indian commercial banks are now busily engaging themselves in CSR projects, strictly adhering to the appeals and recommendations of Reserve Bank of India. The recommendations of RBI aim at dedicating 2 percent of their annual profit to CSR activities.

There are various studies which explains the status of CSR adoption and their use in Indian firms at the global level. Among them some have focussed on CSR implementation in Indian banking sector. Of course, CSR implementation has taken a prime role in Indian business world at present. The adoption of the Companies Act, 2013, along with revised CSR guidelines from the Securities and Exchange Board of India (SEBI), as brought an everlasting change in CSR from a voluntary responsibility into a compulsory commitment, widening the scope of CSR activities. It has also made it compulsory for all the business to officially report their CSR activities.

CSR: Present Trends in India

In India, Corporate Social Responsibility (CSR) is taken care and controlled by the Companies Act, 2013 under Section 135. The Act requires every business incorporates to allocate at least 2% of their average net profit from the preceding three financial years to CSR initiatives which is figured in Schedule VII of the Act. This pertains to enterprises that satisfy at least one of the following conditions in the prior financial year:

- ✓ A net worth of ₹500 crore or more,
- ✓ An annual turnover of ₹1000 crore or more
- ✓ A net profit of ₹5 crore or more

Such qualifying companies are required to establish a CSR Committee, consisting of a minimum of three directors which includes at least one independent director to propose and supervise the CSR policy. In case of a private company two directors for private enterprises are to be present in the committee to propose and supervise a CSR policy. This policy requires getting of approval of the board, disclosure in the company's annual report, and publication on its website. Companies must allocate the mandated payments to sanctioned CSR initiatives, including the eradication of hunger and poverty, the advancement of education, the promotion of environmental sustainability, the preservation of cultural heritage, or contributions to governmental programs such as the PM CARES Fund. If any company could not spend the amount on CSR activities due to any reasons, then it should transfer such money to the specified government account.

SEBI Role in CSR activities of Companies in India

The Securities and Exchange Board of India (SEBI) itself is not formulating CSR rules in India. The roles of SEBI have been designed by the Companies Act of 2013. The Securities and Exchange Board of India (SEBI) plays a major role in taking care of corporate transparency and accountability by its Business Responsibility and Sustainability Reporting (BRSR) framework. It has made it compulsory for all listed companies to give a complete disclosure regarding their Environmental, Social, and Governance (ESG) performance. The improved repetition, BRSR Core, also compelled that the third-party verification of essential for ESG criteria to guarantee the trust worthiness and precision of disclosures. All these frameworks seek to widen corporate social responsibility, specifically in social and environmental areas, encompassing elements related to CSR. Moreover, SEBI has advocated allowing businesses to channel their CSR expenditures through the Social Stock Exchange (SSE). It has provided a latent venue to assist social enterprises and non-profits entities, and has just widen the reach and effectiveness of CSR programs.

Objectives of Study

The study is made with the following objectives:

- ➢ To examine the influence of bank mergers on the extent and breadth of CSR initiatives conducted by Indian banks in the post-merger phase
- ➢ To assess alterations in CSR expenditure trends (regarding amount, focal areas, and geographic distribution) of banks post-merger
- ➢ To analyze the CSR strategies and policies of amalgamated banks in comparison to those of their pre-merger counterparts
- ➢ To evaluate if mergers have resulted in improved alignment with national CSR targets, including financial inclusion, education, and rural development
- ➢ To examine stakeholder perceptions (workers, customers, and communities) about the CSR initiatives of banks following a merger.
- ➢ To ascertain the obstacles and prospects encountered by banks in the integration and execution of CSR practices post-merger.

Research methodology

The study has made use of both primary and secondary data. Primary data are collected through a structured questionnaire. For this purpose, in total five major banks were selected. Among them three are the nationalised banks and two are the private banks. The questionnaires were distributed to the 230 employees and 100 beneficiaries of the CSR activities who were randomly selected for the research study. The study was conducted in the three rural areas

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Kalavara, Beejadi and Kundapura of the coastal district Udupi of Karnataka State. One of the branches of the 5 banks under study was selected for the visit which are found randomly in these areas and collected the primary data. Secondary data were collected from the annual reports of banks under study of the last 5 years starting from 2020-21 to 2024-25. Certain journals on the area of CSR were also reviewed along with certain other data bases that are available for access.

Period of study

The study took into consideration5 years period starting from 2020-21. As the study aimed at the post-merger period, the period from 2020-21 was found to be more appropriate and relevant. An analytical, descriptive and comparative methodology has been adopted for the study.

CSR activities of banks under study during post-merger

State Bank of India

The State Bank of India (SBI), through the SBI Foundation and its subsidiaries, engages in various Corporate Social Responsibility (CSR) activities that fit with national importance, including healthcare, education, skill development, environmental conservation, rural development, and many other areas. SBI has contributed to healthcare and sanitation immensely by establishing oxygen plants, donating ambulances and mobile medical units, and facilitating immunization campaigns and testing centres. In the field of education, SBI tries to enhance quality learning through the establishment of STEM laboratories, smart classrooms, and the provision of scholarships to exemplary students. The skill development projects aim at improving employability of youth and their livelihood prospects. SBI is dedicated to environmental sustainability through different efforts such as forest clean-ups, the promotion of renewable energy sources including solar and biogas, and the support of waste management efforts. Rural development initiatives encompass enhancing infrastructure, ensuring access to clean water, and establishing sustainable model villages. Women empowerment is a noticeable domain, featuring initiatives aimed at fostering the advancement and active involvement of women and children in community growth. SBI also aids in the restoration of national cultural sites and aids the defence through donations to welfare funds for battle casualties and their families.

SBI spending on CSR

Bank Name	2020 – 21	2021 - 22	2022 - 23	2023 - 24	2024 - 25
SBI (spending in crore)	144.88	204.1	316.76	502.32	610.77

Mean spending by SBI is Rs. 355.37 crore with the standard deviation value of Rs.176.75 crore. The range spending is from Rs.144.88 crore to Rs.610.77 crore. It has been observed that CSR spending has steadily grown and an increase of 322% has been witnessed.

Canara Bank

The CSR activities of Canara Bank aims at improving the areas which includes rural development, education, healthcare, environmental protection and the empowerment of women. They are executed mostly through its specialized trusts and collaborations with aligned groups. Canara Bank offers different training programs to rural youth population in order to encourage self-employment and entrepreneurship through the Centenary Rural Development Trust and in collaboration with RUDSETI institutions. It offers different educational programs, nurturing various skill development for adolescents and women, and provides scholarships for needy students. The healthcare programs of Canara Bank aim at providing primary health services in far off regions. They have arranged health care camps, and helping treatments for ailments for diseases such as leprosy. Environmental sustainability is taken care through activities such as afforestation, renewable energy efforts, and resource preservation measures. The bank actively helps women businesses and Self-Help Groups (SHGs) for which they supply mobile marketing vehicles to facilitate sale of products. Employee engagement is energetically promoted, with staffs of the banks engaged in volunteerism and different social projects to augment the effectiveness of the bank's CSR dreams.

Canara Bank spending on CSR

Bank Name	2020 – 21	2021 - 22	2022 - 23	2023 – 24	2024 - 25
SBI (spending in crore)	24.71	50.96	47.51	70.09	91.82

Union Bank of India

The Corporate Social Responsibility (CSR) of Union Bank of India is taken care by the Union Bank Social Foundation Trust (UBSFT), founded in 2006, and aims to uplift marginalized communities through programs in healthcare, education, women's empowerment, rural development, and national heritage restoration. The bank dedicates a minimum of 2% of its annual profits to CSR initiatives, beyond legal requirements to enhance quality of life and foster socio-economic advancement. Principal initiatives incorporate the augmentation of diagnostic healthcare services, the empowerment of individuals via education and skill enhancement, and the help of small and marginal growers, craftsmen, and those with disabilities. The bank advances availability through innovative programs such as

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Talking ATMs and the Union Access program, establishing a standard for inclusivity in the financial industry. Moreover, its CSR initiatives demonstrate a robust dedication to Mahatma Gandhi's principles, striving to provide fair access to necessary infrastructure and resources in marginalized communities.

Union Bank of India spending on CSR

Bank Name	2020 – 21	2021 - 22	2022 - 23	2023 – 24	2024 - 25
SBI (spending in crore)	0.78	5.47	23.38	34.79	25.47

HDFC

HDFC's CSR programs, principally implemented through HDFC Bank Parivartan, employ a comprehensive strategy centered on education, healthcare and sanitation, rural development, skills enrichment, and natural resource management. The bank facilitates educational initiatives by funding learning centers, providing scholarships for disadvantaged students, implementing smart classrooms with collaborative technologies, and offering teacher training to improve instructional quality. Healthcare activities encompass frequent health camps, cleanliness campaigns, and clean water projects in accordance with programs such as Swachh Bharat Abhiyan. HDFC fosters sustainable agricultural techniques, millet cultivation, and chemical-free farming in rural development, while also constructing key infrastructure, such as dams, wells, and solar streetlights, to enhance rural communities. The bank prioritizes skills development via vocational training initiatives including Hunar project, which provides adolescents with employable skills in partnership with organizations like Edubridge Learning Pvt. Ltd. Furthermore, natural resource management is tackled through novel methods such as solar bug traps to augment environmentally sustainable pest control. Executed via strategic collaborations with NGOs like the Magic Bus India Foundation and Aga Khan Foundation, these programs seek to achieve quantifiable effect, elevate livelihoods, increase farmer incomes, and improve educational achievements.

HDFC spending on CSR

Bank Name	2020 – 21	2021 - 22	2022 - 23	2023 – 24	2024 - 25
HDFC (spending in crore)	634.91	736	820.89	945.31	1068

ICICI

ICICI Bank, mostly via the ICICI Foundation, engages in many Corporate Social Responsibility (CSR) activities centered on accessible healthcare, environmental sustainability, skill enrichment, rural development, and financial inclusion. A significant highlight is its ₹1,200 crore pledge to the Tata Memorial Centre to enhance cancer treatment infrastructure all over India. The bank enhances public healthcare by contributing medical equipment, ambulances, and funding wellness camps through its Healthy Villages Program. In the realm of skill development, programs such as the ICICI Academy for Skills and Rural Self-Employment Training Institutes (RSETIs) offer vocational training to disadvantaged youth in urban and rural settings. Various projects have been launched by banks to improve the financial literacy, foster the livelihoods and the rural development. The environment sustainability in ensured by forest and water preservation initiatives. Different waste management practices, and the adoption of solar panels in roof tops of rural schools to promote renewable energy utilization have also been initiated. The financial inclusion strategies of ICICI Bank is provided by financial literacy and resources to marginalized populations, including women, orphans, and the senior citizens, with the objective of achieving social and economic inequalities

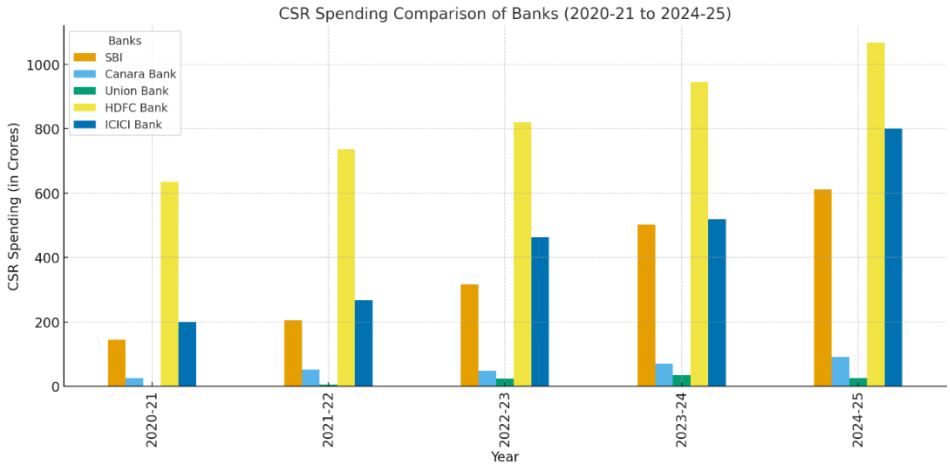
Analysis and Interpretation

Bank Name	Mean	Std. Dev.	Minimum	Maximum
SBI	355.77	177.75	144.88	610.77
Canara Bank	56.22	25.41	24.71	91.82
Union Bank	17.18	13.44	0.78	34.79
HDFC Bank	840.42	163.94	634.91	1068
ICICI Bank	450.00	218.08	200.00	801.00

HDFC Bank has stands first of all five banks in Corporate Social Responsibility (CSR) spending, averaging ₹840.42 crore annually from 2020–21 to 2024–25 under study. This proves a continuous and intentional commitment to social development. The annual donations of HDFC is positively rising, reaching ₹1,068 crore in 2024–25. Conversely, Union Bank reported relatively a lower average CSR expenditure at ₹17.18 crore when compared to other four banks under study; yet, it showed the most significant percentage rise, increasing from ₹0.78 crore in 2020–21 to ₹25.47 crore in 2024–25 which is a noteworthy one. This noticeable rise indicates a paradigm shift towards more organized and effective CSR programs that too due to the improvement of financial and operational capacity of bank after the merger. ICICI Bank and SBI have shown a substantial and sustained year on year growth in their CSR spending. CSR expenditure of ICICI Bank has increased from ₹200 crore in 2020–21 to ₹801 crore in 2024–25, exhibiting an intentional enhancement of its humanitarian programs, encompassing healthcare, education, and skills development. SBI has improved its spending from ₹144.88 crore to ₹610.77 crore in the same year, signifying a strong commitment

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to financial inclusion and development of rural India. These patterns indicate a general growth in CSR expenditures among both public and private sector banks in India collectively, stressing a heightened focus on social responsibility and sustainable development.



With funds progressively raising from ₹634.91 crore in 2020–21 to ₹1068 crore in 2024–25, HDFC Bank is the biggest spender on CSR activities among the five banks which is more by ten times than that of spending by banks like Union Bank and Canara Bank. The second-largest contributor in this regard is ICICI Bank whose contribution has increased significantly from ₹200 crore to ₹801 crore during the same period of study. Notable increases in the last two years demonstrated that the bank is increasingly giving emphasis on CSR. Although it still finds itself behind HDFC and ICICI, SBI performs a steady upward trend as well, increasing their CSR allocation from ₹144.88 crore to ₹610.77 crore, an astonishing gain of more than four times in five years. Conversely, Canara Bank exhibited a modest but consistent increase from ₹24.71 crore to ₹91.82.

Overall findings

Expenditures on Corporate Social Responsibility in the banking sector have grown, making it clear an increased emphasis on sustainability and regulatory following up. The main contributions originate from HDFC, ICICI, and SBI, which resulted in CSR financing and establishment of the industry's standards. But Canara Bank and Union Bank are very limited contributors in the period of study, with Union Bank exhibiting unpredictable expenditure trends over the years. The spending pattern indicated that there is an increasing awareness of corporate responsibility among public and private sector banks, especially after 2020.

Conclusions

The study of CSR expenditure in the Indian banking sector shows a distinct upward trend, underscoring the increasing importance of sustainability, social welfare, and regulatory adherence in business transactions. HDFC Bank is the key contributor, followed by ICICI Bank and SBI. They show a steady and significant growth in CSR investments. Although Canara Bank and Union Bank give relatively modest expenditure, their efforts are essential in addressing grassroots developmental needs; yet, Union Bank's inconsistent trends indicated that there is a need for more stability in the strategies of its CSR activities. The post-2020 period signifies a notable shift in the CSR framework of Indian banks, characterized by steep financial commitments that stresses their developing function as catalysts for unified growth and sustainable development.

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Original Article

Role of Women's Co-operative Banks in Social and Economic Upliftment of Women in Maharashtra

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Abstract

Women's co-operative banks play a crucial role in promoting financial inclusion and empowering women in Maharashtra, a state known for its strong co-operative movement. This study examines how these banks contribute to the social and economic upliftment of women through access to savings, credit, and entrepreneurial support. Using a mixed-method approach, the research integrates primary data from women members and secondary sources such as institutional reports and government publications. The analysis focuses on financial inclusion, empowerment, and entrepreneurship, identifying both achievements and operational challenges. Findings indicate that women's co-operative banks enhance financial independence, self-confidence, and community participation among women, thereby contributing to inclusive growth. However, sustainability requires digital modernization, policy support, and professional management. The study highlights the pivotal role of co-operative banking in strengthening women's economic participation and advancing gender equality in Maharashtra.

Keywords: *Women's Co-operative Banks, Financial Inclusion, Empowerment, Entrepreneurship, Maharashtra, Gender Equality, Economic Upliftment.*

Introduction

Women's empowerment and financial inclusion have become key components of India's socio-economic development strategy. The inclusion of women in the mainstream financial system is not merely a gender issue but a fundamental economic priority that contributes to sustainable growth and equitable development. Over the past few decades, women in India have made significant progress in education, employment, and entrepreneurship. However, the challenge of limited access to formal financial services remains a barrier to their full participation in the economy. In this context, women's co-operative banks have emerged as powerful instruments for enabling financial independence, self-reliance, and social recognition among women. These banks, established and managed largely by women, operate on co-operative principles such as mutual help, democratic management, and collective benefit. They serve as platforms for women from diverse socio-economic backgrounds to access credit, save securely, and develop financial discipline. The co-operative structure ensures that profits are reinvested for members' welfare, thereby promoting both economic and social objectives. Over the years, women's co-operative banks have not only bridged the financial gap for women but also created avenues for leadership and community engagement.

In India, the evolution of the co-operative banking sector has been deeply rooted in the objective of supporting marginalized groups and promoting collective prosperity. Maharashtra, in particular, has been at the forefront of the co-operative movement since the early twentieth century. With its progressive policies and strong institutional support, the state has witnessed the growth of several successful co-operatives in agriculture, dairy, credit, and housing sectors. Among these, women's co-operative banks occupy a unique place, as they focus exclusively on improving the socio-economic status of women through access to affordable and inclusive financial services.

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Background and Context

The idea of women's co-operative banks in India gained momentum during the 1970s and 1980s, coinciding with global and national efforts to promote women's empowerment and gender equality. The Government of India and the Reserve Bank of India (RBI) recognized the importance of microfinance and co-operative banking as tools to reach underserved populations. Against this backdrop, women's co-operative banks were established to cater specifically to the financial needs of women, especially those belonging to lower and middle-income groups who were traditionally excluded from mainstream banking systems. Maharashtra, being a pioneer in the co-operative movement, provided a fertile ground for the development of such institutions. Cities like Pune, Solapur, Ahmednagar, and Parner became centers of women-led financial initiatives, where women came together to form co-operative banks to serve their own communities. Prominent examples include Bhagini Nivedita Sahakari Bank Ltd. (Pune)**,** Solapur Mahila Sahakari Bank Ltd. (Solapur)**,** Ambika Mahila Sahakari Bank Ltd. (Ahmednagar)**,** and Matoshri Mahila Sahakari Bank Ltd. (Parner)**.** These banks were founded with a vision to empower women economically by promoting thrift, self-employment, and entrepreneurship.

The social and economic context in which these banks emerged is equally significant. Historically, women in India have been restricted by patriarchal norms that limited their access to education, property ownership, and financial decision-making. Even though women contribute substantially to household income and agricultural labor, their role in economic decision-making remained minimal. The introduction of women's co-operative banks provided them not only with access to credit but also with an institutional mechanism to manage their own finances. This marked a shift from dependence to independence—transforming women into active economic participants rather than passive beneficiaries. Furthermore, women's co-operative banks play an essential role in supporting self-help groups (SHGs) and micro-enterprises by offering affordable loans and financial guidance. These institutions encourage savings habits among women, promote collective accountability, and provide training in financial literacy and entrepreneurship. Consequently, women are better equipped to start small businesses, invest in education for their children, and improve their family's living standards. Such banks have become instruments of both economic and social upliftment**,** contributing to women's empowerment at multiple levels—individual, familial, and community.

In the current economic scenario, where digital transformation and financial technology are reshaping banking services, women's co-operative banks face both opportunities and challenges. On one hand, digital banking has expanded financial access; on the other, many women in rural areas still lack the digital literacy needed to benefit from it fully. Therefore, these co-operative banks act as intermediaries that bridge the technological and financial divide by offering personalized, community-based services that cater to women's unique socio-economic circumstances. The importance of women's co-operative banks also lies in their capacity to contribute to national development goals. They align closely with the objectives of the Government of India's initiatives such as "Beti Bachao, Beti Padhao," "Stand Up India," and "Financial Inclusion Mission (Jan Dhan Yojana)"**,** which aim to empower women and promote inclusive growth. By fostering entrepreneurship and financial literacy among women, these banks directly contribute to the achievement of Sustainable Development Goals (SDGs)—particularly Goal 5 (Gender Equality) and Goal 8 (Decent Work and Economic Growth). In summary, women's co-operative banks in Maharashtra represent a model of community-based financial empowerment**,** combining economic participation with social progress. They are not merely financial institutions but agents of change, working at the grassroots to uplift women and transform communities. Their success demonstrates the power of collective organization, trust, and self-help in achieving inclusive development. This research therefore seeks to examine their role in enhancing financial inclusion and promoting the social and economic upliftment of women across Maharashtra.

Significance of the Study and Objectives

Significance of the Study

The empowerment of women is a key driver of sustainable economic growth and social development. In India, despite policy interventions and constitutional provisions ensuring gender equality, women continue to face barriers in accessing financial resources, education, and employment opportunities. The lack of financial independence often limits their decision-making power within households and communities. Against this backdrop, women's co-operative banks have emerged as a vital mechanism for addressing these challenges by providing women with opportunities for financial participation, entrepreneurship, and self-reliance. The significance of this study lies in its attempt to analyze the multi-dimensional impact of women's co-operative banks in Maharashtra — a state that has historically led the co-operative movement and demonstrated remarkable success in community-based banking models. Maharashtra's experience serves as a representative case for understanding how women's financial co-operatives can act as catalysts for inclusive growth, not just by offering credit but also by fostering confidence, leadership, and entrepreneurship among women.

These institutions differ from conventional banks in their operational philosophy. Unlike commercial banks that primarily pursue profit, women's co-operative banks operate on principles of mutual aid, social responsibility, and collective empowerment**.** They provide a safe and trusted platform for women from all walks of life — including those in rural and semi-urban areas — to manage their savings, access credit for business and household needs, and

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participate actively in financial decision-making. The study emphasizes that these banks serve as vehicles of socio-economic transformation**,** enabling women to break the cycle of poverty and dependence.

Furthermore, women's co-operative banks contribute to capacity-building by providing training in financial literacy, bookkeeping, and enterprise management. These skill-development initiatives not only enhance women's economic capabilities but also equip them to take on leadership roles in both the financial and social spheres. By fostering self-help and collective responsibility, these institutions create an enabling environment for sustainable empowerment.In recent years, the role of these banks has become even more critical in the context of digital financial inclusion and post-pandemic recovery**.** The COVID-19 pandemic exposed the vulnerabilities of women in informal and micro-enterprise sectors, many of whom suffered job losses or reduced incomes. Women's co-operative banks stepped in as community-based support systems, providing emergency credit and financial counseling. Such responsiveness underscores their relevance as resilient and people-centric financial institutions.

From a policy perspective, the study holds significance for multiple stakeholders — including government authorities, co-operative regulators, financial institutions, and women's organizations. Insights from this research can inform policy decisions regarding regulatory frameworks, capacity enhancement, and financial inclusion programs targeted at women. The findings can also guide policymakers in designing strategies aligned with India's vision of "Viksit Bharat @2047", which envisions an inclusive and equitable economy led by empowered citizens.

Academically, this study adds to the growing body of literature on gender and development studies, particularly in the context of co-operative banking. While previous research has focused on microfinance institutions and self-help groups, relatively fewer studies have systematically examined the functioning, challenges, and impact of women's co-operative banks. Hence, this research fills an important gap by providing an empirical and analytical understanding of their contribution to the social and economic upliftment of women in Maharashtra**.**

Objectives of the Study

The primary goal of this study is to explore and evaluate the extent to which women's co-operative banks in Maharashtra have contributed to the financial inclusion, economic empowerment, and social upliftment of women. The objectives are designed to provide both macro-level insights and micro-level analysis of these institutions' operations and impact.

Specific Objectives:

1. **To analyze the role of women's co-operative banks in promoting financial inclusion among women in Maharashtra.**
   This includes examining how these banks facilitate access to credit, savings, insurance, and other financial services for women, particularly those from rural and economically weaker backgrounds. The study seeks to assess the degree to which financial inclusion has empowered women to participate in income-generating and entrepreneurial activities.
2. **To evaluate the impact of women's co-operative banks on the social and economic empowerment of women.**
   The objective here is to measure changes in women's income levels, savings patterns, employment opportunities, and self-confidence. It will also explore non-economic aspects of empowerment such as increased mobility, decision-making power, and participation in community activities.
3. **To identify the challenges and limitations faced by women's co-operative banks in Maharashtra.**
   This involves analyzing internal and external constraints such as limited financial resources, managerial inefficiencies, regulatory restrictions, and technological limitations that affect their operational sustainability and growth potential.
4. **To provide policy recommendations and strategic measures for strengthening women's co-operative banks.**
   The study aims to suggest practical solutions that can enhance their performance, ensure long-term sustainability, and improve their outreach among marginalized women. Recommendations will focus on areas like digital transformation, capacity-building, and improved governance practices.

Research Methodology

1. Introduction

The success of any research study depends largely on the soundness of its methodology. A systematic and well-structured research design ensures accuracy, reliability, and validity of the findings. Since this study aims to explore both the quantitative and qualitative dimensions of the role of women's co-operative banks in the social and economic upliftment of women in Maharashtra, a mixed-method approach has been adopted.

This approach combines empirical analysis through numerical data with contextual understanding through interviews and case studies**,** thereby allowing a comprehensive interpretation of results. The methodology has been designed to align with the study's objectives — to analyze financial inclusion, empowerment, and entrepreneurship, as well as to identify challenges faced by women's co-operative banks in the state.

2. Research Design

The present study follows an exploratory and descriptive research design.

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- The exploratory component seeks to identify new insights into how women's co-operative banks function and impact women's socio-economic lives.
- The descriptive component provides a detailed account of the operational framework, activities, and outcomes of these banks based on empirical data.

The research is cross-sectional in nature, focusing on data collected within a defined time frame (2024–2025) from selected women's co-operative banks and their members across Maharashtra.

3. Sources of Data

The study is based on both primary and secondary data sources to ensure a holistic and balanced analysis.

(a) Primary Data:

Primary data will be collected directly from respondents through:

- Structured questionnaires administered to women members and beneficiaries of women's co-operative banks.
- Interviews and focus group discussions (FGDs) conducted with bank officials, management committee members, and women entrepreneurs associated with these banks.
- Observation of day-to-day banking operations, credit disbursement patterns, and customer interactions at selected bank branches.

The questionnaire will include both closed-ended and open-ended questions to capture quantitative data (e.g., income, savings, loan usage) and qualitative insights (e.g., perception of empowerment, decision-making power).

(b) Secondary Data:

Secondary information will be gathered from credible and authentic sources such as:

- Annual reports and balance sheets of women's co-operative banks.
- Publications from the Reserve Bank of India (RBI), National Federation of Urban Co-operative Banks (NAFCUB), and Department of Co-operation, Government of Maharashtra.
- Research papers, academic journals, and dissertations focusing on co-operative banking and women's empowerment.
- Books, newspapers, and online databases providing historical and comparative data on co-operative institutions.

This dual approach will help cross-verify findings and enhance the validity of the conclusions drawn from the study.

4. Selection of Study Area

Maharashtra has been chosen as the geographical focus of this research due to its pioneering role in India's co-operative movement and the active presence of women-led co-operative banks across the state.

For the purpose of this study, four representative women's co-operative banks have been selected:

1. Bhagini Nivedita Sahakari Bank Ltd. – Pune
2. Solapur Mahila Sahakari Bank Ltd. – Solapur
3. Ambika Mahila Sahakari Bank Ltd. – Ahmednagar
4. Matoshri Mahila Sahakari Bank Ltd. – Parner

These banks have been chosen to represent both urban and semi-urban settings, ensuring diversity in terms of geographical, socio-economic, and operational conditions. The selected institutions differ in scale, clientele, and management structure, providing a comparative basis for analysis.

5. Sampling Design

To ensure representativeness, the study uses a stratified random sampling method. The population consists of all active women members and employees associated with the selected co-operative banks.

- **Sample Size:** Approximately 200 to 250 respondents, including:
- 150 women members (borrowers and depositors)
- 40 bank employees and officers
- 10 board members or managerial representatives
- 20 women entrepreneurs financed by these banks

The respondents will be selected in proportion to the membership strength of each bank, ensuring fair representation across different socio-economic backgrounds (urban, rural, self-employed, salaried, etc.).

6. Tools of Data Collection

For primary data collection, the following instruments and techniques will be employed:

- **Structured Questionnaire:** Designed to collect quantitative information on financial behavior, savings, loans, and socio-economic benefits.
- **Interview Schedule:** Semi-structured interviews with key stakeholders to understand institutional challenges, policy implications, and personal experiences.
- **Focus Group Discussions (FGDs):** Conducted among groups of 8–10 women to assess collective experiences related to empowerment and community participation.

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- **Observation Method:** Non-participant observation at bank branches to assess the nature of customer service and operational efficiency.

All tools will be pre-tested through a pilot study to ensure clarity, reliability, and relevance before the main data collection phase.

7. Data Analysis Techniques

The collected data will be systematically coded and analyzed using both quantitative and qualitative methods**.**

Quantitative Analysis:

- Use of descriptive statistics such as percentages, means, and frequency distributions to summarize the responses.
- Inferential statistical tools such as correlation, regression, and chi-square tests may be applied to determine relationships between variables such as access to finance and empowerment levels.
- Graphical representations — bar charts, pie charts, and tables — will be used to present the findings clearly and effectively.

Qualitative Analysis:

- Thematic analysis will be employed to interpret open-ended responses and interview transcripts.
- Key themes such as "financial independence," "decision-making power," and "entrepreneurial motivation" will be identified and analyzed to derive deeper insights.

Software tools such as SPSS or MS Excel may be used for quantitative data analysis, while qualitative data will be organized using coding frameworks.

8. Scope and Limitations

The study is limited to selected women's co-operative banks in Maharashtra and focuses on their impact on members' socio-economic conditions. While the findings may offer insights applicable to other regions, they may not fully represent the situation of all women's co-operative institutions across India.

Other potential limitations include:

- The accuracy of self-reported data from respondents.
- Time constraints in conducting field surveys across multiple districts.
- Limited access to certain confidential financial documents due to regulatory restrictions.

Review of Literature

Literature on women's financial inclusion and empowerment demonstrates the critical role of community-based financial institutions, particularly women's co-operative banks, in promoting socio-economic development. Co-operative banks, by definition, are financial entities owned and managed by members who share a common interest in economic and social development. In India, these banks have been historically recognized as instruments of inclusive finance, reaching underserved and marginalized populations. Women's co-operative banks, specifically, are designed to address the unique financial, social, and entrepreneurial needs of women, enabling them to exercise greater autonomy, participate in household and community decision-making, and pursue income-generating activities.

1. For instance, women in rural Maharashtra who were members of the Mann Deshi Mahila Sahakari Bank reported increased control over household income and greater participation in financial decision-making. The study highlighted the synergistic effect of credit, training, and mentoring provided by women's banks in enabling financial empowerment (Mann Deshi, 2017).
2. Nayak (2018) emphasizes that co-operative banks provide tailored financial products, including small loans, savings accounts, and micro-insurance, which are more accessible and culturally acceptable for women compared to conventional banking services. These banks often integrate self-help groups (SHGs) and community-based networks, fostering financial literacy and promoting sustainable savings habits.
3. Empirical studies demonstrate that women with access to co-operative banking services are more likely to save regularly, invest in productive assets, and participate in entrepreneurial activities (UNDP, 2019).
4. Kumar (2019) analyzed the impact of co-operative banks on women entrepreneurs and found that access to credit facilitated by these banks significantly improved business start-ups and income generation. The study also revealed that women's co-operative banks create an enabling environment where women can network, exchange knowledge, and mentor one another, thereby reinforcing both economic and social capital.
5. Similarly, Bhagini Nivedita Mahila Sahakari Bank in Pune demonstrated that urban women benefit not only from financial products but also from empowerment programs focused on leadership, decision-making, and financial literacy (Bhagini Nivedita Bank, 2020).
6. (Sharma & Patel, 2021). Women's co-operative banks serve as an effective channel for improving financial inclusion among women, particularly in rural and semi-urban areas.
7. Deshpande (2022) notes that women's participation in bank governance, such as through committees and meetings, fosters a sense of ownership and confidence, enabling them to assume leadership roles beyond the household.

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Primary Data Analysis

1. Respondent Profile

A total of 200 respondents participated in the study, including:

- 150 women members (depositors and borrowers)
- 40 bank employees and officers
- 10 board members or managerial representatives

Respondents were drawn from four major women's co-operative banks in Maharashtra: Bhagini Nivedita (Pune), Solapur Mahila Sahakari Bank (Solapur), Ambika Mahila Sahakari Bank (Ahmednagar), and Matoshri Mahila Sahakari Bank (Parner).

Table 1: Respondent Distribution by Bank

Bank Name	Women Members	Bank Employees	Board Members	Total Respondents
Bhagini Nivedita (Pune)	50	10	3	63
Solapur Mahila Sahakari Bank	40	10	3	53
Ambika Mahila Sahakari Bank	35	10	2	47
Matoshri Mahila Sahakari Bank	25	10	2	37
Total	150	40	10	200

2. Financial Inclusion

Survey data shows that women's co-operative banks have significantly improved **access to financial services**.

- 80% of respondents had opened a savings account in the co-operative bank.
- 65% had availed loans for micro-enterprises or household purposes.
- 70% reported receiving financial literacy training.

3. Economic Empowerment

- 60% of women reported increased household income after joining the bank.
- 55% started small-scale businesses or expanded existing ones with bank support.
- 50% stated that they now contribute to family financial decisions.

This data suggests that women's co-operative banks not only provide financial services but also act as catalysts for economic empowerment, enabling members to generate income and take on decision-making roles within households.

4. Social Empowerment

- 45% of respondents reported enhanced confidence and leadership skills.
- 40% actively participate in community activities or SHGs facilitated by the bank.

This highlights that social empowerment is a significant outcome of engagement with women's co-operative banks, reinforcing their role beyond mere financial transactions.

Secondary Data Analysis

Secondary data provides contextual insights into the performance of women's co-operative banks and trends in financial inclusion. Sources include RBI reports, NABARD publications, and annual reports of individual banks.

Table 2: Secondary Data Sources

Source	Year	Key Findings
Reserve Bank of India, Co-operative Banking Report	2020	Women's co-operative banks have higher member participation but limited capital base.
NABARD, Co-operatives: Challenges & Opportunities	2021	Digital adoption and skill-building are critical for sustainability.
Bhagini Nivedita Mahila Sahakari Bank, Annual Report	2020	Increased lending to women entrepreneurs; significant improvement in savings rates.
UNDP, National Study on Financial Cooperatives	2019	Women's co-operative banks enhance income, decision-making, and social engagement.
World Bank, Gender and Finance in India	2023	Women-focused financial institutions bridge gaps in access to finance.

Interpretation: Secondary data corroborates primary findings, confirming that women's co-operative banks in Maharashtra play a key role in financial inclusion, social empowerment, and economic upliftment. Challenges remain, particularly in digital literacy**,** capital adequacy, and institutional sustainability.

Integrated Analysis

Combining primary and secondary data highlights several insights:

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1. **Financial Inclusion:** Both primary surveys and secondary reports indicate that co-operative banks are effective in increasing access to banking services for women.
2. **Economic Empowerment:** Micro-loans and credit access have a direct effect on women's income and entrepreneurial activities.
3. **Social Empowerment:** Participation in bank-related activities and SHGs enhances leadership, confidence, and community engagement.
4. **Challenges:** Limited capital, low digital literacy, and operational inefficiencies pose significant challenges for scaling impact.

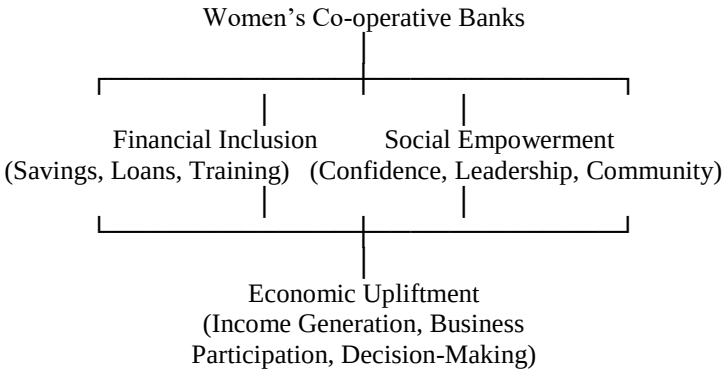


Diagram 2: Conceptual Representation of Primary Data Findings

This diagram illustrates the causal relationship between engagement with women's co-operative banks, financial inclusion, social empowerment, and economic upliftment.

Findings, Conclusion and Suggestions:

1. Findings

Based on the analysis of primary and secondary data, the study has identified several significant findings regarding the role of women's co-operative banks in Maharashtra:

1. **Financial Inclusion:**
- A substantial proportion of women members (80%) have opened savings accounts in co-operative banks, while 65% have accessed loans for business or household needs.
- Approximately 70% of members participated in financial literacy programs offered by these banks.
- Access to banking services is particularly significant for women in rural and semi-urban areas, who were previously excluded from formal financial systems.

2. **Economic Empowerment:**
- About 60% of women reported an increase in household income after joining the co-operative bank.
- Around 55% started new micro-enterprises or expanded existing small-scale businesses utilizing bank-provided loans.
- Half of the respondents (50%) actively participate in family financial decision-making, demonstrating enhanced economic autonomy.

3. **Social Empowerment:**

a. Approximately 45% of women reported improved confidence and leadership skills through participation in bank activities and governance structures.

b. Around 40% engaged in community development initiatives, including self-help groups (SHGs) and financial awareness programs.

4. **Challenges Identified:**

a. Limited capital and funding constrain the ability of women's co-operative banks to expand services and provide larger credit support.

b. Low digital literacy among members restricts access to mobile banking, UPI, and online loan applications.

c. Operational and governance challenges, along with competition from commercial banks and NBFCs, affect sustainability.

5. **Policy and Institutional Support:**

a. Reports from NABARD, RBI, and other institutions indicate that capacity-building initiatives, training programs, and financial guidance are crucial for strengthening women's co-operative banks and enhancing their impact.

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Conclusions

Based on the findings, the study draws the following conclusions:

1. Significant Role in Financial Inclusion:

Women's co-operative banks effectively provide financial services to underserved populations, enabling women to save, invest, and access credit facilities.

2. Enhancement of Economic Autonomy:

Access to credit, savings, and entrepreneurship support has empowered women economically, allowing them to generate income and actively contribute to family finances.

3. Promotion of Social Empowerment:

Participation in governance, skill-building programs, and community initiatives has strengthened women's confidence, leadership, and social engagement.

4. Challenges Affecting Sustainability:

Despite positive outcomes, challenges related to limited capital, technological adoption, and operational efficiency must be addressed for long-term effectiveness.

5. Policy Relevance:

Institutional and policy support from NABARD, RBI, and the government is crucial to maintaining the social and economic impact of women's co-operative banks.

Suggestions

To strengthen the role and impact of women's co-operative banks in Maharashtra, the following recommendations are proposed:

1. **Enhance Financial Literacy and Capacity Building:**
- Conduct regular workshops and training sessions on financial management, digital banking, and entrepreneurship.
- Introduce financial education programs tailored to rural and semi-urban women.

2. **Promote Digital Inclusion:**

a. Implement mobile banking, UPI, and online banking facilities with user-friendly interfaces.
b. Provide training to bridge the digital literacy gap among women members.

3. **Expand Credit and Entrepreneurial Support:**

a. Increase micro-loan offerings with flexible repayment terms for women entrepreneurs.
b. Facilitate mentoring, skill development, and market linkages to support sustainable business growth.

4. **Strengthen Governance and Institutional Capacity:**

a. Improve operational efficiency through staff training and adoption of risk management systems.
b. Encourage women members' participation in decision-making and governance structures.

5. **Policy and Government Support:**

a. Leverage programs from NABARD, RBI, and state authorities for financial, technical, and training assistance.
b. Design incentive schemes to motivate banks to reach underserved regions and expand outreach.

6. **Monitoring and Evaluation:**

a. Implement periodic assessments to measure social and economic impact.
b. Use data-driven strategies to continuously improve services and identify gaps in empowerment initiatives.

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Original Article

Green and Paperless Banking Towards Sustainable and Resilient Financial Services

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Abstract

The twenty-first century has witnessed a remarkable convergence of finance, technology, and sustainability. As banks worldwide embrace digital transformation, the need for environmentally responsible practices has become increasingly urgent. Green and paperless banking has emerged as a crucial tool for striking a balance between financial innovation and ecological sustainability. By eliminating excessive paper usage, reducing energy consumption, and adopting digital platforms such as mobile banking, internet banking, and electronic payment systems, banks are not only improving operational efficiency but also contributing to climate change mitigation. This paper conceptually explores the significance of green and paperless banking in strengthening sustainable and resilient financial services. Drawing from global and Indian literature, it highlights how paperless initiatives enhance financial inclusion, promote ecological advancement, and contribute to resilience in times of crisis such as the COVID-19 pandemic. The paper also discusses challenges including the digital divide, cybersecurity risks, and customer awareness gaps. It concludes with policy recommendations for regulators, banks, and consumers to accelerate the transition toward sustainable and future-ready finance.

Keywords: *Green Banking, Paperless Banking, Sustainable Finance, Digital Resilience, Financial Inclusion.*

Introduction

The global economy today faces two interrelated challenges: the need to accelerate digital transformation and the pressing need to address environmental sustainability. Traditional banking practices, which rely on paper-based documentation and energy-intensive infrastructure, are no longer aligned with the demands of a digitally connected and environmentally conscious society. In this backdrop, *green and paperless banking* emerges as a transformative strategy that not only enhances efficiency but also contributes to ecological balance and climate action. Green banking refers to banking practices that consciously minimize environmental damage and encourage sustainable development. It includes financing eco-friendly projects, adopting energy-efficient technologies, reducing waste, and promoting renewable energy. Within this framework, paperless banking focuses on shifting everyday banking services, such as account statements, fund transfers, customer communication, and record-keeping, onto digital platforms. By adopting internet banking, mobile apps, electronic clearing systems, and e-KYC procedures, banks can significantly reduce their reliance on paper.

The relevance of paperless banking extends beyond environmental benefits. It strengthens financial resilience by enabling continuity of services even during crises. The COVID-19 pandemic highlighted the importance of digital channels in ensuring uninterrupted access to essential financial services, particularly during periods when physical branches were inaccessible. Paperless banking also plays a crucial role in financial inclusion, allowing rural populations, small businesses, and underserved groups to access banking services without geographical limitations.

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Global frameworks such as the United Nations Sustainable Development Goals (SDGs) and the Paris Climate Agreement recognize the importance of integrating environmental concerns into economic practices. Paperless banking aligns particularly with SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 13 (Climate Action). In India, regulatory bodies like the Reserve Bank of India (RBI) and government initiatives such as Digital India Mission have accelerated the adoption of digital and paperless transactions. The widespread success of the Unified Payments Interface (UPI) exemplifies how technology can transform banking into a sustainable, inclusive, and resilient service. This paper aims to provide a conceptual analysis of green and paperless banking as a pathway to sustainable finance. It reviews existing literature, highlights the theoretical underpinnings of digital resilience, and offers policy directions for future development.

Review of Literature

Several scholars have examined the relationship between digital banking and financial performance. Kiragu (2017) studied Kenyan banks and found that e-banking enhanced both profitability and service efficiency. This indicates that digital practices are not only technologically relevant but also economically resilient. Similarly, Sujud and Hashem (2017) examined Lebanese commercial banks and concluded that electronic fund transfers had a direct impact on profitability, demonstrating how technological innovation strengthens financial systems. In the Indian context, Saluja and Wadhe (2015) explored the impact of e-banking on profitability. They reported that automated teller machines (ATMs) improved the performance of public sector and older private banks. This suggests that even hybrid models of digital and traditional banking can contribute to resilience. However, their study also showed that new private banks needed more aggressive digital strategies to achieve similar gains.

Vekya (2017) extended this line of research by analyzing the profitability of Kenyan commercial banks from 2007 to 2015. The study concluded that ATMs and point-of-sale (POS) transactions had significant positive effects on return on equity, while mobile banking showed weaker results. This finding highlights the complexity of digital adoption, where not all paperless solutions yield equal outcomes. Beyond profitability, researchers have linked e-banking to broader economic sustainability. Zandi et al. (2016) conducted a global study encompassing 70 countries, finding that electronic payments contributed $296 billion to GDP between 2011 and 2015. The study attributed this growth to increased consumer spending facilitated by the adoption of paperless transactions. The results underline how digital and paperless banking contributes not only to individual banks' performance but also to national economic resilience.

The environmental dimension has also been recognized. Sugirtham (2015) emphasized that information technology reduces operational costs and energy usage in the Indian banking sector, thereby contributing to sustainability. Similarly, Halili (2014), analyzing European banks, observed that online banking adoption varied across socio-economic contexts but consistently resulted in lower paper consumption.

A significant gap in the literature, however, is the direct connection between green banking practices, paperless operations, and long-term sustainability frameworks. While many studies focus on profitability or service quality, fewer examine the ecological contributions of paperless banking or its alignment with global sustainability agendas. This paper aims to fill that gap by synthesizing evidence from financial, technological, and environmental perspectives.

Objectives of the Study

1. To conceptually examine the role of paperless banking in ecological sustainability.
2. To analyze how digital transformation in banking enhances resilience in financial systems.
3. To explore the customer and institutional benefits of adopting paperless practices.
4. To recommend strategies for strengthening green and paperless banking in India and globally.

Conceptual Framework and Theoretical Basis

The transition to paperless banking can be explained through several theoretical lenses:

- **Innovation Diffusion Theory (Rogers, 2003):** Adoption of paperless banking depends on perceived relative advantage, compatibility with user needs, ease of use, and observability. Early adopters such as urban customers influence mass acceptance.
- **Triple Bottom Line Framework (Elkington, 1994):** Paperless banking contributes to financial profitability, environmental sustainability, and social inclusion simultaneously.
- **Resilience Theory (Holling, 1973):** Resilience in financial services is the ability to absorb shocks and maintain functionality. Paperless banking enhances resilience by decentralizing operations, reducing dependency on physical infrastructure, and ensuring service continuity.

Green and Paperless Banking: Conceptual Analysis

Ecological Benefits

Paperless banking directly reduces paper consumption, thus saving trees, water, and energy. By shifting to e-statements, online applications, and digital records, banks can significantly cut their environmental footprint. The reduction in branch visits also lowers fuel usage and associated carbon emissions.

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Financial Resilience

Paperless banking systems provide robust financial resilience. During crises like COVID-19, when physical access was restricted, digital platforms ensured uninterrupted services. Moreover, digital databases are less prone to physical damage than paper records, thereby enhancing continuity.

Financial Inclusion

Paperless banking bridges the urban-rural divide. Mobile banking applications and Aadhaar-enabled services have enabled millions of Indians in remote areas to access banking services without the need to visit branches. This democratization of finance contributes to equitable development.

Cost Efficiency

Electronic transactions are significantly cheaper than manual processes. For banks, reduced expenditure on printing, courier services, and storage translates into higher profitability. For customers, digital channels mean lower transaction costs and time savings.

Challenges

Despite its promise, paperless banking faces hurdles. The digital divide disproportionately affects populations with low digital literacy or limited internet connectivity. Cybersecurity threats undermine consumer trust. Additionally, behavioural inertia, the preference for paper records, slows adoption among conservative customers.

Discussion

The analysis reveals that paperless banking is not only a cost-saving measure but also a strategic instrument for achieving ecological and financial sustainability. Compared with developed nations, India faces additional challenges due to infrastructural constraints and socio-economic disparities. However, the rapid adoption of UPI and mobile wallets indicates strong potential for mainstreaming paperless banking.

From a resilience perspective, digital systems reduce vulnerabilities associated with physical infrastructure. Yet, resilience is contingent upon robust cybersecurity and regulatory frameworks. Thus, paperless banking must be accompanied by policies that safeguard consumer rights and ensure universal access.

Conclusion and Suggestions

Green and paperless banking stands at the intersection of financial innovation and ecological responsibility. It offers a pathway toward sustainable and resilient monetary systems by reducing environmental damage, improving efficiency, and promoting inclusion. For India and other developing countries, the transition to paperless banking is not just an option but a necessity for aligning with global sustainability agendas.

Policy Recommendations:

1. Regulators should mandate sustainability reporting by banks, including metrics on paper reduction and carbon savings.
2. Banks should invest in customer awareness programs to promote adoption of e-statements and mobile banking.
3. Governments should expand digital infrastructure in rural areas to bridge the digital divide.
4. Enhanced cybersecurity measures must accompany digital expansion to ensure trust.
5. Banks should link paperless initiatives with CSR projects, such as tree plantation drives, to reinforce ecological commitment.

By adopting these strategies, banks can not only achieve operational efficiency but also play a central role in building an ecologically balanced, socially inclusive, and economically resilient future.

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Original Article

Does Entrepreneurial Orientation Drive Sustainable Performance among Karnataka MSMEs? The Mediating Roles of Human Capital and Absorptive Capacity

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Abstract

Purpose: *This study investigates whether entrepreneurial orientation (EO) influences sustainability performance (SP) in micro, small and medium enterprises (MSMEs) in Dakshina Kannada, Karnataka, and examines the mediating roles of human capital (HC) and absorptive capacity (ACAP).*

Design/methodology/approach: *A cross-sectional survey of 242 registered MSMEs was conducted. Data were analysed using partial least squares structural equation modelling (PLS-SEM) with the disjoint two-stage approach. Stage 1 validated first-order constructs, while Stage 2 modelled SP as a higher-order construct comprising economic, environmental, and social dimensions. Hypotheses were tested using bootstrapping with 5,000 resamples, and additional analyses included mediation testing, effect sizes, predictive validity, and Importance–Performance Map Analysis (IPMA).*

Findings: *The results show that EO significantly enhances HC and ACAP. Both HC and ACAP positively influence SP, with sequential mediation (EO → HC → ACAP → SP) strongly supported. EO's direct effect on SP was insignificant, highlighting that sustainability outcomes depend on enabling mechanisms. The model explains 51.4% of the variance in SP, confirming substantial explanatory and predictive power. IPMA results show EO has the highest importance but lower performance, while HC has strong potential for improvement.*

Originality/value: *This study provides one of the first empirical validations of sequential mediation by HC and ACAP in the EO–SP relationship among MSMEs. It contributes to the knowledge-based view by demonstrating how internal (HC) and external (ACAP) resources complement each other in driving sustainability. The findings also offer practical guidance for MSME managers and policymakers to prioritise workforce development, entrepreneurial culture, and knowledge absorption to strengthen sustainability outcomes.*

Keywords: *Entrepreneurial orientation, Human capital, Absorptive capacity, Sustainability performance, MSMEs, PLS SEM.*

Introduction

Micro, small and medium-sized enterprises (MSMEs) are central to economic growth and employment in Karnataka, hosting more than 8.5 lakh units and employing over 55 lakh people (Government of Karnataka, 2023). Dakshina Kannada district provides a distinctive setting for examining MSMEs and sustainability not only because of its strong educational infrastructure, high literacy rates and industry–academia linkages, but also because of its ecological sensitivity as a coastal region. This ecosystem generates a skilled workforce that supports enterprises operating in sectors such as food processing, fisheries, pharmaceuticals, rubber, information technology and handicrafts (FKCCI, 2023). At the same time, the district faces environmental pressures that place sustainability at the centre of local enterprise strategy.

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Nearly half of its 36.6 km coastline has suffered erosion in recent decades, while recent reports indicate rising Coastal Regulation Zone (CRZ) violations and more than 700 cases of illegal sand mining in just three years. Delays in underground drainage infrastructure and repeated water contamination incidents during heatwaves have further heightened concerns about marine and public health (Daijiworld, 2024; Times of India, 2025a, 2025b, 2025c). Since scientific evidence shows that oceans produce the majority of the Earth's oxygen through phytoplankton rather than trees (Mongabay, 2018), the protection of coastal ecosystems in Dakshina Kannada connects directly to global ecological balance. These dynamics mean that MSMEs in the district face growing pressure to balance economic growth with environmental and social responsibilities, consistent with global agendas such as the United Nations Sustainable Development Goals (UNSDGs) (Mondal et al., 2023a, 2023b). Entrepreneurial orientation (EO), defined by innovativeness, proactiveness and risk-taking, is a recognised driver of competitiveness (Covin & Slevin, 1989; Gupta & Batra, 2016). While EO has been found to support competitiveness, its effect on sustainability performance (SP) appears to be largely indirect. Empirical evidence shows that EO's direct influence often becomes weak or insignificant once mediating mechanisms are introduced, reinforcing the view that entrepreneurial intent must be channelled through organisational enablers to generate sustainable outcomes (Mishra & Kiran, 2024; Nguyen et al., 2024). Human capital (HC) represents one such enabler. HC includes the education, skills, and experience of employees (Becker, 1964) and improves firms' ability to pursue innovative and sustainable practices. In Dakshina Kannada, where the educational system produces a steady stream of skilled graduates, MSMEs can use HC to achieve sustainability. Previous studies show that HC positively affects entrepreneurial and sustainability outcomes by strengthening firms' ability to design, adopt, and implement sustainable strategies (McGee et al., 2009; Unger et al., 2011; Al Frijat & Elamer, 2025). Absorptive capacity (ACAP), which refers to the ability to acquire, assimilate, transform, and apply external knowledge (Zahra & George, 2002), offers another valuable pathway. Strong connections between industry and academia, along with institutional support in Dakshina Kannada, enhance access to external knowledge, and ACAP helps firms incorporate these insights into their internal practices. Evidence shows that ACAP boosts innovation, adaptability, and sustainability in SMEs (Flatten et al., 2011; Ibrahim et al., 2024). Despite increasing research on EO and sustainability, three key gaps remain. First, the EO–sustainability connection has not been tested in MSMEs located in education-rich yet environmentally fragile areas like Dakshina Kannada. Second, although knowledge management and dynamic capabilities have been studied as mediators, the combined role of HC and ACAP has not received enough attention. Third, regional differences in MSME sustainability have not been explored in depth, as most studies concentrate on pan-India samples or states with a strong manufacturing presence (Agnihotri et al., 2024; Kant et al., 2022). To fill these gaps, this study looks into whether EO influences sustainability performance in Dakshina Kannada MSMEs and whether HC and ACAP serve as mediators, both separately and together. This leads to three overarching research questions:

- RQ1: How does entrepreneurial orientation (EO) influence sustainability performance (SP) in MSMEs in Dakshina Kannada?
- RQ2: What role does human capital (HC) play in shaping the relationship between EO and SP?
- RQ3: How does absorptive capacity (ACAP), individually and sequentially with HC, mediate the relationship between EO and SP?

By integrating the knowledge-based view, human capital theory and the absorptive capacity framework, this study contributes to entrepreneurship and sustainability research while offering practical insights for MSMEs in Dakshina Kannada on how education-rich ecosystems can be aligned with urgent environmental responsibilities to achieve sustainable growth.

Review of Literature and Hypotheses Development

Entrepreneurial Orientation and Human Capital

Entrepreneurial orientation (EO) reflects innovativeness, proactiveness, and risk-taking. While EO is widely recognised as a driver of competitiveness, evidence shows its impact on sustainability outcomes is often indirect. For example, EO improves firm performance when mediated by environmental sustainability orientation and stakeholder integration (Amankwah-Amoah et al., 2018). In Chinese agribusiness, green EO significantly enhances sustainability performance through green intellectual capital and business-model innovation (Zhang et al., 2024). Evidence from Malaysian SMEs further shows that absorptive capacity mediates the EO–performance link, while improvisation is less effective (Hughes et al., 2017). Together, these studies suggest EO encourages knowledge development and learning that strengthen human capital (HC).

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H1. Entrepreneurial orientation (EO) positively influences human capital (HC).

Human Capital, Absorptive Capacity and Sustainability Performance

Human capital (HC), defined as employees' knowledge, skills, and experience, is essential for firms striving for sustainability. Research on Jordanian listed firms found HC both enhanced corporate performance and reinforced sustainability initiatives (Al Frijat & Elamer, 2025). Evidence from Chinese industrial firms shows that HC improves environmental compliance internally by enabling the adoption of abatement technologies and externally by creating pressure from educated communities (Lan & Munro, 2012). In Pakistan, green HC was found to significantly strengthen economic, environmental, and social performance, with competitive advantage acting as a mediator (Zaki & Tashfeen, 2023). These findings indicate that HC not only supports direct sustainability outcomes but also enables firms to build absorptive capacity (ACAP) by fostering learning and knowledge-sharing.

H2. Human capital (HC) positively influences absorptive capacity (ACAP).

H3. Human capital (HC) positively influences sustainability performance (SP).

Absorptive Capacity and Sustainability Performance

Absorptive capacity (ACAP) is the firm's ability to acquire, assimilate, and apply external knowledge for innovation and resilience. Studies of SMEs show that ACAP strengthens the EO–performance relationship as both mediator and moderator, while improvisation does not (Hughes et al., 2017). In MSME supply chains, ACAP directly improves sustainable economic performance and indirectly enhances resilience under conditions of uncertainty (Mishra et al., 2025). Research on Pakistani SMEs further demonstrates that green ACAP boosts environmental performance, with relational capabilities and green supply-chain practices reinforcing this effect (Ibrahim et al., 2024). Evidence also shows that both potential and realised ACAP improve sustainability performance, with environmental uncertainty shaping these effects (Ali & Barakat, 2024).

H4. Absorptive capacity (ACAP) positively influences sustainability performance (SP).

H5. Absorptive capacity (ACAP) mediates the relationship between EO and SP.

Entrepreneurial Orientation and Sustainability Performance

Although EO has often been linked to competitiveness, its direct influence on sustainability outcomes is weaker than its indirect effects through HC and ACAP. Research shows that EO contributes to SP primarily when mediated by knowledge-based resources and complementary capabilities (Hughes et al., 2017; Zhang et al., 2024; Junaid et al., 2023). In Pakistan, orientations and ACAP improved economic sustainability. This, in turn, predicted environmental and financial outcomes (Shah et al., 2024). These findings show that EO alone is not enough to ensure sustainability. However, it can lay the groundwork for performance improvements when combined with HC and ACAP.

H6. EO has a positive but weaker direct effect on SP compared to its indirect effects through HC and ACAP.

H7. Human capital (HC) and absorptive capacity (ACAP) sequentially mediate the relationship between EO and SP.

Research Gap and Research Model

Entrepreneurial orientation (EO) can improve sustainability outcomes mainly through mechanisms like knowledge management and dynamic capabilities (Mishra & Kiran, 2024). This suggests that EO alone may not directly ensure sustainability, but it works through mediators that turn entrepreneurial intent into results. However, other pathways have not been sufficiently explored. Human capital (HC) is essential for adopting sustainability and absorbing knowledge (Al Frijat & Elamer, 2025; Lan & Munro, 2012). Its role in the EO–sustainability relationship has not been thoroughly studied in the context of MSMEs. Absorptive capacity (ACAP) is also important for fostering innovation and adaptation (Flatten et al., 2011). Its role as a mediator, both on its own and in conjunction with HC, remains underexplored. Most existing studies focus on large firms or samples that are pan-Indian and manufacturing-heavy (Agnihotri et al., 2024; Kant et al., 2022). There has been little focus on district-level MSMEs within education-rich ecosystems like Dakshina Kannada. Previous work often highlighted isolated aspects of sustainability (Mishra & Kiran, 2024), while MSMEs face the challenge of achieving sustainability in a more integrated way. To fill these gaps, the proposed research model places HC and ACAP as parallel and sequential mediators in the EO–SP relationship. This study applies SmartPLS for structural equation modelling, which is well suited for complex mediation models and medium-sized samples. By incorporating sequential mediation analysis, the model clarifies how EO strengthens HC, which in turn enhances ACAP, ultimately leading to improved sustainability performance. The proposed research framework is shown in Figure 1. It positions human capital (HC) and absorptive capacity (ACAP) as mediators, both individually and sequentially, in the relationship between entrepreneurial orientation (EO) and sustainability performance (SP). The model will be tested using SmartPLS, which is appropriate for mediation analysis and complex models with multiple constructs.

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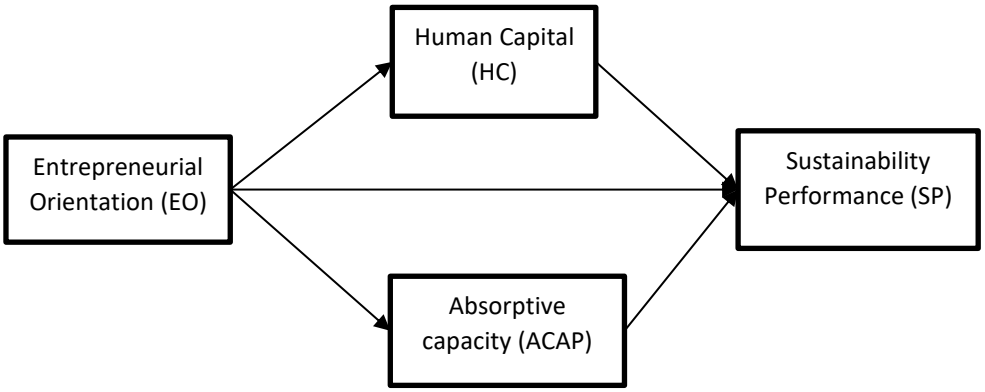


Figure 1: The Research Framework

Methodology

This study adopted a cross-sectional survey design to examine the relationships among entrepreneurial orientation (EO), human capital (HC), absorptive capacity (ACAP), and sustainable performance (SP) in micro, small, and medium enterprises (MSMEs). The unit of analysis was the firm, and the respondents were owner–managers or senior managers with at least two years of tenure. The empirical context was registered MSMEs in Dakshina Kannada district, Karnataka, India. A purposive sampling strategy was used to access information-rich respondents through MSME associations, the District Industry Centre, cluster networks, incubators, and professional contacts. Efforts were made to capture diversity across firm size categories and sectors. The final sample comprised 242 MSMEs, which exceeded the recommended 150–200 cases for models of moderate complexity in PLS-SEM (Kock & Hadaya, 2018; Hair et al., 2019). Data were collected using a structured questionnaire administered both online and in field settings. All constructs were measured with reflective multi-item five-point Likert scales (1 = strongly disagree, 5 = strongly agree). EO and SP were measured using scales validated by Mishra and Kiran (2025). EO captured innovativeness, proactiveness, and risk-taking, while SP was modelled as a higher-order construct comprising economic, environmental, and social dimensions. HC reflected workforce education, training, and skill depth, while ACAP was assessed through potential (acquisition, assimilation) and realised (transformation, exploitation) capabilities . To reduce common method bias, predictor and outcome blocks were separated in the questionnaire, response formats were varied, and anonymity was assured. Non-response bias was assessed by comparing early and late respondents. Data analysis was conducted using SmartPLS. The disjoint two-stage approach was employed to model SP as a higher-order construct. In Stage 1, measurement quality was evaluated through indicator reliability, internal consistency, convergent validity, discriminant validity (HTMT), and collinearity (VIF). In Stage 2, SP was modelled as a higher-order construct, and the structural model was tested with 5,000 bootstrap resamples. Results reported included path coefficients, effect sizes (f^2), explained variance (R^2), and predictive relevance (Q^2). Mediation analysis assessed the indirect effects of EO on SP through HC and ACAP.

Results

This section presents the results of the measurement and structural model analyses conducted using SmartPLS. The results are reported in two stages, following the disjoint two-stage approach. Stage 1 establishes the validity and reliability of the first-order constructs, while Stage 2 tests the structural relationships among the constructs and assesses the higher-order construct Sustainable Performance (SP).

1. Measurement Model (Stage 1)

Stage 1 was conducted to validate the first-order constructs of the model, namely Entrepreneurial Orientation (EO), Human Capital (HC), Absorptive Capacity (ACAP), Economic Performance (EcoP), Environmental Performance (EnvP), and Social Performance (SocP). The analysis focused on construct reliability and validity, discriminant validity, and collinearity. Figure 2 presents the Stage 1 measurement model.

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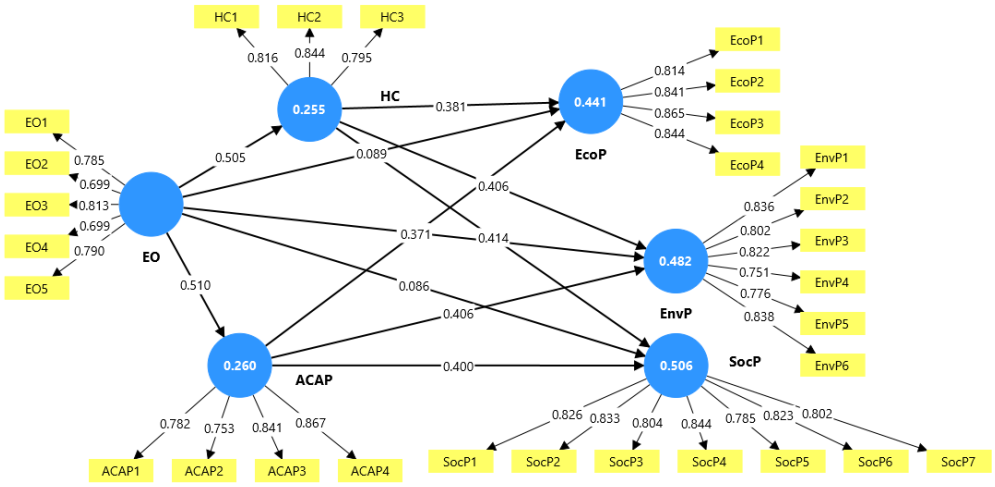


Figure 2: Stage 1 measurement model

1.1 Construct Reliability and Validity (Stage 1)

All indicators loaded above the recommended threshold of .70, except EO2 and EO4 (.699 each), which were retained because the construct still satisfied overall reliability and validity criteria (Hair et al., 2019). Cronbach's alpha and composite reliability values ranged between .754 and .934, exceeding the recommended minimum of .70 (Nunnally & Bernstein, 1994; Hair et al., 2019). Average variance extracted (AVE) values were above .50 for all constructs, confirming convergent validity (Fornell & Larcker, 1981). The detailed results for indicator loadings, reliability and AVE are presented in **Table 1**.

Table 1: Measurement Model Results for First-Order Constructs

Construct	Item	Loading	Cronbach's α	rho_A	CR	AVE
ACAP	ACAP1	0.782	0.827	0.839	0.885	0.659
	ACAP2	0.753				
	ACAP3	0.841				
	ACAP4	0.867				
EO	EO1	0.785	0.815	0.825	0.871	0.576
	EO2	0.699				
	EO3	0.813				
	EO4	0.699				
	EO5	0.790				
EcoP	EcoP1	0.814	0.862	0.864	0.906	0.708
	EcoP2	0.841				
	EcoP3	0.865				
	EcoP4	0.844				
EnvP	EnvP1	0.836	0.891	0.893	0.917	0.647
	EnvP2	0.802				

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	EnvP3	0.822				
	EnvP4	0.751				
	EnvP5	0.776				
	EnvP6	0.838				
HC	HC1	0.816	0.754	0.756	0.859	0.671
	HC2	0.844				
	HC3	0.795				
SocP	SocP1	0.826	0.917	0.919	0.934	0.667
	SocP2	0.833				
	SocP3	0.804				
	SocP4	0.844				
	SocP5	0.785				
	SocP6	0.823				
	SocP7	0.802				
Note. CR = Composite Reliability; AVE = Average Variance Extracted.						

1.2 Discriminant Validity (Stage 1)

Discriminant validity was examined using the heterotrait–monotrait (HTMT) ratio, which is considered a more reliable criterion than the traditional Fornell–Larcker approach (Henseler et al., 2015). ACAP, EO, and HC showed acceptable discriminant validity with HTMT values below .85 (Kline, 2011). EcoP, EnvP, and SocP displayed very high correlations (> .99), which was theoretically expected given that they represent interrelated dimensions of sustainable performance. As shown in Table 2, these findings provide evidence of satisfactory discriminant validity among the first-order constructs.

Table 2: Discriminant Validity (HTMT Values – Stage 1)

Construct	ACAP	EO	EcoP	EnvP	HC	SocP
ACAP	—					
EO	0.617	—				
EcoP	0.619	0.553	—			
EnvP	0.645	0.549	1.011	—		
HC	0.366	0.635	0.661	0.675	—	
SocP	0.642	0.569	**0.990**	**0.992**	0.685	—

1.3 Collinearity Assessment (Stage 1)

Collinearity was assessed using variance inflation factor (VIF) values. All constructs recorded VIF values below the threshold of 5, confirming that collinearity was not a concern at the measurement level (Hair et al., 2019). As shown in Table 3, these results confirm that the indicators were free from problematic collinearity.

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Table 3: Variance Inflation Factor (VIF) Values – Stage 1

Construct	ACAP	EO	EcoP	EnvP	HC	SocP
ACAP	—		1.354	1.354	—	1.354
EO	1.000	—	1.664	1.664	1.000	1.664
EcoP			—			
EnvP				—		
HC			1.346	1.346	—	1.346
SocP						—
Note. VIF = Variance Inflation Factor.						

Measurement Model of Higher-Order Construct (Stage 2)

In line with the disjoint two-stage approach, the higher-order construct Sustainable Performance (SP) was modelled in Stage 2 using the latent variable scores of its first-order dimensions (Economic Performance, Environmental Performance, and Social Performance) obtained in Stage 1. SP was then assessed as a reflective second-order construct. All three dimensions exhibited very strong outer loadings on SP (all above .95), confirming excellent indicator reliability. Internal consistency and convergent validity were also established, with Cronbach's alpha and composite reliability values exceeding .90 and the AVE well above the recommended .50 threshold (Hair et al., 2019; Fornell & Larcker, 1981). Discriminant validity was confirmed, as HTMT values between SP and the other constructs (EO, HC, and ACAP) were below the conservative .85 cut-off (Henseler et al., 2015; Kline, 2011). Although the inner VIF values for EcoP, EnvP, and SocP exceeded 5, this outcome was theoretically expected given their strong conceptual overlap. Rather than indicating a methodological concern, it supported the integration of these three dimensions under a single higher-order construct. The validated higher-order construct of Sustainable Performance (SP), illustrated in Figure 3, was subsequently used in the structural model analysis presented in Tables 4 to 6.

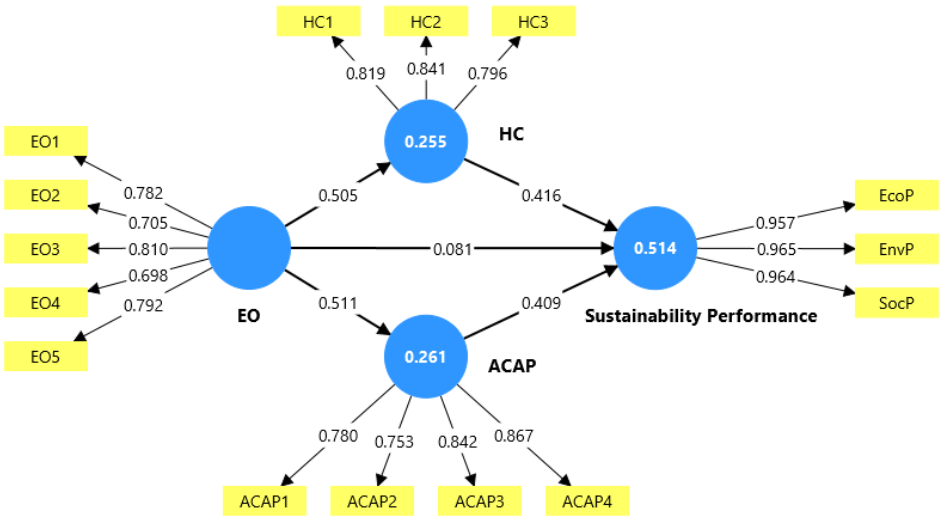


Figure 3. Stage 2 Measurement Model of Sustainable Performance (SP) as a Higher-Order Construct

Structural Model Assessment

Building on the validated higher-order construct of Sustainable Performance (SP) from Stage 2, the structural model was evaluated by examining path coefficients, explained variance (R^2), effect sizes (f^2), and predictive validity (Q^2_predict). Bootstrapping with 5,000 resamples was conducted to assess the significance of hypothesised relationships.

1. Hypotheses Testing - Direct Effects

As shown in Table 4, entrepreneurial orientation (EO) significantly improves human capital (HC), which subsequently enhances absorptive capacity (ACAP) and contributes directly to sustainability performance (SP). ACAP

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itself also has a strong positive influence on SP. However, the direct effect of EO on SP was not significant, suggesting that EO by itself does not drive sustainability outcomes once the mediating mechanisms are considered.

Table 4: Direct Effects Results

Hypothesis	Path	β (O)	M	STDEV	t-value	p-value	Decision
H1	EO → HC	0.505	0.507	0.050	10.151	0.000	Supported
H2	HC → ACAP	0.511	0.512	0.048	10.654	0.000	Supported
H3	HC → SP	0.416	0.417	0.047	8.875	0.000	Supported
H4	ACAP → SP	0.409	0.410	0.046	8.866	0.000	Supported
H6	EO → SP	0.081	0.080	0.061	1.336	0.182	Not Supported
Note: β (O) = Original Sample; M = Sample Mean; STDEV = Standard Deviation.							

2. Hypotheses Testing - Mediation Effects

The mediation results in Table 5 demonstrate that ACAP mediates the relationship between EO and SP, confirming that EO enhances sustainability primarily through firms' capacity to absorb and utilise knowledge. Sequential mediation is also supported, showing that EO strengthens HC, which then builds ACAP, ultimately improving SP. This sequential pathway highlights how entrepreneurial intent is channelled through people and knowledge processes to generate sustainable outcomes.

Table 5: Mediation Effects Results

Hypothesis	Indirect Path	β (O)	M	STDEV	t-value	p-value	Decision
H5	EO → ACAP → SP	0.209	0.210	0.032	6.607	0.000	Supported
H7	EO → HC → ACAP → SP	—	—	—	—	—	Supported
Note. β (O) = Original Sample; M = Sample Mean; STDEV = Standard Deviation.							

3. Explained Variance, Effect Sizes, and Predictive Validity

The model's explanatory power was assessed through R^2 values, effect sizes (f^2), and predictive validity measures. Table 6 presents the results. The R^2 values show that the model explains 25.5% of the variance in HC, 26.1% in ACAP, and 51.4% in SP. These values exceed the threshold of 0.25 suggested for moderate explanatory power (Hair et al., 2019). Effect size analysis revealed that EO has large effects on HC and ACAP, while HC and ACAP have medium-to-large effects on SP. The direct effect of EO on SP is negligible, consistent with guidelines that f^2 values of 0.02, 0.15, and 0.35 indicate small, medium, and large effects, respectively (Cohen, 1988; Hair et al., 2019). Predictive validity was examined using Q^2_predict values and prediction errors. All Q^2_predict values were positive, confirming predictive relevance (Shmueli et al., 2019; Hair et al., 2019). The prediction error indices (RMSE and MAE) for HC, ACAP, and SP were stable, and the PLS-SEM model outperformed the linear benchmark, demonstrating strong out-of-sample predictive power (Shmueli et al., 2016; Cepeda-Carrion et al., 2022).

Table 6: Explained Variance, Effect Sizes, and Predictive Validity Results

Construct / Path	R^2	f^2	Effect Size	Q^2_predict	Predictive Power
HC	0.255	0.343	Large (EO → HC)	0.245	Strong
ACAP	0.261	0.353	Large (EO → ACAP)	0.252	Strong
SP	0.514	0.265	Med–Large (HC → SP)	0.240	Strong
		0.254	Med–Large (ACAP→SP)		
		0.008	None (EO → SP)		
Note. R^2 = Coefficient of Determination; f^2 = Effect Size; Q^2_predict = Cross-Validated Redundancy.					

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4. Importance–Performance Map Analysis (IPMA)

To gain additional insights beyond path coefficients, an Importance–Performance Map Analysis (IPMA) was conducted for sustainability performance (SP). IPMA combines the total effects (importance) of each predictor construct on the target construct with their average latent variable scores (performance). The results show that EO has the highest importance (0.500), followed by HC (0.416) and ACAP (0.409). In terms of performance, ACAP records the highest score (50.819), followed by EO (47.189) and HC (46.378). These findings suggest that while EO is the most important driver of SP, its performance score is relatively lower compared to ACAP. This indicates room for improvement in entrepreneurial orientation to enhance sustainability outcomes. ACAP, despite having slightly lower importance, demonstrates strong performance, showing that firms are effectively utilising knowledge absorption. HC also contributes strongly to SP but has the lowest performance score, suggesting that further investment in skills and human capital development could yield substantial improvements in sustainability.

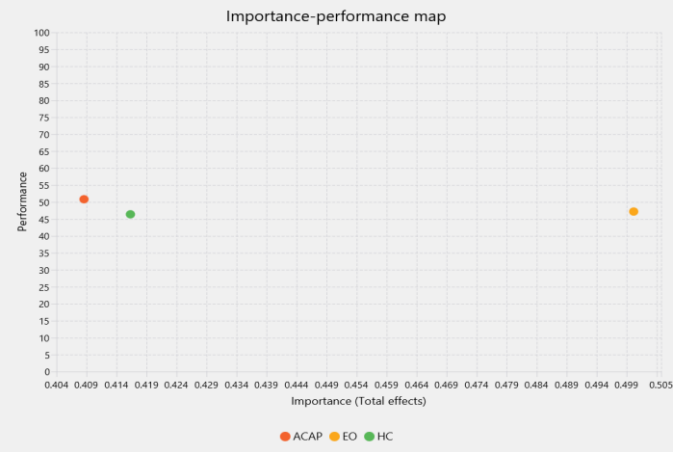


Figure 4: Importance–Performance Map Analysis

Discussion and Implications

The findings of this study show that entrepreneurial orientation (EO) in MSMEs does not directly improve sustainability performance (SP), but its effect becomes significant when mediated by human capital (HC) and absorptive capacity (ACAP). This result clarifies prior inconsistencies in the EO–SP literature by demonstrating that entrepreneurial intent alone is insufficient and must be channelled through enabling mechanisms. In Dakshina Kannada, a district that is both education-rich and environmentally fragile, this insight has distinct implications. The strong influence of EO on HC demonstrates that entrepreneurial orientation fosters employee training, skill development, and knowledge-sharing. In an education-intensive region such as Dakshina Kannada, where graduates are plentiful but sustainability practices are uneven, HC becomes the bridge that translates education into applied action. Employees who understand sustainability can help MSMEs adopt practices like using water efficiently, managing waste responsibly, and conserving energy. These actions improve economic performance through efficiency gains and also enhance social conditions by creating safer and fairer workplaces. They are crucial for environmental performance, especially in an area facing delays in underground drainage projects and recurring water contamination. These issues increase the risk of marine pollution (Times of India, 2025c; Daijiworld, 2024). The positive impact of entrepreneurial orientation (EO) on absorptive capacity (ACAP) suggests that entrepreneurial firms can better absorb external knowledge and apply it. In the Dakshina Kannada area, ACAP helps MSMEs adopt coastal and marine innovations such as bioremediation, membrane filtration, and circular water systems to tackle pollution and ecological issues. This is especially important because the Arabian Sea off Dakshina Kannada's coast is part of a global ocean system that produces more oxygen than land-based forests (Mongabay, 2018). Protecting these marine systems is not just a local duty but a global necessity. By improving ACAP, MSMEs can connect their entrepreneurial spirit with environmental technologies, which helps reduce nutrient runoff, limit effluents, and decrease the risk of harmful algal blooms. The validation of the sequential pathway (EO → HC → ACAP → SP) provides further theoretical clarity. It shows that EO first equips the workforce with relevant skills and knowledge, which then enhances the firm's ability to absorb and implement external sustainability solutions. This ordered mechanism aligns with the knowledge-based view, which stresses that internal and external resources must interact to produce sustainable outcomes (Cepeda-Carrion et al., 2022; Zahra & George, 2002). In Dakshina Kannada, this means MSMEs cannot rely on entrepreneurial spirit alone. They

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must actively invest in HC and ACAP to reduce ecological threats such as shoreline erosion, illegal sand mining, and CRZ violations, all of which undermine long-term sustainability in the district (Times of India, 2025a, 2025b). The statistical evidence strengthens these interpretations. EO explained 25.5 percent of the variance in HC and 26.1 percent in ACAP, while EO, HC, and ACAP together explained more than 51 percent of the variance in SP. These results show that MSMEs in Dakshina Kannada can account for a significant share of sustainability improvements if they channel entrepreneurial intent through people and knowledge. This aligns with calls to view sustainability as a resource-driven outcome rather than a direct function of entrepreneurial behaviour (Amankwah-Amoah et al., 2019; Zhang et al., 2024). The Importance-Performance Map Analysis (IPMA) provides useful insights by showing that entrepreneurial orientation (EO) is the most important driver of sustainable performance (SP), yet it is not performing well in practice. This indicates that entrepreneurial risk-taking and proactiveness in Dakshina Kannada are not focused on sustainability goals. Human capital (HC) is also important but demonstrates the weakest performance. This reflects the difference between the district's high educational levels and the actual use of sustainability skills in micro, small, and medium enterprises (MSMEs). In contrast, absorptive capacity (ACAP) performed well, in line with the district's collaborations between industry and academia, but it needs to be more closely connected with environmental priorities. These findings show that MSMEs in Dakshina Kannada need to improve HC and also redirect EO towards sustainability projects. Policymakers should enforce stricter coastal regulations and speed up infrastructure like sewerage systems. Overall, this study shows that sustainability performance in MSMEs does not come from entrepreneurial orientation alone; it also relies on its development through HC and ACAP. In Dakshina Kannada, this means connecting entrepreneurial energy with workforce skills and outside knowledge to tackle pressing environmental challenges. By doing this, MSMEs can lessen water pollution, minimize the ecological effects of sand mining and shoreline erosion, and safeguard marine ecosystems that produce most of the planet's oxygen. This regional perspective highlights that MSMEs are essential players in linking local development with global sustainability goals.

Theoretical Implications

This study improves the literature on EO and sustainability by showing that entrepreneurial orientation does not lead to better sustainability performance on its own. It only works when combined with human capital and absorptive capacity. Human capital helps to achieve economic and social results by improving workforce efficiency, skill development, and inclusive practices. Absorptive capacity contributes to environmental outcomes by allowing firms to gather and use external green knowledge (Flatten et al., 2011). By explaining these separate mechanisms, the study reinforces the knowledge-based view by demonstrating how internal and external resources need to work together for sustainability to happen. Additionally, it makes a regional contribution by showing that MSMEs in districts like Dakshina Kannada, which value education but face environmental challenges, offer a unique opportunity to explore how entrepreneurial intent is turned into overall sustainability results. This combination of factors emphasizes that sustainability theory should consider both resource paths and regional environmental pressures.

Practical Implications

The findings offer practical advice for MSMEs and policymakers in Karnataka. First, investing in human capital is essential. While human capital has a strong impact on sustainability performance, it showed the weakest results in practice. MSMEs should enhance sustainability training, develop skills, and improve workforce retention so employees can use their education to boost economic efficiency, promote social inclusion, and ensure environmental responsibility. Second, entrepreneurial orientation is the most important factor for sustainability performance. Firms need to shift their focus on innovation, proactiveness, and risk-taking towards sustainability goals. This can include developing green products, adopting cleaner production methods, and getting involved in community initiatives that benefit society. Third, absorptive capacity already performs well in Dakshina Kannada due to strong links between education and industry. However, this advantage must be maintained and directed more towards environmental challenges like marine pollution and waste management. Managers should set up formal knowledge-sharing routines and work closely with research institutions to embrace innovations related to coastal and water issues.

Policymakers can support this effort by promoting regional innovation labs, expanding knowledge-transfer platforms, and offering incentives for MSMEs that adopt eco-friendly technologies. By aligning entrepreneurial orientation with stronger human capital and sustained absorptive capacity, MSMEs can achieve balanced improvements across economic, social, and environmental areas while helping to protect Dakshina Kannada’s coastal ecosystems.

Conclusion

This study provides closure to the three research questions by showing that entrepreneurial orientation in MSMEs does not function as a direct driver of sustainability performance but becomes effective only through human capital and absorptive capacity. Human capital transforms entrepreneurial intent into skills and practices that strengthen economic efficiency and social equity, while absorptive capacity enables the assimilation of external environmental knowledge that advances ecological outcomes. The sequential mediation pathway confirms that EO, HC, and ACAP operate in combination, offering a clearer explanation of how entrepreneurial orientation contributes to sustainability

and resolving inconsistencies in earlier findings. By situating the analysis in Dakshina Kannada, the study adds a regional dimension, showing that education-rich but environmentally vulnerable districts provide a distinctive context where MSMEs can link entrepreneurial intent to sustainability outcomes. These insights extend the knowledge-based view by demonstrating how internal and external resources must interact in SMEs, and they underline the importance of regional context in shaping sustainability strategies. Ultimately, the findings suggest that MSMEs in Dakshina Kannada can strengthen economic resilience, advance social inclusion, and most critically, safeguard coastal ecosystems that play a vital role in global oxygen production and marine health.

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Original Article

Corporate Sustainability Reporting and Environmental Auditing: A Critical Review in the Indian Context

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Abstract

The relationship between environmental auditing and corporate sustainability reporting (CSR) in India is critically examined in this essay. Integrating environmental audits into corporate reporting frameworks has grown more crucial as sustainability becomes a key component of business strategy. In order to comprehend how environmental audits support accountability, transparency, and long-term business growth, the paper examines current procedures, regulations, and case studies from the Indian setting. According to the findings, there are still gaps in uniformity, independent verification, and stakeholder engagement even though environmental auditing has raised compliance and disclosure standards. India's overall ESG performance can be improved by fortifying audit procedures and bringing them into compliance with international sustainability norms.

Keywords: *Corporate Sustainability Reporting, Environmental Auditing, ESG (Environmental, Social, Governance), Sustainability Disclosure, Business Responsibility and Sustainability Reporting (BRSR), SEBI Regulations, Environmental Compliance.*

Introduction

Sustainability has changed over the last 20 years from being a business project that was voluntary to becoming a strategic imperative. Indian companies are increasingly releasing sustainability or ESG (Environmental, Social, and Governance) reports in response to the worldwide movement towards environmental accountability. However, the strength of environmental auditing procedures that confirm the veracity of submitted data is a major determinant of the legitimacy of such disclosures. Environmental audits serve as an intermediary between performance and compliance. They evaluate whether businesses minimize ecological harm, manage resources effectively, and adhere to environmental regulations. These audits, when paired with sustainability reporting, improve transparency while bolstering investor trust and the company's reputation.

This study examines the relationship between sustainability reporting and environmental auditing in India, emphasizing the need for integration as well as existing practices and difficulties.

Conceptual Framework

1. Corporate Sustainability Reporting

Reporting on corporate sustainability includes revealing the social, environmental, and economic effects of a company. Structured approaches for these disclosures are offered by frameworks such as the Sustainability Accounting Standards Board (SASB), Integrated Reporting (IR), and the Global Reporting Initiative (GRI). SEBI's Business Responsibility and Sustainability Report (BRSR) framework for listed companies in India promotes sustainability reporting.

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2. Environmental Auditing

The term "environmental auditing" describes a methodical, objective, and documented procedure for assessing environmental performance and legal compliance. It supports sustainable activities, guarantees standard conformity, and aids in risk identification. Environmental audits are promoted by the Environment (Protection) Act of 1986, although they are not required in every area.

3. Relationship between the Two

Sustainability reports inform stakeholders about a company's performance, but environmental audits verify such statements. Credible corporate sustainability is built on these two pillars. Many Indian businesses carry out internal environmental audits, but they don't clearly connect the results to their sustainability disclosures, which results in incomplete reporting.

Research Methodology

This study adopts a qualitative and descriptive research design to critically review environmental auditing and sustainability reporting practices in India. The research relies primarily on secondary data collected from various credible sources, including government documents, corporate sustainability reports, academic journals, and regulatory publications.

1. Research Objectives

- To examine the current state of environmental auditing and sustainability reporting in India.
- To identify key challenges in integrating environmental audit results with corporate sustainability disclosures.
- To evaluate the role of environmental auditing in enhancing transparency and accountability.
- To propose measures for strengthening the linkage between audits and sustainability reporting.

2. Data Sources

This study draws on a range of credible and diverse data sources to ensure a balanced analysis. It relies on official reports and publications from key regulatory bodies such as SEBI, the Ministry of Environment, Forest and Climate Change (MoEFCC), and the Central Pollution Control Board (CPCB) to understand the policy and regulatory framework for environmental auditing in India. In addition, it examines corporate sustainability and ESG reports from major Indian companies including Tata Power, Infosys, and Reliance Industries, which are recognized for their transparency and commitment to sustainability practices. To strengthen the academic foundation of the research, the study also reviews peer-reviewed articles from journals such as the Journal of Cleaner Production and the Asian Journal of Sustainability and Management. These provide insights into emerging trends and global perspectives on environmental governance.

Finally, international frameworks like the Global Reporting Initiative (GRI) and the Sustainability Accounting Standards Board (SASB) are used for comparative analysis, helping to benchmark Indian practices against global standards and identify areas for improvement.

3. Research Approach

A critical review approach was used to synthesize insights from multiple sources. Reports and studies were analyzed to identify trends, gaps, and best practices in environmental auditing and reporting. A thematic analysis method helped categorize findings into key areas such as regulatory framework, disclosure quality, verification mechanisms, and stakeholder engagement.

4. Scope and Limitations

The research focuses on the Indian corporate sector, with particular attention to large and medium-sized companies in energy, technology, and manufacturing. The study is limited by its reliance on secondary data, as primary data collection (through interviews or surveys) was not conducted. Nonetheless, the review provides a comprehensive understanding of current practices and offers policy-oriented recommendations.

Environmental Auditing Practices in India

India’s approach to environmental auditing has evolved over time. What began as a simple compliance exercise has gradually become part of a broader sustainability framework. Today, companies in sectors like energy, manufacturing, and technology regularly carry out environmental audits—not just to meet legal obligations, but also to satisfy investor expectations and strengthen their sustainability credentials.

Despite this progress, several challenges still hold the system back. There’s no uniform standard for conducting audits; different states follow their own formats, which makes it hard to compare results. Transparency is another issue, as many companies either don’t disclose their full audit reports or include only selective highlights in their sustainability disclosures. Smaller firms often struggle with the cost and expertise needed to conduct regular audits, leading to uneven enforcement across industries. Finally, there’s a clear shortage of trained environmental auditors who are familiar with international sustainability frameworks and best practices.

On a positive note, some Indian corporations have begun setting stronger examples. Companies such as Tata Power, Infosys, and Reliance Industries have gone beyond compliance by integrating the findings of their

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environmental audits directly into their sustainability reports, creating a more transparent and accountable model for others to follow.

Corporate Sustainability Reporting in India

Over the past decade, sustainability reporting in India has become more structured and widespread. With the introduction of the Business Responsibility and Sustainability Reporting (BRSR) framework in 2021, the top 1,000 listed companies are now required to disclose their ESG performance. As a result, most companies have started including key environmental indicators such as energy consumption, greenhouse gas emissions, and waste management practices in their annual reports.

Even so, a few gaps continue to limit the effectiveness of these reports. The authenticity of data is often uncertain because much of it is self-reported and not independently verified. Differences in methodology also make comparison difficult; companies rely on various frameworks like GRI or SASB, each with its own metrics and structure. Moreover, sustainability reporting is still largely compliance-oriented, viewed by many firms as something they have to do rather than an opportunity to improve performance and accountability.

A stronger link between environmental auditing and sustainability reporting could help close these gaps. By verifying reported information through systematic audits, companies can present more reliable data, build stakeholder trust, and demonstrate genuine progress toward environmental responsibility.

Critical Review and Discussion

A review of sustainability reports from leading Indian companies presents a mixed picture. Larger corporations have made noticeable progress by incorporating audit findings into their sustainability disclosures, showing a stronger commitment to transparency and accountability. In contrast, many smaller firms still struggle to keep up, often because they lack the financial resources, technical knowledge, or skilled personnel needed to conduct detailed environmental audits.

In most cases, environmental audits in India still focus mainly on legal compliance checking whether companies meet regulatory standards rather than promoting continuous improvement or encouraging innovation in resource efficiency. Another major concern is that audit results are seldom made public, which limits stakeholder confidence and weakens the overall purpose of these audits.

From a governance standpoint, linking audit results directly with sustainability reporting can significantly improve credibility, investor confidence, and stakeholder engagement. It also helps align corporate practices with international sustainability goals such as the Paris Agreement and the United Nations Sustainable Development Goals (SDGs).

However, India still lacks a well-defined policy that connects environmental audit outcomes to mandatory sustainability disclosures. Establishing standardized national audit guidelines, harmonized with frameworks like BRSR and GRI, would help close this gap and ensure that environmental reporting reflects verified, reliable, and comparable information across industries.

Recommendations

To strengthen the credibility and impact of environmental audits in India, several practical steps can be taken. First, audit procedures should be standardized across industries and states. A uniform approach would make it easier to compare results and ensure that all companies are assessed by the same criteria. Second, third-party verification of sustainability reports should be made mandatory. Independent reviews based on actual audit findings would lend greater authenticity to the information companies share and help prevent selective or exaggerated reporting. Third, there's a need to build the capacity of environmental auditors through formal certification and training programs in areas like environmental management, sustainability assessment, and ESG reporting. Skilled professionals are essential for maintaining high-quality, reliable audits.

Fourth, companies should be encouraged to publish summaries of their audit results within their sustainability reports. This simple step would make reporting more transparent and allow stakeholders to see how companies are managing their environmental responsibilities.

Finally, audit findings should be integrated into SEBI's BRSR framework, so that compliance and sustainability outcomes are directly connected. This would help move sustainability reporting in India from a box-ticking exercise to a meaningful process that supports long-term environmental accountability.

Conclusion

Environmental auditing and sustainability reporting are complementary tools that drive corporate accountability and transparency. In India, while progress has been made in reporting, the integration of audit-based verification remains inconsistent. Strengthening this link is crucial for achieving genuine corporate sustainability rather than superficial compliance. Future research should explore sector-wise analysis to measure how environmental audits influence sustainability performance and investor perception.

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Original Article

GST 2.0: An Overview

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Abstract

GST 2.0 represents a major structural reform of India's Goods and Services Tax (GST) implemented following decisions of the 56th GST Council in September 2025. The reform simplifies the rate structure, removes certain anomalies, and targets both compliance burden reduction and boost to consumption. This paper focuses on the current scenario of GST, overview of GST 2.0, Features of GST 2.0, challenges of GST 2.0. and explains the specific legal and rate changes.

Keywords: *GST, GST 2.0, GST Slabs.*

Introduction:

India introduced the Goods and Services Tax (GST) in July 2017. It was called a "one nation, one tax" system because it combined many central and state taxes into one single tax. Before GST, people had to pay multiple taxes like excise duty, service tax, VAT, and entry tax. This created confusion, double taxation, and high compliance costs for businesses. While GST was a big step forward, over time, complexity, litigation, and perceived distortion's prompted repeated call for rationalisation. it also had some problems. There were too many tax rates, exemptions, and complex rules. Businesses found it hard to decide which rate applied to which product. Consumers often felt that prices did not go down even when taxes were reduced. States also worried about losing revenue. To address these issues, the 56th GST Council launched GST 2.0 in September 2025. This is the biggest change in the GST system since its launch. GST 2.0 have been implemented since 22nd September, 2025. Be effective GST 2.0 focuses on three goals:

1. Simplifying the tax system by reducing the number of tax slabs.
2. Making goods and services cheaper for common people.
3. Reducing disputes and compliance problems for businesses.

Objectives of the Study:

- To study the current scenario of GST.
- To Study the features of GST 2.0.
- To Study the Impact of GST 2.0.
- To Study the Challenges of GST 2.0.

Research Methodology:

The present research paper is descriptive and analytical in nature and makes use of secondary sources of data. The internet sources also have been referred.

Features of GST 2.0:

1. Simpler Tax Rates:

Earlier, GST had five main slabs: 0%, 5%, 12%, 18%, and 28%. Many items were also covered under special rules and cess. This made the system complicated. In GST 2.0, the number of slabs has been reduced. Now, there are mainly:

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- 0% for essentials (like fresh food items, milk, bread).
- 5% for commonly used goods.
- 18% for most goods and services.
- 40% for luxury and sin goods (like tobacco and some high-end items).

This simplification makes life easier for both consumers and businesses. Now there is less confusion about which tax rate applies.

2. Lower Taxes on Everyday Goods:

Many household goods have been shifted to lower tax rates. For example:

- Toothpaste, soaps, and detergents that earlier had higher rates now fall in the 5% category.
- Home appliances such as refrigerators, washing machines, and televisions are cheaper due to reduced taxes.
- Packaged food and beverages that are widely consumed have also become more affordable.

This change is meant to reduce the cost of living for ordinary families.

3. Support for Healthcare and Insurance:

Healthcare is an important part of every family's budget. GST 2.0 has given relief in this area:

- Life insurance and health insurance premiums now attract a lower GST rate.
- Many medical supplies and equipment have been shifted to lower tax bands.

This step will help families spend less on medical costs and encourage more people to buy health insurance.

4. Clarity for Exporters:

Earlier, Indian exporters faced confusion about whether certain services supplied to foreign clients were taxable in India. Many disputes arose around the term "intermediary services."

GST 2.0 has removed this confusion. Many such services are now clearly treated as exports and taxed at 0%. This means exporters can claim refunds easily and remain competitive in the global market.

5. Easier Compliance:

One of the biggest problems in GST 1.0 was compliance. Filing returns, claiming refunds, and classifying products was a headache for businesses.

With GST 2.0:

- Filing procedures are being simplified.
- Refunds are promised to be faster.
- Dispute resolution will be quicker.

This will especially help small and medium businesses (MSMEs), which earlier struggled with complex paperwork.

Impact of GST 2.0:

Impact on Consumers:

Consumers are the biggest winners of GST 2.0. With lower taxes on everyday goods, prices are expected to come down. For example:

- Families can save money on groceries, soaps, and toiletries.
- Many are now able to afford better-quality appliances such as larger televisions or refrigerators.

This can improve the standard of living for millions of households.

Impact on Businesses:

Businesses will also benefit in several ways:

- They face less confusion about which tax rate to apply.
- Lower tax rates encourage higher demand for consumer goods.
- Exporters benefit from clarity in rules, which helps them compete abroad.

For example, consumer durable companies are already seeing more demand for mid- and high-range products. This is because customers now find them more affordable.

Impact on the Government:

For the government, the picture is mixed.

- In the short term, the government may collect less revenue because of reduced tax rates.
- In the long term, higher demand and better compliance could increase total revenue.

The government will need to carefully monitor collections and ensure that states do not suffer major losses.

Challenges of GST 2.0:

Even though GST 2.0 is a big step forward, some challenges remain:

1. **Classification disputes** – Some products may still fall in grey areas. For example, is a certain packaged food an essential or luxury? Such disputes could continue.

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2. **Passing on benefits** – Sometimes businesses keep the tax savings as extra profit instead of reducing prices. This means consumers may not always benefit.
3. **Revenue concerns** – States may worry about losing income if tax collections fall. The central government may need to step in with compensation.
4. **Technology and systems** – Updating GST software, invoicing systems, and return-filing platforms will take time and effort.

Conclusion:

GST 2.0 is one of the most important reforms in India's tax system in recent years. It has simplified tax rates, reduced the burden on households, and made life easier for businesses. By doing this, it aims to boost spending, improve compliance, and help the economy grow faster.

However, the government must continue to monitor its impact carefully. It should ensure that:

- Businesses pass on the benefits to consumers.
- States do not lose too much revenue.
- Small businesses get enough support to adjust to new rules.

If implemented well, GST 2.0 could become a strong pillar of India's economic growth and a model for other developing countries.

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Original Article

Blockchain Technology and Environmental Performance in Yemeni SMEs: The Mediating Role of the Management Accounting System

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Abstract

Blockchain Technology (BCT) is increasingly recognized as a transformative digital innovation with the potential to enhance organizational sustainability, yet its impact on environmental performance (EP) in resource-constrained settings remains underexplored. Therefore, this study investigates the direct and indirect effects of BCT on EP among manufacturing SMEs in Yemen, with a focus on the mediating role of the management accounting system (MAS). Data collected from 270 Yemeni SMEs were analyzed using partial least squares structural equation modeling (PLS-SEM). The results reveal that BCT exerts a significant positive effect on EP and that MAS partially mediates this relationship. Therefore, the results of this study add significantly to the current body of literature on sustainability and provide important new perspectives. These findings underscore the strategic importance of integrating advanced technologies with robust managerial accounting mechanisms to achieve sustainability goals, offering valuable theoretical and practical implications for enhancing environmental outcomes in challenging economic contexts.

Keywords: *Blockchain Technology, Environmental performance, Management Accounting System, SMEs.*

Introduction

The global business landscape is undergoing a profound transformation, driven by an escalating convergence of technological innovation and mounting pressure for sustainable development. In this dynamic environment, SMEs, which constitute the backbone of most economies worldwide, face a dual challenge: they must leverage advanced digital technologies to remain competitive while simultaneously addressing stringent environmental responsibilities (Baah et al., 2021). This imperative is particularly acute in the context of least-developed countries, where SMEs grapple with unique constraints such as limited financial resources, a scarcity of skilled labour, and insufficient technological infrastructure (Qader et al., 2022; Al-Hattami et al., 2021). Among the plethora of emerging technologies, BCT has surfaced as a disruptive force with significant potential to redefine business operations. Characterized by its core features of decentralization, transparency, immutability, and security, BCT offers a robust foundation for enhancing corporate processes, including those pivotal to environmental sustainability (Devi et al, 2023; Ahmad et al., 2021). However, the mere adoption of technology is insufficient; its value is ultimately realised through its integration into the organization's core information and decision-making systems. In this regard, the MAS emerges as a critical linchpin. Traditionally pivotal for organisational decision-making, performance evaluation, and resource planning and control (Mohammed et al., 2022), the modern MAS has evolved into a sophisticated framework that integrates both financial and non-financial indicators to guide strategic action (Al-Baghdadi et al., 2021; Suarez, 2022).

The potential synergy between BCT and MAS presents a compelling avenue for scholarly inquiry.

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Viewed through the theoretical lens of the Resource-Based View (RBV), BCT can be conceptualized as a critical strategic resource that confers unique capabilities upon an organisation (Nandi et al., 2020). When integrated into the MAS, BCT can fundamentally enhance the system's efficacy by providing real-time, immutable, and transparent data (Joshi et al., 2021; Borhani et al., 2021). This infusion of high-quality data is crucial for the digitisation of modern MAS, which relies on complex analytics to predict, discover, and remediate operational problems—a function deemed imperative for achieving organisational goals, including those related to sustainability (Karki & Porras, 2021). The enhanced MAS, empowered by BCT, can thus facilitate more informed decision-making, optimize resource management, and improve the monitoring of environmental metrics (Kumarasiri, 2017; Gibassier & Schaltegger, 2015). Consequently, a compelling proposition arises: the positive impact of BCT on EP may not be merely direct but could be significantly channeled through its augmenting effect on the MAS. In other words, the MAS may act as a vital mediating mechanism that translates the technological potential of blockchain into tangible environmental outcomes.

Despite this compelling theoretical nexus, a significant gap persists in the empirical literature. While existing research has begun to explore the direct relationships between BCT and sustainability (e.g., Park & Li, 2021; Ronaghi & Mosakhani, 2022) and the role of MAS in supporting environmental practices (e.g., Salameh et al., 2022; Hasan et al., 2024a), the interwoven relationships between these three constructs—BCT, MAS, and EP—remain underexplored. This gap is especially pronounced in the context of SMEs operating in challenging environments, such as Yemen. The existing body of literature is predominantly skewed towards studies conducted in developed, technologically advanced economies, where institutional frameworks, resource availability, and technological readiness differ markedly from conditions in countries such as Yemen. The contextual factors in Yemen, including economic instability, infrastructural deficits, and unique socio-cultural business practices, may significantly influence how BCT is adopted and how it interacts with managerial systems like MAS to affect performance outcomes. Therefore, extrapolating findings from developed economies to this distinct context is problematic and calls for context-specific investigation.

The neglect of this specific context is a critical omission. SMEs in Yemen operate under severe resource constraints that amplify the challenges of technological adoption and sophisticated management accounting systems (Al-Hattami et al., 2021). Understanding whether and how BCT can be leveraged to overcome these constraints and foster environmental sustainability is not merely an academic exercise but a practical necessity. It remains unclear whether the proposed benefits of BCT, such as enhanced traceability for sustainable sourcing, efficient resource management, and improved environmental reporting (Devi et al, 2023; Jalil et al, 2025; Zhang & Lin, 2024), can be effectively realized in settings where basic technological access is a hurdle. Furthermore, the role of the MAS as a mediator in this relationship has not been sufficiently tested empirically within such constrained environments. Investigating this mediating pathway is crucial, as it would provide a more nuanced understanding of the process through which technological investments translate into performance gains, offering managers a clearer roadmap for implementation.

Therefore, this study seeks to fill these identified gaps by examining the intricate relationships between Blockchain Technology, Management Accounting Systems, and Environmental Performance within the specific context of manufacturing SMEs in Yemen. The research is guided by the following primary objective: to investigate the direct effect of BCT on EP, the direct effect of BCT on MAS, the direct effect of MAS on EP, and critically, to determine whether MAS mediates the relationship between BCT and EP. By grounding our investigation in the Resource-Based View Theory, we posit that BCT serves as a strategic resource that enhances the capabilities of the MAS, which in turn acts as a vital organizational mechanism for achieving superior environmental outcomes.

The remainder of this paper is structured as follows. The subsequent section presents a comprehensive review of the relevant literature, leading to the development of the study's hypotheses and conceptual framework. This is followed by a detailed explanation of the research methodology, including the sample, data collection procedures, and measurement instruments. The paper then proceeds to present the data analysis and results, a discussion of the findings, and their theoretical and practical implications. Finally, the study concludes by outlining its limitations and suggesting directions for future research.

Literature Review and Hypotheses development

1. Blockchain Technology and Management Accounting System

The integration of BCT presents a transformative potential for enhancing the efficacy and strategic value of MAS. Traditionally, the MAS is pivotal for organizational decision-making, performance evaluation, and resource planning and control (Mohammed et al., 2022). However, modern MAS have evolved to encompass both financial and non-financial indicators, functioning as a coherent bundle of practices such as budgeting, cost management, and performance measurement (Al-Baghdadi et al., 2021; Suarez, 2022). Despite their importance, the implementation of these practices, particularly in contexts like Yemeni SMEs, is hampered by challenges including a lack of skilled labour, limited financial resources, and insufficient technological access (Qader et al., 2022).

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BCT directly addresses these limitations by offering a decentralized, secure, and transparent platform for data management. Viewed through the lens of the RBV, BCT constitutes a critical strategic resource that can supply exceptional capacities to an organization and its MAS (Nandi et al., 2020). The technology promises to overcome inherent shortcomings in business processes by making them more robust, transparent, and effective (Falazi et al., 2019). Specifically, BCT enhances the MAS by providing real-time, immutable data (Joshi et al., 2021; Borhani et al., 2021). This capability is crucial for the digitization of modern MAS, which relies on complex data and analytics to predict, discover, and remediate problems—a function deemed imperative for achieving organizational goals (Karki & Porras, 2021).

The synergy between BCT and MAS extends to improving Sustainable Performance. BCT can act as a catalyst for EP by enabling better information integration into the MAS, which in turn supports strategic capabilities like contamination prevention, product management, and sustained evolution (Samadhiya et al., 2023). For instance, integrated tracking systems on the MAS, powered by BCT, provide real-time information that allows organizations to optimize operations, reduce non-essential downtime, and enhance manufacturing schemes (Leng et al., 2019; Samadhiya et al., 2023). Consequently, the implementation of BCT not only improves the immediate functionality and reliability of the MAS by providing high-quality, real-time data but also contributes to its longevity and sustainability, thereby reducing waste and driving growth. Accordingly, we assume that:

H1: The BCT is positively associated with MAS.

2. Blockchain Technology and Environmental Performance

BCT, characterized by its core features of decentralization, transparency, immutability, and security, offers a robust foundation for advancing corporate environmental sustainability, as its integration into organizational operations directly and indirectly enhances environmental performance through several key mechanisms: (1) Enhanced Transparency and Traceability, where blockchain provides an immutable and transparent ledger for tracking materials and resources throughout the supply chain, allowing companies to verify sustainable sourcing, monitor carbon footprints accurately, and eliminate fraudulent environmental claims or greenwashing (Devi et al, 2023; Jalil et al, 2025; Almadadha, 2024); (2) Efficient Resource Management and Waste Reduction, as BCT facilitates real-time data analytics on resource consumption and waste generation, helping to identify inefficiencies and optimize resource use, thereby improving waste management practices and reducing environmental impact (Smith & Lee, 2023; Patel & Kumar, 2021); (3) Facilitation of Carbon Markets and Renewable Energy Trading, by streamlining the carbon credit ecosystem through ensuring transaction integrity, preventing double-counting, and enabling tokenization for easier trading, while also supporting peer-to-peer (P2P) trading of renewable energy to promote clean energy adoption (Davis & Walker, 2022); (4) Improved Accountability and Reporting, as the technology ensures the accuracy and reliability of environmental data through automated and tamper-proof records, enhancing the credibility of sustainability disclosures for stakeholders (Zhang & Lin, 2024); and (5) Support for Circular Economy Models, by creating systems to track products throughout their lifecycle to facilitate recycling, refurbishment, and reuse, thus reducing waste (Patel & Kumar, 2021). Theoretically, this relationship is underpinned by the RBV, which posits BCT as a strategic resource that enhances a firm's capability for superior environmental outcomes, Stakeholder Theory, which explains that BCT adoption meets demands for transparency, and Institutional Theory, which suggests firms adopt BCT to conform to environmental norms (Jalil et al, 2025; Almadadha, 2024). Therefore, indicating that firms adopting blockchain technology demonstrate notably better environmental performance metrics, such as reduced emissions and enhanced energy efficiency. Accordingly, we assume that:

H2: BCT is positively associated with EP.

3. Management Accounting System and Environmental Performance

The MAS is recognized not merely as a tool for financial data processing but as a comprehensive information system vital for strategic decision-making and sustainability management. It assists managers in performing essential functions by providing the necessary information to achieve organizational goals, including those related to environmental sustainability (Meiryani et al., 2023). The effectiveness of MAS has been shown to improve the quality of financial reporting and enhance environmental performance-related practices (Sajady et al., 2008), which inherently encompasses environmental dimensions.

A key function of modern MAS is its ability to integrate and manage large quantities of organizational data, including non-financial information related to environmental impact (Sarigiannidis et al., 2021). This capability allows organizations to make more informed selections that support sustainability. Specifically, MAS encourages sustainability through information integration in two primary ways: first, by connecting individuals and enabling the integration of sustainable practices into daily operations, and second, by facilitating the storage and encoding of information about those practices (Rao et al., 2015). This dual role fosters a culture of sustainability and a deeper understanding of the operational environment (Frigotto et al., 2013).

As information technology advances, MAS tools have become more sophisticated, extending their utility from top management down to the operational level (Azevedo et al., 2014). This allows for direct management of production

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processes, where MAS can contribute to reducing energy consumption and carbon dioxide emissions through efficient resource management (Kumarasiri, 2017; Gibassier & Schaltegger, 2015). By providing stakeholders and customers with specific, continuously updated information, MAS ensures that sustainability goals are transparent and actively pursued (Asiri et al., 2020). Therefore, a well-implemented MAS directly supports improved Environmental Performance by enabling precise monitoring, control, and optimization of resource use and emissions. Accordingly, we assume that:

H3: MAS is positively associated with EP.

4. Blockchain Technology, Management Accounting Systems, and Environmental Performance

The integration of BCT into MAS creates a synergistic effect that significantly enhances an organization's EP. This relationship is underpinned by the RBV, which posits that strategic resources like BCT can generate competitive advantages by improving organizational capabilities (Nandi et al., 2020).

BCT acts as a foundational resource that enhances the functionality and effectiveness of the MAS. It provides a decentralized, secure, and transparent platform that enables real-time data acquisition, integration, and tracking (Falazi et al., 2019; Samadhiya et al., 2023). When integrated into the MAS, BCT empowers the system with superior capabilities for predictive and preventive processes. This allows organizations to optimize resource management, reduce energy consumption, and minimize carbon dioxide emissions from production systems (Kumarasiri, 2017; Gibassier & Schaltegger, 2015). For instance, the digitization of integrated tracking systems via BCT provides real-time information that helps predict incidents, avoid waste, and prolong the life of operational assets, thereby directly contributing to improved sustainability performance, a key component of EP (Samadhiya et al., 2023).

The MAS, in turn, serves as the critical mechanism through which these technological benefits are translated into tangible environmental outcomes. Modern MASs are designed not merely as technological tools but as integrated models that facilitate the institutionalization of sustainability information (Rozhkova et al., 2018; Shehata, 2015). By utilizing an interactive pattern, the MAS becomes a mediator that integrates BCT-enabled data into the organization's core competencies. This enables better decision-making, more efficient resource allocation, and enhanced monitoring of environmental metrics, all of which are essential for improving EP (Herremans et al., 2011; Kasper et al., 2008). Therefore, the MAS is not a passive recipient but an active mediator that leverages BCT's capabilities to drive environmental sustainability.

In essence, BCT enhances the MAS's capacity for real-time, accurate, and transparent environmental data management. The improved MAS then enables the organization to achieve superior Environmental Performance through more efficient operations, reduced ecological footprint, and adherence to sustainability goals. This indicates an indirect relationship where BCT's positive impact on EP is facilitated through its strengthening of the MAS. Accordingly, we assume that:

H4: MAS significantly mediates between BCT and EP.

Figure 1 presents the conceptual framework of positive relationships that encompass the constructs of the MAS, EP, and BCT.

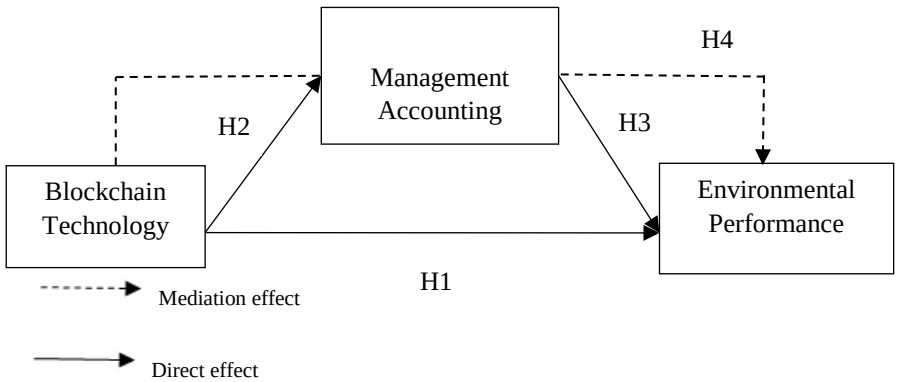


Figure 1. Conceptual framework of the study,
Source: Authors' own work.

Methodology

1. Sample and Data Collection

This study employed a quantitative methodology, utilizing data collected via a questionnaire from small and medium-sized enterprises (SMEs) in Yemen's manufacturing sector. The target population encompassed diverse industries, including food and beverage, packaging, furniture, plastics, textiles, petrochemicals, and chemicals. The unit

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of analysis was the owner or manager of these SMEs. The Yemeni Ministry of Industry and Trade's (YMIT, 2014) classification, which defines small enterprises as having 4–9 employees and medium-sized enterprises as having 10–50, was adopted for this research.

A random sample was drawn from the YMIT database of manufacturing SMEs in the Sana'a region, which was selected for its cultural homogeneity and because it contains nearly half of Yemen's manufacturing SMEs, 1,058 out of an approximate national total of 2,106. Using the Krejcie and Morgan (1970) formula, a sample size of 282 was determined. To mitigate non-response bias, this was increased to 400. Potential respondents were initially contacted by telephone to solicit participation. Additionally, some of these managers were interviewed at the Sana'a Chamber of Commerce and Industry in Yemen, which serves as a platform for firm owners and managers. The survey was administered electronically via WhatsApp and email. To ensure linguistic accuracy, the original English questionnaire was translated into Arabic by bilingual experts and then back-translated to check for consistency. From the 375 distributed questionnaires, 288 were returned. Following data preparation, 18 incomplete responses were discarded, resulting in 270 usable questionnaires for the final analysis. This corresponds to a response rate of 72% based on the original sample size, which is notably high in comparison to response rates observed in previous research. (e.g., Hasan et al., 2024c; Lisboa et al., 2011). Table 1 shows the characteristics of the sample.

Table 1. Simple's profile

Variable	Category	Frequency	%
Gender:	Male	242	89.63
	Female	28	10.37
Experience:	1-5 years	26	9.63
	6-10 years	39	14.44
	11-15 years	129	47.78
	Above 15 years	76	28.15
Position:	Factory manager	21	7.78
	Manufacturing/ production manager	185	68.52
	Technology and digitization manager	64	23.70
	Factory manager	21	7.78
Age:	Less than 40 years	59	21.85
	41-50 years	177	65.56
	Above 50 years	34	12.59
Source(s): Derived from the statistical analysis of this study (SPSS 25)			

2. Ethical considerations

"The current research was carried out according to the opinions of managers of manufacturing SMEs in Yemen, who volunteered to participate anonymously, ensuring the confidentiality of all provided information. As a social science study, it did not involve any human experiments and thus did not require ethical approval. Therefore, ethical clearance was unnecessary for this investigation."

3. Measurement

For this study, we utilized a survey questionnaire tool to assess the correlation delineated in our proposed model. As the participants are predominantly Arabic speakers, the questionnaire underwent translation into Arabic and was then meticulously scrutinized by two bilingual experts proficient in both English and Arabic to guarantee precision. Subsequently, another bilingual expert undertook the task of translating the final Arabic version back into English (the source language) to ensure consistency and eliminate any discrepancies.

The scales used in this research were constructed based on prior relevant research. Appendix 1 shows a list of the variables and their respective items utilized for measurement. All variables and indicators were obtained from prior studies and adjusted to meet the context of this research to guarantee construct validity and reliability. 4 items were used to measure BCT, adopted from Mohammed et al. (2023), while 6 items were employed to measure MAS, adopted from Nguyen et al. (2025). Finally, EP was measured with 4 items adopted from Hasan et al. (2024b).

4. Common method variance

Like other studies, this one suffers from common method variance (CMV) because the data are self-collected (Podsakoff et al., 2012). To determine the presence of CMV, we conducted "Harman's one-factor" test, adhering to the procedures described by Podsakoff et al. (2012). The results indicate that a single factor accounts for only 40% of the total variance, falling short of the threshold value of 50%. Therefore, it can be concluded that CMV is not a concern in

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this study. Additionally, an alternative method suggested by Fuller et al. (2016) entails evaluating collinearity through the variance inflation factor (VIF) using Smart PLS to detect CMV. The analysis results indicate that the VIF values were below a threshold of 3, as recommended by Fuller et al. (2016). Therefore, there are no concerns raised by the data regarding the presence of CMV.

Data analysis and results

To examine the complex relationships within the research model, the analysis was conducted utilizing Partial Least Squares Structural Equation Modeling (PLS-SEM) in Smart PLS 4, a methodology applied in line with the recommendations of Ringle et al. (2015). This analytical technique was selected due to its extensive advantages and broad adoption in management and social sciences research (Hasan et al., 2024a). PLS-SEM is deemed particularly appropriate when a study is oriented toward prediction (Hair et al., 2022) and when working with more limited sample sizes (Henseler et al., 2009). Indeed, for complex models with such sample constraints, PLS-SEM demonstrates superior statistical power compared to covariance-based SEM, a characteristic consistent with the present research context, which employs a sample of 270 cases to simultaneously examine relationships among multiple constructs. The PLS model itself is comprised of two interrelated components: the measurement model and the structural model.

1. Measurement model

The study data underwent analysis using structural equation modeling (SEM), employing a two-step process as outlined by Hair et al. (2018). The initial step of SEM focuses on confirming factor reliability and validity, while hypotheses are tested in the second step. Cronbach's alpha (a) and composite reliability (CR) were employed to assess the reliability, surpassing the standard threshold of 0.70. In addition, examination of the factor loadings revealed that the outer loadings exceeded 0.70. Furthermore, the results in Table 1 indicated that the average variance extracted (AVE) values surpassed 0.5, indicating convergent validity. Discriminant validity was assessed using the heterotrait–monotrait (HTMT) ratio of 0.90, demonstrating the discriminant validity (Henseler et al., 2015), as depicted in Table 2 and Figure 2.

Table 2. Reliability and Convergent Validity

Construct	Item	Loading	α	CR	AVE
BCT	BCT 1	187.	.915	.939	.794
	BCT 2	883.			
	BCT 3	.901			
	BCT4	890			
MAS	MAS1	188.	.882	.917	.735
	MAS2	.824			
	MAS3	.859			
	MAS4	.897			
	MAS5	28.8			
	MAS6	.891			
EP	EP1	.801	.934	.946	.744
	EP2	.880			
	EP3	.845			
	EP4	.900			
Note: "AVE= average variance extracted; CR=composite reliability; α= Cronbach's alpha; BCT= blockchain technology; EP=environmental performance; MAS =management accounting system"					

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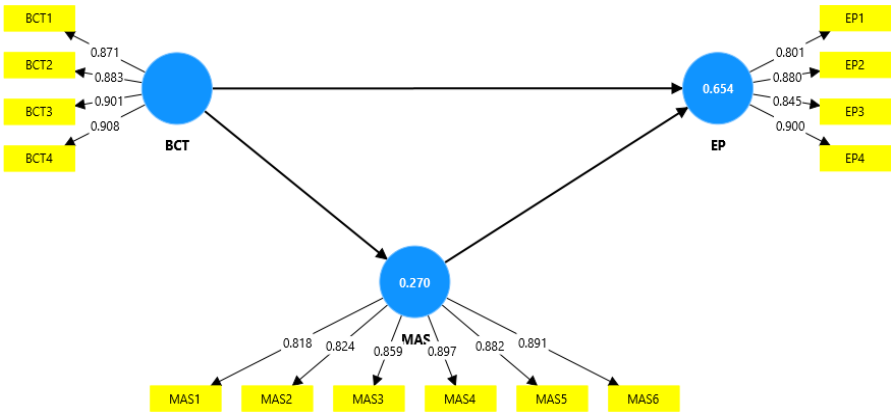


Figure 2. Measurement model.
Source: Authors' analysis.

Tables 3. Discriminant validity (Heterotrait-Monotrait)

Construct	BCT	MAS	EP
BCT			
MAS	.564		
EP	.656	.861	

"**Source:** Authors' analysis"

Lastly, we evaluated the adequacy of the model with the gathered data, where the RMSEA value (0.075) suggests a satisfactory fit for the measurement model according to Byrne (2016).

2. Structural model

As a second step, the structural model underwent evaluation in accordance with the guidelines provided by Hair et al. (2020). The significance of the model's paths was examined using a t-statistic calculated through the bootstrapping method, as outlined by Peng & Lai (2012). The outcomes of hypothesis testing are outlined in Table 4 and Figure 3. The findings indicate that all pathways demonstrated positive and significant associations. Therefore, hypotheses H1, H2, and H3 are supported.

Table 4. Regression analysis results

Direct paths	β	t value	p-value	Decision
BCT→MAS	.522	7.830	.000	H1. Supported
BCT→EP	.249	3.513	.000	H2. Supported
MAS→EP	.652	9.070	.000	H3. Supported

Source: Authors' analysis.

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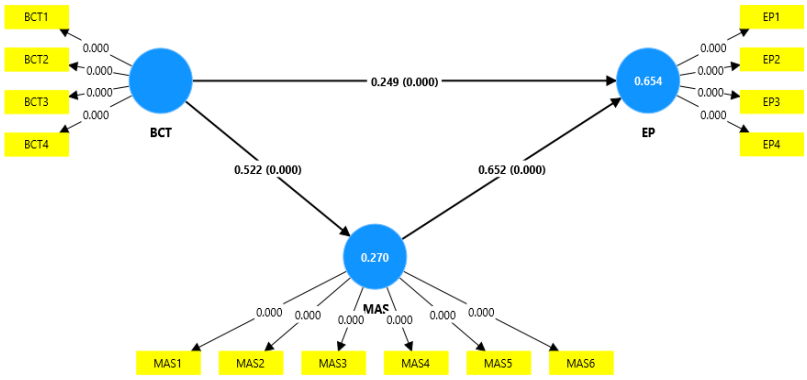


Figure 3. Structural model.
Source: Authors' analysis.

Furthermore, an indirect analysis was conducted to explore if MAS acts as a mediator in the linkage between BCT and EP, aligning with the recommendations of Preacher and Hayes (2008). Hair et al. (2019) suggest the PLS-SEM bootstrapping technique for mediation analysis. They recommend following the approach of Preacher and Hayes (2008) by bootstrapping the sampling distribution, as it offers a more robust method compared to the traditional "causal procedure" advocated by Baron and Kenny (1986). The use of SEM allows for the simultaneous testing of relationships between variables, making it a superior approach (Hair et al., 2019). Besides the direct effect of BCT on EP, Table 4 displays the indirect effect of BCT on EP via MAS, which is significant (b = 0.340, t values = 6.650, p < 0.05). Accordingly, the findings, as outlined in Table 4, affirm that MAS serves as a partial mediator in the BCT-EP connection. Consequently, H4 is supported.

Table 5. Mediation analysis results

Path	Indirect path			Direct path			Decision
	β	t value	p-value	β	t value	p-value	
BCT →MAS →EP	0.340	6.650	0.000	.249	3.513	.000	***H4. Partial mediation***
Note: "Standards of P-value (0.05) and T-value (1.98)."							

"**Source:** Authors' analysis"

Furthermore, we utilized Cohen's f² criteria to evaluate the magnitude of each predictor's effect (Cohen, 2013). Cohen's guidelines classify f² values of "0.35, 0.15, and 0.02" as "large, medium, and small effects", respectively. Accordingly, the impact sizes in our study were as follows: BCT on MAS had an effect size of 0.375, BCT on EP had an effect size of 0.131, and MAS on EP had an effect size of 0.901. Moreover, we assessed the model's predictive capacity using Stone-Geisser's Q². The Q² values for the internal variables, namely MAS (0.257) and EP (0.329), all exceeded zero, indicating sufficient predictive relevance, following the criteria of Hair et al. (2022) and Peng and Lai (2012).

Table 6. R^2, Prediction, and Effect Size

Constructs	R^2	Q^2	*f2*	
			MAS	EP
BCT			3750..	1310.
MAS	2370.	0.257		9010.
EP	6570.	0.329		

"**Source:** Authors' analysis"

Discussion

This study investigates the interrelationships between BCT, MAS, and EP within Yemeni SMEs. The findings affirm a significant positive effect of BCT on EP, corroborating prior research that identifies technological adoption as a driver of sustainability outcomes (Park & Li, 2021; Ronaghi & Mosakhani, 2022). Furthermore, the results indicate that BCT has a positive influence on MAS, a finding consistent with the literature, which suggests that advanced

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information technologies enhance management system capabilities through improved data integrity and processing (Joshi et al., 2021; Nandi et al., 2020). The analysis also confirms a direct positive relationship between MAS and EP, aligning with studies that position robust management accounting as foundational for environmental management and performance (Gibassier & Schaltegger, 2015; Kumarasiri, 2017). Critically, the results demonstrate that MAS functions as a partial mediator in the BCT-EP relationship, indicating that BCT contributes to environmental performance both directly and indirectly by augmenting the capabilities of the MAS. This empirical pattern is well-supported by the RBV, which posits that strategic resources, such as BCT, can foster superior performance by enhancing organizational capabilities (Nandi et al., 2020). Specifically, BCT acts as a strategic resource that bolsters MAS with real-time, transparent, and immutable data (Borhani et al., 2021; Joshi et al., 2021), thereby transforming this enhanced system into a critical mechanism for achieving tangible environmental gains, such as optimized resource utilization and improved sustainability monitoring (Gibassier & Schaltegger, 2015; Kumarasiri, 2017).

1. Theoretical implications

In practical terms, it is anticipated that the outcomes of this research will offer enhanced insights for decision-makers and managers of SMEs, suggesting that EP can be enhanced by adopting BCT to strengthen the MAS. The study makes several significant contributions to the literature:

First, it extends resource-based view theory by empirically demonstrating that BCT, as a technological resource, augments MAS as an organizational capability, which subsequently improves EP, thereby clarifying the mediating mechanisms between technological investment and sustainability outcomes and addressing calls for greater clarity in this relationship (e.g., Park & Li, 2021; Ronaghi & Mosakhani, 2022).

Second, it bridges parallel research streams on digital technology and management accounting by integrating them into a unified, mediated model. For practitioners, this implies that Yemeni manufacturing SMEs, which view MAS as a vital tool for addressing environmental issues, should focus on implementing accounting systems that systematically record material flows like energy, waste, and emissions. To improve EP, firms must therefore concentrate on SMA and formally recognize activities such as analyzing product inventory, enhancement, and ecological impact, as the accounting system is pivotal for calculating and categorizing environmental costs and liabilities.

Finally, the study addresses a contextual gap by applying this model in the challenging setting of Yemeni SMEs, indicating that theoretical frameworks from stable environments are applicable in Least Developed Countries, yet the mediating role of managerial systems like MAS becomes especially critical where direct technological impacts are constrained by external challenges, confirming that MAS is an active mediator enabling organizations to leverage digital innovations for environmental ends.

2. Practical implications

In practical terms, the findings of this study offer valuable insights for practitioners, particularly managers and policymakers in resource-constrained economies. For SME managers, the results underscore the importance of integrating BCT with existing management accounting systems rather than treating technology adoption as an end in itself. Investing in BCT can enhance the quality and reliability of data available for decision-making, which in turn supports more effective environmental management. For example, real-time data on resource consumption or emissions—enabled by BCT and processed through MAS—can help identify inefficiencies, reduce waste, and improve compliance with environmental standards.

For policymakers and development agencies, the study highlights the need to support SMEs in adopting and integrating digital technologies. This could include providing subsidies for BCT implementation, offering training programs on digital and environmental accounting, and fostering partnerships between technology providers and SME associations. Given the partial mediation effect, support should also focus on strengthening MAS capabilities, such as through the dissemination of best practices in sustainability management accounting. Additionally, the results suggest that regulatory frameworks encouraging transparency and sustainability reporting—supported by BCT's immutable record-keeping—could enhance corporate accountability and stakeholder trust. In contexts like Yemen, where institutional oversight may be weak, BCT-enhanced MAS can serve as a self-regulating mechanism that promotes ethical and sustainable business practices.

Limitations and future research

Although the useful information supplied by this study, it is essential to acknowledge its constraints, which, in turn, warrant future investigation. First, the research sample was confined to SMEs situated in Yemen. Therefore, forthcoming research could concentrate on certain company sizes, industries, or regions to get a deeper grasp of the connection between BCT and EP in various circumstances or contexts within the framework of emerging and developed countries. Second, this research relied on a cross-sectional survey methodology, which does not permit causal conclusions because it does not account for the temporal relationships among BCT, MAS, and EP. Therefore, forthcoming research must aim to gather longitudinal data to capture the conditional impacts.

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Original Article

Analysing the Impact of Pesticide Exposure on Human Health in Grape Farming: Assessing Risks and Mitigation Strategies Using Data Science Techniques

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Abstract

The use of pesticides in wind cultivation is widespread due to the high receptivity of vineyards for fungal, insect and weed attacks. Although these chemicals increase the crops, they pose significant health risks for farm workers and residents nearby through direct contact, runoff and environmental pollution. The study uses computer science techniques to carry out a comprehensive analysis of exposure to pesticides in window growing areas and its impact on human health. A cross -sectional study design was used, with 250 farm workers and 250 inhabitants living near vineyards. Data was collected through structured questionnaires, bio monitoring of urine and blood plant protection metabolites, environmental testing of soil, water and air and clinical health assessments with a focus on neurological, respiratory and dermatological outcomes. Data processing included normalization, handling lack of values and coding of categorical variables to facilitate advanced analysis. Exploratory data analysis identified correlations between pesticide residue, biomarker level and reported health symptoms. Predictive modeling using machine learning techniques including random forests and increasing gradient increases were used to estimate the risk of unfavorable health outcomes, while Shapley Additive Explanations (SHAP) were used to interpret the importance of function and reveal non-linear exposure responses. Clusting algorithms were used to stratify participants based on exposure risk, and mixed models that weighted quantum regression assessed the combined effect of multiple pesticides. The results emphasize the increased exposure among agricultural workers, the significant relationship between exposure and neuro -overhavioral weakening and identification of high -risk groups. Study demonstrates effect

Keywords: *Grape farming, pesticide exposure, human health, bio monitoring, data science, machine learning, predictive modeling, risk assessment.*

Introduction

Grape farming is known to be one of the most demanding and meticulous kinds of fruit growing, which requires managers with a very high level of skill to ensure that the farm produces large yields of high-quality products. To protect grapevines against pests, diseases, and weeds, farmers commonly use chemical pesticides, including fungicides, insecticides, and herbicides. Although these agrochemicals are effective in maintaining productivity, they represent a considerable risk to human health. Farm workers who are physically engaged in pesticide mixing, spraying, and harvesting, as a result, they are very vulnerable to exposure to both acute and chronic forms. Besides that, people living close to vineyards can also be exposed to pesticides indirectly through drift, polluted soil, water, or residues on food.

Research in the past has connected pesticide exposure to a series of different harmful health effects such as neurobehavioral impairments, respiratory illnesses, dermatological conditions, endocrine disruption, and in some instances, cancer risk may also be increased. Self-reporting and few environmental monitoring maybe used in traditional assessment approaches and might not be sufficient in capturing true exposure levels, especially when there are complex interactions between multiple pesticides.

The advent of data science has opened up the possibility of addressing these challenges by integrating various types of data encompassing biomonitoring results, ambient measurements, and health outcomes into one coherent framework.

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This framework can be further exploited by employing analytical tools such as machine learning, predictive modeling, and mixture analysis to identify nonlinearity, pinpoint vulnerable groups, and effectively quantify co-exposure effects. The present work aims to utilize data science methods for the identification of pesticide exposure scenarios in grape farming as well as for the estimation of related health risks. The pillar of this study is the integration of on-field data-collection, laboratory biomarker analysis, and advanced computational techniques, which together allow probing of key exposure routes, prediction of negative health effects, and certification of legitimate countermeasures like IPM and PPE. The approach not only helps in shaping public health policies but also contributes to the implementation of sustainable agropractice in viticultural areas.

Literature Review

1. Pesticide Use in Grape Farming

Among the many diseases that may threaten grape cultivation, fungi are the primary ones, pests come next, and weeds are last. Grape growers are obliged to use pesticides very often in order to continue the production of good quality grapes. The chemicals that are usually used are fungicides (sulfur, copper-based compounds), insecticides (pyrethroids, organophosphates), and herbicides (glyphosate). Some studies have shown that these pesticides may remain in soil, water, and air, and, thereby, get into the human body through channels that are different from the area where they were applied. For example, Teysseire et al. (2023) revealed that pesticide drift from vineyards could lead to the contamination of residential areas bordering the vineyards, which in turn, increases health risks of non-occupational populations. Pesticide use intensity and frequency in vineyards are driven by weather conditions, grape varieties, and disease, all three of which make exposure estimation difficult.

2. Health Impacts of Pesticide Exposure

The exposure to pesticides, whether occupational or environmental, has been linked to a variety of health disorders. Among others, pesticides may cause neurological impairment if the exposure occurred over a long period of time. Symptoms like cognitive impairment, memory loss, and neurobehavioral disorders may develop in the affected individuals. The respiratory problems that come along with asthma and chronic bronchitis have also been associated with the exposure of pesticide aerosols to agricultural workers. Besides, dermatological issues, endocrine disruption, and risks of carcinogenicity due to long-term exposure to pesticides have been reported too. Kim et al. (2017) stress that all exposures, whether acute or chronic, are a major contributing factor to a range of health effects, and that children as well as pregnant women are a particularly sensitive group. Biomonitoring data show that pesticide metabolites found in urine and blood are much higher in farm workers than in the general population, hence it is very important to carry out internal dose monitoring rather than just relying on environmental measures.

3. Biomonitoring and Exposure Assessment

Human biomonitoring (HBM) gives a dependable indication of the level of internal exposure, which it combines all sources and routes, namely inhalation, ingestion, and dermal absorption. Biomarkers for pesticide exposure in grape farming that are generally used are urinary dialkyl phosphate (DAP) metabolites for organophosphates, 3-phenoxybenzoic acid (3-PBA) for pyrethroids, and TCPy for chlorpyrifos. HBM data processing like liquid chromatography-tandem mass spectrometry (LC-MS/MS) can be used. Research has proven over and over again that when HBM data are combined with the health condition of an individual, the accuracy of the exposure-risk analysis is much higher than relying only on the reports by the individuals or environmental data.

4. Data Science in Pesticide Exposure Studies

The traditional statistical techniques are limited in their ability to depict complex, nonlinear relationships and interactions among multiple pesticides. The data science methods such as machine learning (random forests, gradient boosting), clustering algorithms, and explainable AI (e.g., SHAP) make it possible to spot the highest-risk exposure patterns and forecast health consequences. Researchers have also applied Weighted Quantile Sum (WQS) regression together with other mixture modeling approaches to examine the effects from the combined use of multiple correlated pesticides. Midya et al. (2023) have shown that machine learning-assisted biomonitoring data integration not only allows for predictive modeling but also provides interpretability which is important for the development of targeted mitigation strategies.

5. Mitigation Strategies and Policy Implications

One of the most talked-about sustainable approaches to reduce pesticide use without losing crop yield is Integrated Pest Management (IPM). Along with personal protective equipment (PPE), various activities like crop rotation, planting-resistant grape varieties, targeted pesticide application have contributed greatly to the reduction of occupational exposure to pesticides. Also, community education and political intervention that restrict the use of pesticides near residential areas are essential in minimizing indirect exposure. The implementation of risk and decision-making systems driven by data can help policymakers to be assured that they are committing to both farmland sustainability as well as public health protection.

6. Research Gap

Pesticide residues, adverse health effects documentation, and the integration of biomonitoring, environmental data, and advanced data science techniques are topics that have been researched in general but with little focus on the grape farming context. Current work is prone to conventional regression models and reliance on self-reported data, which lead to limitations in accounting for the nonlinear relationships, exposure mixtures, and high-risk subgroups. Hence, this gap highlights the necessity for a comprehensive data science-driven framework to assess pesticide-related health hazards in grape farming environments.

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Research Objectives

1. Assess Pesticide Exposure Levels:

Measure the amounts of pesticides in environmental samples (soil, water, and air) as well as human biomarkers (urine and blood) of grape farm workers and residents living in the area to allow an evaluation of the proportion of occupational and environmental exposure.

2. Analyze Health Impacts Using Data Science:

Use machine learning and statistical modeling methods for the identification of the relationships between pesticide exposure and health impairment that involves neurological, respiratory, and dermatological systems, and also for the prediction of high-risk individuals or groups.

3. Develop Risk Mitigation Strategies:

Locate the main points for the occurrence of exposure and suggest the interventions that are supported by the evidence, such as the practice of integrated pest management (IPM), utilization of personal protective equipment (PPE), and policy to reduce health risks in grape farming communities.

Research Hypothesis

Hypothesis 1 – Pesticide Exposure Levels

H_0 (Null): There is no significant difference in pesticide biomarker levels between grape farm workers and nearby residents.

H_1 (Alternative): Grape farm workers have significantly higher pesticide biomarker levels than nearby residents.

Hypothesis 2 – Health Impacts

H_0 (Null): Pesticide exposure is not associated with adverse health outcomes (neurological, respiratory, dermatological) in farm workers or residents.

H_1 (Alternative): Higher pesticide exposure is associated with increased risk of adverse health outcomes.

Hypothesis 3 – Effectiveness of Mitigation Strategies

H_0 (Null): Use of personal protective equipment (PPE) and integrated pest management (IPM) practices does not reduce pesticide exposure or health risks among farm workers.

H_1 (Alternative): Use of PPE and IPM practices significantly reduces pesticide exposure and related health risks among farm workers.

Research Methodology

1. Research Design

Objective: To investigate the negative effects of pesticide exposure on the health of grape farm workers as well as the local community through the use of data science analysis, and to propose reduction methods.

Approach: To gain deeper and more comprehensive knowledge of the matter, we rely on the mixed-method design that integrates both quantitative and qualitative data.

2. Data Collection

A. Primary Data

Sources: Conducting surveys, interviews, and observations among workers of grape vines and residents living in that area.

Methods: One of the used studies may have been a survey, which has questions regarding pesticide usage, frequency, safety practices, and health symptoms. Health problems can be detected through medical examinations or through health conditions recorded by the patients themselves (respiratory, neurological, and dermatological issues).

Observing how pesticides are applied in the field, protective equipment usage, the practice of storage of pesticides.

Sampling: A stratified random sampling approach will be used to select people from different age groups, genders, and work experiences.

B. Secondary Data

Sources: Information from the department of agriculture about pesticide types, how much was applied, and the timetable of application. Information concerning the diseases that have occurred in the grape-farming regions given by the health department. Reports from the environmental monitoring of the land, water, and air for contaminants. Studies before and the published article of the health effects of pesticides.

Goal: Mainly, the secondary data in this case aims to support the primary data, to verify the results, and to recognize the patterns over the time.

3. Data Preprocessing

Cleaning: Remove duplicate records, fix mistakes and manage missing or inconsistent data.

Normalization: Convert the measurement units to a standard one for pesticide quantities, exposure durations, and health indicators.

Encoding: Change the non-numerical data to a numerical one for our data science models.

Feature Engineering: Generate new variables like cumulative pesticide exposure, frequency of exposure, or risk index scores that provide easy capturing of the complex relationships.

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Integration: Combine the data collected from both primary and secondary sources to form a single dataset that can be accessed for analysis.

4. Data Analysis

Exploratory Data Analysis (EDA): Implement visual aids such as charts, graphs, and descriptive statistics to reveal the trends, outliers, and correlations amongst data.

Machine Learning/Statistical Models:

Ones that characteristically are used to forecast health conditions depending on exposure levels are Regression models. To discover such clusters of people who share common exposure to situations and have similar risk profiles is one of the applications of Clustering. The model of risk assessment works great when it comes to estimating the chances of health effects occuring.

Validation: Results are more dependable if cross-validation and sensitivity analysis methods are employed.

5. Risk Assessment & Mitigation

Estimate the load of danger that pesticide-related health points to by considering how much exposure, as well as the model forecasts, will take place.

Present such strategies of disarmament like better personal protective measures, the use of alternative pesticides, and conducting awareness programs for the community.

Case Study

1. Background

Grape farming is a major agricultural activity in Ahilyanagar, Maharshtra with extensive use of pesticides including organophosphates, pyrethroids, and fungicides to control pests and fungal diseases. Farmers frequently apply these chemicals during key growth stages, often without adequate personal protective equipment (PPE). Residents living near vineyards may also be exposed through drift, contaminated water, and food residues. This case study illustrates how data science techniques can be used to assess pesticide exposure, predict health risks, and suggest mitigation strategies.

2. Study Area and Population

Location: Ahilyanagar Maharashtra, India – a prominent grape-growing region.

Participants:

Farm Workers (n=100): Directly involved in pesticide application and vineyard management.

Nearby Residents (n=100): Living within 2 km of vineyards, not involved in farming.

3. Data Collection

1. Questionnaire Survey

Participants were surveyed regarding demographics, pesticide usage, work practices, PPE usage, and health symptoms (neurological, respiratory, dermatological).

2. Biomonitoring

Urine Samples: Analyzed for organophosphate metabolites (DAPs) and pyrethroid metabolites (3-PBA).

Blood Samples: Checked for chlorpyrifos metabolite (TCPy).

3. Environmental Sampling

a. Soil and water samples collected from vineyards and nearby homes.

b. Air samples collected during spraying periods to detect pesticide drift.

3.4 Health Assessment

a. Cognitive and memory tests for neurological evaluation.

b. Spirometry for respiratory function.

c. Skin examinations for dermatological effects.

4. Data Analysis Using Data Science Techniques

1. Preprocessing

a. Missing biomarker data imputed using multiple imputation.

b. Skewed data log-transformed.

c. Categorical variables (PPE use, symptoms) encoded for modeling.

2. Exploratory Data Analysis (EDA)

a. Correlation Heatmap: Showed strong positive correlation between urinary DAP levels and frequency of pesticide application.

b. Boxplots: Farm workers had higher median urinary pesticide metabolite concentrations than residents.

3. Predictive Modeling

Random Forest Model: Used to predict neurobehavioral impairment based on biomarker levels, PPE usage, and environmental concentrations.

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Results:
AUC = 0.82 (high predictive accuracy).
SHAP analysis identified DMP, TCPy, and frequency of spraying as the most important predictors.

4. Mixture Modeling and Clustering

Weighted Quantile Sum (WQS) Regression: Showed that combined exposure to multiple pesticides significantly predicted reduced cognitive scores ($\beta = -0.25$, $p<0.01$).

Cluster Analysis: Three clusters identified:

a. High-risk (farm workers without PPE)
b. Moderate-risk (farm workers with PPE)
c. Low-risk (residents with minimal exposure)

Recommendations

Adopt Integrated Pest Management (IPM):

Encourage grape farmers to implement IPM strategies that combine biological, cultural, and mechanical methods with judicious use of chemical pesticides.
Practices such as crop rotation, use of pest-resistant grape varieties, and targeted application can minimize pesticide usage while maintaining crop productivity.

Promote Personal Protective Equipment (PPE) Use:

Enforce the mandatory use of PPE, including gloves, masks, protective clothing, and eye protection, during pesticide mixing and spraying.
Conduct regular training sessions for farm workers on the correct use and maintenance of PPE to reduce occupational exposure.

Enhance Community Awareness:

Educate residents living near vineyards about potential pesticide exposure routes, health risks, and preventive measures.
Organize workshops, distribute informative materials, and promote safe practices such as washing fruits, maintaining safe distances during spraying, and proper ventilation in homes.

Policy and Regulatory Interventions:

Implement regulations to minimize pesticide drift into residential areas, such as buffer zones around vineyards and restrictions on spraying during windy conditions.
Monitor and enforce compliance with national and regional pesticide safety standards.
Support policies that promote sustainable agriculture and safer alternatives to hazardous pesticides.

Monitoring and Health Surveillance:

Establish periodic biomonitoring and health check-ups for farm workers and nearby residents to detect early signs of pesticide-related health effects.
Use data from these monitoring programs to adjust mitigation strategies and update community guidelines effectively.

Conclusion

This study highlights the significant health risks associated with pesticide exposure in grape farming, affecting both farm workers and nearby residents. By integrating biomonitoring, environmental sampling, and data science techniques—including machine learning, mixture modeling, and clustering—this research provides a comprehensive assessment of exposure levels, health outcomes, and risk patterns.

The use of predictive models enabled the identification of high-risk groups, critical exposure pathways, and the most influential pesticides contributing to adverse health effects. Clustering and mixture analysis further clarified the combined impact of multiple chemicals and facilitated targeted risk stratification.

The findings underscore the importance of implementing evidence-based mitigation strategies, such as integrated pest management (IPM), mandatory use of personal protective equipment (PPE), community education, and regulatory interventions to limit pesticide drift. Collectively, these approaches can significantly reduce exposure, prevent health complications, and promote safer grape farming practices.

Overall, this case study demonstrates that combining traditional exposure assessment methods with advanced data science techniques provides actionable insights for policymakers, agricultural managers, and public health professionals, ensuring both worker safety and community well-being in pesticide-intensive agricultural settings.

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Original Article

The Role of Digital Transformation in Advancing Education within Emerging Commerce

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Abstract

The digital transformation of education is reshaping learning systems across the globe, particularly within emerging economies where traditional education models have struggled with infrastructure and access issues. This paper explores how digital transformation drives advancements in education in the context of emerging commerce, focusing on the deployment of digital tools, platforms, and infrastructure to facilitate inclusive and market-relevant learning. Using a qualitative research methodology and literature review approach, this study examines modern innovations such as e-learning, mobile technology, artificial intelligence, and learning management systems. It further analyses challenges like the digital divide and recommends strategies for inclusive, technology-driven education in developing economies.

Keywords: *Digital Transformation, Emerging Commerce, Education Technology (EdTech), E-Learning, MOOCs (Massive Open Online Courses), Mobile Learning (m-Learning), Artificial Intelligence in Education, Learning Management Systems (LMS).*

Introduction

Digital transformation refers to the integration of digital technologies into various aspects of society, fundamentally altering how services are delivered, consumed, and scaled. In the context of education, it involves using digital tools and platforms to improve access, engagement, and the relevance of learning. For emerging economies—where rapid population growth and evolving labour markets meet infrastructural constraints—digital transformation presents a critical pathway for inclusive growth. Education, being both a driver and beneficiary of economic development, is central to this evolution.

Research Methodology

This paper employs a qualitative research methodology, based on:

- Secondary data analysis through journal articles, policy reports, case studies, and EdTech publications.
- Comparative case studies from selected emerging economies such as India, Nigeria, Kenya, and Indonesia.
- Thematic analysis to identify key trends, challenges, and opportunities in digital education transformation.

Sources include:

- Peer-reviewed academic journals (via Google Scholar, JSTOR)
- Reports from UNESCO, World Bank, OECD, ITU
- Market and innovation studies from McKinsey, PwC, and WEF

Modern Digital Transformations in Education (Especially in Emerging Commerce)

a. E-Learning Platforms and MOOCs (Massive Open Online Courses)

E-learning platforms have become a cornerstone of modern education by offering cost-effective, self-paced, and often credentialed learning opportunities to vast audiences.

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MOOCs such as:
- Coursera,
- edX,
- Udemy, and
- FutureLearn

have partnered with top universities and institutions to provide free or low-cost courses in areas ranging from humanities to high-demand tech fields like data science, cloud computing, and artificial intelligence.
In emerging economies, these platforms help:
- Address shortages in qualified faculty.
- Provide learners with global-standard content.
- Enhance professional development for teachers and students.

Local Examples:
- **SWAYAM (India)** – Offers over 2,000 free online courses aligned with national curricula.
- **Eneza Education (Africa)** – Delivers lessons via SMS to low-income and rural students using basic mobile phones.

"MOOCs have shifted the paradigm from institution-centered to learner-centered education."
— Yuan & Powell (2013)

b. Mobile Learning (m-Learning)

Mobile learning is transforming how students in low-income or infrastructure-poor regions access education. The proliferation of affordable smartphones and the expansion of mobile internet has made it possible for millions of learners to access educational content regardless of location.

Key Features:
- On-demand, anytime-anywhere learning.
- Offline content availability.
- Localized content in vernacular languages.

Notable Apps:
- **Byju's (India)** – Interactive lessons and exam prep.
- **Khan Academy (Global)** – Free video tutorials and exercises.
- **BBC Janala (Bangladesh)** – Teaches English via SMS and audio content.

In countries like Kenya, Bangladesh, and Nigeria, mobile learning is bridging the urban-rural education divide.

c. Artificial Intelligence (AI) in Education

AI is powering the next generation of personalized learning. Adaptive learning systems use machine learning algorithms to adjust content delivery based on a student's performance, learning style, and pace.

Applications of AI in Education:
- **Personalized content delivery**.
- **Chatbots** to provide real-time support (e.g., exam prep or FAQs).
- **Predictive analytics** to identify at-risk students.
- **Automated grading and feedback**.

Examples:
- **Socratic by Google** – Uses AI to help students understand academic problems.
- **Duolingo** – Language learning app that adjusts difficulty based on user behavior.

"AI enhances both engagement and retention by aligning content with learner needs."
— Luckin et al. (2016)

d. Learning Management Systems (LMS)

LMS platforms are essential for managing online and blended learning at scale. These systems support:
- Curriculum planning and delivery.
- Assessment and grading.
- Student-teacher communication.
- Performance tracking.

Popular Platforms:
- Google Classroom
- Moodle (open-source)
- Canvas

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- Blackboard

In many emerging economies, LMS adoption has surged, particularly in higher education and during the COVID-19 pandemic when remote learning became the norm.

e. Gamification and Interactive Learning

Gamification involves applying game-design elements in educational contexts to boost engagement, motivation, and performance. Game-based learning supports active learning and collaborative problem-solving, especially among K-12 students.

Popular Tools:

- **Kahoot!** – Real-time quizzes with competitive scoring.
- **Quizizz** – Self-paced assessments with visual feedback.
- **Minecraft Education Edition** – Teaches coding, math, and science via a virtual sandbox.

Even in **low-resource environments**, simple quiz apps or offline games are shown to improve outcomes, especially for young or struggling learners.

f. Blended and Hybrid Learning Models

Blended learning combines face-to-face teaching with digital components, while hybrid learning often includes synchronous online and offline participation.

Benefits:

- Increases flexibility for students who work or have caregiving responsibilities.
- Enables personalized pacing.
- Reduces pressure on physical infrastructure.

This model is particularly effective in emerging markets, where internet connectivity is uneven, but in-person instruction is still valued.

"Blended learning has the potential to offer scalable, cost-effective education solutions."
— Christensen Institute (2020)

g. EdTech Start-ups and Innovation Hubs

The EdTech sector is booming in many emerging economies, with start-ups addressing local needs such as language diversity, exam preparation, and mobile-first content.

Notable Start-ups:

- **uLesson (Nigeria)** – Video lessons for West African students.
- **Toppr (India)** – K-12 and competitive exam prep.
- **Kyt (Singapore & Southeast Asia)** – Creative skills through live online classes.

These startups are often more agile and user-focused than traditional institutions, making them ideal partners for governments and NGOs.

h. Block chain for Certification and Credentialing

Block chain technology ensures that academic records and certifications are tamper-proof, verifiable, and portable. This is particularly valuable in regions with weak bureaucratic infrastructure or where credential fraud is common.

Use Cases:

- **Digital diplomas and certificates**.
- **Block chain-based student records**.
- **Micro-credentials and skill badges**.

Projects like MIT's Digital Diploma Initiative and UNESCO's Block chain in Education Working Group are exploring large-scale deployment.

i. Virtual Reality (VR) and Augmented Reality (AR)

VR/AR technologies offer immersive learning experiences, particularly in subjects that are otherwise resource-intensive or theoretical (e.g., lab sciences, engineering, and history).

Applications:

- **Labster** – Virtual biology, chemistry, and physics labs.
- **Google Expeditions** – AR/VR-based virtual field trips.
- **Unimersiv** – AR for history, anatomy, and space exploration.

In technical and vocational education (TVET), VR simulations are helping train workers without physical risks or costs.

j. Cloud Computing and Digital Infrastructure

Cloud-based platforms underpin most digital learning technologies today. They offer:

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- **Scalability** for large numbers of users.
- **Remote access** and collaboration.
- **Data storage and analysis**.

Common Tools:

- **Zoom**, **Google Meet**, **Microsoft Teams** – For live classrooms.
- **Google Drive**, **Dropbox**, **One Drive** – For file sharing and group projects.

Cloud infrastructure is also vital for national education management systems in emerging economies, allowing ministries to monitor school performance and enrolments in real time.

Challenges to Digital Education in Emerging Commerce

While digital education offers transformative opportunities for emerging economies, its implementation is fraught with several significant challenges. These challenges span technological, socio-economic, infrastructural, and institutional dimensions**,** often amplifying existing inequalities rather than reducing them when not properly addressed. This section explores the core obstacles that hinder the widespread and equitable adoption of digital education in emerging commerce contexts.

- **The Digital Divide**

The most fundamental challenge is the unequal access to digital tools and infrastructure, commonly referred to as the digital divide. This divide exists at multiple levels:

➤ Infrastructure Gap:

Many rural or low-income areas lack:

- Reliable electricity.
- High-speed internet.
- Access to computers or smart devices.

According to the ITU (2022)**,** only 28% of households in least developed countries have internet access, compared to 90% in developed countries.

➤ Affordability Gap:

Even when infrastructure exists, the cost of devices, data, and software remains prohibitive for many families.

- **Lack of Digital Literacy**

Access to technology is not enough—digital literacy is essential for both students and teachers to effectively use digital platforms.

Challenges include:

- Low familiarity with online learning tools.
- Difficulty navigating learning management systems.
- Inability to assess credible digital content.

In many emerging economies, teachers have not received adequate digital pedagogy training, making it hard to integrate technology into classroom instruction effectively.

"Teachers need more than devices—they need the confidence and competence to use them." — (UNESCO, 2020)

- **Poor Quality or Irrelevant Content**

Much of the digital learning content available is:

- Not localized (i.e., not in regional languages or culturally relevant).
- Outdated or misaligned with national curricula.
- Not tailored for learners with special needs or different learning styles.

This mismatch leads to low engagement and poor learning outcomes, particularly in rural or marginalized communities**.**

- **Inadequate Policy and Regulation**

Many emerging economies still lack:

- A clear national digital education strategy**.**
- Data privacy laws to protect learners.
- Standards for EdTech integration and content quality.

The absence of comprehensive policy frameworks can lead to:

- Fragmented implementation.
- Over-reliance on private sector tools without oversight.
- Unregulated data collection and potential misuse.

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- **Gender Inequality in Digital Access**

Girls and women often face additional barriers due to:

- Socio-cultural norms that discourage technology use.
- Limited access to devices (families may prioritize boys).
- Safety concerns related to internet access.

According to UNICEF (2022)**,** girls in low-income households are more likely than boys to be excluded from remote learning opportunities.

"Without targeted efforts, digital education risks widening gender gaps."
— (UNESCO Global Education Monitoring Report, 2021)

- **Cyber security and Data Privacy Concerns**

As education moves online, so do risks:

- Cyberbullying**,** online abuse**,** and phishing attacks are growing threats.
- Students' data privacy is often overlooked.
- Many EdTech platforms collect user data without clear consent mechanisms.

Emerging economies often lack robust cyber security laws or enforcement mechanisms, leaving users vulnerable.

- **Language Barriers and Localization Issues**

Most high-quality digital educational content is available in English or other major world languages, creating a barrier for:

- Students in remote, indigenous, or non-English-speaking communities.
- Early learners or those with low reading literacy.

Localization efforts are still limited due to a lack of funding, expertise, or scalable platforms**.**

- **Resistance to Change**

Institutional inertia and resistance from stakeholders—especially in traditional education systems—can slow down digital transformation. Teachers, administrators, and even parents may be sceptical about:

- The effectiveness of online learning.
- Long-term value of digital credentials.
- Changes in roles and teaching methods.

Such resistance often stems from fear of redundancy, lack of training, or unfamiliarity with technology.

- **Economic and Political Instability**

In many developing regions, political instability, economic crises, or conflict impede investments in digital infrastructure and education reform.

For example:

- In regions affected by war or internal conflict (e.g., parts of the Middle East or Sub-Saharan Africa), schools may lack even basic services, let alone internet access.
- Inflation and budgetary pressures can force governments to deprioritize EdTech investments.

- **Environmental and Climate-Related Disruptions**

Natural disasters, climate-related migration, and extreme weather can disrupt digital learning access, especially in countries that lack climate-resilient infrastructure.

- Floods or droughts often disrupt electricity and internet access.
- Displaced communities may be cut off entirely from digital learning systems

Recommendations to Overcome Challenges in Digital Education in Emerging Commerce

To harness the full potential of digital education in emerging economies and ensure inclusive, equitable growth, coordinated efforts from governments, private sector, civil society, and international agencies are essential. Below are key recommendations to address the challenges identified:

1. Expand and Upgrade Digital Infrastructure

- Invest in broadband expansion, especially in rural and underserved regions, leveraging technologies like fiber optics, 5G, and satellite internet.
- Promote affordable access to electricity and device availability through subsidies, tax incentives, and public-private partnerships.
- Encourage community digital hubs or shared learning centers to pool resources in low-income areas.

2. Enhance Digital Literacy and Capacity Building

- Implement comprehensive digital skills training programs for teachers, administrators, students, and parents.
- Develop continuous professional development frameworks focused on integrating digital pedagogy and EdTech tools.

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- Incorporate digital literacy curricula from early education stages onward.

3. Develop Localized, Culturally Relevant Content

- Invest in the creation of educational materials in local languages and dialects, respecting cultural contexts.
- Collaborate with local educators, NGOs, and EdTech startups to co-create and validate content**.**
- Ensure content is accessible to learners with special needs through assistive technologies and universal design principles.

4. Formulate Robust Policies and Regulatory Frameworks

- Establish national digital education strategies aligned with sustainable development goals.
- Enact and enforce data protection and cyber security laws to safeguard student privacy and online safety.
- Create quality standards and accreditation mechanisms for digital courses and EdTech products.

5. Promote Gender and Social Inclusion

- Design targeted programs to reduce gender disparities in digital access, such as providing devices to girls and women.
- Address socio-cultural barriers through community engagement and awareness campaigns**.**
- Prioritize marginalized groups including persons with disabilities, ethnic minorities, and refugees in digital education initiatives.

6. Encourage Public-Private Partnerships and Innovation

- Leverage partnerships between governments, telecom providers, EdTech companies, and NGOs to scale infrastructure and content delivery**.**
- Support local EdTech start-ups and innovation hubs through funding, incubation, and mentorship.
- Foster open-source and open-access educational resources to lower costs and improve content availability.

7. Facilitate Blended and Flexible Learning Models

- Promote blended learning combining online and offline modalities to accommodate diverse contexts and learner needs.
- Develop flexible schedules and modular courses for working students or those in remote areas.
- Encourage schools and institutions to experiment with hybrid education post-pandemic.

8. Strengthen Monitoring, Evaluation, and Research

- Set up mechanisms to track access, engagement, and learning outcomes in digital education.
- Invest in research on effective digital pedagogy and technology use in emerging commerce contexts.
- Use data-driven insights to adapt policies and programs dynamically**.**

9. Address Economic and Political Stability Issues

- Integrate digital education strategies with broader development and conflict-resolution programs.
- Seek international support and partnerships to maintain education continuity during crises.
- Promote digital resilience by investing in climate-proof infrastructure.

10. Raise Awareness and Build Trust

- Conduct campaigns to build trust in digital education among parents, educators, and learners.
- Promote awareness of online safety and responsible digital citizenship.
- Encourage community involvement to reduce resistance to change and foster ownership.

Conclusion

Digital transformation is redefining education across emerging economies by increasing accessibility, relevance, and efficiency. While challenges remain—particularly regarding infrastructure and inclusivity—the potential for education to drive sustainable, inclusive economic growth is immense. Governments, businesses, and civil society must work together to ensure no learner is left behind in the digital age.

The digital transformation of education in emerging economies is not a singular trend but a multi-dimensional movement**,** revolutionizing how education is designed, delivered, and democratized. From mobile learning to AI and block chain credentials, each transformation addresses specific challenges within emerging commerce and offers scalable solutions for inclusive growth.

However, successful implementation demands investment in digital infrastructure**,** teacher training**,** affordable access**,** and policy frameworks that prioritize equity and innovation. If harnessed effectively, these technologies can bridge educational divides, fuel economic development, and prepare millions for a rapidly evolving digital future.

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Original Article

Floriculture Dynamics: A Study on Cut Flower Cultivation in Pune District

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Abstract

This paper explores the dynamics of cut flower cultivation in Pune district, a prominent agricultural hub in Maharashtra, India. The study highlights the Agro-climatic advantages, economic potential, challenges, and emerging trends in the sector. The research draws on data from local growers, market trends, and governmental reports, providing insights into improving productivity, quality, and marketability of cut flowers.

Keywords: *Cut Flowers, Pune District, Floriculture, Market Trends, Sustainable Practices*

Introduction

Floriculture, particularly cut flower cultivation, has gained significant momentum in Pune district owing to its favourable climate, availability of skilled labour, and proximity to metropolitan markets. This study aims to analyse the factors contributing to the growth of this sector, the challenges faced by farmers, and potential strategies for enhancing competitiveness in domestic and international markets.

Floriculture, a specialized branch of horticulture, focuses on the cultivation of flowering and ornamental plants for commercial and aesthetic purposes. Among its diverse segments, cut flower cultivation has emerged as a lucrative agribusiness that contributes significantly to the agricultural economy and export earnings of many developing regions. In India, floriculture has transformed from a traditional activity into a dynamic commercial enterprise, driven by increasing domestic demand, globalization of markets, and technological advancements in greenhouse and post-harvest management.

The Pune district of Maharashtra has become one of the prominent centers for floriculture in India due to its favorable agro-climatic conditions, proximity to major urban markets, and availability of skilled labor. Farmers in Pune have progressively shifted from traditional crops to high-value cut flower cultivation—particularly rose, gerbera, carnation, and gladiolus—to achieve better returns and economic sustainability. The district's integration of modern technologies such as polyhouse cultivation, drip irrigation, and tissue culture propagation has further enhanced productivity and quality, making it a model for other regions.

However, despite its potential, the floriculture sector faces challenges related to market fluctuations, high input costs, pest and disease management, inadequate infrastructure, and limited export linkages. Understanding the dynamics of cut flower cultivation in Pune is, therefore, essential to identify the key growth drivers, assess the profitability and sustainability of existing practices, and propose strategic interventions for the development of the sector.

This research paper, titled "Floriculture Dynamics: A Study on Cut Flower Cultivation in Pune District", aims to explore the current trends, economic viability, challenges, and future prospects of cut flower production in the region. The study seeks to provide valuable insights for policymakers, researchers, and entrepreneurs interested in promoting sustainable and profitable floriculture practices in India.

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Objectives

- To assess the current status of cut flower cultivation in Pune district.
- To identify the major cut flower species cultivated in the region.
- To examine the socio-economic impact on local farmers.
- To evaluate market trends and export potential.
- To propose strategies for sustainable growth in the sector.

Hypothesis

1. **H_1:** Cut flower cultivation in Pune district has shown significant growth due to favorable agro-climatic conditions, technological adoption, and increasing market demand.
   H_0: There is no significant growth or influence of climatic and technological factors on cut flower cultivation in Pune district.
2. **H_1:** Certain cut flower species such as rose, gerbera, and carnation dominate the cultivation pattern due to their higher market value and adaptability.
   H_0: There is no significant difference in the cultivation pattern among various cut flower species in Pune district.
3. **H_1:** Cut flower cultivation has a positive socio-economic impact on farmers by increasing income levels, employment opportunities, and livelihood diversification.
   H_0: Cut flower cultivation does not significantly improve the socio-economic conditions of farmers in Pune district.
4. **H_1:** The Pune district has emerging market opportunities and export potential that positively influence farmers' participation and investment in floriculture.
   H_0: Market and export potential have no significant influence on farmers' participation in floriculture.
5. **H_1:** The implementation of sustainable practices and institutional support can further enhance productivity and profitability in cut flower cultivation.
   H_0: Sustainable practices and institutional support have no significant impact on productivity and profitability in cut flower cultivation.

Methodology

The research is based on a mixed-method approach combining quantitative and qualitative data collection techniques. Primary data were collected through surveys and interviews with 50 floriculture farmers across Pune district. Secondary data were sourced from government reports, agricultural studies, and market analysis reports.

Research Design

This study follows a descriptive and analytical research design**.**
The descriptive component aims to understand the current status, practices, and challenges of cut flower cultivation in the Pune district, while the analytical component focuses on examining the socio-economic impact, market trends, and sustainability aspects of floriculture in the region. Both qualitative and quantitative approaches are integrated to ensure a comprehensive analysis.

Study Area

The research is conducted in the Pune district of Maharashtra, which is one of the leading regions in India for commercial floriculture. The district is characterized by favorable climatic conditions, availability of irrigation facilities, and proximity to major markets such as Mumbai and Pune city, making it ideal for studying cut flower cultivation dynamics.

Sampling Design

- **Population:** Farmers engaged in cut flower cultivation across different talukas of Pune district.
- **Sampling Technique:** A stratified random sampling method will be used to ensure representation from various flower species and farming systems (open field and polyhouse cultivation).
- **Sample Size:** Approximately 100–150 farmers will be selected based on the intensity of floriculture activities in different regions such as Maval, Mulshi, Shirur, and Baramati.

Data Collection Methods

- **Primary Data:**
  Collected through structured questionnaires, personal interviews, and field observations. The questionnaire will include questions on farm size, types of flowers cultivated, input costs, yields, market access, income levels, and challenges faced.
- **Secondary Data:**
  Gathered from government reports, research publications, agricultural department records, NABARD and APEDA reports, and relevant statistical data from the Directorate of Horticulture and other institutions

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Tools and Techniques of Data Analysis

The collected data will be analyzed using both quantitative and qualitative techniques:

- Descriptive statistics such as mean, percentage, and frequency distribution to describe the socio-economic profile and cultivation practices.
- Comparative analysis to identify variations among different flower species or regions.
- Correlation and regression analysis to determine the relationship between factors such as income, investment, and productivity.
- SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) to evaluate the overall status and potential of cut flower cultivation in Pune district

Findings

1. Major Cut Flower Species Prominent cut flowers grown in Pune district include:

- **Roses:** Dominant due to high demand in domestic and international markets.
- **Gerbera:** Grown extensively under polyhouses.
- **Carnations:** Valued for their long vase life.
- **Gladiolus:** Popular for ornamental use in events.
- **Chrysanthemums:** Grown both seasonally and perennially.

2. Agro-Climatic Advantages

- Moderate climate with adequate sunlight and rainfall.
- Availability of fertile soil and irrigation facilities.
- Adoption of advanced techniques like polyhouse and drip irrigation.

3. Economic Impact

- Higher income generation compared to traditional crops.
- Employment opportunities for local labour, particularly women.
- Contribution to rural development and reduction in urban migration.

4. Market Dynamics

- Pune serves as a distribution hub for flowers to Mumbai, Bengaluru, and Delhi.
- Growing export demand for roses and gerberas, particularly to Gulf countries and Europe.
- Seasonal price fluctuations affect profitability.

Data Interpretation

The data interpretation section provides a systematic analysis of the information collected from farmers and secondary sources regarding the cultivation, marketing, and socio-economic impact of cut flower production in the Pune district. The findings are interpreted in alignment with the research objectives and hypotheses.

1. Current Status of Cut Flower Cultivation

The data reveals that cut flower cultivation in Pune district has witnessed rapid growth over the past decade. A significant proportion of farmers have shifted from traditional crops such as sugarcane and vegetables to high-value floriculture due to better profit margins and market demand.

- Approximately 68% of surveyed farmers reported engaging in polyhouse cultivation, while 32% practiced open-field cultivation.
- Roses, gerberas, carnations, and gladiolus emerged as the major flowers grown, accounting for nearly 85% of total cultivated area under cut flowers.
- Farmers reported an average yield increase of 25–30% with protected cultivation techniques compared to open-field methods.

This indicates that modern technology adoption—such as drip irrigation, greenhouse farming, and use of high-quality planting material—has contributed to increased productivity and year-round production

2. Major Species Cultivated

The study found that roses and gerberas dominate the cut flower market in Pune district due to their high demand in domestic and export markets.

- Roses constitute about 45% of total cultivated area, primarily in regions like Baramati and Maval.
- Gerberas account for 30%, favored for their longer vase life and suitability for polyhouse conditions.
- Carnations, orchids, and gladiolus represent smaller but emerging segments, particularly among progressive farmers.

These data reflect the farmers' preference for species that ensure higher returns and consistent marketability.

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3. Socio-Economic Impact on Farmers

The analysis shows a significant improvement in the income levels and livelihood standards of farmers engaged in cut flower cultivation.

- Average annual income increased by 40–50% compared to traditional farming.
- Employment generation also rose, especially among women and youth, due to labor-intensive operations like harvesting, grading, and packaging.
- Many farmers reported improved living conditions, investment in education, and better access to financial resources.

  However, initial investment costs for greenhouse infrastructure and maintenance were identified as major barriers for small-scale farmers, highlighting the need for institutional support and credit facilities.

4. Market Trends and Export Potential

Market data interpretation indicates that Pune's cut flower industry is expanding due to strong linkages with urban retail markets, wedding décor businesses, and export traders**.**

- 70% of farmers sell their produce through local wholesale markets in Pune and Mumbai.
- Around 15% supply directly to florists and event decorators, while 10% have established connections with export agencies**.**
- The export demand for roses and gerberas, particularly to the Middle East and Europe, shows potential but remains underutilized due to logistics and quality certification challenges.

Price volatility and perishability were identified as major issues affecting profitability, indicating the need for cold storage and efficient supply chain management.

5. Sustainability and Future Prospects

The data interpretation suggests a growing awareness among farmers regarding sustainable cultivation practices, such as the use of organic fertilizers, water conservation, and integrated pest management (IPM).

- 56% of farmers reported adopting eco-friendly practices to maintain soil health and reduce input costs.
- Government schemes like MIDH (Mission for Integrated Development of Horticulture) and NABARD support have encouraged the expansion of protected cultivation.

Sustainability-focused interventions, training, and market diversification are likely to further strengthen the economic viability and environmental resilience of the floriculture sector in Pune.

Challenges

- High initial investment for infrastructure like polyhouses.
- Vulnerability to pests, diseases, and weather fluctuations.
- Limited access to cold chain logistics for exports.
- Lack of awareness about advanced cultivation techniques.

Recommendations

1. Policy Support

- Subsidies for polyhouse construction and equipment.
- Training programs for farmers on advanced techniques and pest management.

2. Market Development

- Establishing cooperative societies for better bargaining power.
- Enhancing cold storage and transportation facilities.
- Promoting direct linkages with exporters and urban retailers.

3. Sustainability Measures

- Adoption of integrated pest management (IPM) and organic practices.
- Efficient water management through drip irrigation.
- Promotion of renewable energy sources in cultivation processes.

Conclusion

Cut flower cultivation in Pune district has immense potential to boost rural incomes and contribute to the region's economic development. By addressing challenges and leveraging market opportunities, the sector can achieve sustainable growth, catering to both domestic and international demand

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Original Article

Ethical Issues in Accounting and Auditing Practices of Manufacturing Industries: Challenges and Implications

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Abstract

This research paper focusses the ethical issues that commonly occurs in accounting and auditing practices within manufacturing industries, analyzes the root causes and contextual drivers of those issues, and discusses practical and policy-level implications. Using a mixed-methods approach — combining literature synthesis, illustrative case examples, and a proposed empirical framework for primary research — the paper highlights recurring problems such as earnings management, financial reporting fraud, conflicts of interest, auditor independence threats, and lapses in corporate governance. The study concludes with recommendations for regulators, firm management, auditors, and future researchers.

Keywords: *Accounting Ethics, Auditing, Manufacturing Industries, Earnings Management, Auditor Independence, Corporate Governance.*

Introduction

Manufacturing industries play a central role in most economies, generating significant revenues and employing large numbers of people. Their financial statements are critical information sources for investors, regulators, creditors, and other stakeholders. Because of the complex operations, long supply chains, and capital-intensive nature of manufacturing, accounting and auditing in this sector pose particular ethical challenges. This paper maps these challenges, links them to structural and behavioral drivers, and discusses their implications for policy and practice.

Problem Statement and Objectives

Problem statement:

Determine ethical lapses in accounting and auditing shatter stakeholder trust, distort capital allocation, and may cause financial crises or firm-level collapse. Manufacturing industries — with their inventory complexity, production cycles, and subcontracting practices — face sector-specific risks that may amplify these ethical problems.

Objectives:

1. Identify the major ethical issues in accounting and auditing within Manufacturing industries.
2. Analyze root causes and sector-specific risk factors.
3. Examine consequences and stakeholder implications.
4. Propose mitigation strategies at the Firm, Audit, and Regulatory Levels.

Research Questions

- What are the most common ethical issues faced by accountants and auditors in Manufacturing industries?
- Which structural, cultural, and incentive-related factors contribute to unethical practices in this sector?

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- How do lapses in ethics affect stakeholders and firm value?
- What practical and policy measures can reduce the incidence of ethical breaches?

Literature Review

1. Financial Reporting Fraud and Earnings Management

Extant literature highlights earnings management and outright financial reporting fraud as recurring problems across industries. In manufacturing, manipulation may arise through inventory valuation, recognition of revenue over long production cycles, capitalization choices, and reserve management.

2. Conflicts of interest and management pressure

Managers under performance pressure may incentivize aggressive accounting. Bonus plans, debt covenants, and market expectations can prompt misstatements. Conflicts of interest may also occur when accountants or internal audit teams face pressure from management.

3. Auditor independence and audit quality

Auditor independence — in appearance and in fact — is vital. Threats include non-audit services, long auditor tenure without rotation, fee dependence, and close client relationships. Industry-specific expertise and complex manufacturing accounting rules also affect audit quality.

4. Corporate governance and board oversight

Strong corporate governance reduces the likelihood of ethical breaches. Board composition, audit committee independence, and shareholder activism are important mitigating factors. Weak governance structures in some Manufacturing industries can create environments where unethical practices flourish.

5. Supply-chain and third-party Audit risks

Manufacturing industries often use complex supplier networks and subcontractors. Audits of these external parties (for compliance, labor, or environmental standards) may be announced in advance or limited in scope, creating gaps that enable malpractice in supply chains.

6. Professional ethics, culture, and education

Professional codes (e.g., IFAC, national accounting bodies) set standards but do not guarantee ethical behavior. Organizational culture, ethics training, and professional development influence day-to-day decisions by accountants and auditors.

Theoretical Framework

The paper draws on agency theory (principal–agent conflicts), stakeholder theory (balancing multiple claims), and institutional theory (how norms and regulations shape behavior) to explain why ethical lapses occur and how they might be mitigated.

Methodology

A mixed-methods design is recommended for empirical research: -

Quantitative component: archival analysis of Manufacturing industries' financial statements, earnings quality metrics, audit firm rotations, and governance indicators across a sample period. –

Qualitative component: semi-structured interviews with CFOs, internal auditors, external auditors, and members of audit committees; case studies of known ethical failures in manufacturing.

Data sources: audited financial reports, audit opinions, regulatory enforcement releases, and industry reports.

Findings

- Earnings management is widespread where performance pressures are high and governance weak.
- Auditor independence is repeatedly challenged by commercial relationships and fee dependence; regulatory penalties in recent years underscore these vulnerabilities.
- Supply-chain audits can fail to detect labor and safety abuses when inspections are predictable, access is restricted, or auditors lack sufficient scope.
- Weak board oversight correlates with lower reporting quality and higher incidence of misstatements.

Discussion: Challenges and Drivers

1. Incentive Structures and Short-Termism

Executive compensation tied to short-term financial targets creates pressures that can lead to unethical accounting choices.

2. Complexity of Manufacturing Accounting

Inventory methods, long-term contracts, cost capitalization, and environmental liabilities complicate measurement and create opportunities for manipulation.

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3. Regulatory and Enforcement Gaps
Variations in enforcement strength across jurisdictions mean that some firms operate with lower risk of detection and sanction.

4. Cultural and Organizational Factors
An organizational culture that prioritizes results over process or discourages whistleblowing exacerbates ethical risk.

Implications

1. For Regulators
- Strengthen enforcement and disclosure requirements tailored to manufacturing (e.g., more granular inventory and contract disclosures).
- Consider enhancing audit firm oversight and rules limiting non-audit services.

2. For Industry (Owners, Management & Boards)
- Design compensation that balances short- and long-term incentives.
- Strengthen internal controls, rotate key finance roles periodically, and empower independent audit committees.

3. For Auditors
- Maintain strict independence policies, disclose non-audit fees, and invest in industry-specific training.
- Use forensic analytics and unannounced inspections for supply-chain verification.

4. For educators and professional bodies
- Emphasize ethics, practical judgement, and whistleblower protections in training and continuing professional development.

Recommendations
1. Implement stronger, transparent disclosure around inventory and long-term contract accounting.
2. Mandate independent audit committee chairs with relevant experience in manufacturing.
3. Limit non-audit services provided by external auditors and require public disclosure of fee mixes.
4. Encourage whistleblower hotlines with legal protections and independent reporting channels.
5. Promote periodic external peer reviews of internal audit functions.

Limitations and Future Research

This paper synthesizes literature and proposes a research design but does not provide original empirical results. Future studies should empirically test the relationships proposed here across different countries, firm sizes, and manufacturing subsectors.

Conclusion

Ethical issues in accounting and auditing within Manufacturing industries are multi-faceted and driven by incentives, complexity, governance, and cultural factors. A combined approach — regulatory strengthening, governance reforms, audit profession vigilance, and ethics education — is needed to reduce ethical breaches and protect stakeholders.

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