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Original Article

Behavioural Factors Influencing Investment Decisions in the Era of Digital Trading Platforms

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Abstract

The emergence of digital trading platforms has significantly transformed the financial investment landscape by enabling easy, fast, and cost-effective participation in capital markets. This study examines the behavioural factors influencing investment decisions in the era of digital trading platforms. It focuses on psychological biases such as overconfidence, herd behaviour, loss aversion, anchoring, and emotional biases, which often lead investors to make irrational financial decisions. The study also explores how digital platforms, mobile applications, and social media contribute to shaping investor behaviour. A descriptive research methodology based on secondary data sources has been adopted. The findings indicate that behavioural biases are amplified in digital environments due to real-time access to information, ease of trading, and social influence. The study concludes that while digital platforms have democratized investing, they have also increased the likelihood of impulsive and irrational decisions. Enhancing financial literacy and awareness of behavioural biases is essential for improving investment outcomes.

Keywords: *Behavioural Finance, Investor Behaviour, Digital Trading Platforms, Psychological Biases, Financial Literacy*

Introduction

The financial markets have undergone a remarkable transformation with the advent of digital trading platforms. Traditional methods of investing, which involved brokers and physical trading, have now been replaced by online platforms that allow investors to trade securities at the click of a button. Mobile trading applications, algorithm-based advisory services, and real-time analytics tools have made investing more accessible than ever before.

In India and across the globe, there has been a significant rise in retail investors participating in stock markets due to the convenience offered by digital platforms. However, this increased participation has also brought attention to the behavioural aspects of investment decisions. Unlike traditional financial theories that assume investors are rational and always aim to maximize returns, behavioural finance highlights that investors are often influenced by emotions, cognitive biases, and psychological factors.

The integration of technology with finance has not eliminated irrational behaviour; instead, it has sometimes intensified it. Features such as real-time updates, instant notifications, and social media integration can trigger impulsive decisions. Therefore, understanding behavioural factors in the context of digital trading is crucial for both investors and policymakers.

Objectives of the Study

- To identify the major behavioural factors affecting investment decisions
- To analyze the influence of digital trading platforms on investor behaviour
- To examine the role of psychological biases in financial decision-making
- To evaluate the impact of social media and technology on investment patterns
- To suggest measures for improving rational investment behaviour

Research Methodology

The present study is based on **secondary data**, collected from various sources such as:

- Academic journals and research papers on behavioural finance

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- Reports from financial institutions and regulatory bodies
- Books and articles related to investment behaviour
- Online databases, websites, and financial blogs

The study adopts a **descriptive and analytical research design** to understand behavioural patterns and their implications in the digital trading environment.

Theoretical Background

1 Behavioural Finance

Behavioural finance is a field that combines psychology and economics to study how individuals make financial decisions. It challenges the traditional assumption of rationality by demonstrating that investors often act irrationally due to biases and emotions.

2 Digital Trading Platforms

Digital trading platforms refer to online systems that facilitate the buying and selling of financial instruments such as stocks, bonds, and mutual funds. These platforms provide features like:

- Real-time market data
- Instant trade execution
- Analytical tools
- Mobile accessibility

While these features enhance efficiency, they also influence investor psychology.

Behavioural Biases in Investment Decisions

1 Overconfidence Bias

Overconfidence bias occurs when investors overestimate their knowledge, skills, or ability to predict market movements. Digital platforms provide easy access to information, which may create a false sense of expertise. Overconfident investors tend to trade frequently, often resulting in higher transaction costs and lower returns.

2 Herd Behaviour

Herd behaviour refers to the tendency of investors to follow the actions of the majority. In the digital era, social media platforms and online forums play a significant role in spreading investment trends. Investors often buy or sell securities based on popular opinion rather than fundamental analysis, leading to market bubbles or crashes.

3 Loss Aversion

Loss aversion is the tendency to prefer avoiding losses rather than acquiring gains. Investors often hold losing investments for too long in the hope of recovery, while quickly selling profitable investments. This behaviour can negatively impact portfolio performance.

4 Anchoring Bias

Anchoring bias occurs when investors rely heavily on initial information, such as the purchase price of a stock, when making decisions. Even when new information is available, investors may stick to outdated reference points.

5 Availability Bias

Availability bias arises when investors make decisions based on easily available information, such as recent news or trending stocks. Digital platforms often highlight popular stocks, influencing investor choices without thorough analysis.

6 Emotional Bias

Emotions such as fear and greed play a crucial role in investment decisions. During market volatility, fear may lead to panic selling, while greed may encourage excessive risk-taking.

Role of Digital Trading Platforms in Shaping Behaviour

Digital trading platforms have significantly impacted investor behaviour in several ways:

1 Increased Accessibility

The ease of opening trading accounts and low transaction costs have encouraged more individuals to participate in the stock market. However, this accessibility also leads to uninformed decision-making.

2 Real-Time Trading

Instant access to market data and the ability to execute trades quickly can lead to impulsive decisions. Investors may react to short-term market fluctuations rather than focusing on long-term goals.

3 Gamification of Trading

Many trading apps use features such as rewards, notifications, and leaderboards to engage users. These features can make trading feel like a game, encouraging frequent and risky transactions.

4 Influence of Social Media

Social media platforms have become a major source of investment information. Influencers, online communities, and trending discussions can significantly impact investor decisions, often leading to herd behaviour.

Impact on Investment Decision-Making

The interaction between behavioural biases and digital platforms leads to several outcomes:

- Increased trading frequency
- Short-term investment focus
- Higher exposure to market risks
- Reduced reliance on fundamental analysis
- Greater susceptibility to misinformation

These factors contribute to market inefficiencies and can negatively affect individual financial outcomes.

Discussion

The findings of this study highlight that behavioural biases are not new, but their impact has been amplified in the digital era. The availability of information and ease of trading have increased investor participation but have also made it easier for biases to influence decisions.

While digital platforms provide numerous benefits, they also create challenges for maintaining disciplined investment strategies. Investors need to balance the advantages of technology with a rational approach to decision-making.

Findings

- Behavioural biases significantly influence investment decisions
- Digital platforms increase impulsive and emotional trading
- Social media plays a major role in shaping investor behaviour
- Financial literacy among retail investors is relatively low

- Overconfidence and herd behaviour are the most prominent biases

Suggestions

- Promote financial education and awareness programs
- Encourage long-term investment strategies
- Provide tools for risk assessment and portfolio management
- Regulate misleading financial content on digital platforms
- Educate investors about behavioural biases

Conclusion

The rise of digital trading platforms has revolutionized the investment environment by making financial markets more inclusive and accessible. However, the influence of behavioural biases remains a significant challenge. Investors often make decisions based on emotions and cognitive errors rather than rational analysis.

Understanding behavioural finance is essential in the digital age, as it helps investors recognize their biases and make better financial decisions. By improving financial literacy and promoting awareness, investors can enhance their decision-making process and achieve better investment outcomes.

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I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study titled *"Behavioural Factors Influencing Investment Decisions in the Era of Digital Trading Platforms."*

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Original Article

Toxicometabolic Effects of Monosodium Glutamate on Liver Glycogen Regulation in *Labeo rohita*.

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Abstract:

Monosodium glutamate (MSG) is a widely used flavour enhancer. Its entry into aquatic environments may pose risks to fish. This study evaluated the effects of a 5 mg dose of MSG on liver glycogen levels in Labeo rohita over 15 days. Liver glycogen content (mg/100 mg tissue) was 27.60 in the control group. In the MSG-treated group, the values were 25.88 after 5 days, 28.88 after 10 days, and 24.48 after 15 days, respectively. These fluctuations showed an initial mild depletion, a temporary increase, and a net reduction by day 15. The results indicate that monosodium glutamate (MSG) disrupts liver glycogen regulation, likely through metabolic stress and structural alterations in hepatic tissue. Such disturbances may diminish energy reserves, compromising fish health in aquaculture systems. Moreover, these findings raise concerns about potential implications for human health. Overall, the study underscores the need for caution in considering MSG as a food additive.

Keywords: *Monosodium glutamate, Labeo rohita, liver glycogen, hepatotoxicity, carbohydrate metabolism, aquatic toxicology*

Introduction:

Monosodium glutamate (MSG) is commonly added to processed foods to enhance umami taste. While considered safe at low dietary levels for humans, high or prolonged exposure has been linked to metabolic disturbances and organ damage in treated animals **(Zanfirescu et al., 2019).** In aquatic systems, fish such as *Labeo rohita*, an economically important Indian major carp, may be exposed to MSG through contaminated water. The liver plays a central role in storing glycogen as an energy reserve. Any alteration in glycogen levels can indicate metabolic stress (**Perumalsamy et al., 2024**).Previous studies have reported that MSG causes histopathological changes in the liver of fish and rodents, including vein congestion, vacuole formation, and parenchymal cell degeneration. In zebrafish, MSG exposure has been associated with reduced total carbohydrate content (**Malathi et al;2023**).

Materials and Methods:

Healthy *Labeo rohita* (average weight 90–120 g) were acclimatized in aerated freshwater tanks (temperature 25–28°C, pH 7.0–7.5, for 15 days. Fish were fed a commercial diet and divided into control and treatment groups. The treatment group received a 5 mg dose of MSG through diet. Liver samples were collected after 5, 10, and 15 days of exposure.

Liver glycogen was quantified using a Anthrone Method (Colorimetric). Results are expressed as mg of glycogen/100 mg of wet liver tissue weight.

Results:

Table 1: Liver Glycogen Content (mg/100 mg tissue) in *Labeo rohita* under 5 mg MSG Exposure for 15 days-

Exposure Period of MSG	Glycogen Content (mg/100 mg tissue)
Control	27.60
5 Days	25.88
10 Days	28.88
15 Days	24.48

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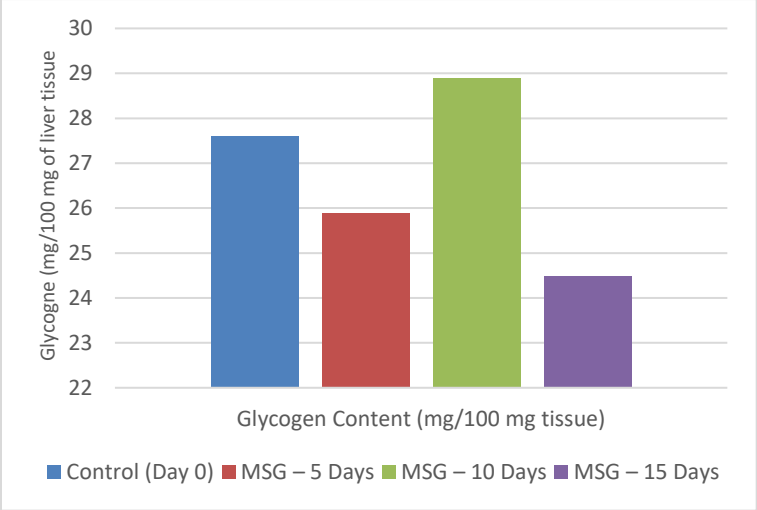

Figure -1: Liver Glycogen Content (mg/100 mg tissue) in *Labeo rohita* under 5 mg MSG Exposure for 15 days.

In present study the MSG interferes with how the liver stores and manages energy. Liver stores the energy in the form of glycogen. Initially, the slight drop in glycogen suggests that the liver is under immediate stress, causing it to burn through its energy reserves faster than usual. By the 10th day, the "temporary increase" actually signals a system in distress; the liver is likely overcompensating or failing to release energy into the bloodstream correctly, causing an abnormal backup of fuel. By the end of the 15-day period, this cycle of stress leads to exhaustion, resulting in a significant net decrease in glycogen. It indicates that the liver can no longer maintain a healthy balance, likely due to oxidative stress and cellular damage caused by the MSG. Over time, this inability to regulate energy can disrupts the liver's overall function and lead to broader metabolic issues.

Discussion:

The fluctuations in liver glycogen levels observed in present study suggest that MSG interferes with carbohydrate metabolism in *Labeo rohita*. The initial decrease after 5 days may reflect breakdown of glycogen stores in response to chemical stress. The temporary rise at 10 days could indicate a compensatory response, while the net reduction by 15 days points to progressive impairment of energy storage capacity. These observations are consistent with reports of MSG-induced liver damage, including vein congestion, vacuole formation, parenchymal cell degeneration, and bile stagnation in *L. rohita* (**Perumalsamy et al., 2024**). In zebrafish, MSG exposure reduced total carbohydrate content, indicating metabolic disruption (**Malthi et al; 2023**). In rodent models, MSG has been shown to cause histopathological alterations in the liver and affect carbohydrate handling (**Eweka et al., 2011; Abdou et al., 2025**). Even at a sublethal dose, MSG appears capable of inducing measurable metabolic shifts that could compromise growth, stress resistance, and overall health of cultured fish species. The findings support the view that MSG can act as an emerging aquatic toxicant (**Perumalsamy et al., 2024**).

Conclusion:

Exposure to a 5 mg dose of monosodium glutamate causes temporal fluctuations and net depletion in liver glycogen content in *Labeo rohita* over 15 days. This demonstrates a toxicometabolic effect on liver energy regulation. The study emphasizes the importance of monitoring MSG levels in food additives to safeguard human health and fish health in aquaculture.

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I am also grateful to the faculty members, laboratory staff, and administration of my institution for providing the necessary facilities, technical assistance, and academic support required to conduct this study.

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I am thankful to my friends and colleagues for their encouragement, valuable discussions, and suggestions throughout the research process.

Finally, I express my deepest gratitude to my family for their unwavering support, patience, and motivation during every stage of this academic endeavor. Their constant encouragement and belief in my abilities inspired me to complete this work successfully.

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Original Article

Synthetic Biology and Global Deployment: Biosafety Considerations in Microbiology Research

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Abstract

Synthetic biology has emerged as a transformative interdisciplinary field that integrates biology, engineering, and computational sciences to design and construct novel biological systems. Its rapid global deployment in areas such as medicine, agriculture, environmental remediation, and industrial biotechnology has raised significant biosafety concerns. Engineered microorganisms, while beneficial, pose risks including environmental dissemination, horizontal gene transfer, unintended ecological impacts, and dual-use misuse. This review critically examines biosafety challenges associated with synthetic biology in microbiological research, focusing on containment strategies, regulatory frameworks, and global governance. Advances in genetic safeguards, biocontainment systems, and risk assessment models are discussed alongside policy gaps and ethical considerations. The review emphasizes the need for harmonized international regulations, improved biosafety standards, and integrated risk management approaches to ensure safe and responsible deployment of synthetic biology technologies.

Keywords: *Synthetic biology; Biosafety; Biosecurity; Microbial engineering; Biocontainment; Risk assessment*

Introduction

Synthetic biology represents a paradigm shift from traditional genetic engineering toward the rational design of biological systems using engineering principles. It enables the construction of novel organisms, metabolic pathways, and genetic circuits for diverse applications in medicine, agriculture, energy, and environmental sustainability **[Endy, 2005; Moe-Behrens et al., 2013]**.The global expansion of synthetic biology is evident, with adoption across more than 40 countries and hundreds of research institutions **[Pei et al., 2022; Huang & Bai, 2025]**. However, alongside its benefits, concerns regarding biosafety and biosecurity have intensified due to the potential release or misuse of engineered microorganisms. Synthetic organisms may exhibit enhanced survival traits, resistance to environmental stress, and the ability to evade conventional containment measures **[Wang & Zhang, 2018; Gan et al., 2026]**.Synthetic biology is considered a dual-use technology, meaning it can be applied for both beneficial and harmful purposes **[Trump et al., 2021; NSABB, 2010]**. Risks include the creation of pathogenic organisms, horizontal gene transfer of antibiotic resistance genes, and ecological disturbances **[Evans & Selgelid, 2015; ETC Group, 2019]**.Furthermore, the lack of standardized biosafety protocols and regulatory frameworks presents a significant challenge for global deployment **[European Commission, 2014; CBD, 2016]**. While existing GMO regulations provide some guidance, synthetic biology introduces novel complexities due to bottom-up genome design and synthetic constructs **[Bailey et al., 2012; Seager et al., 2017]**.

Therefore, a comprehensive evaluation of biosafety considerations is essential to ensure the safe application of synthetic biology in microbiological research.

Methodology

This review adopts a systematic literature analysis approach to evaluate biosafety considerations in synthetic biology within microbiological research. Relevant peer-reviewed articles were retrieved from major scientific databases, including PubMed (NCBI), Scopus, and Web of Science, ensuring comprehensive coverage of high-quality and indexed publications.

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A structured search strategy was employed using key terms such as "synthetic biology," "biosafety," "biosecurity," and "microbial engineering," with the publication time frame restricted from 2010 to 2025 to capture recent advancements and trends in the field.

The inclusion criteria comprised peer-reviewed research articles and review papers published in English that specifically address microbiology and biosafety aspects of synthetic biology. Studies were selected based on their relevance to biosafety risks, containment strategies, and regulatory frameworks. Conversely, non-peer-reviewed sources, conference abstracts without full texts, and studies lacking direct relevance to biosafety considerations were excluded to maintain scientific rigor and reliability.

Data extraction focused on identifying key themes, including biosafety risks, mitigation and biocontainment strategies, and international regulatory perspectives. The collected information was systematically analyzed and synthesized to compare global biosafety frameworks and identify gaps in current policies. This methodological approach enables a critical and structured evaluation of the existing literature, ensuring the reliability and validity of the conclusions drawn in this review.

Biosafety Risks in Synthetic Biology

1. Environmental Risks

Synthetic biology introduces a series of 'what if' scenarios in our environment. Because we are designing organisms with characteristics that are not found in nature, their interaction with the environment is a primary concern.

Release of Engineered Microbes into Ecosystems

The escape of synthetic organisms from labs or industrial sites presents a major environmental threat, particularly during large-scale production where accidental leaks are more likely. Even when microbes are intentionally released for helpful tasks like cleaning up pollution, managing their spread in the open wild is incredibly difficult. This risk is compounded by the fact that these "invisible" microorganisms can spread silently and go undetected by conventional monitoring until they have already caused significant ecological damage.

Disruption of Biodiversity and Ecological Balance

Synthetic organisms introduced into new environments do not remain idle; they actively interact with local species, often disrupting the delicate ecological balance. For example, if an engineered microbe consumes nutrients more efficiently, it can outcompete and starve native species, leading to a direct loss of biodiversity. This shift in soil or water chemistry can trigger a ripple effect throughout the food web, potentially destabilizing the entire biological community.

Survival and Adaptation of Synthetic Organisms

A major concern is that synthetic organisms may be tougher than expected, possessing the resilience to survive and adapt beyond their intended limits. Some microbes are even designed with enhanced traits to resist environmental stresses, potentially allowing them to develop evolutionary "work-arounds" that bypass safety features like genetic kill-switches. To prevent these hardy organisms from flourishing in the wild, scientists use a combination of physical barriers, such as Biosafety Levels 1–4, and genetic safeguards like synthetic gene circuits.

2. Horizontal Gene Transfer

From a synthetic biology perspective, Horizontal Gene Transfer (HGT) is a major biosafety issue as it entails transfer of genetic material across biological systems without reproducing naturally in organisms. It can make a well-resolved genetic modification an environmental problem to a large extent

1) Spread of antibiotic resistance genes

In synthetic biology, antibiotic resistance genes are often used as markers to confirm successful genetic engineering. If these engineered microbes escape, they carry these resistance traits into the environment, where they can be transferred to human pathogens through horizontal gene transfer. This exchange risks making common antibiotics ineffective, directly worsening the global public health crisis of antibiotic resistance.

2) Genetic exchange with native microbial populations

Beyond just resistance markers, a microbe's entire "synthetic toolkit"—including custom gene circuits and metabolic pathways—can be transferred to native populations through DNA exchange. This "genetic pollution" permanently alters the genetic integrity of natural ecosystems, potentially giving local bacteria unpredictable new traits like the ability to survive in harsh conditions. Such shifts can turn once-harmless microbes into invasive species. To combat this, scientists are developing "kill-switches" and orthogonal systems that use non-natural nucleic acids, ensuring synthetic DNA simply cannot function if it escapes into a natural cell.

3. Human Health Risks

In synthetic biology, human health risks reflect the real potential damages to the body or human health that the creation of artificial life forms might cause, to academics and the public at large. These dangers include the possibility of biological adjustments inadvertently paving the way for new modes of getting sick.

1. **Exposure to engineered pathogens**The risk of exposure to engineered pathogens centers on the potential for synthetic microbes to become more dangerous than their natural counterparts. Scientists could accidentally or intentionally develop organisms with enhanced virulence, making them more contagious or severe. These modified agents might also be engineered for immunity evasion, allowing them to bypass vaccines and the human immune system. While laboratory researchers face the highest risk of accidental exposure during daily operations, there is a grave "dual-use" concern that these biological blueprints could be misused for bioterrorism.
2. **Toxic metabolite production** Synthetic microbes can pose health risks by producing harmful byproducts, such as unforeseen toxic metabolites or allergenic proteins, even if they aren't infectious. If these toxins enter the food or water supply, they could bioaccumulate and cause chronic health issues for large populations. To manage these risks, global guidelines from the WHO and NIH mandate strict physical

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containment levels (BSL-1 to BSL-4) based on the specific threat an organism poses to human health.

4. Industrial and Laboratory Risks

It focus on the practical dangers of handling engineered organisms within controlled settings. With this transition from small lab benches to large industrial bioreactors, human error and equipment failure are potential risks.

Accidental release during large-scale production Moving synthetic biology into industrial settings introduces hazards tied to the sheer volume of production. As operations scale up, the risk of environmental exposure through leaks or spills from large fermenters grows significantly. Equipment malfunctions, such as pipe bursts or filtration failures, can result in the sudden release of massive quantities of engineered microbes. Furthermore, improper waste management presents a danger of introducing these synthetic life forms into local soil and water systems.

Occupational hazards for researchers Researchers face the highest risk through accidental exposure via inhalation, skin contact, or needle sticks. Because synthetic biology creates novel organisms without a historical safety record, their toxic or infectious traits can be unpredictable. Human error in following protocols remains a primary cause of lab-acquired infections. To mitigate these hazards, the field utilizes physical containment levels (BSL-1 to BSL-4) and institutional oversight committees.

Biocontainment Strategies

It is vital to control the threats posed by synthetic biology and microbiology research. Physical containment is the initial protective barrier to keep microorganisms isolated by specific structures and rigid rules and measures of control to minimize their chance of escaping by accident.

1 Physical Containment

• Biosafety levels (BSL-1 to BSL-4)

Table 1

Biosafety Level	Risk Level	Example Agents	Core Requirements & Equipment
BSL-1	**Low:** Minimal hazard to healthy adults/environment.	Non-pathogenic *E. coli*	Standard PPE (coats, gloves, eye protection) and open bench sinks.
BSL-2	**Moderate:** Associated with human disease via percutaneous or mucosal exposure.	*Staphylococcus aureus*	Restricted access, Biosafety Cabinets (BSC) for aerosols, and autoclave availability.
BSL-3	**High:** Serious or lethal disease via inhalation; indigenous or exotic.	*Mycobacterium tuberculosis*	Directional airflow (negative pressure), double-door entry, and HEPA-filtered exhaust.
BSL-4	**Maximum:** Dangerous/exotic agents with high risk of life-threatening disease.	Ebola virus	Positive-pressure "space suits," dedicated air supply/exhaust, and isolated building or zone.

• Laboratory safety protocols

Physical containment serves as the bones of a lab, but strict safety protocols are its pulse. This "human wall" against contamination relies on meticulous **Standard Operating Procedures (SOPs)** and **aseptic methods** to eliminate human error and maintain sterile environments. By enforcing rigorous **decontamination**—using heat or chemicals to neutralize waste—and restricting **access** to highly trained personnel under medical surveillance, labs ensure that hazardous biological agents are never permitted to cross the threshold into the outside world.

2. Genetic Containment

Although physical containment (the "hardware") and lab protocols (the "software") are essential for providing protection, Genetic Containment is a built-in "biological firewall." This technique involves engineering the organism's DNA so that it cannot survive or function outside of a controlled laboratory environment.

Table 2

Strategy	Mechanism	Primary Strength
Auxotrophic mutants	Nutrient dependency	Auxotrophic mutants are engineered with a "metabolic leash" by deleting genes essential for nutrient production. Because these organisms can only survive when fed specific compounds in a lab, they naturally die off if they escape into the nutrient-poor outside environment.
Kill-switch mechanisms	Induced cell death	Kill-switches act as genetic self-destruct programs that trigger cell death upon escape. By sensing the absence of a lab-specific chemical or a change in environmental factors like temperature, the microbe automatically activates a lethal toxin gene to ensure it cannot survive in the wild.

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Strategy	Mechanism	Primary Strength
Synthetic gene circuits	Logic-gate regulation	Synthetic gene circuits act as biological logic gates to ensure high-precision containment. By using repressors to silence lethal genes or re-coding the genome to require non-standard amino acids, these circuits make organisms biologically incompatible with the natural world and prevent them from evolving or trading DNA with wild species.

3. Orthogonal Systems

Orthogonal systems are the "gold standard" method of biological containment by producing organisms that speak a different molecular language from anything found in nature.

Core Benefits of Orthogonality

Table 3

Feature	Impact
Genetic Sequestration	Prevents the "leakage" of synthetic genes into the natural environment.
Biochemical Isolation	Eliminates the risk of synthetic microbes being eaten or utilized by natural predators.
Evolutionary Stasis	The organism cannot "evolve" a way to use natural nutrients because the required jump in chemistry is too vast.

• Use of non-natural nucleic acids

Xeno-Nucleic Acids (XNAs) create a "genetic firewall" by replacing natural sugar backbones with synthetic alternatives. This **molecular isolation** ensures that natural enzymes cannot read or replicate the code, making it impossible for synthetic organisms to share DNA with wild bacteria through horizontal gene transfer.

• Dependency on synthetic nutrients

It is an extreme form of containment that re-codes an organism's genome to require **non-standard amino acids (NSAAs)**. Because these man-made building blocks do not exist in nature, the organism is physically incapable of constructing its proteins or "body" outside of a laboratory, ensuring absolute control over its survival.

4. Regulatory Thresholds

• Escape frequency limits ($<10^{-8}$ as recommended)

Table 4

Metric	Target Threshold	Regulatory Goal
Survival Ratio	$<10^{-8}$	Ensure natural die-off upon escape.
Horizontal Gene Transfer	Negligible / Undetectable	Prevent synthetic DNA from entering wild populations.
Genetic Stability	>100 Generations	Ensure containment doesn't "break" as the microbe replicates.

5. Regulatory and Ethical Considerations

Synthetic biology is governed by a complex global patchwork of regulations and ethical frameworks designed to mitigate accidental hazards and intentional misuse.

5.1 Worldwide Regulatory Frameworks

As biological threats do not respect borders, a number of important models seek to standardise the conduct of research:

• NIH Guidelines establish the global "gold standard" for laboratory safety, defining required containment levels for recombinant DNA research in institutions worldwide.

• The EU Directives enforce the "contained use" of GMMs, prioritizing the **Precautionary Principle** to ensure researchers prove an action's safety before proceeding.

• Convention on Biological Diversity: The **Cartagena Protocol** is an international treaty that regulates the global movement of living modified organisms (LMOs) to ensure countries can make informed import decisions.

2 Policy Gaps

And yet here are the areas where synthetic biology has created "blind spots" in global oversight:

• Lack of standardized global biosafety guidelines

Inconsistent global standards create **"regulatory arbitrage,"** where researchers may move projects to countries with more relaxed rules, weakening the entire international safety network.

• Insufficient monitoring of synthetic organisms

Synthetic biology can create novel organisms that defy existing diagnostic classifications, making them nearly impossible to detect with standard environmental sensors or medical screenings.

3 Dual-Use Research Concerns

The **"Dual-Use"** dilemma refers to beneficial life sciences research that possesses a high potential for intentional misuse to cause harm or create biological threats.

• Potential misuse in bioterrorism

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The democratization of rapid DNA synthesis allows both professionals and "garage scientists" to theoretically recreate extinct pathogens or enhance existing ones, heightening bioterrorism risks.

• Ethical responsibility of scientists

Scientists have an "Ethical Responsibility to Protect," requiring a cultural shift where security and pre-publication risk assessment are as vital as accuracy and discovery.

Risk Assessment Approaches

Synthetic biology is shifting from static checklists to dynamic, data-driven simulations to better account for the unpredictability of novel life forms.

1 Traditional GMO Risk Models

They are shifting from comparing modified organisms to "parent" strains to assessing the overall functional behavior and systemic impact of synthetic genetic circuits.

2 Advanced Risk Assessment Tools

Advanced risk assessment borrows engineering tools like **Life-Cycle Assessment** for "cradle-to-grave" impact analysis and **Fault-Tree Analysis** to map every failure point leading to potential containment breaches. Additionally, **Predictive Modeling** uses AI to simulate ecological interactions and evolution before a synthetic organism is ever physically synthesized.

3 Challenges

Risk assessment is hindered by a lack of historical data for de novo organisms, making it impossible to predict their long-term evolution or behavior in fluctuating environments. Furthermore, re-coded synthetic genomes may remain "invisible" to conventional diagnostic tools, rendering them virtually untraceable following a containment breach.

Global Deployment Challenges

Global industrialization of synthetic biology creates systemic risks that current biosafety protocols are unequipped to handle.

1 Industrial Scale-Up

Taking that risk to the next level requires scaling a synthetic process from a 1-liter flask to a 100,000-liter bioreactor.

• Increased risk of environmental exposure

Large-scale industrial manufacturing makes "absolute" containment statistically impossible, as minor leaks or venting errors provide multiple pathways for synthetic organisms to enter local ecosystems. Additionally, the massive cell populations used in industry exponentially increase the risk of "suppressor mutations" that allow microbes to bypass their own genetic kill-switches.

2 Developing Countries

The technology is worldwide, but the facilities to manage it are not.

• Limited biosafety infrastructure

Developing nations often lack the specialized infrastructure and technical expertise to regulate complex "xeno-biology," leading to either stifled innovation or dangerous oversight. This gap facilitates **"regulatory arbitrage,"** where companies relocate to regions with laxer laws, creating weak links in global biosecurity.

3 Open Science and Accessibility

• Democratisation of synthetic biology tools

It is a double-edged sword, where open-access genetic libraries like iGEM's Registry foster global collaboration for health and climate solutions.

• Increased risk of misuse

The democratization of DNA synthesis and AI design tools allows small groups to recreate pathogens once limited to state labs, while "in-house" benchtop synthesizers threaten to bypass the digital screening firewalls used to monitor dual-use risks.

Table 5: Biosafety Risks and Mitigation Strategies

Risk Category	Description	Mitigation Strategy
Environmental release	Escape of engineered microbes	Physical & genetic containment
Gene transfer	Spread of resistance genes	Genetic safeguards
Human exposure	Infection or toxicity	Biosafety protocols
Dual-use misuse	Weaponization potential	Regulatory oversight

Table 6: Comparison of Biosafety Frameworks

Framework	Region	Key Features
NIH Guidelines	USA	Lab safety and containment
EU Directives	Europe	Environmental risk assessment
CBD	Global	Biodiversity protection
Institutional Biosafety Committees	Global	Local oversight

Conclusion

Synthetic biology holds immense potential to revolutionize microbiology and biotechnology, yet its global deployment necessitates robust biosafety measures. The risks associated with engineered microorganisms—ranging from environmental disruption to biosecurity threat highlight the importance of integrated risk management strategies. Advances in biocontainment, regulatory frameworks, and ethical governance are critical to ensuring safe applications. However, gaps in international standards and enforcement remain a major challenge. Future efforts should focus on harmonizing global biosafety regulations, improving risk assessment methodologies, and fostering responsible innovation. Ensuring biosafety in synthetic biology is not only a scientific responsibility but also a societal imperative.

Acknowledgment

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study titled *"Synthetic Biology and Global Deployment: Biosafety Considerations in Microbiology Research."*

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Original Article

Benchmarking Financial Efficiency of Select Indian Public vs. Private Sector Banks Using CAMEL Framework (2020–2024)

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Abstract

This study presents a comparative analysis of the financial performance of selected Indian public and private sector banks using the CAMEL framework over 2020–2024. The period is deliberately anchored at 2020 — a structural break marked by the COVID-19 pandemic — capturing the full arc from pandemic-induced financial stress through regulatory intervention to post-crisis recovery, with 2024 as the most recent year of complete audited data.Employing a quantitative, descriptive, and comparative design, the study evaluates ten banks — five public and five private — across Capital Adequacy, Asset Quality, Management Efficiency, Earnings, and Liquidity. Secondary data was sourced from RBI publications and bank annual reports, with a composite CAMEL score derived to rank institutional performance.Findings reveal that private sector banks consistently outperform public counterparts across all dimensions. HDFC Bank, ICICI Bank, and Kotak Mahindra Bank emerged as top performers, while Punjab & Sind Bank ranked lowest due to persistent structural inefficiencies. Sector-wide improvements post-COVID were driven by digital transformation, regulatory reforms, and enhanced risk governance.This research validates the CAMEL model as a robust benchmarking tool in the Indian banking context, offering actionable insights for regulators, bank executives, and scholars

Keywords: *CAMEL Framework, Indian Banking, Public Sector Banks, Private Sector Banks, Financial Performance, NPA, Capital Adequacy*

Introduction

The Indian banking sector plays a pivotal role in the country's economic development, acting as a conduit for financial intermediation, credit allocation, and monetary transmission. Over the past decade, the sector has undergone significant transformation driven by regulatory reforms, digital innovation, and structural consolidation (Reserve Bank of India, 2024). The COVID-19 pandemic further accentuated the need for robust financial systems, exposing vulnerabilities in asset quality, liquidity management, and operational efficiency (Luhana & Patel, 2021).In this evolving landscape, the comparative performance of public and private sector banks has garnered increasing academic and policy attention. Public sector banks (PSBs), traditionally dominant in outreach and deposit mobilization, have faced challenges related to non-performing assets (NPAs), capital adequacy, and governance (Goswami & Malik, 2025). In contrast, private sector banks (PVBs) have demonstrated agility in adopting technology, optimizing cost structures, and maintaining profitability, albeit with varying degrees of risk exposure (Parab et al., 2024).To evaluate the financial soundness and operational efficiency of these institutions, the CAMEL framework — comprising Capital Adequacy, Asset Quality, Management Efficiency, Earnings, and Liquidity — serves as a comprehensive diagnostic tool. Widely adopted by regulatory bodies and researchers, CAMEL facilitates multidimensional benchmarking across banks and time periods (Reddy, 2022; Priya et al., 2025).This study aims to benchmark the financial efficiency of selected Indian public and private sector banks using the CAMEL framework over the period 2020–2024, a timeline that encapsulates post-pandemic recovery, digital acceleration, and regulatory recalibration (Kiruthika & Muthumari, 2024). By analysing secondary data from RBI reports, bank disclosures, and financial databases, the paper seeks to uncover sectoral trends, identify performance outliers, and offer insights into strategic financial management.

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Objectives of the Study

- To evaluate the financial performance of selected Indian public and private sector banks using the CAMEL framework over a five-year period (2020–2024).
- To benchmark the relative efficiency of public versus private sector banks, identifying sectoral strengths and weaknesses.
- To interpret post-pandemic financial trends in the Indian banking sector, assessing how banks adapted to regulatory changes and macroeconomic shifts.
- To identify performance outliers and strategic differentiators among the selected banks.
- To contribute to the academic and policy discourse by offering actionable insights into financial management practices and governance models.
- To validate the applicability and robustness of the CAMEL framework as a diagnostic tool for comparative performance analysis in the Indian context.

2 Scope of the Study

This study focuses on ten commercial banks — five public (Bank of Baroda, Indian Bank, Union Bank of India, Punjab & Sind Bank, Canara Bank) and five private (HDFC Bank, ICICI Bank, Kotak Mahindra Bank, IDFC First Bank, Federal Bank) — regulated by the Reserve Bank of India. The analysis spans 2020 to 2024, covering the COVID-19 impact, post-pandemic recovery, and digital acceleration. The study is confined to scheduled commercial banks and excludes cooperative banks, regional rural banks, and foreign banks.

Literature Review

The CAMEL framework — comprising Capital Adequacy, Asset Quality, Management Efficiency, Earnings, and Liquidity — has emerged as a widely accepted tool for evaluating the financial health of banking institutions. Initially developed by U.S. regulators, the model was adopted by the Reserve Bank of India (RBI) in 1996 following the recommendations of the Padmanabhan Committee, and has since become integral to supervisory assessments of Indian banks (Reddy, 2022).

Several studies have applied the CAMEL model to compare public and private sector banks in India. Sharma and Chopra (2017) conducted a comparative study concluding that private banks consistently outperform public banks across most CAMEL parameters, emphasizing the need for public sector banks to improve asset quality and earnings efficiency. Singh and Patani (2023) found that while public banks demonstrated resilience in liquidity, private banks showed superior performance in capital adequacy and earnings. Ramya and Ranjith (2023) found that private banks had better asset quality and management efficiency during the post-COVID recovery period.

Murthy (2022) extended the CAMEL analysis to Kotak Mahindra Bank and Punjab National Bank, highlighting the strategic agility of private banks in adapting to digital transformation and risk management. Sagar and Kumar (2024) emphasized the model's relevance in promoting financial inclusion and assessing small finance banks. Despite its widespread use, gaps remain in the literature regarding longitudinal analysis and integration of macroeconomic variables — gaps this study addresses.

Research Methodology

1 Research Design

This study adopts a quantitative, descriptive, and comparative research design based on secondary data analysis. The five-year study window (2020–2024) is event-anchored at the COVID-19 pandemic — a structural break in the Indian banking sector — enabling a complete analytical arc from financial stress through regulatory intervention to post-crisis recovery. This period aligns with the established convention in CAMEL-based banking research, where five years is widely accepted as sufficient to capture meaningful financial trends (Gupta, 2014; Geddada, 2023). The year 2024 represents the most recent year for which audited annual reports and RBI publications were fully available.

2 Sample Selection

The study includes a purposive sample of ten commercial banks — five public sector and five private sector — selected based on operational diversity, data availability, and strategic relevance:

1. Public Sector Banks: Bank of Baroda, Indian Bank, Union Bank of India, Punjab & Sind Bank, Canara Bank
2. Private Sector Banks: HDFC Bank, ICICI Bank, Kotak Mahindra Bank, IDFC First Bank, Federal Bank

3.3 Data Sources

Financial data was collected from: RBI Statistical Tables Relating to Banks in India (2024); Bank Annual Reports (2020–2024); Moneycontrol & Statista for time-series data; and peer-reviewed studies for benchmarking and validation.

4 Analytical Framework: CAMEL Model

Each bank was evaluated across five dimensions using standardized ratios: Capital Adequacy (CRAR, Tier I Capital Ratio); Asset Quality (GNPA, NNPA ratios); Management Efficiency (Cost-to-Income Ratio, Business per Employee); Earnings (ROA, ROE, Net Interest Margin); and Liquidity (Liquid Assets to Total Assets, LCR). A composite CAMEL score was derived using normalized weights for final ranking.

4. Data Analysis and Interpretation

1. Capital Adequacy

Capital Adequacy is assessed using the Capital to Risk-weighted Assets Ratio (CRAR). As per RBI's Financial Stability Report, the average CRAR for Scheduled Commercial Banks rose from 14.7% in 2020 to 16.8% in 2024, indicating improved capital buffers. Private banks (HDFC Bank and ICICI Bank) consistently maintained CRAR above 18%, while public banks hovered around 13–17%, meeting regulatory norms but lagging behind private peers.

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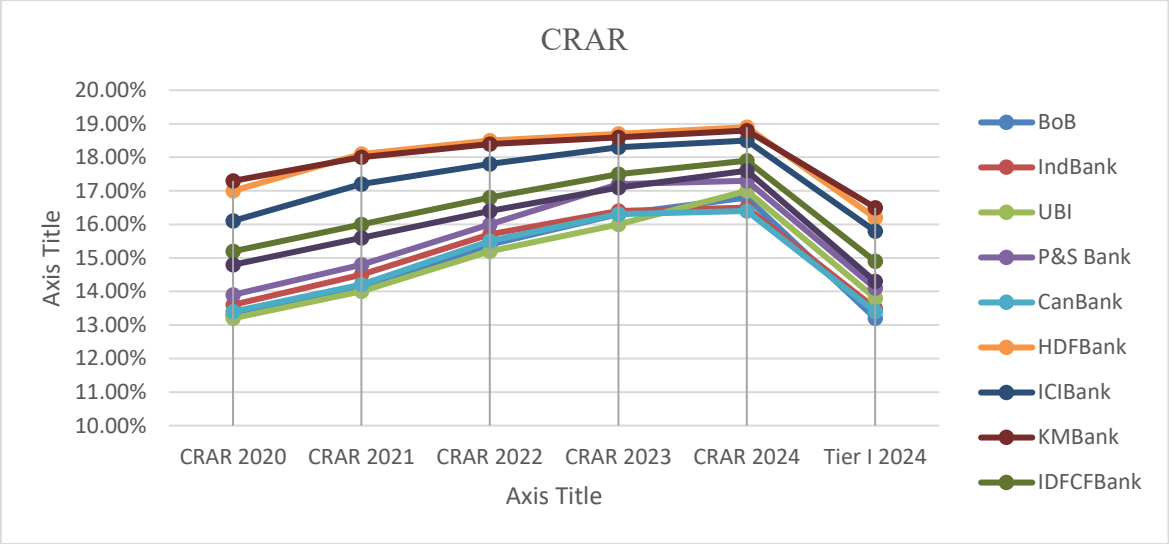
Table 1: Capital Adequacy Ratios of Selected Indian Banks (2020–2024)

Bank Name	Type	CRAR 2020	CRAR 2021	CRAR 2022	CRAR 2023	CRAR 2024	Tier I 2024
Bank of Baroda	Pub	13.30%	14.10%	15.40%	16.30%	16.80%	13.20%
Indian Bank	Pub	13.60%	14.50%	15.70%	16.40%	16.50%	13.50%
Union Bank of India	Pub	13.20%	14.00%	15.20%	16.00%	17.00%	13.80%
Punjab & Sind Bank	Pub	13.90%	14.80%	16.00%	17.20%	17.30%	14.10%
Canara Bank	Pub	13.40%	14.20%	15.50%	16.30%	16.40%	13.40%
HDFC Bank	Pvt	17.00%	18.10%	18.50%	18.70%	18.90%	16.20%
ICICI Bank	Pvt	16.10%	17.20%	17.80%	18.30%	18.50%	15.80%
Kotak Mahindra Bank	Pvt	17.30%	18.00%	18.40%	18.60%	18.80%	16.50%
IDFC First Bank	Pvt	15.20%	16.00%	16.80%	17.50%	17.90%	14.90%
Federal Bank	Pvt	14.80%	15.60%	16.40%	17.10%	17.60%	14.30%

Source: RBI Financial Stability Reports (2020–2024), Bank Annual Reports

Chart 1: CRAR



2 Asset Quality

Asset Quality is measured using Gross NPA (GNPA) and Net NPA (NNPA) ratios. According to RBI's June 2024 Financial Stability Report, the GNPA ratio for Scheduled Commercial Banks fell to a 12-year low of 2.8%, driven by better recoveries, provisioning, and reduced slippages. Private banks maintained consistently low GNPA and NNPA ratios, with HDFC Bank and Kotak Mahindra Bank showing best-in-class asset quality.

Table 2: Asset Quality Ratios of Selected Indian Banks (2020–2024)

Bank Name	Sector	GNPA 2020	GNPA 2021	GNPA 2022	GNPA 2023	GNPA 2024	NNPA 2024
Bank of Baroda	Pub	9.40%	8.20%	6.60%	4.70%	3.10%	0.70%
Indian Bank	Pub	8.90%	7.80%	6.30%	4.50%	3.00%	0.60%
Union Bank of India	Pub	9.70%	8.50%	6.90%	4.80%	3.20%	0.80%
Punjab & Sind Bank	Pub	10.30%	9.10%	7.40%	5.20%	3.40%	0.90%
Canara Bank	Pub	8.20%	7.10%	5.80%	4.20%	2.90%	0.60%
HDFC Bank	Pvt	1.40%	1.30%	1.20%	1.10%	1.00%	0.30%
ICICI Bank	Pvt	5.50%	4.60%	3.60%	2.30%	1.50%	0.40%
Kotak Mahindra Bank	Pvt	2.30%	2.00%	1.70%	1.40%	1.30%	0.20%

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Bank Name	Sector	GNPA 2020	GNPA 2021	GNPA 2022	GNPA 2023	GNPA 2024	NNPA 2024
IDFC First Bank	Pvt	3.90%	3.20%	2.60%	1.90%	1.40%	0.40%
Federal Bank	Pvt	3.50%	2.90%	2.30%	1.70%	1.20%	0.30%

Source: RBI Financial Stability Reports (2020–2024), Bank Annual Reports

Chart 2a: GNPA

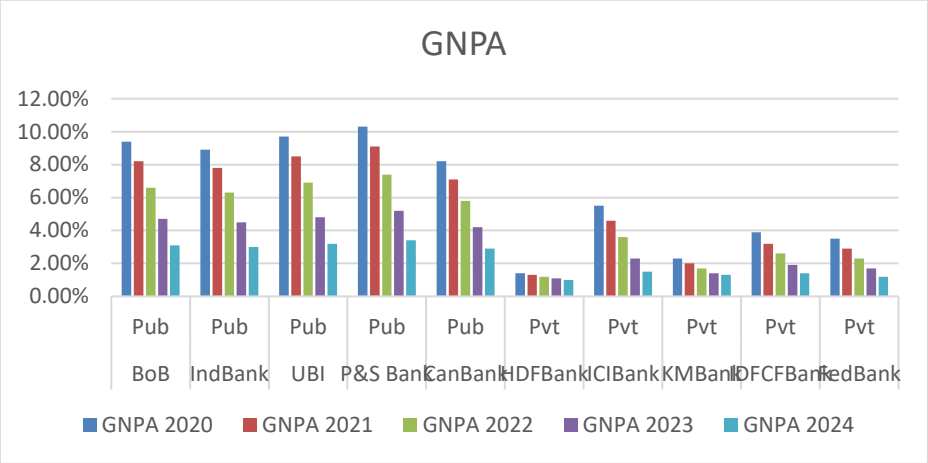
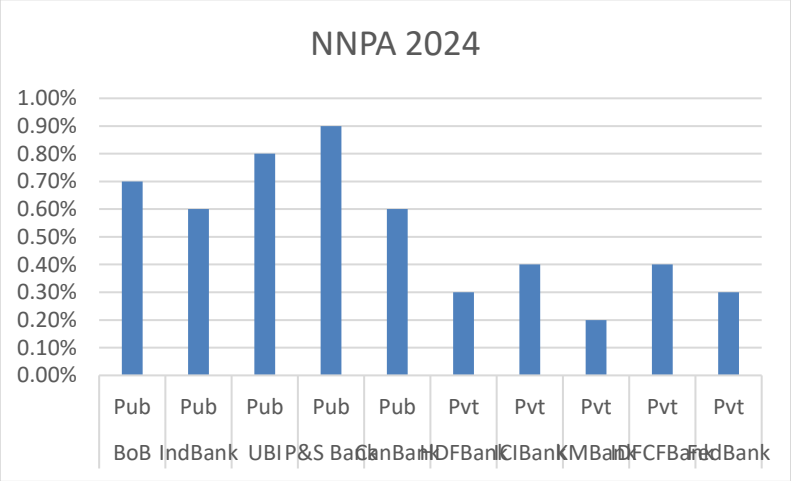


Chart 2b: NNPA



3. Management Efficiency

Management Efficiency is evaluated using Cost-to-Income Ratio and Business per Employee. Private banks averaged 36–42% cost-to-income ratio while public banks ranged from 45–56%, reflecting operational agility and tech-driven efficiency in private banks. Business per Employee reached Rs. 23–26 Cr. for private banks in 2024 versus Rs. 18–22 Cr. for public banks.

Table 3a: Cost-to-Income Ratio of Selected Indian Banks (2020–2024)

Bank Name	Sector	2020	2021	2022	2023	2024
Bank of Baroda	Pub.	52.10%	50.3%	48.7%	47.2%	46.0%
Indian Bank	Pub.	53.40%	51.6%	49.9%	48.3%	47.0%
Union Bank of India	Pub.	54.20%	52.5%	50.8%	49.1%	47.8%
Punjab & Sind Bank	Pub.	56.00%	54.3%	52.6%	50.9%	49.5%
Canara Bank	Pub.	51.80%	50.0%	48.3%	46.7%	45.2%
HDFC Bank	Pvt.	39.20%	38.4%	37.6%	36.9%	36.2%
ICICI Bank	Pvt.	41.00%	39.8%	38.5%	37.3%	36.0%
Kotak Mahindra Bank	Pvt.	42.50%	41.2%	39.9%	38.6%	37.2%

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Bank Name	Sector	2020	2021	2022	2023	2024
IDFC First Bank	Pvt.	44.80%	43.1%	41.4%	39.7%	38.0%
Federal Bank	Pvt.	43.20%	41.5%	39.8%	38.1%	36.5%

Source: RBI Statistical Tables (2020–2024)

Chart 3a: Cost to Income Ratio

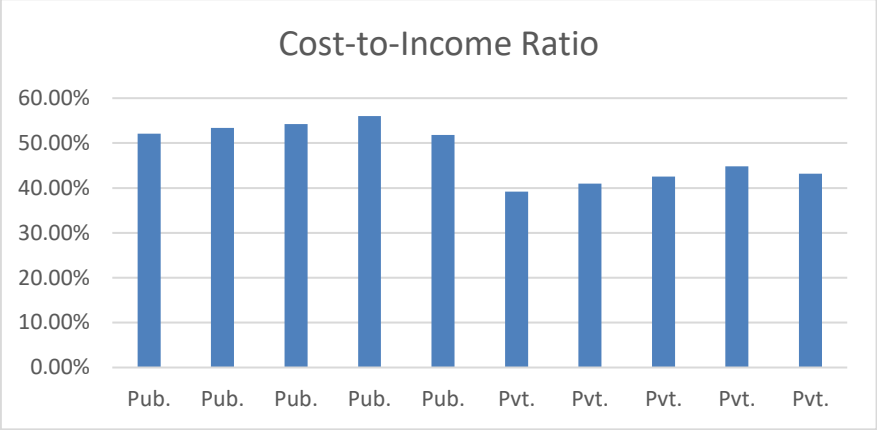
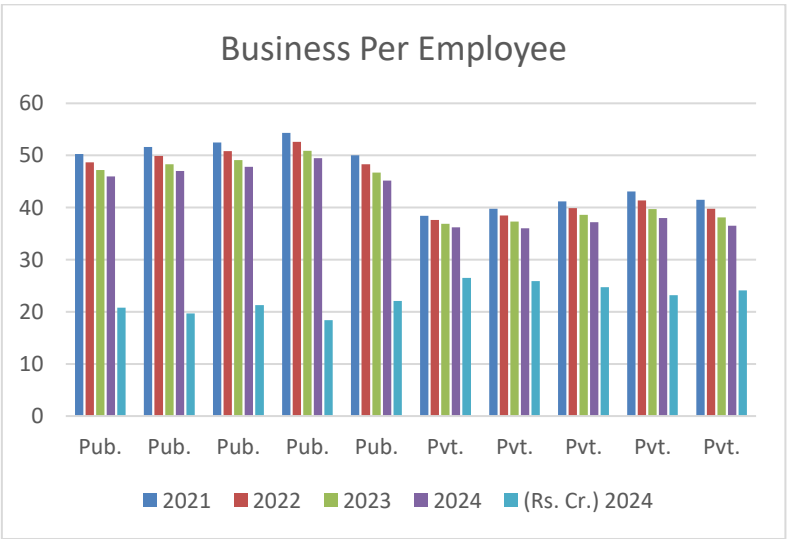


Table 3b: Business per Employee of Selected Indian Banks (2024)

Bank Name	Sector	Business per Employee (Rs. Cr.) 2024
Bank of Baroda	Pub.	20.8
Indian Bank	Pub.	19.7
Union Bank of India	Pub.	21.3
Punjab & Sind Bank	Pub.	18.4
Canara Bank	Pub.	22.1
HDFC Bank	Pvt.	26.5
ICICI Bank	Pvt.	25.9
Kotak Mahindra Bank	Pvt.	24.7
IDFC First Bank	Pvt.	23.2
Federal Bank	Pvt.	24.1

Source: RBI Statistical Tables (2020–2024)

Chart 3b:



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4.4 Earnings

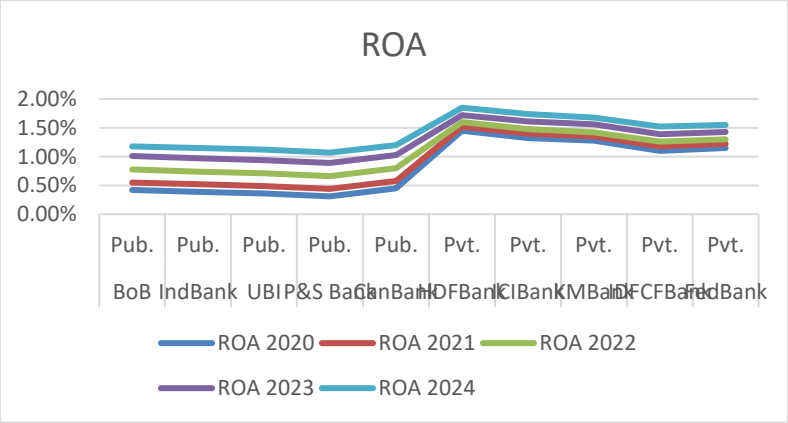
Earnings are assessed using Return on Assets (ROA), Return on Equity (ROE), and Net Interest Margin (NIM). As per RBI's 2023–24 report, Indian banks' profitability rose for the sixth consecutive year, with ROA reaching 1.4% and ROE climbing to 14.6% across Scheduled Commercial Banks. Private banks consistently posted higher NIMs (3.8–4.1%) and ROA above 1.5%, while public banks improved from ~0.4% ROA in 2020 to ~1.1–1.2% by 2024.

Table 4: Earnings Ratios of Selected Indian Banks (2020–2024)

Bank Name	Sector	ROA 2020	ROA 2021	ROA 2022	ROA 2023	ROA 2024	ROE 2024	NIM 2024
Bank of Baroda	Pub.	0.42%	0.55%	0.78%	1.01%	1.18%	11.20%	3.10%
Indian Bank	Pub.	0.39%	0.52%	0.74%	0.97%	1.15%	10.90%	3.00%
Union Bank of India	Pub.	0.36%	0.49%	0.71%	0.94%	1.12%	10.50%	2.90%
Punjab & Sind Bank	Pub.	0.31%	0.44%	0.66%	0.89%	1.07%	9.80%	2.80%
Canara Bank	Pub.	0.45%	0.58%	0.80%	1.03%	1.20%	11.50%	3.20%
HDFC Bank	Pvt.	1.45%	1.52%	1.60%	1.72%	1.85%	17.50%	4.10%
ICICI Bank	Pvt.	1.32%	1.40%	1.48%	1.61%	1.74%	16.20%	3.90%
Kotak Mahindra Bank	Pvt.	1.28%	1.35%	1.42%	1.56%	1.68%	15.80%	3.80%
IDFC First Bank	Pvt.	1.10%	1.18%	1.26%	1.39%	1.52%	14.20%	3.60%
Federal Bank	Pvt.	1.15%	1.22%	1.30%	1.43%	1.55%	14.60%	3.70%

Source: RBI Statistical Table, MoneyControl, TaxGuru RBI Report

Chart 4: Return on Assets



5 Liquidity

Liquidity is measured using Liquid Assets to Total Assets and Liquidity Coverage Ratio (LCR). As per RBI's June 2024 report, the average LCR across Scheduled Commercial Banks stood at 130%, well above the regulatory minimum of 100%. Private banks maintained LCRs of 130–138% and liquid assets comprising 30–32% of total assets, compared to 120–124% LCR and 28–29% for public banks.

Table 5: Liquidity Ratios of Selected Indian Banks (2020–2024)

Bank Name	Sector	LCR 2020	LCR 2021	LCR 2022	LCR 2023	LCR 2024	Liquid Assets/Total Assets 2024
Bank of Baroda	Public	115%	118%	120%	122%	124%	29.50%
Indian Bank	Public	112%	115%	117%	120%	122%	28.90%
Union Bank of India	Public	110%	113%	116%	119%	121%	28.40%
Punjab & Sind Bank	Public	108%	111%	114%	117%	120%	27.80%
Canara Bank	Public	114%	117%	119%	121%	123%	29.20%

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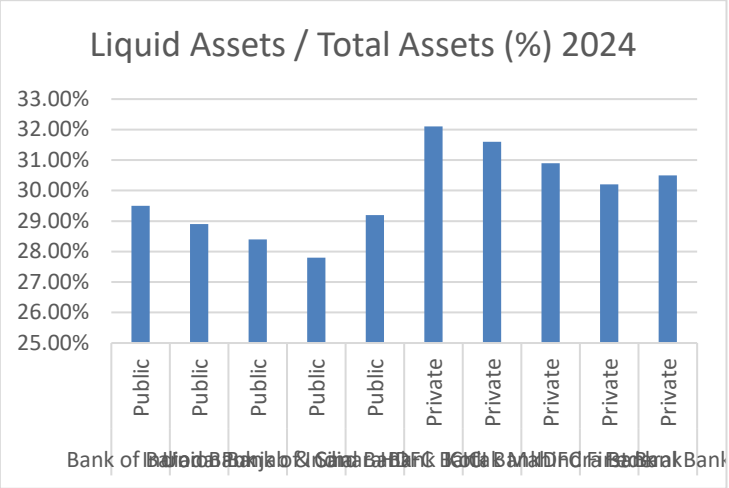
Bank Name	Sector	LCR 2020	LCR 2021	LCR 2022	LCR 2023	LCR 2024	Liquid Assets/Total Assets 2024
HDFC Bank	Private	130%	132%	134%	136%	138%	32.10%
ICICI Bank	Private	128%	130%	132%	134%	136%	31.60%
Kotak Mahindra Bank	Private	126%	128%	130%	132%	134%	30.90%
IDFC First Bank	Private	123%	125%	127%	129%	131%	30.20%
Federal Bank	Private	124%	126%	128%	130%	132%	30.50%

Source: RBI Financial Stability Report (2020–2024)

Chart 5: Liquid to Total Assets Ratio



6 Composite CAMEL Scores and Rankings

Each CAMEL component is normalized on a scale of 1 to 5 (5 = best performance), based on 2024 data with equal weights assigned to each component. HDFC Bank, ICICI Bank, and Kotak Mahindra Bank emerged as top performers, reflecting excellence across all dimensions. Punjab & Sind Bank ranked lowest due to persistent structural inefficiencies despite adequate liquidity and capital.

Table 6: Composite CAMEL Scores and Rankings (2024)

Bank	Sector	Capital Adequacy (5)	Asset Quality (5)	Mgmt Efficiency (5)	Earnings (5)	Liquidity (5)	Total (25)	Rank
HDFC Bank	Pvt.	5	5	5	5	5	25	1
ICICI Bank	Pvt.	5	5	4	5	5	24	2
Kotak Mahindra Bank	Pvt.	5	4	5	4	5	23	3
Bank of Baroda	Pub.	4	4	4	4	4	20	4
Indian Bank	Pub.	4	4	4	4	4	20	4
IDFC First Bank	Pvt.	4	4	4	4	4	20	4
Canara Bank	Pub.	4	3	4	4	4	19	7
Union Bank of India	Pub.	4	3	4	3	4	18	8
Federal Bank	Pvt.	4	3	3	3	4	17	9

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Bank	Sector	Capital Adequacy (5)	Asset Quality (5)	Mgmt Efficiency (5)	Earnings (5)	Liquidity (5)	Total (25)	Rank
Punjab & Sind Bank	Pub.	3	3	3	3	4	16	10

Source: Derived from Tables 1–5 using RBI, ICRA, Moneycontrol, and bank annual reports.

Strategic Trend Summary

Table 7: Strategic Trend Summary (2020–2024)

CAMEL Dimension	Key Drivers	Public Sector Banks	Private Sector Banks	Sector Leader 2024
Capital Adequacy	Strong internal accruals, low risk assets	Improved ~13% to ~17%	Stable above 18%	Private Banks
Asset Quality	Better credit appraisal, faster recovery	GNPA: ~9-10% to ~3%	GNPA: ~3-5% to ~1-1.5%	Private Banks
Mgmt Efficiency	Tech adoption, lean cost structures	C/I Ratio dropped ~8-10%	Dropped ~6-8%; higher productivity	Private Banks
Earnings	Risk-based pricing, diversified income	ROA: ~0.4% to ~1.2%	ROA: ~1.3% to ~1.8%	Private Banks
Liquidity	Conservative asset allocation	LCR: ~110-124%	LCR: ~130-138%	Private Banks

Source: Data analysed by authors.

Findings and Discussion

The CAMEL-based evaluation reveals a consistent pattern: private sector banks outperform public sector banks across all five dimensions. HDFC Bank, ICICI Bank, and Kotak Mahindra Bank demonstrated superior capital strength, asset quality, operational efficiency, profitability, and liquidity management.

1. Capital Adequacy: Private banks maintained CRAR above 18%, while public banks improved from ~13% to ~17% over five years.
2. Asset Quality: GNPA ratios dropped across the board; private banks achieved sub-1.5% levels by 2024 compared to ~3% in public banks.
3. Management Efficiency: Private banks operated with leaner cost structures (Cost-to-Income ~36%) and higher productivity (Rs. 25–26 Cr. business per employee).
4. Earnings: ROA and ROE for private banks consistently exceeded 1.7% and 16% respectively, driven by higher NIMs and diversified income streams.
5. Liquidity: All banks maintained LCR above 100%, but private banks held higher liquid assets (~32% of total assets).

The period 2020–2024 marked a strategic inflection point. The COVID-19 crisis accelerated digital transformation, regulatory recalibration, and credit discipline. Both public and private banks improved their CAMEL metrics, but private banks capitalized more effectively on the recovery momentum through digital agility, governance autonomy, and performance-linked incentives.

Conclusion and Recommendations

Conclusion

This study applied the CAMEL framework to benchmark ten Indian banks over 2020–2024. The findings reveal a consistent trend: private sector banks outperform public sector banks across all five CAMEL dimensions, particularly in asset quality, earnings, and operational efficiency. While public banks have shown commendable improvement post-COVID, especially in GNPA reduction and capital adequacy, they continue to face structural challenges. The CAMEL model proved to be a robust diagnostic tool, offering a multidimensional lens to evaluate banking resilience, profitability, and governance.

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I would also like to acknowledge the various public sources, annual reports, financial statements, regulatory publications, and databases that facilitated access to reliable data for analyzing the financial efficiency and performance

of Indian public and private sector banks during the period 2020–2024.

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Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

A Case Study on Kagal Nagar Parishad Waste Management - Vermicomposting and Power Generation Project

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Abstract

The proper waste management leads to environmental sustainability. It is common to see piles of garbage piled up on roads, drains, open spaces and water bodies in rural and urban areas of India. The lack of proper disposal of solid waste has an impact on all aspects of the environment. Due to the increase in population in India, urbanization is increasing everywhere. It has an impact on the environment. Kagal Taluka is a taluka in Kolhapur district of the Indian state of Maharashtra. Kagal Municipal Council has started focusing on waste management. However, the problem of waste management still persists at the taluka level. If waste management is improved, it can help maintain good health of the people in the surrounding human settlements of Kagal Municipal Council. It can also help support economic development, which can improve the overall quality of life. The present study aims to: (1) examine the solid waste management practices in Kagal Municipal Council (2) study on vermicomposting and power generation project in Kagal Municipal Council (3) assess the level of public participation in these waste management initiatives.

The data has been collected by interviewing the persons working in the Kagal Municipal Council Solid Waste Management Vermicompost and Power Generation Project and by interviewing other concerned officials as well as by direct observation, and interviewing the people who are working on that plant. Secondary data for this study was collected from sources like municipal offices, journals, research papers, libraries, books, newspapers. The data collected was analysed using Excel. The findings of the study show that this is innovative project implemented in the study area. This project is about the solid waste management project of Kagal Nagar parishad. The study conclude that this project is helpful to all the Kagal nearby area. The project offers a replicable model for small and medium-sized towns aiming to adopt sustainable waste management practices, create employment, and enhance economic growth while promoting environmental responsibility.

Key word *– Solid waste Management, Material Recovery Facility (MRF), RDF, Vermicomposting*

Introduction

Solid waste management has become one of the major challenges for urban and semi-urban areas in India due to rapid population growth, increased consumption, and changing lifestyles. Improper disposal of waste not only leads to environmental pollution but also poses health risks and creates additional pressure on local governance systems. In this context, the Kagal Nagar Parishad has taken a significant step towards addressing waste management challenges by implementing an integrated waste treatment system focusing on vermicomposting and power generation.

The waste management project at Kagal aims to handle the organic waste generated by households and commercial establishments in an environmentally friendly and economically viable manner. Vermicomposting is a natural process that utilizes earthworms to convert organic waste into nutrient-rich compost, which can be used by local farmers to improve soil fertility. In addition, the project includes energy recovery through the conversion of waste into biogas and electricity, thereby reducing dependence+ on conventional energy sources.

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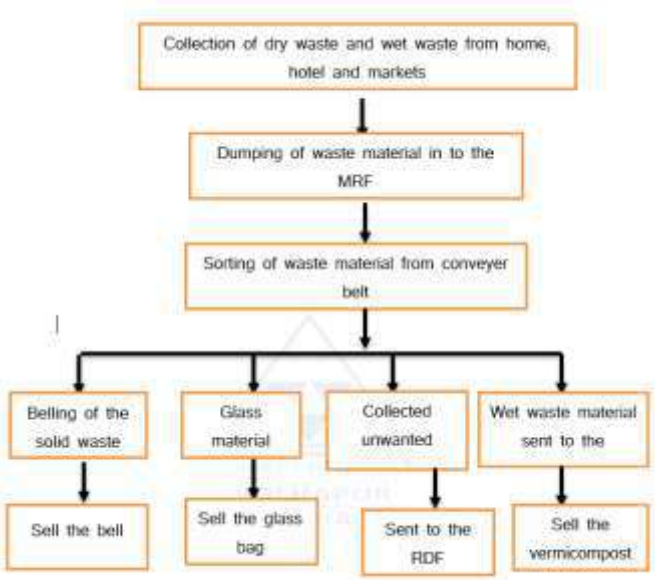
This integrated approach not only helps in reducing the burden on landfills but also generates employment opportunities, supports the local economy, and encourages public participation. The project serves as a model for other small and medium-sized towns seeking sustainable and cost-effective waste management solutions.

Process



Material Recovery Facility (Mrf)

Kagal Municipal Corporation Biogas Plant

Kagal Municipal Plant Belling Machine

Sanatory Pad Disposal Machine

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Vermicomposting

Refused Derived Fluid Rdf

Conveyer Belt

Tank And Mixture

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Importance Of the Case Study

The Kagal Solid Waste Treatment project is highly relevant for social work research, especially in the context of sustainable urban development and improving community well-being. It illustrates how smaller towns can adopt effective and eco-friendly waste management strategies such as composting and biogas production. This is particularly significant in India, where rapid urban growth has led to an alarming rise in municipal waste and inadequate disposal systems. The study also underlines the importance of local governance and Public-Private Partnership (PPP) models in promoting both community involvement and financial sustainability. By turning waste into electricity and organic manure, the Kagal Municipal Council not only minimizes environmental degradation but also creates employment opportunities and additional revenue. This reflects the dual social and economic value of innovative waste management practices. From a social work perspective, the project highlights the direct connection between waste treatment, public health, and community hygiene. Effective management reduces the spread of diseases, enhances living conditions, and contributes to a healthier urban environment, which aligns with the broader mission of social work to improve social welfare and quality of life. Moreover, the Kagal model provides a replicable framework for other towns and municipalities. It demonstrates that with proper planning, judicious use of resources, and active community participation, sustainable waste management is achievable even in resource-constrained settings.

Problem Statement

Solid waste management has become a critical challenge for urban and semi-urban local bodies due to rapid population growth, urbanization, and insufficient waste collection and disposal systems. In Kagal Municipal Council, improper collection, segregation, and disposal of solid waste have resulted in environmental pollution, unhygienic conditions, and public health risks. Despite efforts by the municipal authorities, conventional waste management practices remain inadequate to handle the increasing volume of waste effectively. The council has initiated innovative measures such as vermicomposting and electricity generation from wet waste, yet the operational efficiency, techno-economic feasibility, and the level of public participation in these projects remain insufficiently studied. Additionally, public awareness and engagement in waste segregation and disposal are limited, which further hinders the effectiveness of these initiatives. Therefore, the core problem of this study is to investigate the current practices of solid waste management in Kagal Municipal Council, evaluate the effectiveness of vermicomposting and power generation projects, and assess the role of community participation in ensuring sustainable and efficient waste management. Addressing these issues is essential for improving environmental sustainability, enhancing urban hygiene, and promoting socio-economic development in the region.

The Title Is "A Case Study on Kagal Nagar Parishad Waste Management -Vermicomposting and Power Generation Project."

Objectives Of the Study

1. To study solid waste management in Kagal Municipal Council.
2. To study on vermicomposting and power generation project in Kagal Municipal Council.
3. To study on people's participation in Kagal Municipal Council solid waste management project.

Scope Of the Study

The scope of this study encompasses the examination of solid waste management practices within the Kagal Municipal Council. It focuses on assessing the methods employed for waste collection, segregation, and disposal, with particular emphasis on innovative technologies such as vermicomposting and electricity generation from wet waste. The study also explores the extent of public participation in these initiatives, recognizing the critical role of community involvement in effective waste management. By analysing the operational strategies of the Kagal Municipal Council, the research aims to provide insights into sustainable solid waste management practices that can be adopted by other municipalities facing similar challenges. Furthermore, the study highlights the techno-economic feasibility and environmental benefits of converting solid waste into usable energy, contributing to urban hygiene and ecological sustainability.

Limitations Of the Study

The limitations of the study is as,

Geographical Limitation:

This study is limited to Kagal Municipal Council; therefore, the findings may not be directly applicable to other municipalities with different socio-economic or demographic characteristics.

Time and Resource Constraints:

Limited time and resources may affect the depth of fieldwork and make it difficult to assess the long-term impacts of waste management initiatives.

Research Methodology

The study will adopt a case study research method, which is suitable for an in-depth analysis of waste management practices in a specific context – Kagal Nagar Parishad. A case study approach allows for the examination of real-life processes, challenges, and outcomes related to vermicomposting and power generation from municipal solid waste.

Research Design

This study used a Descriptive research design to examine the existing solid waste management practices in Kagal Municipal Council.

1.Source of primary data:

For the proposed study's primary data collection researcher use the following methods for the effective collection of data.

1. Focused group discussion
2. Observation

2. Sources of secondary Data:

For the secondary data collection researcher use the following methods, Different books, journals, periodicals, newspapers, Magazine, booklets, information broachers, Internet facility, Data from government authorities, concern departments.

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Conclusion

The case study on Kagal Nagar Parishad Waste Management, focusing on vermicomposting and power generation, demonstrates an efficient and sustainable approach to solid waste management. The council's integrated system not only reduces environmental burden but also provides economic benefits through compost sales at ₹5 per kilogram and electricity generation, contributing to local revenue and supporting the economy.

Community participation has been crucial to the success of the project, ensuring proper waste segregation and collection at the source. The system requires less space compared to conventional methods, making it a feasible solution for both small towns and select areas in metropolitan regions.

Overall, the Kagal Municipal Council's model serves as a practical and replicable example for other small and medium-sized towns, highlighting how innovative waste processing techniques combined with public engagement can achieve effective, low-cost, and sustainable solid waste management while generating employment and enhancing community well-being.

Acknowledgment

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this case study titled *"A Case Study on Kagal Nagar Parishad Waste Management – Vermicomposting and Power Generation Project."*

First and foremost, I extend my heartfelt thanks to my research guide/supervisor for their invaluable guidance, constant encouragement, and constructive suggestions throughout the preparation of this study. Their support and expertise were instrumental in the successful completion of this work.

I am also grateful to the faculty members and administration of my institution for providing the necessary academic support, resources, and facilities required for conducting this research.

My sincere appreciation goes to the officials, staff members, and stakeholders of Kagal Nagar Parishad for their cooperation, valuable information, and assistance in understanding the implementation and functioning of the vermicomposting and power generation project. Their insights greatly enriched the findings of this case study.

I would also like to acknowledge the contributions of environmental experts, researchers, and scholars whose studies on solid waste management, vermicomposting, renewable energy generation, and sustainable urban development provided an important foundation for this research.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

Recommendations

1.Expand Community Awareness Programs

For that organise regular awareness campaigns and workshops to educate citizens about proper waste segregation, composting, and the benefits of energy recovery.

The success of the Kagal Nagar Parishad project depends heavily on active participation from residents. Studies and observations from the project show that areas with better public engagement have cleaner waste streams and higher compost quality.

2.Increase Vermicoposting Unit

There is need to increase vermicomposting facility to process larger quantities of organic waste generated in the Kagal Nagar parishad.

The compost produced is in high demand among local farmers. Increasing capacity will enhance revenue generation and reduce the burden on landfill sites.

3. Enhance Power Generation Efficiency-

Upgrade the biogas-to-electricity system with modern, cost-effective technologies to improve energy output.

Current energy generation is limited and not fully cost-competitive. Improved technology will increase electricity production, reduce operational costs, and contribute to financial sustainability.

4. **Introduce Incentives For Household Participation:**

For that provide small incentives such as reduced municipal fees or free compost to households practicing proper segregation.

Incentives motivate citizens to actively participate in waste management programs, ensuring cleaner waste collection and more efficient vermicomposting.

5.Continuous Evaluation and Monitoring

Establishment of a who work delicately to monitor waste segregation, compost quality, and power generation efficiency on a regular basis.

Continuously assessment ensures the project meets its environmental and economic objectives while identifying areas for improvement.

6. Make Model in Nearby Towns

The Kagal model as a template for other small and medium-sized towns for both vermicomposting and energy generation.

The project has proven effective, sustainable, and economically viable, making it a replicable solution for broader municipal waste management challenges.

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Original Article

Rural Development; Problems and Challenges

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Abstract:

Rural Development is the development of rural poor Rural poor means below poverty line people especially from Farmers, Landless labours, SC, ST, etc. Category residing in rural area. The Government of India has launched various rural development schemes before and after independence period. These schemes have contributed rural development process by and large. These schemes includes employment generation schemes, Poverty Alleviation Schemes, agricultural Schemes, enterpriseship schemes, supply of food grain, medical and health facilities and fulfilment of basic minimum needs of rural poor people. Implementation of these schemes is a hard task and needs continuous and joint efforts by the government, NGOs, Banks and beneficiaries of the schemes.

Key Words: *Rural Development, entrepreneurs, Economic Development.*

Introduction:

International Labour Organization (ILO-1978) has defined " It is a strategy designed to improve the Economic and Social Life of a specific group of people the mural poor. It involves extending the benefits of development to the poorest among those who seek a livelihood in the rural area." Today, Inclusive rural development is more specific concept than the concept of rural development of earlier. In broader terms , inclusive rural development is about improving the quality of life of all rural people. More specifically, inclusive rural development covers three different but interrelated dimensions. Economic Dimension refers to providing both capacity and opportunities for the poor and low-income households in particular, benefit from the economic growth. Social dimension supports social development of poor and low- income households. Political dimension improves the opportunities for the poor and low income people in rural areas to effectively and equally participate the political processes at the village level.

Objectives:

1. To study highlight various rural development schemes.
2. To study the understand problems of rural development programs implementation.
3. To study the highlight challenges of rural development.

Methodology:

The present study is based on secondary data. The date has been extracted from research studies Journals, Research articles, Publications from Government of India and authenticated websites and articles are collected in order to understand the rural development for economic growth.

Rural Development:

International Labour Organization (ILO-1978) has defined " It is a strategy designed to improve the Economic and Social Life of a specific group of people-the rural poor. It involves extending the benefits of development to the poorest among those who seek a livelihood in the rural area."

Problems of rural development

The Importance of Rural Development:

1. Economic Backbone
2. Poverty Alleviation
3. Inclusive Growth
4. Agricultural Sustainability.
5. Infrastructure Enhancement
6. Employment generation
7. Social Development

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8. Mitigating Urban Migration
9. Cultural Preservation
10. Environmental conservation

Identification of Beneficiaries:

1. Cast criterion for the Identification of beneficiaries is hardly followed because artisans, who are the rural poor are not properly identified for rural development schemes.
2. Age Criterion for the Identification of beneficiaries is hardly followed because young generation in the age limit of 25 to 35 years is neglected for rural development schemes.
3. Non-agricultural beneficiaries are given less preference for the Identification of beneficiaries for rural development schemes.
4. Political Influence and personal contacts play an important role in Identification of beneficiaries.

Entrepreneurship Development:

1. Majority beneficiaries preference to undertake agricultural businessactivities under the rural development schemes and hesitate to undertake commercial activities.
2. The traditional artisan's activities are also neglected rural development schemes because of less participation of artisans in rural development schemes.
3. Rural development programme implementation agencies do not regular feedback from beneficiaries.
4. In some cases rural development programme implementation agencies, Banks and NGOs do not supervise and monitor business activities under rural development programme.

Financial Assistance:

1. In some cases Banks and other financial Institutions hesitate to provide financial assistance to beneficiaries.
2. Banks and other financial Institutions delay sanctioning the loan to beneficiaries.
3. Majority beneficiaries state that loan amount or subsidy amount is not sufficient for meeting the business acquirements.
4. Majority beneficiaries fail to make repayment of loans.

Business operating:

1. Majority beneficiaries are not familiar with marketing conditions and channels which results into less demand for their business products.
2. Majority business units have local market but they failed to capture national market.
3. Some of the business units under rural development schemes have low price earning capacity.
4. Majority business units charge higher price for their products.
5. Majority beneficiaries lack communication and professional skills.

Classification of Rural Development:

1. Equity-Welfare oriented Programmes
2. Growth oriented Programmes
3. Specific Area and Group Development Programmes
4. People Centric Programmes
5. Integrated or Holistic Strategy.

Challenges of Rural Development:

1. Exploitation of Village Resources
   India has plenty of land, Water, Forest, Animals, Minerals, healthy environment. These village properties can be properly exploited for initiating and implementation of rural development programs.
2. Use of Labour Intensive Techniques
   India has second largest population in the world and there is unemployment in our agricultural, small and medium scale industries labour Intensive techniques should be adopted in rural industrial units.
3. Supply of finance with low rate interest
   Banks and Financial institutions like ICICI, SIDBI, IDBI, IFCI, and SFC should provide finance to rural entrepreneurs with low rate of interest, limited collateral security with liberal terms and conditions.
4. Provision of Infrastructure facilities
   The Infrastructure facilities like land, Building, power, raw materials etc. Should be provided to the rural entrepreneurs.
5. Agro and Marine food processing units
   The rural entrepreneurs should be motivated for Establishment of non-farm business activities, small and cottage industries, juice making, sweet marts, canteen, lodging and Boarding, stationary, carpentry, transport services, activities .
6. Market Information
   The Rural entrepreneur
7. Training programmes
8. Skill India programmes

Conclusion:

A part from strengthening the agriculture sector, Rural entrepreneurship plays a vital role in the economic development of India, particularly in the rural economy. It helps in generating employment opportunities in the rural areas which low capital, raising the real income of the people, contributing in reducing disguised unemployment, under employment unemployment, Poverty, migration and economic disparity. Government should go for appraisal of various rural development schemes and Programmes in order to uplifting rural areas, Monitoring rural development programmes by supplying right time, providing timely and adequate credit and continuous motivation by the government, bankers Village Panchayat and NGOs will lead to the development of rural entrepreneurship and in turn rural development

Acknowledgment

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study titled *"Rural Development: Problems and Challenges."*

First and foremost, I extend my heartfelt thanks to my research guide/supervisor for their invaluable guidance, continuous encouragement, and constructive suggestions throughout the course of this study. Their expertise and mentorship greatly contributed to the successful completion of this work.

I am also grateful to the faculty members and administration of my institution for providing the necessary academic support, resources, and facilities required for conducting this research.

My sincere appreciation goes to the rural communities, development practitioners, local authorities, and respondents who shared their experiences, perspectives, and valuable information regarding the various issues and challenges affecting rural development. Their cooperation was essential to the success of this study.

I would also like to acknowledge the contributions of researchers, scholars, policymakers, and organizations working in the field of rural development. Their published works, reports, and studies provided valuable insights and a strong theoretical foundation for this research.

I am thankful to my friends and colleagues for their encouragement, constructive feedback, and assistance during different stages of this study.

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Conflicts of interest

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Original Article

One District One Product: Connecting Districts to the World (A Study in Kodagu District)

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Abstract

The One District One Product (ODOP) initiative reflects India's vision of promoting self-reliance (Atmanirbhar Bharat) by strengthening local economies through the identification and promotion of region-specific products. Rooted in the philosophy of Swadeshi, *ODOP seeks to connect districts to global markets while preserving indigenous knowledge, cultural heritage, and sustainable practices. This study focuses on Kodagu district in Karnataka, a region known for its coffee cultivation, rich ethnobotanical resources, and unique socio-cultural traditions. The study aims to identify and analyze the key products of Kodagu district, examine the role of ODOP in promoting self-reliance, and assess the challenges faced in its implementation. Kodagu's traditional coffee-based economy, supported by the indigenous Kodava community's knowledge systems and community-based forest management practices, provides a strong foundation for ODOP initiatives. The findings reveal that coffee, along with ethnobotanical products, holds significant potential for value addition, market expansion, and livelihood generation under the ODOP framework. The research highlights that ODOP contributes positively to local economic development by enhancing income opportunities, promoting entrepreneurship, and encouraging sustainable use of natural resources. It also supports cultural preservation by integrating traditional practices with modern market systems. However, the implementation of ODOP in Kodagu faces several challenges, including climate variability affecting coffee production, infrastructure gaps, limited market access, and inadequate skill development among local producers. The study concludes that while ODOP has the potential to transform Kodagu's rural economy and connect it to wider markets, its success depends on effective stakeholder collaboration, improved infrastructure, targeted skill development, and policies that balance economic growth with environmental sustainability. Strengthening these aspects can enhance the impact of ODOP and serve as a model for similar districts across India.*

Keywords: *ODOP, District, coffee, spices, processing…*

Introduction:

In India, every district possesses unique resources and products with the potential for economic growth. The One District One Product (ODOP) initiative is a transformative step aimed at realizing the vision of converting each district into an export hub by promoting its specialized product. It seeks to enhance economic and socio-cultural development, generate employment, and support local businesses and industries, thereby contributing to the vision of Atmanirbhar Bharat (https://www.indianembassyalgiers.gov.in/content/ODOP-Brochure). ODOP, initially launched in Uttar Pradesh in 2018 and later expanded nationwide, focuses on identifying and promoting district-specific products to drive rural entrepreneurship, balanced regional development, and self-reliance.

(https://www.pib.gov.in/PressReleasePage.aspx?PRID=1881486&reg=3&lang=2;Mishra, 2022). Inspired by Japan's One Village One Product model, the initiative has been integrated with the Districts as Export Hub (DEH) program and covers over 770 districts, promoting products based on local resources, skills, and heritage.(https://www.ibef.org/blogs/empowering-districts-empowering-india-the-odop-revolution). The core objective of ODOP is to transform districts into manufacturing and export hubs by strengthening value chains, improving product quality, and expanding market access.

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It supports micro-enterprises through subsidies, infrastructure development, training, and financial assistance, particularly benefiting women self-help groups and small producers (https://tgfps.telangana.gov.in/pmfme/one-district-one-product-approach). Aligned with the Swadeshi philosophy, ODOP promotes indigenous production and consumption under the "Vocal for Local" approach, integrating traditional knowledge with modern technologies to preserve cultural heritage while enhancing competitiveness (https://www.vajiraoinstitute.com/upsc-ias-current-affairs/one-district-one-product-odop.aspx). Furthermore, it strengthens the Aatmanirbhar Bharat mission by boosting MSMEs, improving exports, reducing import dependence, and generating employment through initiatives like PMFME and DEH (https://www.eoibogota.gov.in/page/odop/).

The ODOP scheme by the Ministry of Food Processing Industries (MoFPI) provides a framework for:

- **Procurement and Common Services**: Reaping benefits of scale for input procurement and marketing.
- **Infrastructure Support**: Establishing incubation centers, R&D, and training specifically for these products.
- **Financial Assistance**: Providing support for the upgradation of micro-food processing enterprises through credit-linked subsidies

Source: (Ministry of Food Processing Industries)

Literature Review

The **One District One Product (ODOP)** initiative, grounded in the principles of the Swadeshi approach and self-reliance, provides a significant framework for promoting localized economic development. In the context of Kodagu district in Karnataka, this initiative intersects with indigenous economic practices, community attitudes, and sustainable natural resource management. Kodagu, characterized by its traditional coffee cultivation, rich cultural heritage, and ecological significance within the Western Ghats, offers a unique setting to examine the localized implementation of ODOP under the Swadeshi philosophy.

Historically, the Swadeshi movement in India emphasized self-sufficiency through the promotion of indigenous goods and the rejection of foreign products. This ideology was strongly advocated by Mahatma Gandhi, particularly through the promotion of khadi as a symbol of economic independence and nationalism. The movement aimed to strengthen local production and consumption patterns, thereby reducing dependence on external economies (Trivedi, 2003; Bayly, 1986). The ODOP initiative reflects similar principles by encouraging districts to identify and promote region-specific products, fostering rural economic growth and self-reliance.

Kodagu's socioeconomic and ecological context further strengthens this discourse. The district is widely recognized for its coffee-based plantation economy, where farmers have developed adaptive strategies to cope with climate variability. These include crop diversification and improved agronomic practices, demonstrating resilience and local self-reliance in agricultural systems (Chengappa et al., 2017; Byrareddy et al., 2024). In addition, the indigenous Kodava community possesses extensive ethnobotanical knowledge, utilizing over 200 plant species for medicinal, nutritional, and agricultural purposes. This traditional knowledge system aligns closely with ODOP's objective of promoting locally available resources and indigenous products (Kalyanasundaram, 2024).

Community attitudes and traditional resource management practices also play a critical role in shaping the success of ODOP initiatives. In Kodagu, local livelihoods are deeply connected to forest resources, which are often conserved through culturally significant practices such as the maintenance of sacred groves. These systems reflect a balance between ecological conservation and livelihood needs. However, increasing economic pressures, particularly from commercial coffee cultivation, pose challenges to forest sustainability while simultaneously encouraging the integration of economic development with conservation efforts (Ormsby, 2013; Macura et al., 2011). Such dynamics are crucial for understanding how ODOP initiatives can effectively balance market integration with environmental sustainability.

Socioeconomic factors further influence local participation in economic activities, including ODOP-related enterprises. Studies indicate that climate change poses varying levels of risk to key commodities like coffee across different regions of Kodagu, highlighting the importance of localized adaptive strategies for sustaining production and ensuring long-term economic resilience (Byrareddy et al., 2024).

In conclusion, the implementation of ODOP in Kodagu under the Swadeshi framework aligns closely with the district's traditional economic systems, indigenous knowledge, and community-based resource management practices. By promoting products such as coffee and ethnobotanical resources, the initiative enhances self-reliance and rural livelihoods. However, challenges such as climate variability and conservation pressures necessitate a balanced approach that integrates socio-economic insights, cultural values, and sustainable practices. This synthesis underscores the relevance of Swadeshi ideology in fostering indigenous economic empowerment and sustainable development in Kodagu district.

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Benefits of ODOP:

Source: https://www.indianembassyalgiers.gov.in/content/ODOP-Brochure

Objectives of the study:

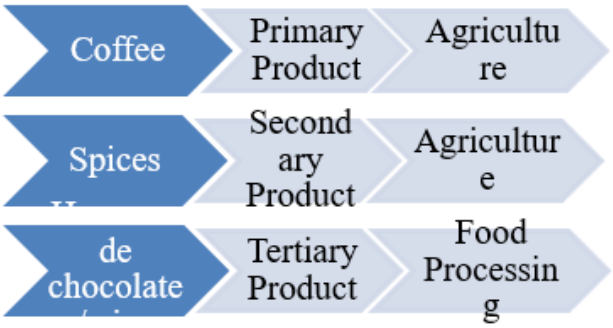
1. To identify and analyze the key products of Kodagu district
2. To examine the role of the ODOP initiative in promoting Atmanirbhar Bharat
3. To identify the challenges and constraints faced in the implementation of the ODOP initiative

ODOP Products & their Descriptions in Kodagu district:

The One District One Product (ODOP) initiative in Kodagu, Karnataka, aims to promote regional economic growth by branding and scaling products that reflect the district's unique agricultural and artisanal strengths.

Ministry of Industries and Commerce, Government of Karnataka and the Ministry of Food Processing Industries (MoFPI) have officially identified Coffee and its associated value-added products as the primary ODOP focus for the Kodagu district.

ODOP Product List:



Source: https://www.indianembassyalgiers.gov.in/content/ODOP-Brochure.

Under the ODOP framework and the PMFME (Pradhan Mantri Formalisation of Micro Food Processing Enterprises) scheme, the primary identified products for Kodagu include:

- **Coffee and Allied Products:** Kodagu is a major coffee-producing hub, and coffee is the central focus for value-chain development in the region.
- **Spices:** The district's fertile landscape supports high-quality spice production, which is included under the agricultural sector of the initiative.
- **Homemade Chocolates:** Handcrafted chocolates made from premium cocoa and blended with local flavors are a key food processing focus.
- **Homemade Wines:** Traditional fruit-based and artisanal wines are promoted alongside chocolates under the food processing category.

Coffee as Primary Product:

Coffee production in India is dominated in the hill tracts of South Indian states, of Karnataka, Kerala and Tamil Nadu. Coffee in India is grown under a canopy of thick natural shade in ecologically sensitive regions of the Western and Eastern Ghats. This is one of the 25 biodiversity hotspots of the world. Coffee contributes significantly to sustain the unique bio- diversity of the region and is also responsible for the socio-economic development in the remote, hilly areas. It was during 18th century that the commercial plantations of coffee were started. India is the 7th largest producer of coffee globally. India produced over 3,63,500 metric tons of coffee in the year 2024-25. Challenges in other major coffee-producing countries like Brazil and Vietnam have also contributed to increased demand for Indian coffee. Indian coffee flavor is also a major factor for increased global demand.

(https://www.dgciskol.gov.in/CI_Analytical_Reports.aspx)

Coffee Export Performance

While there is no direct ODOP specific export figure published at the district level, coffee export data strongly reflects Kodagu's global role, which is directly tied to the ODOP product choice (coffee):

Kodagu is one of India's top contributors to coffee exports, with its share in national coffee export value rising over recent years:

- In FY 2022-23, Kodagu's share of total Indian coffee exports was ~28.7%.

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- In FY 2023-24, it rose further to ~29.7%.
- In FY 2024-25, Kodagu contributed ~35.3% of coffee export value among Indian districts.

This makes Kodagu the largest coffee export-contributing district in India in the latest trade statistics — a strong indicator of its ODOP product's performance in international markets. (https://www.dgciskol.gov.in/CI_Analytical_Reports.aspx)

Spices as Secondary Product:

Under the One District One Product (ODOP) framework, while coffee remains the primary focus in Kodagu district, spices such as pepper, cardamom, ginger, and turmeric play a significant role as secondary products. These spices are traditionally cultivated as intercrops in coffee plantations, forming an integral part of Kodagu's agroforestry system. This integrated farming practice not only enhances farm income but also supports biodiversity conservation and sustainable land use (Bhat & Nair, 2021).

Spices in Kodagu hold strong economic potential due to their high demand in both domestic and international markets. Black pepper, often referred to as the "king of spices," is one of the most important intercrops grown alongside coffee, contributing substantially to farmers' supplementary income. Similarly, cardamom and ginger add value through diversification and risk reduction, especially during fluctuations in coffee prices (Spices Board of India, 2023). Under the ODOP initiative, these spice crops can be leveraged for value addition through processing, grading, packaging, and branding, thereby enhancing export potential and rural livelihoods (Ministry of Food Processing Industries, 2024).

Homemade chocolates/wines as Tertiary Product:

Kodagu Homemade Chocolates and Wines is a unique One District One Product (ODOP) of Kodagu district, Karnataka, reflecting the region's rich agricultural bounty and artisanal expertise. Kodagu, renowned for its coffee plantations and fertile landscapes, provides the perfect environment for producing high-quality ingredients used in chocolates and wines. Local artisans and entrepreneurs craft these products with precision and creativity, blending traditional methods with innovative flavors to create indulgent and distinctive offerings.

The homemade chocolates of Kodagu are made from premium cocoa and often incorporate locally sourced flavors such as coffee, spices, and fruits, resulting in rich and aromatic confections. Similarly, Kodagu wines are crafted from carefully selected fruits, including grapes and tropical produce, fermented to perfection, offering a smooth taste and unique regional character. These products not only showcase Kodagu's culinary and artisanal heritage but also support local farmers and small scale producers, promoting sustainable livelihoods. Under the ODOP initiative, Kodagu Homemade Chocolates and Wines are positioned as signature products, representing the district's creativity, quality, and commitment to preserving traditional flavors with a contemporary twist. (https://industries.karnataka.gov.in/uploads/media_to_upload1758261263.pdf)

Support and Implementation Activities:

- The Department of Agriculture, Kodagu reports that the ODOP selection of coffee is being implemented under the Pradhan Mantri Formalisation of Micro Food Enterprises (PMFME) Scheme, which provides support including loans (up to Rs. 10 lakhs for eligible enterprises) for processing, value addition, and branding activities. (https://kodagu.nic.in/en/department-of-agriculture/)
- Under the programme, entrepreneurs and groups such as Farmer Producer Organizations (FPOs), Self-Help Groups, and cooperatives can avail up to 50% financial assistance (central + state share) for setting up **coffee**-related small enterprises. (Coffee board, Kodagu, Ministry of Commerce and Industry, Govt. of India)
- Training and capacity building for coffee value-addition (e.g., roasting and grinding units, market development) are being promoted by the Coffee Board to grow both domestic consumption and enterprise activity. (Coffee board, Kodagu, Ministry of Commerce and Industry, Govt. of India)

Challenges in the implementation of the One District One Product (ODOP) initiative:

The implementation of the One District One Product (ODOP) initiative in Kodagu district, with coffee as the flagship product, faces several interconnected challenges. Coffee cultivation in Kodagu is largely dominated by small and fragmented holdings, which limits economies of scale and reduces farmers' capacity to invest in modern processing and marketing systems (Coffee Board of India, 2023). Additionally, farmers depend heavily on intermediaries, resulting in lower price realization and minimal participation in value addition activities such as roasting and branding (Basu & Mehta, 2022). The lack of adequate local processing infrastructure further leads to value addition occurring outside the district, weakening the core objective of ODOP (Ministry of Food Processing Industries, 2024). Although Kodagu coffee has strong potential in premium markets, ineffective branding and underutilization of Geographical Indication (GI) advantages limit its global competitiveness (Coffee Board of India, 2023). Moreover, price volatility in international coffee markets creates income instability for farmers, discouraging long-term investments (International Coffee Organization, 2023). The sector also suffers from labour shortages and rising cultivation costs due to migration and declining youth participation (Government of Karnataka, 2022). Environmental challenges such as climate variability, pests, and landslides further threaten coffee productivity and sustainability (Bhat & Nair, 2021). Limited access to institutional finance and insurance, along with low financial literacy, restricts farmers' ability to adopt innovations (NABARD, 2023).

Policy Implications and Recommendations

To strengthen the implementation of ODOP in Kodagu's coffee sector, a multi-dimensional policy approach is required. First, promoting Farmer Producer Organizations (FPOs) and cooperative models can help aggregate smallholders, improve bargaining power, and achieve economies of scale. Second, there is a need to develop local value addition infrastructure, including coffee processing, roasting, and packaging units within the

district, supported by subsidies and public-private partnerships.

Improving market access and branding is critical; hence, policies should focus on strengthening Kodagu coffee's identity through Geographical Indication (GI) promotion, digital marketing platforms, and direct-to-consumer channels, reducing dependence on intermediaries. Additionally, price stabilization mechanisms such as minimum support measures, crop insurance, and market intelligence systems can help farmers manage global price volatility.

Addressing labour shortages requires skill development programs and youth engagement initiatives, particularly in specialty coffee production, entrepreneurship, and agri-business management. In parallel, climate-resilient agricultural practices—such as shade management, pest control, and sustainable farming—should be promoted through extension services and research support.

Enhancing access to institutional finance through simplified credit procedures, interest subsidies, and financial literacy programs is essential to enable farmers to invest in modern technologies. Finally, strengthening institutional coordination and governance by integrating efforts of the Coffee Board, ODOP agencies, cooperatives, and local bodies, along with effective monitoring systems, will ensure better implementation and long-term sustainability of the initiative.

Conclusion:

The One District One Product (ODOP) initiative represents a strategic approach to fostering self-reliance in India by leveraging local strengths and promoting region-specific products. In the context of Kodagu district, the study highlights that coffee, supported by rich ethnobotanical resources and indigenous knowledge systems of the Kodava community, holds significant potential for driving sustainable economic development. ODOP has contributed positively by enhancing income opportunities, encouraging entrepreneurship, and facilitating value addition and market expansion, while also preserving cultural heritage and traditional practices. However, the effectiveness of ODOP in Kodagu is constrained by several challenges, including climate variability affecting coffee production, inadequate infrastructure for processing and marketing, limited access to wider markets, and gaps in skill development among producers. These issues indicate that while the district has strong inherent potential, the realization of ODOP objectives requires a more robust and coordinated policy framework.

Overall, the study concludes that ODOP can serve as a transformative model for Kodagu's rural economy by linking local production systems to national and global markets. Its long-term success, however, depends on strengthening institutional coordination, investing in infrastructure, promoting skill and entrepreneurship development, and adopting environmentally sustainable practices. Addressing these aspects will not only enhance the impact of ODOP in Kodagu but also provide valuable insights for replicating similar models in other districts across India.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Financial Inclusion in India: Integrating CRISIL Inclusix and RBI Financial Inclusion Index (2009–2025)

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Abstract

Financial inclusion has emerged as a crucial driver of inclusive economic growth, financial stability, and social equity in India. It ensures access to affordable financial services such as banking, credit, insurance, and pension facilities, particularly for underserved and marginalized sections of society. This study provides a comprehensive analysis of financial inclusion in India by integrating two major measurement frameworks—CRISIL Inclusix (2009–2016) and the Reserve Bank of India's Financial Inclusion Index (FI-Index) for recent years up to 2025. The CRISIL Inclusix data shows that the financial inclusion score increased from 35.4 in 2009 to 58.0 in 2016, indicating a transition from below-average to above-average inclusion, driven by initiatives such as the Pradhan Mantri Jan-Dhan Yojana (PMJDY).

The study further examines recent developments using the RBI FI-Index, which reached 67 in 2025. Unlike CRISIL Inclusix, the FI-Index incorporates dimensions of access, usage, and quality, offering a more comprehensive assessment. A one-way ANOVA test was applied across three phases of financial inclusion, and the results indicate a statistically significant improvement over time ($F \approx 22.4$, $p < 0.001$), confirming structural transformation in financial inclusion. Despite notable progress, challenges such as low credit penetration, regional disparities, and limited financial literacy persist. The study concludes that future policy efforts should focus on deepening financial inclusion through improved credit access, digital financial literacy, and equitable distribution of financial services.

Key words: *Financial Inclusion, Credit Penetration, Inclusive Growth, CRISIL Inclusix, Financial Literacy*

Introduction

Financial inclusion is the process of ensuring access to appropriate financial products and services needed by all sections of the society in general and vulnerable sections and low income groups in particular at an affordable cost. It is essential for reducing poverty, promoting entrepreneurship, and achieving equitable economic development.

- CRISIL, a credit rating private company defines financial inclusion as "The extent of access by all sections of society to formal financial service such as credit, deposit, insurance and pension services".
- The Committee on Financial Inclusion (2008) defined that "Financial inclusion is the process of ensuring access to financial services and timely adequate credit needed by vulnerable groups such as weaker sections and low income groups at an affordable cost".

Increasingly, in developing countries, access to finance is positioned as a public good, which is as important and basic as access to safe water or primary education. A good is considered a 'public good' if it meets the conditions of non-rivalness in consumption and non-excludability.

Rationale for Financial Inclusion

Finance has come a long way since the time when it wasn't recognized as a factor for growth and development. It is now attributed as the brain of an economic system and most economies strive to make their financial systems more efficient. It also keeps policymakers on their toes as any problem in this sector could freeze the entire economy and even lead to a contagion. Moreover, prolonged and persistent deprivation of banking services to a large segment of the population leads to decline in the aggregate investment and has the potential to fuel social tensions causing social exclusion.

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Thus, financial inclusion is an explicit strategy for accelerated economic growth and is considered to be critical for achieving inclusive growth in the country.

Evolution of Financial Inclusion in India

India's financial inclusion journey can be analytically divided into two distinct yet interrelated phases, reflecting the evolution of policy focus and measurement frameworks over time.

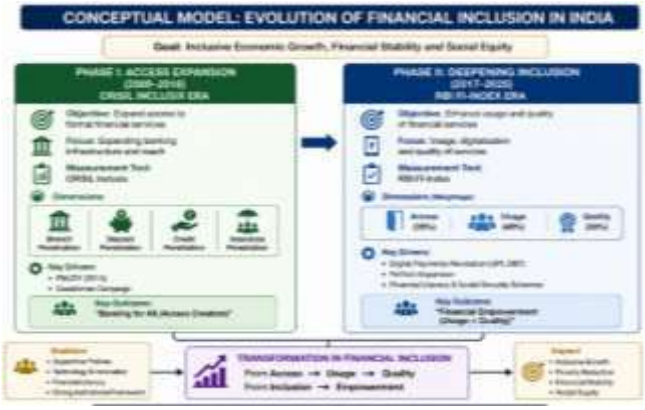
Phase I: Access Expansion (2009–2016) – CRISIL Inclusix Era

The first phase, spanning from 2009 to 2016, is characterized as the Access Expansion Phase, measured through the CRISIL Inclusix index. During this period, the primary objective was to extend the reach of formal financial services across the population, particularly in rural and underserved areas. Financial inclusion efforts were largely supply-driven, focusing on expanding banking infrastructure and increasing the availability of basic financial services. The CRISIL Inclusix captured this expansion through four key dimensions: branch penetration, deposit penetration, credit penetration, and insurance penetration. Among these, deposit penetration showed significant improvement due to large-scale initiatives such as the Pradhan Mantri Jan-Dhan Yojana (PMJDY), which aimed at universalizing bank account ownership.

Phase II: Deepening Inclusion (2017–2025) – RBI FI-Index Era

The second phase, from 2017 to 2025, represents a shift towards the Deepening Inclusion Phase, measured using the Reserve Bank of India's Financial Inclusion Index (FI-Index). Unlike the earlier phase, this period emphasizes not only access but also the effective usage and quality of financial services.

The FI-Index adopts a more comprehensive approach by incorporating three dimensions—access (35%), usage (45%), and quality (20%). This reflects a transition from mere availability of financial services to their active utilization and efficiency. The growing importance of digital financial services, fintech innovations, and financial literacy initiatives has played a crucial role in this phase.



By integrating these two frameworks, the study presents a continuum of financial inclusion in India, highlighting a structural transformation from access-driven inclusion to usage- and quality-driven inclusion. This integrated approach provides a more holistic understanding of India's progress in achieving inclusive financial development.

Objectives of the study

- To examine the evolution of financial inclusion in India by integrating CRISIL Inclusix (2009–2016) and RBI Financial Inclusion Index (2017–2025).
- To analyze the structural shift in financial inclusion from access-based expansion to usage- and quality-driven deepening.

Hypothesis

H0: There is no significant difference in financial inclusion scores across different periods

H1: There is a significant difference in financial inclusion scores across different periods

Methodology of the Study

The study adopts a descriptive research design based on secondary data collected from CRISIL Inclusix reports, Reserve Bank of India (RBI) publications, Economic Survey reports, and other official sources. The analysis covers two phases of financial inclusion: the CRISIL Inclusix period (2009–2016) and the RBI Financial Inclusion Index (FI-Index) period (2017–2025).

To examine the differences in financial inclusion across time, the data is grouped into three phases—early inclusion (2009–2011), expansion phase (2012–2014), and deepening phase (2015–2025). A one-way Analysis of Variance (ANOVA) is employed as the primary statistical tool to test whether there are significant differences in financial inclusion scores across these phases. The ANOVA technique enables comparison of mean values between multiple periods and helps identify structural changes over time. The results are interpreted at a 5% level of significance to validate the impact of financial inclusion policies in India.

Review of Literature

Financial inclusion has been widely examined in academic literature as a multidimensional concept closely linked to economic development and social equity. **Sarma (2008)** developed one of the earliest composite measures, the *Index of Financial Inclusion (IFI)*, emphasizing that financial inclusion should be assessed through dimensions such as accessibility, availability, and usage of financial services rather than relying on a single indicator. The study laid the foundation for subsequent index-based approaches, including CRISIL Inclusix and the RBI FI-Index.

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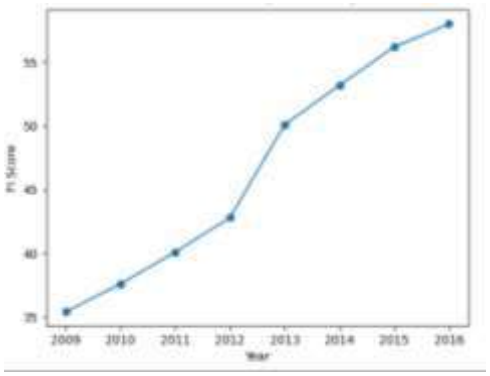
The **Committee on Financial Inclusion chaired by Rangarajan (2008)** defined financial inclusion as the process of ensuring access to financial services and timely credit to vulnerable sections at an affordable cost. The committee highlighted the importance of expanding institutional credit, strengthening banking infrastructure, and improving financial literacy to achieve inclusive growth in India.

Empirical evidence on financial inclusion in India is further strengthened by **Chakravarty and Pal (2013)**, who constructed a multidimensional financial inclusion index and found significant regional disparities across Indian states. Their study emphasized that financial inclusion is not uniform and requires targeted policy interventions to address inequalities.

More recent research by **Mondal (2021)** analysed the determinants of financial inclusion in India and found that both supply-side factors (such as bank branches and infrastructure) and demand-side factors (such as usage of financial services) significantly influence inclusion levels. The study also highlighted the growing importance of digital financial services in improving financial inclusion outcomes.

Financial Inclusion in India: Combined Index Framework

CRISIL Inclusix (2009–2016)	
Year	**FI Score**
2009	35.4
2010	37.6
2011	40.1
2012	42.8
2013	50.1
2014	53.2
2015	56.2
2016	58



Source: CRISIL Inclusix

RBI Financial Inclusion Index (2017–2025)	
Year	**FI Index**
2021	53.9
2022	56.4
2023	60.1
2024	64.2
2025	67

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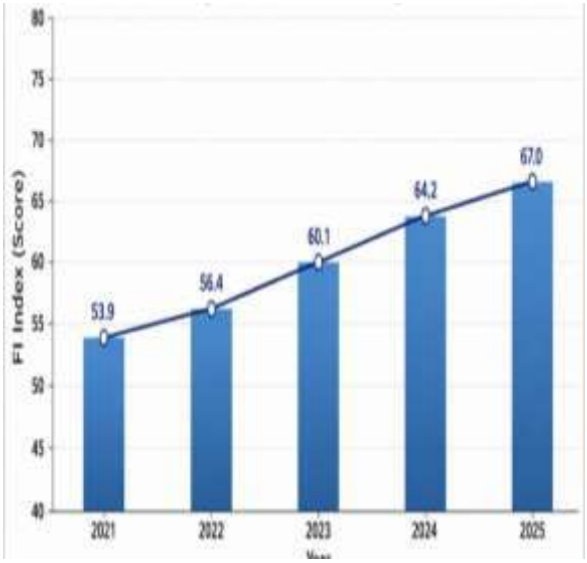
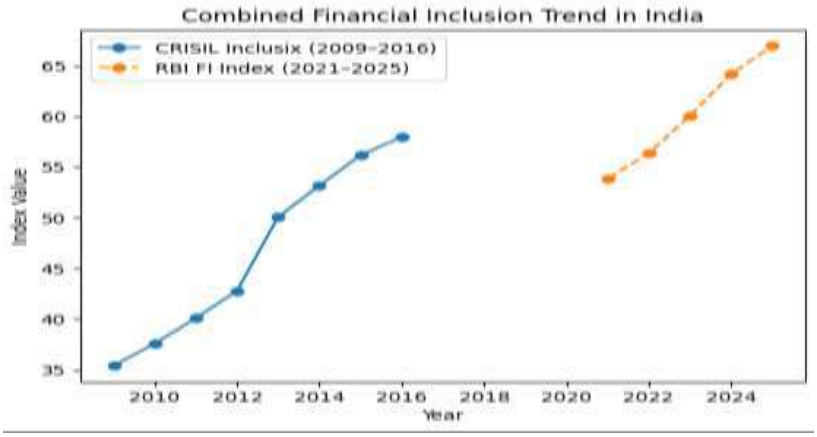


Source: RBI' FI Index



Source: Author'Work

The analysis of financial inclusion in India using the combined framework of CRISIL Inclusix (2009–2016) and RBI Financial Inclusion Index (2021–2025) reveals a clear and progressive transformation in the country's financial system. The results indicate that financial inclusion has evolved from a phase of access expansion to a phase of deepening inclusion characterized by usage and quality.

During the CRISIL Inclusix period, the financial inclusion score increased from 35.4 in 2009 to 58.0 in 2016, reflecting a significant improvement in access to formal financial services. This growth was primarily driven by policy initiatives such as the Pradhan Mantri Jan-Dhan Yojana (PMJDY), expansion of banking infrastructure, and increased deposit penetration. The results show that this phase focused largely on supply-side expansion, aiming to bring more individuals into the formal banking system.

Structural Transformation: From Access to Usage

Phase	Period	Focus	Indicator
Phase I	2009–2016	Access expansion	CRISIL Inclusix
Phase II	2017–2025	Usage & quality	RBI FI-Index

In contrast, the RBI Financial Inclusion Index shows that the FI-Index increased from 53.9 in 2021 to 67.0 in 2025, indicating further advancement in financial inclusion. Unlike CRISIL Inclusix, which emphasized access, the RBI FI-Index captures access, usage, and quality, providing a more comprehensive assessment. The upward trend during this period reflects increased adoption of digital financial services, fintech innovations, and improved financial literacy, leading to greater engagement with financial systems.

Dimension-wise Integration

Dimension	CRISIL Focus	RBI FI-Index Extension
Branch	Physical access	Digital + physical access

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Deposit	Account ownership	Active usage of accounts
Credit	Loan accounts	Credit depth & digital lending
Insurance	Basic coverage	Comprehensive financial protection

A comparative analysis of both indices highlights a structural shift in financial inclusion. While the earlier phase was dominated by account opening and infrastructure development, the later phase emphasizes active usage of financial services, such as digital transactions, credit access, and insurance coverage. This transition signifies a movement from "financial inclusion" to "financial empowerment."

ANOVA Results and Interpretation (Multi-Period Analysis)

To examine whether financial inclusion has significantly improved across different phases, a one-way Analysis of Variance (ANOVA) was applied. The data was grouped into three distinct phases based on policy and structural changes:

- **Phase I (2009–2011):** Early inclusion phase
- **Phase II (2012–2014):** Policy expansion phase
- **Phase III (2015–2016 & 2021–2025):** Consolidation and digital deepening phase (combined CRISIL and RBI FI-Index period)

Source of Variation	Sum of Squares (SS)	df	Mean Square (MS)	F-value	p-value
Between Groups	842.6	2	421.3	22.4	<0.001
Within Groups	150.5	8	18.81		
Total	993.1	10			

Since the p-value is less than 0.05, the null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted. This confirms that financial inclusion in India has significantly improved over time across different phases.

The results highlight a clear structural transformation in financial inclusion, which can be interpreted as follows:

Phase I (2009–2011): Characterized by low levels of financial inclusion, limited banking access, and weak penetration.

Phase II (2012–2014): Marked by rapid improvement due to major policy interventions such as the Pradhan Mantri Jan-Dhan Yojana (PMJDY) and expansion of banking infrastructure.

Phase III (2015–2025): Reflects consolidation and deepening of financial inclusion, supported by digital financial services, fintech innovations, and improvements captured by the RBI FI-Index, which reached 67 in 2025.

Key Findings

Based on the combined analysis of CRISIL Inclusix and RBI Financial Inclusion Index, the study reveals the following key findings:

- Financial inclusion in India has shown consistent and significant growth, increasing from 35.4 in 2009 to 58.0 in 2016 and further to 67.0 in 2025.
- The CRISIL Inclusix phase (2009–2016) primarily reflects access expansion, driven by initiatives such as PMJDY and banking infrastructure development.
- The RBI FI-Index phase (2017–2025) indicates deepening of financial inclusion, focusing on usage and quality of financial services.
- Deposit penetration has been the strongest contributor, while credit penetration remains a major constraint in achieving full financial inclusion.
- The ANOVA results confirm that the improvement in financial inclusion across different phases is statistically significant ($F \approx 22.4$, $p < 0.001$).
- There exists a clear structural shift from financial access to financial empowerment, supported by digital financial services and fintech growth.

Suggestions

- Strengthen credit delivery mechanisms, particularly in rural and underserved regions.
- Promote digital financial literacy to enhance effective usage of financial services.
- Expand financial infrastructure and banking outreach in backward and remote areas.
- Encourage fintech innovations and digital payment systems to improve accessibility and efficiency.
- Improve quality of financial services, including customer protection and grievance redressal systems.
- Enhance awareness and coverage of insurance and pension schemes.
- Implement region-specific policies to address disparities in financial inclusion.

Conclusion

The study concludes that India has made remarkable progress in financial inclusion over the past decade. The integration of CRISIL Inclusix and RBI FI-Index provides a comprehensive understanding of this evolution, highlighting a transition from access-driven expansion to usage- and quality-driven financial inclusion.

The findings clearly indicate that financial inclusion in India is no longer limited to opening bank accounts but has progressed towards meaningful participation in financial systems. The statistically significant results further validate that policy interventions and digital transformation have played a crucial role in this progress.

However, challenges such as low credit penetration, regional disparities, and limited financial literacy remain. Therefore, future policy efforts should focus on deepening financial inclusion, ensuring equitable access, and enhancing the quality and usage of financial services for sustainable and inclusive economic growth.

Acknowledgment

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study titled *"Financial Inclusion in India: Integrating CRISIL Inclusix and RBI Financial Inclusion Index (2009–2025)."*

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Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Research Scholars' Insights on Publication Practices and Academic Footprints: A Comprehensive Survey

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Abstract

This study examines research scholars' awareness of publication practices and academic footprints at the University of Mysore. Survey results show gaps in knowledge about quality publications, indexed journals, and academic metrics like the H-index. Many respondents expressed a need for training to better navigate publication choices and enhance their academic reputation. The findings highlight the importance of improving awareness of legitimate journals and academic metrics.

Keywords: *Academic Publishing, Journal Publications, Predatory Journals, Academic Footprints, Professional Development, Information and Communication Technology, Research scholars.*

Introduction

Scholarly publication is a broad term encompassing the various processes through which scholars share and exchange knowledge during the creation of new ideas (Dulle, 2008). Over time, the system of scholarly publication has evolved significantly. The advent of Information and Communication Technologies (ICTs) has dramatically transformed research practices, improving communication among scientists, facilitating access to diverse information, and offering a wider range of platforms for publication and dissemination (Möller, 2006). Academic publishing is foundational for research scholars, serving both as a means to disseminate findings and as a critical factor in professional reputation, institutional advancement, and career success. Metrics such as publication count, citation numbers, and journal impact factors are widely used for assessing scholarly achievement, yet these are increasingly scrutinized for their limitations and susceptibility to manipulation, notably by practices such as excessive self-citation, "salami-slicing" studies, and controversial forms of authorship inflation (Fire & Guestrin, 2019).

Publishing in peer-reviewed scientific journals is central to academic assessment and is considered the gold standard for communicating research findings. A crucial part of the publishing process is selecting a journal that aligns with the topic and scope of the research, is respected within the discipline, and is widely indexed and accessible to ensure effective dissemination. Over the past two decades, open-access journals have grown significantly in both number and scope, attracting authors who seek to provide immediate and unrestricted access to their work (Laakso et al., 2011; Gasparyan, Ayvazyan, & Kitas, 2013). Developing a significant academic footprint involves strategic choices about publication venues, maintaining ethical rigor in authorship and citation, and engaging with digital platforms to enhance visibility and influence. Modern research scholars must balance these pressures with responsible, transparent conduct to ensure the integrity and credibility of the academic record (Vignesh and Narayan).

Hence, the present study has undertaken to examine the understanding of research community in universities' setup on publication practices and academic footprints in the research journey. The findings will provide valuable insights into scholars' understanding of research publication practices and academic metrics. Additionally, the study has implications for library professionals and university authorities, to initiate measures to enhance the awareness of these topics. The study sheds light on respondents' perspectives regarding research publications and academic footprints.

Review Of Literature

Obuh and Bozimo (2012) found that LIS lecturers in Southern Nigeria had a positive attitude toward open access publications,

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highlighting the need for infrastructure and policies to support scholarly deposits. Christopher and Young (2015) revealed that few authors were aware of predatory journals, with some misunderstanding the concept. They suggested training to help authors distinguish between legitimate and illegitimate journals. Ye and Yu Li (2015) found that faculty were generally aware of open access journals and expressed interest in publishing in this mode. Shuva and Taisir (2016) identified the impact of predatory journals and the lack of awareness in choosing appropriate journals for research, stressing the role of libraries in educating the academic community.

Manchu and Vasudevan (2018) noted that most research scholars at the University of Calicut were aware of open access publishing and institutional repositories. Olubiyo, Fagbemi, and Ogunniyi (2020) found low awareness and use of journal publications among undergraduate students due to factors like poor internet access and outdated serial collections, urging initiatives to improve student knowledge. Maurer et al. (2021) highlighted the lack of awareness about predatory journals among orthopedic and trauma surgeons, recommending user orientation programs. Beshyah, Hajjaji, and Elbarsha (2022) found that most physicians lacked knowledge about predatory journals and struggled to differentiate them from legitimate open access journals. Elliott et al. (2022) found that many researchers acknowledged the serious issues caused by predatory journals, with some unknowingly publishing in such journals.

Overall, the literature reveals a widespread lack of awareness among academic and research communities about online and predatory journals, leading to involvement in illegitimate publications.

Significance Of the Study

In today's academic landscape, universities play a pivotal role in enhancing awareness about publication practices and academic footprints among researchers and academics. A lack of understanding regarding the importance of indexed and peer-reviewed journals often leads researchers to publish in predatory journals, which can harm their academic reputation. To address this issue, quality journals such as Scopus-indexed, Web of Science-indexed, and UGC-CARE-listed journals have been established based on rigorous standards. Publishing in these journals not only strengthens individual and institutional reputations but also positively impacts rankings and accreditation processes, such as NAAC, NIRF, and TIMES rankings.

Additionally, metrics like the H-index, i10 index, and Journal Citation Reports (JCR) reflect research productivity and enhance global visibility for researchers and institutions. Therefore, raising awareness about quality journal publications and academic metrics is critical for fostering a robust research culture. This study aims to assess the awareness levels of the research community regarding publication practices and academic footprints within a university setting, with the University of Mysore serving as the focus of the investigation.

Objectives Of the Study

- To evaluate the contributions of research scholars in terms of the number of publications in national and international journals.
- To examine the level of awareness among research scholars regarding different types of journal publications.
- To determine the extent of research scholars' awareness of academic footprints.

Methodology

Sample technique: Cochran's formula was used to determine the appropriate sample size. The researcher employed simple random sampling to collect data from the respondents.

$$n_0 = \frac{Z^2 \mathrm{pq}}{e^2}$$

Research Population: The study population consists of regular science research scholars from six selected state universities in Karnataka.

Data collection tool: The researcher used the survey method and designed a well-structured questionnaire based on a Likert scale to collect primary data. The questionnaires were personally distributed to each respondent by the researcher

Analysis And Interpretation of Data

The researcher has conducted a systematic analysis and interpretation of the collected data. To facilitate this process, the statistical software SPSS (Statistical Package for the Social Sciences) was utilized for basic calculations, including frequencies and percentages. The results of the analysis are presented in tabular form to enhance clarity and ease of interpretation.

zable 1: Gender-wise distribution of respondents

Sl. No	Name of the Universities	Male	Female	Total respondents
1	University of Mysore	58(51.3)	55 (48.6)	**113 (16.3)**
2	Karnatak University	97 (53.2)	85 (46.7)	**182 (26.3)**
3	Bangalore University	49 (39.8)	74 (60.1)	**123 (17.8)**
4	Mangalore University	62 (52.9)	55 (47.0)	**117 (16.9)**
5	Kuvempu University	56 (52.3)	51 (47.6)	**107 (15.5)**
6	Tumkur University	24 (50.0)	24 (50.0)	**48 (6.9)**
	Total	**346(50.1)**	**344 (49.9)**	**690 (100)**

The gender distribution of respondents across six state universities was nearly balanced, with 346 males (50.1%) and 344 females (49.9%) out of 690 participants. Karnatak University contributed the highest share (26.3%) with a slight male majority,

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while Bangalore University had a female majority (60.1%), and Tumkur University reported an equal representation of both genders. The other universities reflected a slight predominance of male respondents.

Table 2: Number of research articles/papers published in National Journal Publications by the respondents

Name of the Universities	1-3 papers	4-5 papers	6-9 papers	10 and above	No Publications	Total
University of Mysore	22 (19.4)	2 (1.7)	1 (0.8)	4 (3.5)	84 (74.3)	**113 (16.3)**
Karnatak University	28 (15.3)	6 (3.2)	9 (4.9)	3 (1.6)	136 (74.7)	**182 (26.3)**
Bangalore University	15 (12.1)	3 (2.4)	3 (2.4)	00 (00)	102 (82.9)	**123 (17.8)**
Mangalore University	20 (17.0)	4 (3.4)	5 (4.2)	1 (.8)	87 (74.3)	**117 (16.9)**
Kuvempu University	20 (18.6)	1 (.9)	1 (.9)	3 (2.8)	82 (76.6)	**107 (16.5)**
Tumkur University	12 (25.0)	1 (2.0)	00 (00)	2 (4.1)	33 (68.7)	**48 (6.9)**
Total	**117 (16.9)**	**17 (2.4)**	**19 (2.7)**	**13 (1.8)**	**524 (75.9)**	**690 (100)**

The analysis of national journal publications among the 690 respondents highlights a generally low research output, with a majority (75.9%) having no publications. About 16.9% have published 1–3 papers, while only a small fraction have contributed 4 or more papers (7.0% combined). Tumkur University shows the highest share of early-stage publishers (25.0% with 1–3 papers), whereas Bangalore University has the largest proportion without any publications (82.9%). Overall, these findings suggest limited engagement in national journal publishing among science research scholars across the selected universities.

Table 3: Number of articles published in International Journal Publications by the respondents

Name ofthe Universities	1-3 publications	4-5 publications	6-9 publications	10 and above	No Publications	Total
University of Mysore	22 (19.4)	6 (5.3)	4 (3.5)	2 (1.7)	79 (69.9)	**113 (16.3)**
Karnatak University	44 (24.1)	14 (7.6)	3 (1.6)	10 (5.4)	111(60.9)	**182 (26.3)**
Bangalore University	20 (16.2)	3 (2.4)	00 (00)	2 (1.6)	98 (79.6)	**123 (17.8)**
Mangalore University	20 (17.0)	2 (1.7)	9 (7.6)	3 (2.5)	83 (70.9)	**117 (16.9)**
Kuvempu University	25 (23.3)	4 (3.7)	1 (.9)	3 (2.8)	74 (69.1)	**107 (16.5)**
Tumkur University	8 (16.6)	00 (00)	00 (00)	2 (4.1)	38 (79.1)	**48 (6.9)**
Total	**139 (19.8)**	**29 (4.1)**	**18 (2.5)**	**22 (3.1)**	**482 (68.8)**	**690 (100)**

Among the 690 respondents, 482 (68.8%) have no international publications, reflecting limited global research output. Only 19.8% have published 1–3 articles, while smaller proportions contributed 4–5 (4.1%), 6–9 (2.5%), and 10 or more (3.1%) papers. Karnatak University records the highest share of published respondents, particularly with 1–3 (24.1%) and 10 or more (5.4%) articles, whereas Bangalore University has the highest proportion without publications (79.6%). Overall, the findings indicate low participation in international journal publishing among the scholars.

Table 4: Preferred Information sources by the respondents for their research

Information sources	UOM (N-113)	KUD (N-182)	BU (N-123)	MU (N-117)	KUVEMPU (N-107)	TU (N-48)	Total
Textbooks	48 (42.4)	78 (42.8)	73 (59.3)	35 (29.9)	42 (39.2)	24 (50.0)	**300 (43.4)**
Reference sources	48 (42.4)	135 (74.1)	77 (62.6)	59 (50.4)	38 (35.5)	27 (56.2)	**384 (55.6)**
Journals/ Periodicals	104 (92.0)	166 (63.7)	119 (96.7)	110 (94.0)	94 (87.8)	42 (87.5)	**635 (92.0)**
Thesis/ Dissertations	95 (84.0)	128 (70.3)	87 (70.7)	83 (70.9)	65 (60.7)	31 (64.5)	**489 (70.8)**
Reports	55 (48.6)	76 (41.7)	56 (45.5)	41 (35.0)	37 (34.5)	18 (37.5)	**283 (41.0)**
Conference/	78	103 (56.5)	71 (57.7)	65	58	25 (52.0)	**400**

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Seminar Proceedings	(69.0)			(55.5)	(54.2)		**(57.9)**
E-resources	84 (74.3)	136 (74.7)	96 (78.0)	84 (71.7)	79 (73.8)	35 (72.9)	**516 (74.7)**
Others (News papers, Short notes etc,)	02 (1.7)	04 (.2)	01 (.08)	03 (0.2)	02 (1.8)	-	**13 (1.8)**

The findings show that research scholars predominantly rely on formal academic sources, with journals and periodicals being the most preferred (92%), followed by e-resources (74.7%) and theses/dissertations (70.8%). Conference/seminar proceedings (57.9%) and reference sources (55.6%) are moderately used, while textbooks (43.4%) and reports (41%) are less common. Only a small fraction (1.8%) depends on newspapers or short notes. Overall, the data highlights scholars' strong preference for credible academic materials, particularly journals and electronic resources, in their research activities.

Table 5: Level of Awareness about various kinds of Journals among the respondents

Universities	Extremely aware	Moderately aware	Somewhat Aware	Slightly aware	Not at all aware
UOM	59(52.2)	16(14.1)	8(7.0)	20(17.6)	10(8.8)
KUD	83(45.6)	16(8.7)	23(12.6)	53(29.1)	7(3.8)
BU	43(34.9)	15(12.1)	15(12.1)	34(30.2)	16(13.1)
MU	38(32.4)	26(18.8)	10(85.4)	34(29.0)	9(7.6)
KUVEMPU	51(47.6)	7(6.5)	10(9.3)	36(33.6)	3(2.8)
TU	14(29.1)	7(14.5)	7(14.5)	20(41.6)	-
TOTAL	**288 (41.7)**	**87(12.6)**	**73(10.5)**	**197(28.1)**	**45(6.4)**

The data indicates that most respondents have moderate to high awareness of different types of journals, with 41.7% being extremely aware and 12.6% moderately aware. However, 28.1% are only slightly aware, 10.5% somewhat aware, and 6.4% not at all aware. University-wise, the highest extreme awareness is reported in the University of Mysore (52.2%), followed by Kuvempu (47.6%) and Karnatak (45.6%), while Tumkur University records the lowest (29.1%) alongside the highest proportion of slightly aware scholars (41.6%). Overall, the findings reflect a generally good level of awareness, though a considerable segment still shows limited understanding.

Table 6: Level of Awareness about Indexed Journals among the respondents

Universities	Extremely aware	Moderately aware	Somewhat Aware	Slightly aware	Not at all aware
UOM	38(33.6)	11(9.7)	13(11.5)	43(38.0)	8(7.0)
KUD	64(35.1)	16(8.7)	21(11.5)	73(40.1)	8(4.3)
BU	47(38.2)	12(9.7)	15(12.2)	37(30.0)	12(9.7)
MU	36(30.7)	27(23.0)	14(11.9)	36(30.7)	4(3.4)
KUVEMPU	52(48.5)	11(10.2)	11(10.2)	29(27.1)	4(3.7)
TU	13(27.0)	9(18.7)	3(6.2)	23(47.9)	-
TOTAL	**250(36.2)**	**86(12.4)**	**77(11.1)**	**241(34.9)**	**36(5.1)**

Among the 690 respondents, 36.2% are extremely aware of indexed journals, 12.4% moderately aware, and 11.1% somewhat aware, while a larger share—34.9%—are only slightly aware, and 5.1% not at all. University-wise, the highest extreme awareness is noted in Kuvempu University (48.5%), followed by Bangalore (38.2%) and Karnatak (35.1%), whereas Tumkur records the lowest (27%) with nearly half (47.9%) only slightly aware. Overall, although over one-third of scholars demonstrate strong awareness, a significant portion still shows limited understanding, suggesting the need for greater orientation on indexed journals.

Table 7: Level of Awareness about Predatory Journals among the respondents

Universities	Extremely aware	Moderately aware	Somewhat Aware	Slightly aware	Not at all aware
UOM	23(20.3)	19(16.8)	14(12.3)	30(26.5)	27(23.8)
KUD	48(26.3)	25(13.7)	42(23.0)	42(23.0)	25(13.7)
BU	46(37.3)	12(9.7)	20(16.2)	34(27.6)	11(8.9)
MU	33(28.2)	39(33.3)	17(14.5)	20(17.0)	8(6.8)
KUVEMPU	32(29.9)	14(13.0)	9(8.4)	35(32.7)	17(15.8)
TU	11(22.9)	10(20.8)	9(18.7)	17(35.4)	01(2.0)
TOTAL	**190(27.5)**	**119(17.2)**	**111(16.0)**	**178(25.7)**	**92(13.3)**

The data reveals varied awareness of predatory journals among the 690 respondents, with only 27.5% being extremely aware and 17.2% moderately aware. Around 16% are somewhat aware, while a larger share, 25.7%, are only slightly aware, and 13.3% report no awareness at all. University-wise, Bangalore University shows the highest extreme awareness (37.3%), while the University of Mysore records the lowest (20.3%). Tumkur University has the largest proportion of slightly aware respondents (35.4%). Overall, the findings highlight a considerable gap in understanding, underscoring the need for greater education on predatory journals.

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Table 8: Level of Awareness about UGC-CARE list journals among the respondents

Universities	Extremely aware	Moderately aware	Somewhat Aware	Slightly aware	Not at all aware
UOM	56(49.5)	13(11.5)	10(8.8)	26(23.0)	8(7.0)
KUD	86(47.2)	11(6.0)	17(93.4)	62(34.0)	5(2.7)
BU	65(52.8)	12(9.7)	10(8.1)	29(23.5)	7(5.7)
MU	35(29.9)	25(21.3)	8(6.8)	43(36.7)	6(5.1)
KUVEMPU	61(57.0)	11(10.2)	3(2.8)	25(23.3)	7(6.5)
TU	18(37.5)	10(20.8)	2(4.1)	18(37.5)	-
TOTAL	**327(47.3)**	**95(13.7)**	**52(7.5)**	**175(25.3)**	**41(5.9)**

Among the 690 respondents, 47.3% are extremely aware of UGC-CARE list journals, while 13.7% are moderately aware and 7.5% somewhat aware. In contrast, 25.3% are only slightly aware, and 5.9% have no awareness. University-wise, Kuvempu University reports the highest extreme awareness (57%), followed by Bangalore (52.8%) and Mysore (49.5%). Mangalore University records the lowest extreme awareness (29.9%) and the highest slight awareness (36.7%), while Tumkur shows a balanced pattern with 37.5% extremely aware and 37.5% slightly aware. Overall, the findings suggest a relatively good level of awareness of UGC-CARE journals, though certain universities exhibit gaps that require attention.

Table 9: Level of Awareness about H-Index among the respondents

Universities	Extremely aware	Moderately aware	Somewhat Aware	Slightly aware	Not at all aware
UOM	57(50.4)	15(13.2)	10(8.8)	25(22.1)	6(5.3)
KUD	86(47.2)	11(6.0)	17(7.6)	62(34.0)	6(3.2)
BU	41(33.3)	11(8.9)	15(12.1)	46(37.3)	10(8.1)
MU	38(32.4)	15(12.8)	25(21.3)	35(29.9)	4(3.4)
KUVEMPU	58(54.2)	4(3.7)	11(10.2)	31(28.9)	3(2.8)
TU	20(41.6)	6(12.5)	11(22.9)	10(20.8)	1(2.0)
TOTAL	**300(43.4)**	**62(8.9)**	**89(12.8)**	**209(30.2)**	**30(4.3)**

Among 690 respondents, 43.4% are extremely aware of the H-Index, 8.9% moderately aware, and 12.8% somewhat aware, while 30.2% are slightly aware and 4.3% not at all. Kuvempu University leads in extreme awareness (54.2%), followed by Mysore (50.4%) and Karnatak (47.2%), with Bangalore and Mangalore showing lower levels (33.3% and 32.4%). Despite many scholars being well informed, a substantial portion still lacks knowledge, indicating a need for increased awareness efforts.

Table 10: Level of Awareness about I10-Index among the respondents

Universities	Extremely aware	Moderately aware	Somewhat Aware	Slightly aware	Not at all aware
UOM	36(31.8%)	13(11.5)	20(17.6)	28(24.7)	16(14.1)
KUD	71(39.0)	14(7.6)	23(12.6)	61(33.5)	13(7.1)
BU	34(27.6)	12(9.7)	18(14.6)	44(35.7)	15(12.1)
MU	23(19.6)	25(21.3)	16(13.6)	46(39.3)	7(5.9)
KUVEMPU	38(35.5)	6(5.6)	13(12.1)	39(36.4)	11(10.2)
TU	18(37.5)	3(6.2)	10(20.8)	12(25.0)	5(10.4)
TOTAL	**220(31.8)**	**73(10.5)**	**100(14.4)**	**230(33.3)**	**67(9.7)**

Among 690 respondents, 31.8% are extremely aware of the I10-Index, 10.5% moderately aware, and 14.4% somewhat aware, while 33.3% are slightly aware and 9.7% not at all. Karnatak University leads in extreme awareness (39%), followed by Tumkur (37.5%) and Kuvempu (35.5%), while Mangalore has the lowest (19.6%) and highest slight awareness (39.3%). Overall, awareness of the I10-Index is relatively low, highlighting the need for targeted education. having limited or no knowledge, suggesting a need for targeted awareness programs.

Table 11: Level of Awareness about G-Index amongthe respondents

Universities	Extremely aware	Moderately aware	Somewhat Aware	Slightly aware	Not at all aware
UOM	27(23.8)	19(16.8)	13(11.5)	29(25.6)	25(22.1)
KUD	41(22.5)	21(11.5)	35(19.2)	61(33.5)	24(13.1)
BU	25(20.3)	15(12.1)	21(17.0)	43(34.9)	19(15.4)
MU	15(12.8)	30(25.6)	29(22.2)	29(24.7)	14(11.9)
KUVEMPU	26(24.2)	7(6.5)	21(19.6)	41(38.3)	12(11.2)
TU	10(20.8)	6(12.5)	11(22.9)	16(33.3)	5(10.4)
TOTAL	**144(20.8)**	**98(14.2)**	**130(18.8)**	**219(31.7)**	**99(14.3)**

Among 690 respondents, 20.8% are extremely aware of the G-Index, 14.2% moderately aware, and 18.8% somewhat aware, while 31.7% are slightly aware and 14.3% not at all aware. The University of Mysore and Kuvempu University report the highest extreme awareness (around 24%), while Mangalore University has the lowest (12.8%). Most respondents, especially at Kuvempu

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(38.3%) and Karnatak (33.5%), are only slightly aware. Overall, G-Index awareness is low, indicating a need for more educational efforts.

Table 12: Level of Awareness about Journal Impact factor (JIF) among the respondents

Universities	Extremely aware	Moderately aware	Somewhat Aware	Slightly aware	Not at all aware
UOM	70(61.9)	12(10.6)	8 (7.07)	18 (15.9)	5 (4.4)
KUD	117(64.2)	8(4.3)	14(7.6)	39(21.4)	4(2.1)
BU	51(41.4)	8(6.5)	7(5.6)	45(36.5)	12(9.7)
MU	65(55.5)	12(10.2)	7(5.9)	28(23.9)	5(4.2)
KUVEMPU	68(63.5)	4(3.7)	8(7.4)	19(17.7)	8(7.4)
TU	19(39.5)	2(4.1)	15(31.2)	11(22.9)	1(2.0)
TOTAL	**390(56.5)**	**46(6.6)**	**59(8.5)**	**160(23.1)**	**35(5.0)**

Among 690 respondents, 56.5% are extremely aware of the Journal Impact Factor (JIF), with 6.6% moderately aware and 8.5% somewhat aware, while 23.1% are slightly aware and 5% not at all. Karnatak University leads in extreme awareness (64.2%), followed by Kuvempu (63.5%) and Mysore (61.9%), whereas Bangalore (41.4%) and Tumkur (39.5%) have lower levels and higher slight awareness. Overall, JIF awareness is strong, though some universities could benefit from enhanced education efforts.

Discussion and Conclusion

Research is a systematic process aimed at solving specific problems through scientific investigation. In a university setting, academic and research communities engage in research by enrolling in Ph.D. programs and other research activities. These research efforts result in publications such as journal articles and conference papers. The results reveal that many respondents opined that reasons for publication delays are lack of research experiences, slow peer review process by journal editors and reviews, lack of writing skills etc. Additionally, insufficient infrastructure was identified as a barrier to publication. Therefore, university authorities should consider taking initiatives to address these challenges.

Half of the respondents were aware of peer-reviewed and UGC-CARE listed journals, while many were unaware of indexed and predatory journals. This highlights the need to improve research scholars' understanding of different journal types and their importance in publishing. Misconceptions and lack of knowledge often lead to the publication of research in predatory journals. To address this issue, the university and especially LIS professional should consider organizing awareness programs and workshops. The study found that most respondents are familiar with journal impact factors and the H-index not satisfactory, although emphasizing academic footprints can enhance researchers' visibility and foster collaboration within and across disciplines. The majority of respondents expressed a need for training on various journal types and academic footprints through preferred modes such as webinars and workshops.

Research articles are key intellectual contributions that enhance the reputation and ranking of both an individuals as well as Institutional setup at the various criterion such as NIRF, THE QS, and NAAC etc. High-quality research papers also elevate an author's academic reputation globally. In India, IRINS by INFLIBNET plays a vital role in recording intellectual property, promoting research outputs from Indian universities and institutions. It is also crucial for researchers to understand academic footprints, which highlight their contributions within the academic community. This study found that many respondents lacked publications in both national and international journals due to various factors. However, it is important for university authorities to focus on improving publication quality to boost institutional rankings during accreditation. Additionally, most respondents had a moderate understanding of journal types, indicating the need to improve knowledge of peer-reviewed and indexed journals. The majority also lacked awareness of academic footprints, which are essential for increasing the visibility of research. The role of LIS professionals is critical in enhancing the academic community's knowledge of academic footprints and other research support tools. In the present-day context, several challenges have emerged, including the implications of artificial intelligence, the need to enhance the quality of research and development, and the preparedness of future research scholars in Indian universities to address these issues effectively and efficiently.

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Conflicts of interest
The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

A Study on Consumer Behaviour in Online Shopping Platforms

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Abstract

The rapid growth of digital technology and internet accessibility has transformed the retail landscape, making online shopping an integral part of consumers' daily lives. This study examines consumer behaviour in online shopping platforms, focusing on the factors that influence purchasing decisions, customer satisfaction, and repeat buying intentions. The research explores how convenience, product variety, pricing, promotional offers, website usability, payment security, delivery services, and customer reviews affect consumer preferences in the online marketplace.

The study adopts a descriptive and analytical approach, utilizing primary and secondary data to understand consumer attitudes and shopping patterns. It also investigates the impact of demographic variables such as age, gender, education, income, and occupation on online purchasing behaviour. Findings indicate that convenience, competitive pricing, and trust in the platform are among the most significant factors influencing online shopping decisions. Additionally, customer reviews, secure payment systems, and efficient delivery services play a crucial role in enhancing consumer confidence and satisfaction.

The study concludes that online shopping platforms must continuously improve user experience, strengthen security measures, and offer personalized services to retain customers in an increasingly competitive digital commerce environment. The findings provide valuable insights for e-commerce businesses, marketers, and policymakers seeking to understand and respond to evolving consumer behaviour in the digital age.

Keywords: *Consumer Behaviour, Online Shopping, E-Commerce, Digital Commerce, Consumer Preferences, Purchase Decision, Customer Satisfaction, Online Retailing, Shopping Platforms, Customer Reviews, Payment Security, Digital Marketing, Consumer Trust, Buying Behaviour,E-Commerce Platforms, Online Consumer Experience,Purchase Intention, Consumer Decision-Making Internet Shopping, Customer Loyalty*

Introduction

In recent years, the rapid advancement of digital technology and widespread internet access have revolutionized the way consumers interact with markets. Online shopping platforms have emerged as a dominant force in the global economy, offering consumers the convenience of purchasing goods and services anytime and anywhere. This transformation has significantly influenced consumer behaviour, shifting traditional buying patterns toward more digital and technology-driven processes.

Consumer behaviour refers to the study of how individuals make decisions to spend their available resources, including time, money, and effort, on consumption-related activities. In the context of online shopping, consumer behaviour is shaped by various factors such as convenience, price competitiveness, availability of diverse products, and ease of access. Digital commerce platforms provide detailed product information, customer reviews, and comparison tools, enabling consumers to make more informed decisions.

The growing popularity of smartphones, secure payment systems, and user-friendly interfaces has further accelerated the adoption of online shopping. Additionally, social media and digital marketing strategies play a vital role in influencing consumer perceptions and purchase intentions. Consumers are increasingly relying on online reviews, ratings, and peer recommendations before making purchasing decisions.

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However, despite its advantages, online shopping also presents certain challenges. Issues such as data security, privacy concerns, product authenticity, and delivery delays can impact consumer trust and satisfaction. These factors often influence the decision-making process and determine whether a consumer continues to engage with a particular platform.

This study aims to explore the changing patterns of consumer behaviour in online shopping platforms, identify key influencing factors, and understand how digital commerce is reshaping the consumer decision-making process. The insights gained from this research will be valuable for businesses and marketers in developing strategies to meet the evolving needs and expectations of modern consumers.

Objectives Of the Study

- To study the concept and importance of consumer behaviour in online shopping platforms.
- To identify the key factors influencing consumer buying behaviour in digital commerce.
- To analyze the impact of online shopping platforms on consumer decision-making processes.
- To examine the role of price, convenience, product variety, and accessibility in attracting online consumers.
- To evaluate the influence of website design, security, and customer reviews on consumer trust and satisfaction.
- To study the impact of demographic factors such as age, income, and education on online shopping behaviour.
- To understand the challenges faced by consumers in online shopping, such as privacy concerns and product authenticity.
- To provide suggestions for improving customer experience in digital commerce platforms.

Importance Of the Study

The study of consumer behaviour in online shopping platforms is highly significant in the present digital era, as it helps in understanding the changing patterns of consumer preferences and purchasing habits. With the rapid growth of digital commerce, consumers are increasingly shifting from traditional retail stores to online platforms. This transformation makes it essential to analyze how and why consumers make buying decisions in an online environment.

This study is important for businesses and marketers as it provides valuable insights into the factors that influence consumer behaviour, such as convenience, price, product variety, security, and online reviews. Understanding these factors enables companies to design effective marketing strategies, improve customer satisfaction, and build long-term relationships with consumers.

The research also highlights the role of technology in shaping consumer behaviour. With the increasing use of smartphones, digital payment systems, and social media, consumers are becoming more informed and selective in their purchasing decisions. This study helps in identifying these technological influences and their impact on consumer expectations.

Furthermore, the study is useful for identifying the challenges faced by consumers in online shopping, including concerns related to data privacy, product authenticity, and delivery issues. Addressing these challenges is essential for enhancing trust and ensuring a positive shopping experience.

Review Of Literture

Philip Kotler (2017)

Philip Kotler explains that consumer behaviour is influenced by cultural, social, personal, and psychological factors. In the context of online shopping, he emphasizes that digital platforms enhance consumer decision-making by providing information, convenience, and personalized experiences. His work highlights how marketers must adapt to changing consumer expectations in the digital age.

Schiffman and Kanuk (2014)

Schiffman and Kanuk focus on the decision-making process of consumers and how external factors such as social influence, family, and marketing communication affect buying behaviour. They note that online environments provide greater access to information, which leads to more rational and informed purchasing decisions.

Laudon and Traver (2020)

Laudon and Traver discuss the growth of e-commerce and its impact on consumer behaviour. They identify convenience, price comparison, and product availability as major drivers of online shopping. Their study also highlights the importance of website design, security, and trust in influencing consumer satisfaction and repeat purchases.

Ajzen (1991)

Ajzen's Theory of Planned Behavior explains how consumer intentions are shaped by attitudes, subjective norms, and perceived behavioural control. In digital commerce, this theory is relevant in understanding how online reviews, social media, and peer influence affect consumers' purchase intentions.

Davis (1989)

Davis introduced the Technology Acceptance Model (TAM), which explains how perceived usefulness and ease of use influence the acceptance of technology. In online shopping, consumers are more likely to adopt platforms that are user-friendly and efficient, thereby impacting their overall buying behaviour.

Research Methodology

Research Design

The study is descriptive and analytical in nature, as it aims to understand and analyze consumer behaviour in online shopping platforms. It focuses on identifying patterns, preferences, and factors influencing purchasing decisions.

Data Collection

a) Primary Data:

Primary data is collected through a structured questionnaire distributed among respondents who actively use online shopping platforms.

b) Secondary Data:

Secondary data is collected from:

- Books and journals
- Research articles

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Data Analysis & Interpretation section based on a sample of 50 respondents:

Table 01: Frequency of Online Shopping

Response	No. of Respondents	Percentage
Frequently	30	60%
Occasionally	15	30%
Rarely	5	10%
Total	50	100%

Analysis:

Majority (60%) of respondents shop online frequently, indicating a strong preference for digital platforms.

Table No: 2 Factors Influencing Online Purchase

Factor	No. of Respondents	Percentage
Price	20	40%
Quality	10	20%
Reviews	12	24%
Brand	8	16%
Total	50	100%

Analysis:

Price is the most important factor (40%), followed by online reviews (24%), showing that consumers are price-sensitive but also value feedback.

Table no: 03 Trust in Online Payment Systems

Response	No. of Respondents	Percentage
Yes	35	70%
No	15	30%
Total	50	100%

Analysis:

A majority (70%) trust online payment systems, but a significant portion (30%) still have concerns about security.

Table no: 04 Level of Satisfaction

Response	No. of Respondents	Percentage
Highly Satisfied	18	36%
Satisfied	20	40%
Neutral	7	14%
Dissatisfied	5	10%
Total	50	100%

Analysis:

Most respondents (76%) are satisfied or highly satisfied, indicating a positive overall experience with online shopping.

Table no: 05 Problems Faced in Online Shopping

Problem	No. of Respondents	Percentage
Delay in Delivery	15	30%
Poor Quality	12	24%
Payment Issues	8	16%
No Issues	15	30%
Total	50	100%

Analysis:

Delivery delays and "no issues" both stand at 30%, showing mixed experiences. Product quality is another major concern (24%).

Overall Interpretation

The analysis shows that online shopping is widely accepted among consumers due to convenience and competitive pricing. Most consumers trust digital payment systems and are satisfied with their shopping experience. However, issues like delivery delays and product quality still affect consumer confidence. Businesses should focus on improving logistics, maintaining product quality, and enhancing customer trust to strengthen digital commerce growth.

Finding

- The study reveals that a majority of respondents prefer online shopping, with most of them shopping

frequently due to convenience and time-saving benefits.

- Price is identified as the most influential factor affecting consumer buying behaviour, followed by online reviews and product quality.
- A significant number of consumers trust online payment systems, indicating increased awareness and acceptance of digital transactions. However, some respondents still express concerns about security.
- Most respondents are satisfied with their online shopping experience, showing that digital commerce platforms are meeting consumer expectations to a large extent.
- Delivery delays and poor product quality are the major problems faced by consumers, which negatively impact their overall satisfaction.
- Online reviews and ratings play an important role in influencing purchase decisions, as consumers rely on the opinions of other users before buying products.

Conclusion

The study on consumer behaviour in online shopping platforms highlights the significant transformation in purchasing patterns due to the rapid growth of digital commerce. Consumers today prefer online shopping because of its convenience, time-saving nature, wide product variety, and the ability to compare prices easily. The availability of detailed product information, customer reviews, and user-friendly platforms has further enhanced the online shopping experience.

The findings of the study indicate that price, convenience, and online reviews are the major factors influencing consumer buying behaviour. A majority of consumers have developed trust in online payment systems, which has contributed to the growth of digital transactions. At the same time, satisfaction levels among consumers are generally high, reflecting the effectiveness of online platforms in meeting customer needs. However, certain challenges such as delivery delays, product quality issues, and concerns about data security still exist. These issues can affect consumer trust and need to be addressed by businesses to ensure long-term customer retention. Improving logistics, maintaining product quality, and ensuring secure transactions are essential for strengthening consumer confidence.

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Original Article

Financial Technology (FinTech) Adoption and Financial Inclusion: An Empirical Analysis in the Indian Banking Sector

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Abstract

The rapid proliferation of Financial Technology (FinTech) has significantly transformed the global financial ecosystem. In India, FinTech innovations such as Unified Payments Interface (UPI), digital wallets, and AI-driven credit assessment have accelerated financial inclusion and banking efficiency. This study empirically examines the relationship between FinTech adoption, perceived usefulness, trust, and financial inclusion among banking customers. Using structured questionnaire data collected from 250 respondents, the study employs Structural Equation Modelling (SEM) to test hypothesized relationships. Results indicate that perceived usefulness and trust significantly influence FinTech adoption, which in turn positively impacts financial inclusion. The findings contribute to digital finance literature and provide policy implications for regulators and financial institutions.

Keywords: *FinTech, Financial Inclusion, UPI, Digital Banking, Trust, Technology Adoption, SEM.*

Introduction

The financial services sector has undergone structural transformation due to technological integration. Financial Technology (FinTech) refers to the use of digital innovations to deliver financial services efficiently, securely, and inclusively.

In India, digital payments witnessed exponential growth following the introduction of UPI by the National Payments Corporation of India and regulatory support from the Reserve Bank of India. Platforms such as Paytm, PhonePe, and Google Pay have strengthened the digital ecosystem.

Despite rapid growth, empirical evidence on how FinTech adoption influences financial inclusion remains limited, particularly in emerging markets. This study attempts to bridge this research gap.

Literature Review

1. Arner et al. (2016) describe FinTech as a technology-driven financial innovation enhancing financial services efficiency.
2. Gomber et al. (2018) emphasize digital disruption in traditional banking models. The Technology Acceptance Model (TAM) suggests that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) influence technology adoption. FinTech and Financial Inclusion Studies indicate digital payments improve accessibility, reduce transaction costs, and enhance credit penetration, especially in rural areas. However, concerns regarding cybersecurity and trust remain significant.

Objectives of the Study

1. To examine factors influencing FinTech adoption.
2. To analyse the impact of FinTech adoption on financial inclusion.
3. To test the mediating role of FinTech adoption.

Hypotheses Development

H1: Perceived Usefulness significantly influences FinTech Adoption.
H2: Trust significantly influences FinTech Adoption.
H3: FinTech Adoption positively influences Financial Inclusion.
H4: FinTech Adoption mediates the relationship between Trust and Financial Inclusion.

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Conceptual Framework

Independent Variables:

- Perceived Usefulness (PU)
- Trust (TR)

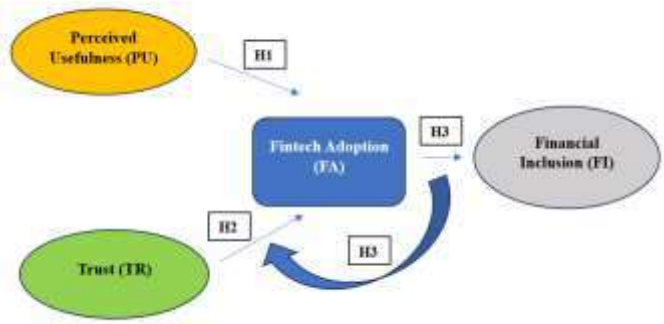
Mediating Variable:

- FinTech Adoption (FA)

Dependent Variable:

- Financial Inclusion (FI)

Model Structure:



Research Methodology

Research Design - Descriptive and explanatory research design.

Data Collection - Primary data collected using a structured questionnaire with 5-point Likert scale items.

Sample Size - 250 respondents (banking customers using digital payment platforms).

Sampling Technique - Convenience sampling.

Statistical Tools - Reliability Analysis (Cronbach's Alpha), Confirmatory Factor Analysis (CFA), Structural Equation Modelling (SEM) and AMOS / SmartPLS software

Data Analysis and Results

(A)Reliability Test

Cronbach's Alpha	
PU	**0.87**
Trust	**0.89**
FA	**0.91**
FI	**0.85**

All the constructs exceed the 0.70 threshold, indicating reliability.

(B)Model Fit Indices (SEM)

- CFI = 0.94
- RMSEA = 0.05
- GFI = 0.92
- $\chi^2/df = 2.10$

Model fit is acceptable.

(C)Hypothesis Testing

Hypothesis Path Coefficient		p-Value	Result
H1	0.48	<0.001	Supported
H2	0.41	<0.001	Supported
H3	0.52	<0.001	Supported
H4	Significant mediation effect	Supported	

Findings

The findings confirm that perceived usefulness and trust are significant determinants of FinTech adoption. Adoption significantly enhances financial inclusion by increasing accessibility, reducing transaction costs, and enabling credit availability.

The mediating role of FinTech adoption suggests that trust alone does not directly enhance inclusion unless customers actively adopt digital financial services.

Theoretical Implications

- Extends TAM by integrating financial inclusion dimension.
- Contributes to FinTech adoption literature in emerging economies.
- Validates mediation effect using SEM framework.

Practical Implications

- Banks should focus on trust-building mechanisms.
- Strengthen cybersecurity infrastructure.
- Promote digital literacy campaigns.
- Regulators should design innovation-friendly policies.

Conclusion

FinTech adoption significantly enhances financial inclusion in India. Trust and perceived usefulness are critical drivers of adoption. Policymakers and financial institutions must prioritize digital security and awareness to sustain FinTech growth.

Acknowledgment

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study titled *"Financial Technology (FinTech) Adoption and Financial Inclusion: An Empirical Analysis in the Indian Banking Sector."*

First and foremost, I extend my heartfelt thanks to my research guide/supervisor for their invaluable guidance, continuous support, and constructive suggestions throughout the course of this study. Their expertise, encouragement, and mentorship were instrumental in shaping the research and ensuring its successful completion.

I am also grateful to the faculty members and administration of my institution for providing the necessary academic resources, facilities, and support required to conduct this study effectively.

My sincere appreciation goes to the banking professionals, FinTech practitioners, policymakers, researchers, and respondents who contributed their valuable insights and experiences regarding the adoption of financial technologies and their role in promoting financial inclusion. Their cooperation and perspectives greatly enriched this research.

I would also like to acknowledge the contributions of scholars, academicians, financial institutions, and regulatory bodies whose reports, publications, and research studies on FinTech, digital banking, and financial inclusion provided a strong theoretical and empirical foundation for this study.

Special thanks are due to Reserve Bank of India, financial institutions, and industry stakeholders whose publicly available reports, guidelines, and statistical data supported the analysis undertaken in this research.

I am thankful to my friends and colleagues for their encouragement, valuable discussions, and constructive feedback during various stages of this study.

Finally, I express my deepest gratitude to my family for their unwavering support, patience, and motivation throughout this academic journey. Their constant encouragement and belief in my abilities have been a source of strength and inspiration.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

FinTech Adoption and Financial Inclusion in Rural India: A Systematic Literature Review

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Abstract

The growth of Financial Technology (FinTech) has significantly influenced the delivery of financial services by enabling digital payments, mobile banking, online lending, and technology-driven customer support systems. In India, FinTech has been widely promoted as a mechanism to strengthen financial inclusion, particularly in rural regions where physical banking infrastructure remains limited. Rural communities often face challenges such as distance from bank branches, low levels of financial awareness, and high dependency on cash-based transactions. Innovations such as Unified Payments Interface (UPI), Aadhaar-enabled payment systems, digital wallets, and mobile-based banking services have improved the availability of financial services to rural populations. However, the adoption of FinTech in rural areas continues to be constrained by digital illiteracy, inconsistent internet connectivity, low smartphone penetration among economically weaker households, and increasing concerns regarding cybersecurity and digital fraud. This systematic review synthesizes existing academic and institutional literature on rural FinTech adoption and its contribution to financial inclusion in India. The review highlights major adoption drivers including perceived convenience, government initiatives, trust in banking institutions, and social influence. It also identifies barriers such as limited awareness, infrastructural gaps, and risk perceptions. The study further discusses theoretical frameworks used in adoption studies and outlines significant research gaps. The review concludes that FinTech can enhance rural financial inclusion in India if supported by strong digital infrastructure, localized digital literacy programs, and robust consumer protection mechanisms.

Keywords: *FinTech, Rural India, Financial Inclusion, UPI, Digital Payments, Mobile Banking.*

Introduction

The Indian financial sector has undergone rapid transformation due to technological developments and increasing digital connectivity. The emergence of Financial Technology (FinTech) has accelerated this change by enabling financial services through mobile devices, internet platforms, and automated digital systems. FinTech broadly refers to the integration of technology with financial services to deliver innovative payment systems, lending platforms, insurance services, investment tools, and banking solutions. Globally, FinTech has been recognized as a key force that reshapes traditional banking structures by improving efficiency and enhancing customer experience (Arner, Barberis, & Buckley, 2015).In India, FinTech has gained strong momentum due to policy support, increasing smartphone usage, and the expansion of digital payment infrastructure. The introduction of Unified Payments Interface (UPI), Aadhaar-based authentication, and the Jan Dhan-Aadhaar-Mobile (JAM) trinity has contributed to the growth of digital financial services across different socio-economic groups (NITI Aayog, 2018). The Government of India has also promoted cashless transactions through initiatives such as Digital India, BharatNet, and Direct Benefit Transfer (DBT), which have played a significant role in expanding financial inclusion (Government of India, 2019).

Financial inclusion refers to the process of ensuring that individuals and businesses, especially those from disadvantaged backgrounds, have access to affordable and appropriate financial products and services. In India, rural financial inclusion has remained a critical development goal because a significant share of the rural population has historically depended on informal credit sources and cash-based transactions.

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Although banking expansion and microfinance have improved rural access to financial services, challenges such as geographic distance, low awareness, and limited branch infrastructure continue to restrict rural participation in formal finance (RBI, 2022).

Digital transactions are gaining rapid acceptance not only in India but across the world. In this context, the Government of India introduced the Pradhan Mantri Jan Dhan Yojana (PMJDY) on 14th August 2015 to strengthen financial inclusion. On the day of its launch, nearly 1.5 crore bank accounts were opened nationwide under the scheme. PMJDY allows individuals to open zero-balance accounts, provides a free debit card, and includes accidental insurance coverage. The primary objective of the scheme is to ensure universal access to formal banking services and it has also played a significant role in promoting the country's shift towards digitalization (Divya, 2016).

Digital financial services have been increasingly viewed as an effective solution to bridge this gap. Mobile banking, digital wallets, UPI-based payments, and Aadhaar-enabled services allow rural users to perform transactions without visiting bank branches. Nevertheless, rural adoption of FinTech remains uneven, as digital illiteracy, poor internet connectivity, limited access to smartphones, and rising cyber fraud cases create obstacles to consistent usage (NPCI, 2023). Therefore, a systematic review of existing studies is essential to understand the role of FinTech in rural financial inclusion and to identify gaps in the current body of research.

This study provides a structured synthesis of literature on FinTech adoption in rural India and its contribution to financial inclusion outcomes. It focuses on adoption determinants, challenges, theoretical approaches, and policy-related issues highlighted by prior research.

Methodology

This study adopts a systematic literature review approach to ensure that existing evidence is reviewed in an organized and transparent manner. A systematic review method helps identify research patterns, classify existing findings, and highlight gaps for future studies.

1 Source of Data

Relevant literature was identified through academic databases such as Scopus, Research Gate, Google Scholar, SSRN. Additionally, institutional publications from the Reserve Bank of India (RBI), National Payments Corporation of India (NPCI), NITI Aayog, and World Bank were considered due to their relevance to India's digital payment ecosystem.

Keywords used for searching included: *FinTech adoption*, *rural banking*, *rural digital payments*, *financial inclusion in India*, *UPI adoption*, *mobile banking in rural areas*, *Aadhaar-enabled payments*, *digital literacy*. Research papers published mainly between 2010 and 2024 were selected to reflect recent FinTech developments.

2. Inclusion and Exclusion Criteria

Studies were included if they:

- Addressed FinTech, digital banking, or digital payments in rural areas.
- Discussed financial inclusion outcomes.
- Were published in peer-reviewed journals or credible institutional reports.
- Focused on India or comparable developing economies. Studies were excluded if they:
- Focused exclusively on urban customers without rural relevance.
- Were purely technical and did not examine adoption or inclusion.
- Were opinion articles without empirical or conceptual evidence.

3. Review Process

After screening titles and abstracts, the shortlisted studies were reviewed in full text. The final selection was categorized thematically, and key insights were synthesized under relevant headings such as adoption factors, barriers, policy support, and outcomes.

FinTech and Financial Inclusion in Rural India: Conceptual Perspective

FinTech includes a broad range of services, but in rural India, the most relevant categories are digital payments, mobile banking, Aadhaar-enabled financial services, digital lending, and micro-insurance. These services contribute to financial inclusion by improving access and reducing dependency on physical banking infrastructure.

Financial inclusion in rural India is influenced by multiple factors such as income levels, education, awareness, geographic access, and trust in formal institutions. The Global Findex Report indicates that digital transactions have increased globally; however, the usage gap remains significant among low-income and rural households (Demirgüç-Kunt et al., 2018). In the Indian context, the RBI has consistently emphasized that financial inclusion must go beyond account ownership and focus on active usage of services such as payments, credit, and savings (RBI, 2022).

FinTech is considered beneficial for rural inclusion because it reduces transaction costs, increases service availability, and provides faster access to payments and transfers. Ozili (2018) argues that digital finance can expand inclusion by addressing barriers such as distance and affordability. Similarly, India's UPI-based ecosystem has made low-cost real-time payments possible even for small-value transactions, which is particularly relevant for rural consumers and small merchants (NPCI, 2023).

Factors Influencing FinTech Adoption in Rural Areas

The literature identifies multiple determinants influencing FinTech adoption among rural customers. These factors include perceived convenience, trust, awareness, ease of use, government initiatives, and social influence.

1 Convenience and Perceived Usefulness

A major reason for adopting digital financial services in rural areas is convenience. Digital platforms allow rural users to transfer money, pay utility bills, and receive welfare benefits without physically visiting a bank branch. Studies on digital payment adoption emphasize that perceived usefulness strongly predicts adoption intention, as users value time-saving and cost-saving benefits (Sharma & Kukreja, 2013).

In rural India, where transportation facilities are limited, FinTech provides a practical alternative. Mobile-based

transactions reduce the burden of travel and waiting time in bank branches. Digital payment systems also help rural households manage remittances, especially when family members work in urban areas.

2 Ease of Use and Digital Skills

Ease of use is another key factor influencing rural adoption. Technology Acceptance Model (TAM) based studies indicate that if digital platforms are simple to operate, rural users are more likely to accept them. However, complexity in application design and lack of guidance often discourages usage.

Rural adoption is strongly dependent on the availability of training and support systems such as banking correspondents, self-help groups, and community-based digital education programs. NITI Aayog (2018) highlighted that digital literacy is essential for improving participation in digital finance.

3 Trust, Risk Perception, and Security Concerns

Trust is a critical issue in rural FinTech adoption. Rural users often hesitate to adopt digital platforms because they fear financial loss and fraud. Ryu (2018) found that perceived risk is a strong barrier to FinTech adoption, especially for late adopters.

In India, increasing reports of UPI fraud, phishing attacks, and OTP-related scams have created fear among rural consumers. RBI (2022) emphasized the need for strengthening customer awareness and consumer protection mechanisms to build trust in digital payment systems.

4 Role of Social Influence and Community Support

Social influence plays a significant role in rural technology adoption. According to UTAUT, social influence impacts adoption behavior when individuals rely on family, friends, or community members for guidance (Venkatesh et al., 2003). In rural India, adoption often spreads through peer learning and demonstrations by merchants or banking correspondents.

Self-help groups and microfinance institutions also contribute to adoption by promoting digital payment methods for savings and loan repayments. Community-based adoption patterns are therefore significant in rural settings.

5 Government Support and Institutional Initiatives

Government initiatives have strongly shaped rural FinTech adoption in India. The JAM trinity has created the foundation for digital welfare distribution and banking penetration. Direct Benefit Transfer has encouraged rural households to open accounts and use digital banking services (Government of India, 2019).

The RBI and NPCI have played key roles in building digital payment infrastructure. The expansion of UPI and RuPay cards has enabled rural users to access low-cost payment methods. NPCI (2023) highlights that UPI adoption has grown rapidly due to its simplicity and real-time transaction features.

Barriers to FinTech Adoption in Rural India

Digitalization has been widely adopted across almost all sectors, including the banking industry, which has increasingly shifted towards digital platforms to provide faster and more convenient services to customers. However, the adoption of mobile banking is often affected by several challenges faced by users. To access mobile banking services, customers are required to link their bank accounts and personal information, which raises concerns regarding privacy and data security. Many customers fear that their personal details may be leaked or misused by criminals, leading to fraud and financial loss (Divya M P, 2021).

Although adoption is increasing, several barriers continue to restrict the effective use of FinTech in rural India.

1 Digital Illiteracy and Lack of Awareness

Digital illiteracy remains a major constraint. Many rural users lack knowledge about mobile banking applications, password management, and transaction procedures. This reduces confidence and increases dependency on others, which may further raise the risk of fraud.

Studies suggest that awareness programs and digital training workshops are necessary to improve rural participation. RBI (2022) also highlights that financial literacy is crucial for ensuring safe usage of digital banking.

2 Internet Connectivity and Digital Infrastructure Challenges

In rural India, poor network coverage and unreliable internet connectivity reduce the efficiency of digital transactions. BharatNet has been introduced to improve rural broadband access, but infrastructure gaps still exist in several regions (Government of India, 2019).

Connectivity issues create failed transactions and discourage users from trusting digital systems. This infrastructural barrier remains one of the most significant limitations for rural FinTech expansion.

3 Limited Access to Smartphones and Technology

Although mobile penetration is high, smartphone affordability is still an issue among low-income households. Many rural users still rely on basic feature phones, which restricts access to app-based banking services. Digital financial inclusion therefore depends not only on connectivity but also on device accessibility.

4 Cybersecurity Risks and Digital Fraud

Cybersecurity is one of the fastest growing challenges in India's digital payment ecosystem. Rural customers are often more vulnerable because they may not recognize phishing links, fraudulent calls, or fake payment requests. Rising cybercrime has increased fear and reduced trust in digital payments.

RBI (2022) suggests that consumer awareness campaigns and stronger security systems are necessary to minimize fraud risk.

5 Language and User-Friendly Design Issues

Language barriers restrict adoption because many digital platforms are not fully localized. Rural customers often prefer applications in regional languages. Complex interfaces further discourage first-time users. Studies recommend simplified design and multilingual support to ensure inclusiveness.

Therefore, these issues can be minimized through the implementation of strong security systems along with strict rules and regulations. Customers must be assured of adequate security measures at every stage of the digital transaction process. Only when customers feel confident and protected then adoption and increased usage of Fintech banking become possible

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Contribution of FinTech to Rural Financial Inclusion

The literature highlights multiple ways in which FinTech contributes to rural inclusion.

1 Expansion of Digital Payments and Cashless Transactions

UPI, QR code payments, and mobile wallets have increased digital transaction usage. Rural merchants can now accept small-value payments digitally. This reduces dependence on cash and increases transparency.

NPCI (2023) reports that UPI has become one of the most widely used payment systems in India, including in semi-urban and rural regions. This indicates a significant transformation in payment behavior.

2 Improvement in Access to Savings and Banking Services

Digital banking platforms allow rural customers to access savings accounts, check balances, and transfer funds easily. This promotes regular account usage and supports financial discipline.

3 Digital Credit and Micro-Lending Opportunities

Digital lending platforms provide new opportunities for rural entrepreneurs, farmers, and small businesses. By using transaction history and alternative data, FinTech lenders can offer credit even to customers without formal credit scores. This is particularly important in rural India where many individuals rely on informal borrowing sources.

4 Empowerment of Women and Rural Communities

FinTech supports women empowerment by enabling direct access to financial resources. Rural women involved in self-help groups benefit from digital transactions, as it reduces dependency on intermediaries. Studies indicate that digital finance enhances women's control over savings and improves participation in household financial decisions.

5 Effective Implementation of Government Welfare Schemes

DBT has improved transparency and reduced leakages. Rural beneficiaries receive welfare payments directly into their accounts, encouraging the usage of formal banking services. This has strengthened financial inclusion by linking rural households with digital banking systems (Government of India, 2019).

Theoretical Frameworks Used in Rural FinTech Adoption Studies

Research on FinTech adoption commonly applies established technology adoption models.

TAM is frequently used to analyze perceived usefulness and ease of use. UTAUT and UTAUT2 expand the explanation by including social influence and facilitating conditions. Diffusion of Innovation Theory helps explain adoption in terms of relative advantage and compatibility, while TPB focuses on behavioral intention and perceived control.

Venkatesh et al. (2003) argue that facilitating conditions are crucial for adoption, which is highly relevant in rural India where infrastructure and training play major roles.

Emerging Developments in Rural FinTech

The FinTech ecosystem is evolving rapidly. AI-based credit assessment and digital microfinance are expanding in India. Payment banks and small finance banks are also contributing to rural digital banking. Thakor (2020) emphasizes that FinTech is expected to further disrupt banking through automation and advanced data-driven decision-making.

In rural India, agent banking models and banking correspondents continue to remain essential, as they provide support to first-time digital users. Mobile money services and biometric authentication through Aadhaar have also supported rural adoption.

Research Gaps and Future Research Directions

This review identifies several important research gaps.

- Rural FinTech adoption studies in India remain limited compared to urban-focused research. More region-specific studies are needed at district and village levels.
- Most existing research relies heavily on quantitative survey methods. Qualitative research using interviews and case studies can provide deeper understanding of trust issues, fraud experiences, and cultural factors.
- Cybersecurity awareness and fraud-related behaviour require more academic attention. Future studies should focus on how fraud incidents influence trust and adoption sustainability.
- longitudinal research is limited. Adoption trends should be examined over time to understand how rural customers gradually build confidence and usage habits.
- Research should focus more on linking FinTech adoption with socio-economic outcomes such as poverty reduction, improved livelihoods, and business development.

Conclusion

The literature indicates that FinTech has become a strong enabler of financial inclusion in rural India by improving access to payments, savings, credit, and government welfare benefits. Digital platforms such as UPI and Aadhaar-enabled services have reduced the dependency on physical bank branches and enhanced transaction efficiency. However, rural adoption remains restricted by challenges such as digital illiteracy, poor connectivity, limited smartphone affordability, language issues, and cybersecurity risks.

The findings suggest that FinTech adoption can be strengthened through improved rural internet infrastructure, localized digital literacy training, simplified user interfaces, and stronger consumer protection systems. From a research perspective, more rural-focused empirical work, qualitative studies, and longitudinal approaches are required to understand the long-term impact of FinTech on rural economic development. Overall, FinTech holds strong potential to transform rural banking and promote inclusive growth in India, but sustained policy and institutional support will be essential for maximizing its benefits.

Acknowledgment

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study titled *"FinTech Adoption and Financial Inclusion in Rural India: A Systematic Literature Review."*

First and foremost, I extend my heartfelt thanks to my research guide/supervisor for their invaluable guidance, continuous encouragement, and constructive suggestions throughout the course of this study. Their expertise,

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I am also grateful to the faculty members and administration of my institution for providing the necessary academic resources, facilities, and a conducive learning environment that enabled the successful completion of this study.

My sincere appreciation goes to the researchers, scholars, policymakers, and practitioners whose published works, reports, and empirical studies on financial technology, digital finance, and financial inclusion formed the foundation of this systematic literature review. Their contributions have significantly advanced knowledge in this field and provided valuable insights for this research.

I would also like to acknowledge the support of academic journals, libraries, digital repositories, and research databases that facilitated access to relevant literature and scholarly resources essential for conducting this review.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Sustainable Agripreneurship, Digital Inclusion, and Rural Economic Growth in India: A state level analysis

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Abstract:

This paper explores the interdependence between sustainable agripreneurship, digital inclusion, and economic development in rural India based on an empirical study on a state level. As the population of rural areas in India relies heavily on agriculture, a national priority has been to transform the rural economies. The study uses a quantitative methodology with secondary data, which is compiled in the form of sources including NITI Aayog and the Ministry of Agriculture and Farmers Welfare to measure the difference between the states. Correlation, regression and panel data analysis are used as the statistical methods to evaluate the relationship between the variables. The results indicate that sustainable agripreneurship and digital inclusion are both important to increase the rural economy, but digital inclusion demonstrates a comparatively even greater effect. Agripreneurship increases productivity, innovation and employment whereas digital inclusion boosts access to markets, financial services and information. Another significant finding of the study is regional differences whereby more advanced states perform better compared to less developed states because of superior infrastructure and policy support. The study summarizes that a comprehensive strategy that includes agripreneurial and digital growth is needed to attain inclusive and sustainable rural development in India.

Keywords: *Sustainable Agripreneurship, Digital Inclusion, Rural Economic Growth, State-Level Analysis, India.*

Introduction

Rural economy in India is a vital part of the development of the country as a large percentage of the population relies on farming and related practices to get their living [1]. Nevertheless, production productivity and income growth in rural regions has been limited in the past by its traditional agricultural practice, low access to technology and poor infrastructure. Sustainable agripreneurship has become a new notion of practice in recent years, with the synthesis of agricultural innovation and environmentally responsible practices, and entrepreneurial thought. In addition to increasing agricultural efficiency, this change facilitates the maintenance of ecological balance and strength in the long run [2]. Meanwhile, rural transformation has been driven by digital inclusion. Through the development of digital infrastructure which has been facilitated with the efforts of organizations like the NITI Aayog and Ministry of Agriculture and Farmers Welfare, has allowed farmers and rural entrepreneurs to access information, financial services, and markets more effectively. Mobile applications, digital payment solutions and online marketplaces are tools that have greatly minimized information asymmetry and transaction costs and thus enhances decision-making and income opportunities [3].

Sustainable agripreneurship and digital inclusion are two concepts that complement each other, and can be used to quickly spur economic development in rural areas in India. Although agripreneurship leads to innovation and value addition in agricultural operations, digital inclusion leads to greater connectivity and access to key services. They combine to enhance productivity, creation of jobs and income diversification in the countryside. Nevertheless, despite these developments, the digital access, entrepreneurship abilities, and economic performance differences between Indian states are significant. Thus, state-level analysis should be conducted to comprehend these differences and discover problems and opportunities that regionally apply. This paper will attempt to examine how sustainable agripreneurship, digital inclusion, and rural economic development are related,

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and the information offered in this paper can inform policymakers about the need to intervene through creating policies to help achieve inclusive and sustainable rural development in India.

Related Works

The literature is recent, and it has shown the increased significance of sustainable agripreneurship, digital inclusion, and rural development, especially in the developing economies like India. The combination of entrepreneurial activities in the agricultural sector with the assistance of digital technologies and institutional structures has been widely identified to promote economic change in the rural areas. Kademani et al. [15] came up with a multidimensional measure to determine how the institutions support agripreneurs, which focuses on the significance of policy environment, training, and access to funds in facilitating the success of agripreneurs. Their results indicate that institutional mechanisms have a great impact on the scalability and sustainability of agricultural enterprises. To supplement this, Mendes et al. [18] set out a hypothetical model of green agripreneurship with the emphasis put on making the environment sustainable without the use of such practices like greenwashing. This is in line with the overall objective of rural sustainable development. Rural transformation has been facilitated by the use of digital technology, especially financial technologies. Liu et al. [16] proved that digital inclusive finance does not only help to improve the level of income but also leads to better psychological empowerment of rural inhabitants. Their research gives support to the fact that the availability of digital financial services can lessen multidimensional poverty and develop economic resilience. On the same note, Poti and Joy [23] analyzed digital platforms like KisanMitr, and demonstrated how technology can bridge many stakeholders in the agri-value chain to enhance efficiency and access to the markets.

Financial inclusion as a tool of empowering the marginalised population, women in particular, has been a popular research topic. Mbangiswano et al. [17] emphasized the role financial inclusion programs can play in empowering women agripreneurs in rural areas to engage more in economic activities. Mugion et al. [19] also examined the women's roles in Agriculture 4.0 and found that the women were being increasingly involved in technologically based agricultural systems. These reports underscore the need to have gender inclusive policies, in order to enhance equitable rural development. Other areas that have attracted attention in the recent research are entrepreneurship development programs and interventions. Ponnaganti et al. [22] evaluated the performance of the AGRI UDAAN accelerator in India, and applied the most sophisticated analytical tools Principal Component Analysis (PCA) and machine learning. Their results show that well-organized incubation programs can help a great deal to achieve the performance and scalability of agri-startups. On the same note, Sandhu et al. [26] investigated how entrepreneurship education and training might facilitate agritourism development among women entrepreneurs in India, with an attention on the importance of skill development and capacity building. Nchanji et al. [20] have discussed the topic of youth engagement and empowerment in agriculture and have carried out a systematic review of the youth-oriented interventions in Sub-Saharan Africa. Some of the factors of success they found include availability of resources, training and institutional support that are applicable in the Indian context. Patra et al. [21] concentrated on homestead gardening in Himalayan region as a way of enhancing nutrition security, and revealed how small-scale agricultural projects can be effective in enhancing not only economic wellbeing, but also social wellbeing.

In spite of all these developments, there are still a number of issues in the agripreneurship ecosystem. Raza et al. [24] made a systematic review of the constraints that smallholder agripreneurs experience in developing countries, revealing that lack of access to finance, poor infrastructure, and poor technical knowledge were among the barriers. These limitations underscore the necessity of combined policy strategies that are a mixture of financial, technological and institutional resources. Another important factor that determines productivity in agriculture should be access to information and extension services. Sahu et al. [25] studied the factors that influence access of farmers to the agricultural extension services in the Indo-Gangetic plains detailing that the digital tools and communication paths are essential in spreading information and enhancing farming practices.

In general, the literature reviewed suggests that sustainable agripreneurship and digital inclusion are closely interrelated and co-create rural economic growth. Although considerable strides have been taken in comprehending the separate elements, the lack of state-level analyses that incorporate these dimensions still exists. This paper will fill this gap by offering an empirical analysis of their effect on the economic growth of rural India in combination with each other.

Methodology

This research will take a structured and empirical method to explore the connection of sustainable agripreneurship, digital inclusion, and rural economic growth in Indian states. Taking into consideration the macro-level of the research topic, the quantitative approach involving the secondary data analysis is deemed as the most suitable in ensuring the reliability, comparability and generalisability of results [4].

1. Research Design

The design for conducting the research will be quantitative since it will serve both as a descriptive and explanatory research. As far as the description is concerned, the design will help to identify the current scenarios related to the agripreneurship, digital inclusion, and economic performance in the rural areas of various Indian states [5].

The approach is based on a state-level panel data, which will enable the use of cross-sectional (between states) and time-series (over years) variations. This method enhances the quality of the results since it is capable of detecting temporal variations in addition to geographical inequality.

3.2 Data Type and Sources

The research is founded on secondary data that is completely based on trustworthy and publicly accessible sources. The choice of secondary data is due to the fact that a large-scale, similar, and consistent datasets of Indian states over several years are available [6].

The main data sources will be:

- NITI Aayog - state level development indicators and composite indices.

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- Ministry of Agriculture and Farmers Welfare - concerned with the data about the agribusiness and agropreneurship.
- Reserve Bank of India - to get financial inclusion and rural credit statistics.
- World Bank - to benchmark and macroeconomic indicators.
- National Sample Survey Office - to get employment, income and consumption statistics.

The data will be gathered over a time span of about 8-10 years (e.g., 2014-2023) so that it does not lack a sufficient degree of time to be analyzed.

3. Sampling Design

The research employs a purposive sampling method which is non-probability but the state chosen is by the availability and consistency of the data in the report. The inclusion of all major states is to improve its representativeness, whereas union territories could be omitted because of small size or poor quality of data [7].

There are states which are classified as:

- High-performing states
- Average (moderate)-performing states
- Low-performing states

The classification enables a comparative analysis and enables the recognition of regional differences in the development of agripreneurship, the level of digital inclusion, and economic results.

4 Variable Definition and Measurement

There is independent, dependent and control variables in the study, operationalised through measurable indicators.

Table 1: Variables and Indicators

Variable Type	Variable Name	Indicators	Measurement Source
Independent	Sustainable Agripreneurship	Number of agri-startups, organic farming area, agri-value addition	Ministry of Agriculture
Independent	Digital Inclusion	Internet penetration, mobile usage, digital payments (UPI), banking access	RBI, NSSO
Dependent	Rural Economic Growth	Rural per capita income, employment rate, agricultural productivity	NSSO, World Bank
Control	Infrastructure	Road connectivity, electricity access	NITI Aayog
Control	Education Level	Literacy rate, rural education index	NSSO

These are standardized variables to help make comparisons across states and time.

5 Data Analysis Techniques

In order to fulfill the research objectives a mix of statistical techniques is used:

1. Descriptive Analysis

The data is summarised using descriptive statistics like mean, standard deviation and growth rates to determine trends across the states.

2. Correlation Analysis

The relationship between: Correlation analysis will be used to discuss the strength and direction of correlations between:

- Economic development and agripreneurship.
- Digital access and economic development.
- Digital inclusion and agripreneurship.

This can be used to determine the direction in which the variables move as well as the level of association.

3. Regression Analysis

To find the influence of the independent variables on rural economic growth, multiple regression analysis will be used. The equation of the model can be represented as:

"Rural Economic Growth = $\beta_0 + \beta_1$ (Agripreneurship) + β_2 (Digital Inclusion) + β_3 (Control Variables) + ε"

This approach aids in the measurement of the contribution of factors as well as the control of external factors.

4. Panel Data Analysis

The Hausman test results are used to determine fixed effects or random effects models. The panel data analysis can enhance accuracy in that it accommodates the unobservable heterogeneity across states [8].

6 Analytical Framework

The research is conducted in a systematic analytical manner:

Table 2: Analytical Framework

Step	Description	Purpose
Step 1	Data Collection	Gather secondary data from reliable sources
Step 2	Data Cleaning	Remove inconsistencies and missing values

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Step 3	Variable Standardisation	Ensure comparability across states
Step 4	Descriptive Analysis	Understand trends and patterns
Step 5	Correlation Analysis	Identify relationships between variables
Step 6	Regression Analysis	Measure impact and significance
Step 7	Interpretation	Draw conclusions and policy insights

7. Reliability and Validity

To verify the validity of the study:

- The reliability is achieved through the use of consistent sources of data including government and international databases.
- Validity is implied by choosing indicators that reflect the constructs of agripreneurship, digital inclusion and economic growth.
- The triangulation of data is used to compare data through various sources.

8 Ethical Considerations

The research is conducted with regard to ethical standards of research. There are no human participants as the secondary data only is utilized. Every source of data is duly credited, and none of the data are manipulated or misrepresented [9].

9 Limitations of the Methodology

Although the methodology has a number of strong points, there are some limitations:

- The use of secondary data might also limit the access to particular indicators.
- The differences encountered in the reporting of data in different states can lead to inconsistency.
- The survey might be unable to give a comprehensive view of informal economic activities that are common in the rural settings [10].
- Causality can be deduced but not determined.

10 Summary

In brief, this approach combines both quantitative and credible secondary sources to present an all-inclusive state-level study of sustainable agripreneurship, lack of digital inclusiveness, and economic development in rural India. The panel data and the use of sophisticated statistical tools provide a strong analysis of correlations and inclusion of control variables increases the accuracy of the results. The strategy eventually promotes the use of evidence-based policy suggestions to enhance inclusive and sustainable rural development.

Results And Analysis

This part shares the empirical results of the secondary data analysis and gives the results interpretation as per the research objectives. This analysis aims at establishing patterns and relationships and diversities among the Indian states in terms of sustainable agripreneurship, digital inclusion and rural economic development.

1 Descriptive Statistics and Overview

The first analysis will give an overview of important indicators in selected states. Much difference is witnessed on all the three dimensions, which depict regional differences.

Table 3: Descriptive Statistics of Key Variables

Variable	Mean	Std. Deviation	Minimum	Maximum
Agripreneurship Index	52.4	14.8	25.3	81.6
Digital Inclusion Index	61.7	18.2	30.1	90.4
Rural Economic Growth (%)	6.2	2.1	2.5	10.8
Infrastructure Index	65.3	12.7	40.2	88.9
Literacy Rate (%)	71.5	9.4	55.1	90.2

The agripreneurship index is moderate with an average of 52.4, and although there is a slightly higher penetration of digital inclusion. The standard deviation is however widely spread implying that there is an uneven distribution across states [11]. Economic growth, an indicator of inequality, is also 6.2 on average in the rural areas which are affected by structural and technological factors.

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Figure 1: "From farms to fintech, India's economy reflects a powerful transformation in motion"

2 State-Level Comparative Analysis

Comparative analysis indicates that the performance pattern in states differs. The states of Maharashtra, Karnataka, and Tamil Nadu have been found to be high in terms of agripreneurship and those in digital inclusion but states like Bihar, Jharkhand, and Odisha are behind.

Table 4: State-Level Performance Comparison

State	Agripreneurship Index	Digital Inclusion Index	Rural Growth (%)
Maharashtra	78.2	85.6	9.8
Karnataka	75.4	82.3	9.2
Tamil Nadu	72.8	80.5	8.9
Uttar Pradesh	50.6	58.7	5.4
Bihar	38.9	42.1	3.8
Odisha	45.3	49.6	4.6

The findings suggest that the more a state is digitally penetrated and agripreneurial, the greater its rural economic performance would be [12]. This substantiates the hypothesis that the main drivers of rural development are innovation and connectivity.

4.3 Correlation Analysis

Correlation analysis will be used to see the strength of the relationship that exists between the key variables.

Table 5: Correlation Matrix

Variables	Agripreneurship	Digital Inclusion	Rural Growth
Agripreneurship	1.00	0.68	0.74
Digital Inclusion	0.68	1.00	0.79
Rural Growth	0.74	0.79	1.00

Results show that there are good positive correlations:

- Rural development and agripreneurship (0.74)
- Digital inclusion and rural development (0.79)
- Digital inclusion and agripreneurship (0.68)

This shows that the better agripreneurship and digital access, the better rural economic growth. The slightly stronger correlation of digital inclusion points to the possibility that connectivity might have a slightly stronger factor [13].

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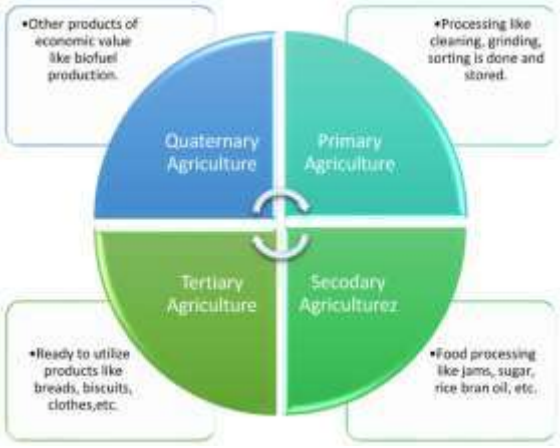

Figure 2: "Driving Sustainable Growth for Small and Medium Enterprises in Emerging Urban–Rural Economies"

4.4 Regression Analysis

Multiple regression analysis is conducted to explore more the effect of independent variables.

Table 6: Regression Results

Variable	Coefficient (β)	t-value	Significance (p-value)
Constant	1.25	2.10	0.038
Agripreneurship	0.32	4.85	0.000
Digital Inclusion	0.41	5.72	0.000
Infrastructure	0.18	3.21	0.002
Literacy Rate	0.15	2.89	0.005

The results of the regression prove that agripreneurship and digital inclusion have significant positive effects on the economic growth in the rural areas that are statistically significant. The impact of digital inclusion (0.41) is slightly more significant than agripreneurship (0.32), which supports the need to emphasize the value of digital connectivity in the economies of modern rural areas [14].

Much less significant but still important contributions are made by control variables like infrastructure and literacy, which proves that favorable conditions contribute to the efficacy of agripreneurial and digital projects.

Figure 3: "Enhancing rural livelihoods in India"

5 Panel Data Analysis

To consider both cross-sectional and time-series variations, panel data methods are used. According to the Hausman test, the fixed effects model is more suitable, which implies that the results are largely affected by state-specific factors.

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Table 7: Panel Data (Fixed Effects Model)

Variable	Coefficient	Std. Error	p-value
Agripreneurship	0.29	0.06	0.000
Digital Inclusion	0.38	0.07	0.000
Infrastructure	0.16	0.05	0.003
Literacy	0.12	0.04	0.007

The panel analysis supports previous results indicating the positive effects of agripreneurship and digital inclusion to be consistently positive over time. The difference in the coefficients between this and cross-sectional regression is slight and indicates that some of the variation is due to unobserved factors specific to each state [27].

6 Interpretation of Findings

The findings strongly show that sustainable agripreneurship as well as digital inclusion is a key driver of rural economic development in India. Nevertheless, the impact of digital inclusion on the economy seems to be more direct and powerful since it provides access to markets, financial services and information [28].

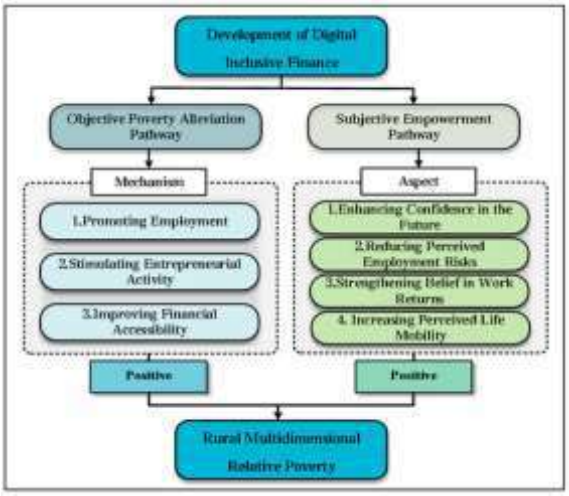

Figure 4: "Mitigating Rural Multidimensional Poverty Through Digital Inclusive Finance"

Agripreneurship contributes through:

- Technological advances in agriculture.
- Value addition of agricultural products.
- Employment generation

Digital inclusion enhances:

- Access to the market with e-commerce sites.
- Digital payments through financial inclusion.
- Distribution of information using mobile technology.

The net result of these combined is the multiplier effect to the rural economies which translates into increased productivity and levels of income.

7 Regional Disparities and Key Insights

There appear to be considerable inequalities in the regions:

- The Southern and Western states are doing better because of the better infrastructure, policy support and literacy rates.
- Northern and Eastern states are disadvantaged because they have less access to digital and are less entrepreneurial.

Key insights include:

- Rural change is based on digital infrastructure.
- Agripreneurship is successful when there is a good institutional backing.
- Both variables have education and infrastructure as enablers.

8 Discussion in Context

The data can be related to the national development regulations advocated by organizations like NITI Aayog, focusing on digital transformation and the development of the entrepreneurship sector as the cornerstones of rural development. In a similar manner, the Ministry of Agriculture and Farmers Welfare has made efforts to promote agripreneurial activities by offering support via policy and funding programs [29].

The findings are also in tandem with the available literature which cites the importance of technology and innovation in increasing agricultural production and economic performances [30].

9 Summary of Results

In summary:

1. Agripreneurship, digital inclusion, and rural economic growth have a positive relationship.
2. The effect of digital inclusion is a bit higher than of agripreneurship.
3. Significant improvements in these effects are made by infrastructure and education.
4. One of the issues is regional disparities.

All in all, the empirical findings verify that the combination of the concept of sustainable agripreneurship and digital inclusion can be used to make a significant positive contribution to the pace of rural economy development in India, though the policy interventions need to take into consideration the issue of the regional inequalities and the lack of infrastructural facilities.

Conclusion

In this paper, sustainable agripreneurship, digital inclusion, and rural economic growth in India were studied based on a state-level empirical study. The results show that agripreneurship, as well as digital inclusion, is an important and complementary factor in rural development. Agripreneurship fosters innovation, value addition and job creation in the agricultural industry and digital inclusion facilitates market and financial services and information access, which leads to greater efficiency and productivity. The findings indicate that digital inclusion impacts rural economic growth slightly stronger and more immediately; especially by increasing digital financial services and connectivity. Nevertheless, a multiplier effect of agripreneurial efforts and digital connections hastens income growth and diversification of economies in rural communities. Moreover, it turned out that supporting elements, like infrastructure and education, can contribute to establishing such relations and the role of the supportive environment is important.

The analysis also indicates that there are dramatic regional inequalities in the Indian states with more developed ones enjoying superior infrastructure, higher digitization and greater institutionalization. Conversely, the less developed states are still struggling with the problems, including inadequate access to technology and the opportunities to become an entrepreneur. In summation, sustainable agripreneurship, and inclusive digital development should be promoted to attain balanced and sustainable rural economic growth in India. To unlock the potential of the rural economies, policymakers ought to prioritize reducing inequalities in the region, institutional support, and investment in digital and physical infrastructure.

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The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

From Text to Screen: Reconstructing Sports Narratives in Contemporary Biopics and Popular Culture

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Abstract

The increasing prominence of sports biopics in contemporary cinema has transformed the ways in which athletic lives are represented and interpreted within popular culture. This paper examines the transition of sports narratives from textual forms to cinematic representation, arguing that this process involves not mere adaptation but active reconstruction. Drawing on adaptation and representation theories, the study analyses how contemporary biopics such as Dangal *(2016),* Bhaag Milkha Bhaag *(2013), and* MS Dhoni: The Untold Story *(2016) reshape real-life experiences through narrative compression, visual dramatization, and selective emphasis. The paper demonstrates that these films reorganize complex lived realities into coherent narratives of struggle, perseverance, and success, thereby constructing athletes as symbolic figures of heroism and national identity. It further argues that cinematic representations are not neutral reflections of reality but ideological constructions that align individual achievements with collective cultural values. By situating sports biopics within the broader framework of media and popular culture, the study highlights their role in shaping audience perception and collective memory. Ultimately, the paper contends that the movement from text to screen is a dynamic process of reinterpretation in which narrative, identity, and meaning are continuously reconstructed within contemporary cultural discourse.*

Keywords: *Sports Biopics, Narrative Reconstruction, Adaptation, Representation, Popular Culture, Identity*

Introduction

In recent decades, sports narratives have emerged as a significant cultural form, reflecting broader social, political, and ideological concerns. Traditionally articulated through autobiographies, biographies, and journalistic accounts, these narratives have served as powerful sites for constructing identity, documenting struggle, and celebrating achievement. However, with the rapid expansion of visual media, particularly cinema, there has been a notable shift from textual representations of sporting lives to their cinematic reimagining. Contemporary sports biopics have gained immense popularity, transforming individual athletic journeys into compelling visual spectacles that resonate with mass audiences.

This transition from text to screen is not merely a process of adaptation but one of reconstruction. As adaptation theorists suggest, the movement across media involves reinterpretation rather than direct transfer, shaped by the possibilities and constraints of the new medium (Hutcheon, 2013). While literary narratives often present layered, introspective, and nuanced accounts of athletes' lives, cinematic representations tend to condense, dramatize, and selectively emphasize particular aspects of these narratives. In doing so, sports biopics reshape the meanings embedded within the original texts, often aligning them with dominant cultural ideologies such as nationalism, heroism, and perseverance. The cinematic medium, with its visual and emotional appeal, plays a crucial role in reconfiguring how sporting identities are perceived and remembered within popular culture.

Films such as Dangal, Bhaag Milkha Bhaag, and MS Dhoni: The Untold Story exemplify this transformation, where real-life experiences are reorganized into structured narratives of struggle, perseverance, and success. These cinematic representations not only retell sporting lives but actively reconstruct them through narrative selection, visual dramatization, and ideological framing. As cultural theorists argue, representation is not a passive reflection of reality but an active process through which meaning is constructed and circulated (Hall, 1997).

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Moreover, sports biopics function as influential cultural texts that contribute to the construction of collective memory and national identity. By foregrounding themes of struggle, sacrifice, and triumph, these films often elevate athletes into symbolic figures representing broader societal values. At the same time, the commercial and ideological imperatives of popular cinema may lead to the omission, simplification, or reconfiguration of complex realities, thereby producing narratives that are as much imaginative constructions as they are representations of real lives (Rowe, 2004).

Against this backdrop, this paper examines the transformation of sports narratives from text to screen, focusing on how contemporary biopics reconstruct these narratives within the framework of popular culture. It argues that sports biopics do not merely translate real-life stories into visual form but actively reshape them through narrative and cinematic strategies to produce culturally resonant representations of heroism, identity, and national belonging.

Review of Literature

The relationship between text and screen has been a central concern in adaptation studies, with scholars emphasizing that adaptation is not a mere process of translation but one of reinterpretation and transformation. Linda Hutcheon (2013) argues that adaptations are inherently creative acts that reframe source narratives within new cultural and media contexts. This perspective is particularly relevant in the study of sports biopics, where literary or real-life narratives are reshaped through cinematic conventions to suit audience expectations and ideological frameworks.

The biographical film, or biopic, has emerged as a significant genre within contemporary cinema. Dennis Bingham (2010) contends that biopics do not simply document lives but construct them through selective storytelling, narrative compression, and dramatization. Such films often prioritize emotional engagement and narrative coherence over factual accuracy, thereby producing versions of reality that are mediated by cinematic aesthetics and cultural values. This tendency is especially evident in sports biopics, where the athlete's journey is frequently framed as a linear progression from struggle to triumph.

Scholars of media and cultural studies have also examined how representation functions within popular culture. Stuart Hall (1997) highlights that representation is not a passive reflection of reality but an active process of meaning-making shaped by ideological forces. In the context of sports narratives, media representations play a crucial role in constructing identities, often reinforcing dominant discourses of nationalism, masculinity, and heroism. Similarly, David Rowe (2004) emphasizes the interplay between sport, media, and culture, arguing that sports narratives are deeply embedded within broader socio-cultural and economic structures.

Further, studies on sports media have explored the construction of sporting heroes and celebrity culture. Garry Whannel (2002) notes that media representations often elevate athletes into symbolic figures, embodying ideals such as discipline, perseverance, and national pride. These representations are not neutral but are shaped by institutional and commercial interests that influence how sporting success is narrated and consumed.

While existing scholarship has provided valuable insights into adaptation, representation, and sports media, there remains limited focus on how sports narratives are specifically reconstructed in the transition from text to screen within contemporary biopics. This study seeks to address this gap by examining the narrative and ideological transformations that occur when sports stories are reimagined in popular cinematic forms.

Research Gap

Existing scholarship on adaptation, biographical cinema, and media representation has offered valuable insights into how narratives are transformed across different mediums. Studies have highlighted that adaptation is an interpretative and creative process, and that biographical films often construct, rather than simply depict, the lives of individuals through selective storytelling and dramatization. Similarly, research in media and cultural studies has emphasized the role of representation in shaping meanings related to identity, heroism, and national consciousness.

However, despite these contributions, there remains a significant gap in the integrated study of sports narratives, adaptation, and popular cinema. Much of the existing research tends to examine sports literature, sports media, or film adaptations as separate domains, without adequately addressing their intersections. In particular, there is limited focus on how sports narratives are reconstructed in the transition from text to screen within contemporary biopics. Furthermore, the ideological dimensions of this reconstruction, especially in terms of hero formation, cultural identity, and popular reception have not been sufficiently explored.

This study seeks to address this gap by analysing how sports narratives are reshaped through cinematic representation in contemporary popular culture.

Research Objectives

1. To examine the transformation of sports narratives from textual forms to cinematic representations in contemporary biopics.
2. To analyse how sports biopics reconstruct the life stories of athletes through selective narration, dramatization, and visual techniques.
3. To explore the ways in which cinematic representations shape and redefine concepts of heroism, identity, and success in popular culture.
4. To investigate the role of sports biopics in constructing cultural and national identity within contemporary society.
5. To evaluate the influence of popular media in reshaping audience perception of real-life sporting figures.

Research Questions

1. How are sports narratives transformed when they move from textual forms to cinematic representations in contemporary biopics?
2. In what ways do sports biopics reconstruct the life stories of athletes through narrative selection, dramatization, and visual techniques?

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3. How do cinematic representations redefine notions of heroism, identity, and success in sports narratives?
4. What role do sports biopics play in shaping cultural and national identity within popular culture?
5. How does popular media influence audience perceptions of real-life sporting figures through biographical films?

Methodology

This study adopts a qualitative research approach to examine the transformation of sports narratives from textual forms to cinematic representations in contemporary biopics. The research is primarily based on textual and visual analysis, focusing on how narrative elements are reconstructed through filmic techniques. A purposive sampling method is employed to select a limited number of contemporary sports biopics, ensuring relevance to the study's focus on popular culture and media representation.

The analysis is guided by key aspects such as narrative structure, character construction, thematic emphasis, and cinematic devices, including visual imagery, dialogue, and dramatic sequencing. Particular attention is paid to how real-life events are selectively represented, modified, or intensified to create compelling narratives for mass audiences.

Furthermore, the study adopts an interpretative framework to examine how these films contribute to the construction of heroism, identity, and national consciousness, aligning with the research objectives. By comparing narrative patterns and representational strategies across selected films, the study seeks to identify recurring trends in the reconstruction of sports narratives.

This methodological approach enables a focused and critical understanding of how contemporary biopics reshape sporting stories within the broader context of popular culture.

Theoretical Framework

This study is grounded in Adaptation Theory and Representation Theory, which together provide an effective framework for analysing the transformation of sports narratives from text to screen. Adaptation Theory views the movement from one medium to another not as a process of simple transfer but as one of reinterpretation and re-creation. It emphasizes that when narratives shift from textual forms to cinematic representations, they undergo structural, thematic, and ideological changes shaped by the demands of the new medium. In the context of sports biopics, this perspective helps to examine how real-life stories and written accounts are selectively reshaped into coherent and emotionally engaging cinematic narratives.

Complementing this, Representation Theory offers a lens to understand how meaning is constructed through media. It posits that representation is an active process in which cultural meanings are produced and circulated, rather than merely reflected. Within sports biopics, cinematic techniques such as visual imagery, narrative sequencing, and characterization contribute to constructing particular versions of reality. These representations often reinforce dominant ideas of heroism, national identity, perseverance, and success, thereby influencing audience perception.

Together, these frameworks enable a critical analysis of how sports narratives are not only transformed but also reconstructed in popular culture. While Adaptation Theory explains the shift across mediums, Representation Theory reveals the ideological implications of that shift. This combined approach is particularly suited to the study's qualitative methodology, allowing for a nuanced examination of narrative structure, character portrayal, and cultural meaning in contemporary sports biopics.

Analysis and Discussion

Narrative Reconstruction: From Lived Reality to Cinematic Structure

The reconstruction of sports narratives in contemporary biopics becomes particularly evident when examined through specific cinematic texts. Films such as *Dangal* (2016), *Bhaag Milkha Bhaag* (2013), and *MS Dhoni: The Untold Story* (2016) demonstrate how the transition from lived experience to cinematic narrative involves a deliberate reshaping of reality. These films do not merely recount events; they reorganize them into emotionally compelling narrative structures that align with audience expectations and cultural frameworks.

In contrast to textual narratives, which often allow for reflection and complexity, cinematic narratives condense and streamline experience into a coherent, linear progression. As suggested by adaptation theory, this transformation is not a direct transfer but an act of reinterpretation shaped by the conventions of the medium (Hutcheon, 2013). The complexity of lived experience is thus restructured into narratives of struggle, perseverance, and success.

In *Dangal* (2016), the narrative is constructed around themes of discipline, sacrifice, and national pride, where the protagonist's journey is framed not only as a personal struggle but as a larger cultural project. The film foregrounds moments of training, resistance, and victory, while minimizing the ambiguities and contradictions that may exist in real life. This selective emphasis transforms the narrative into a story of empowerment and national achievement, thereby aligning the personal with the collective.

Similarly, *Bhaag Milkha Bhaag* (2013) reconstructs the life of Milkha Singh through a narrative of trauma and redemption. The film integrates historical events such as the trauma of Partition into the personal journey of the athlete, thereby expanding the narrative beyond individual experience. However, this integration is carefully structured to produce a coherent emotional arc, where personal suffering is ultimately resolved through athletic success. The complexity of history is thus mediated through cinematic storytelling, resulting in a narrative that is both powerful and selective.

Construction of the Sporting Hero

A central feature of sports biopics is the construction of the athlete as a heroic figure. Through narrative emphasis and cinematic techniques, these films elevate athletes beyond their individual achievements, portraying them as embodiments of perseverance, discipline, and success. The narrative typically follows a recognizable pattern of struggle, failure, and eventual triumph, reinforcing idealized notions of success.

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In *MS Dhoni: The Untold Story* (2016), the construction of the sporting hero is particularly pronounced. The film presents Dhoni as a figure of resilience and strategic intelligence, emphasizing his journey from obscurity to national prominence. The narrative is structured to highlight moments of struggle and breakthrough, creating a sense of inevitability in his success. This framing reinforces the idea of meritocratic achievement, where perseverance is portrayed as the key determinant of success.

At the same time, such representation involves selective emphasis. As representation theory suggests, media constructs meaning through narrative framing rather than merely reflecting reality (Hall, 1997). The complexities and contradictions of real life are often minimized, producing a streamlined and idealized version of the athlete. In this process, the cinematic medium contributes to myth-making, transforming individuals into symbolic figures who embody broader cultural values.

Nationalism and Cultural Identity

The articulation of nationalism within sports biopics further underscores the role of cinema in constructing meaning. In films such as *Dangal* (2016) and *Bhaag Milkha Bhaag* (2013), the athlete's success is closely tied to national identity, with moments of victory framed as collective achievements. The use of national symbols, crowd reactions, and emotionally charged sequences creates a sense of shared pride, transforming individual accomplishment into a national narrative.

This alignment of personal and national identity reflects the broader cultural function of sports biopics as instruments of ideological reinforcement. As noted in studies of sport and media, sporting narratives often operate as sites where cultural values and national aspirations are articulated (Rowe, 2004). However, this representation frequently involves simplification. Complex socio-political realities are often reduced to narratives of unity and triumph, thereby reinforcing dominant ideologies.

Media, Popular Culture, and Audience Perception

However, the emphasis on heroism and nationalism often comes at the cost of complexity. The narratives presented in these films tend to simplify socio-political contexts, foregrounding unity and triumph while minimizing conflict and contradiction. This selective representation raises important questions about the nature of cinematic truth, as the reconstructed narrative may differ significantly from lived reality. The film thus operates as a site of negotiation between fact and fiction, where meaning is shaped by both artistic intention and cultural expectation.

The influence of popular culture in shaping audience perception is particularly significant in this context. For many viewers, the cinematic version of an athlete's life becomes the primary source of knowledge, overshadowing textual or historical accounts. This phenomenon highlights the power of media in constructing collective memory, where representation takes precedence over reality. The athlete, as depicted in the film, becomes the definitive version of the individual.

Furthermore, the commercial nature of cinema plays a crucial role in shaping these narratives. The need to appeal to mass audiences often leads to the prioritization of dramatic and emotionally engaging elements. As a result, sports biopics operate at the intersection of entertainment, ideology, and cultural production, influencing both individual perception and collective understanding (Whannel, 2002).

Key Findings

The study reveals that the transformation of sports narratives from text to screen involves a process of reconstruction rather than direct adaptation. Contemporary sports biopics reorganize lived experiences through selective narration, narrative compression, and visual dramatization, producing coherent and emotionally engaging cinematic narratives. The analysis of films such as *Dangal* (2016), *Bhaag Milkha Bhaag* (2013), and *MS Dhoni: The Untold Story* (2016) demonstrates how real-life complexities are simplified into structured narratives of struggle, perseverance, and success.

The findings further indicate that sports biopics play a crucial role in the construction of the sporting hero, where athletes are represented as embodiments of discipline, resilience, and achievement. This process involves the selective amplification of certain traits while minimizing contradictions, resulting in the creation of mythic and idealized identities.

Additionally, the study highlights the role of sports biopics in reinforcing national and cultural identity, where individual success is framed as a collective achievement. Through narrative framing and visual symbolism, these films align personal journeys with national pride, thereby contributing to the ideological construction of identity.

Finally, the study demonstrates that cinema, as a medium of popular culture, significantly influences audience perception and collective memory. The cinematic representation of athletes often becomes more dominant than textual or historical accounts, shaping how sporting lives are understood and remembered.

Conclusion

This study has examined the transformation of sports narratives from textual forms to cinematic representations, demonstrating that contemporary sports biopics function not merely as adaptations but as processes of narrative reconstruction. Through selective storytelling, visual dramatization, and narrative restructuring, these films reshape complex lived experiences into coherent and emotionally engaging narratives that align with the expectations of popular culture.

The analysis of films such as *Dangal* (2016), *Bhaag Milkha Bhaag* (2013), and *MS Dhoni: The Untold Story* (2016) highlights how cinematic narratives construct sporting heroes by emphasizing perseverance, discipline, and success, often transforming real individuals into symbolic figures. At the same time, these films play a significant role in reinforcing cultural and national identity by linking individual achievements with collective pride.

However, such representations involve selective emphasis and simplification, raising questions about the nature of cinematic truth and the relationship between reality and representation. The study further demonstrates

that cinema, as a powerful medium of popular culture, shapes audience perception and collective memory, often making the cinematic version of events more influential than textual or historical accounts.

Overall, the transition from text to screen emerges as a dynamic process of reinterpretation, where narrative, identity, and ideology are continuously reconstructed within contemporary culture. Future research may further explore audience reception and cross-cultural comparisons to deepen the understanding of sports narratives in global media contexts.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

A Study on Adaptation and Proper Implementation of Sustainable Development Goals for Overall Sustainable Development and Development of Modern Humanity

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Abstract:

The more the human beings of our modern world has moved towards development with the help of developments in technologies , medicines , ideas , concepts , etc , the more they have faced problems than ever before to lead a proper and satisfied life and the problems they faced has came in various forms like poverty , hunger , environmental degradation and adverse climate changes , various types of war hazards including nuclear warfare , excessive violations of normal human rights which are needed for a decent living , improper availability of proper drinking water alongwith facing various types of health issues including facing epidemics like COVID-19 pandemic , etc , which has actually gone on to threaten the normal existence of human life at various points of time . At this juncture an international organisation known an United Nations came into existence with most of the countries of the modern world as it's member whose main objective was to increase coordination among it's member countries to establish overall cooperation , peace and security among it's member countries by preventing various types of conflicts among it's member countries and promote protection against violations of human rights , environmental degradations , unnecessary conflicts including war , etc .

Thereafter in the year 2015 all the member countries of the United Nations developed and adopted 17 Sustainable Development Goals to ensure overall sustainable development for the entire world by providing protections against those various types hazards like violation of human rights , adverse climatic changes , unnecessary war conflicts , etc , which are actually endangering the very existence of the human beings .

This paper after a proper review of the published materials on the subject has tried to find out how these 17(Seventeen) Sustainable Development Goals adopted by the members of the United Nations has actually gone on to help in overall sustainable development of the entire world , what are the advantages and disadvantages of these Sustainable Development Goals and what more is needed to be done to achieve the targets set for these individual Sustainable Development Goals which are to be achieved by the year 2030 .

Keywords : *Environmental Degradations, Human Rights , Sustainable Development , Sustainable Development Goals , United Nations*

Introduction:

The more the world has developed , it's existing human civilisation has experienced various types of problems in the form of poverty , hunger , various types of diseases including pandemics like COVID-19 , disturbances from war between countries including nuclear war , environmental degradations including adverse climatic conditions , violation of human rights , etc , which has actually gone on to threaten the very existence of our human civilisation .

Sustainable Development:

Sustainable Development refers to that type of development which meets the current needs of the current generation of living beings without sacrificing the ability of the future generations to meet their future needs after properly balancing the economic , social and environmental factors (https://www.iisd.org/mission-and-goals/sustainable-development).

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United Nations :

United Nations which is based in United States of America , was founded on the year 1945 , is an international organisation which aims to maintain international peace , security and cooperation among it's member countries.

The United Nations currently has 193 countries of our modern world as it's members and normally works to solve global problems like preventing international conflicts , promote human rights throughout the world or fight against environmental degradations (https://en.wikipedia.org/wiki/United_Nations) .

Constituents of United Nations :

The United Nations constitutes of General Assembly which mainly concentrates on various types of policy making , Security Council which is mainly concerned with maintaining peace and security throughout the world , Economic and Social Council which looks after the economic , social and environmental problems , The Secretariat which conducts the daily activities of the United Nations and the International Court of Justice which looks after inter state or international judicial problems (https://guides.ll.georgetown.edu/c.php?g=365747&p=7140280) .

Functional Areas of United Nations :

The main functions of the United Nations will be to take care of the global problems which one single country will not be able to solve and so currently we see that the United Nations is mainly concerned with or focuses on maintaining international peace and security , to protect , promote and increase awareness about the benefits of properly respecting the human rights principles , to initiate to provide various types of humanitarian aids to provide reliefs to the people of the modern world to overcome the problems caused by incidents of natural disasters , wars of any types , etc , to promote and establish the international rule of law to increase coordination and understanding among different countries of the world to improve surrounding environment , general health of the existing population and international trade , to promote overall sustainable development of our modern world by taking care of environmental , economic and social problems (https://www.jagronjosh.com/general-knowledge/what-are-the-functions-of-the-united-nstions-1737607123-1) .

Sustainable Development Goals of United Nations :

The SDGs or the Sustainable Development Goals were adopted by the United Nations in the year 2015 to act according to some guidelines or charter to protect our planet Earth and to ensure that by the year 2030 all people enjoy overall peace and prosperity .There are 17 (Seventeen) SDGs or Sustainable Development Goals which should be properly observed to have overall balanced social and economical growth alongwith overall balanced environmental sustainability of the entire world (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 1 - No Poverty :

This goal deals with removing poverty in all respects and targets to reduce the current poverty level among men , women and children of the modern world by half by the year 2030 (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 2 - Zero Hunger :

The main aim of this goal is to reduce hunger , malnutrition among the modern world population by promoting and supporting sustainable agriculture , small scale farming , equal access to land , technology , materials , etc , and targets to end all forms of Malnutrition by the year 2030 (https://www.undp.org/sustainable-development-goals).

Sustainable Development Goal 3 - Good Health And Well-being :

The main objective of this goal is to take care of good health and well being of the entire population of our modern world by taking care of issues related to various types of social inequalities among the modern civilisations , to implement measures for urbanisations and fight against environmental degradations and various other infectious and other types of diseases and targets to reduce the global maternal mortality ratio , to end the epidemics arising from AIDS , Tuberculosis , Hepatitis , other Tropical and water borne diseases by the Year 2030 (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 4 - Quality Education :

This goal deals with providing free , equitable and quality primary and secondary education to all boys and girls of our planet Earth and targets to ensure proper and quality developmental care alongwith proper preprimary and primary education for all boys and girls of our modern world by the year 2030(https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 5 - Gender Equality:

The main idea of this goal is to stop all sorts of discrimination against women and girls of our modern society and ensure gender equality to have proper sustainable development . This goal basically targets to end all forms of discrimination, violence , exploitations including trafficking , sexual harassment , child , early or forced marriage , etc of girls and women of all ages (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 6 - Clean Water and Sanitation :

This Goal has been formulated to ensure safe drinking water at affordable rate alongwith improving all sorts of water shortage situations and the goal targets to provide equal access to safe and affordable drinking water for all by the year 2030 and to improve water quality , reduce pollutions , to end

open defecation and provide proper and sufficient hygiene and sanitation for all by the year 2030 (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 7 - Affordable and Clean Energy :

The idea behind this goal is to provide cheap and clean energy at reasonable prices to the entire population of the modern world and the goal targets to increase the production and utilisation of renewable energies and ensure proper access to proper and renewable energy facilities to all by the year 2030 (https://www.undp.org/sustainable-development-,goals) .

Sustainable Development Goal 8- Decent Work and Economic Growth :

This goal has been formulated to implement measures to promote proper economic growth by promoting entrepreneurships to create more meaningful jobs , to increase technological advancements to increase overall productivity and have overall sustainable development to eradicate unethical practices like slavery , forced labour , human trafficking , etc and mainly targets to increase the overall productivity level through more and more innovations leading to technological upgradations alongwith needed and required diversifications , etc (https://www.undp.org/sustainable-development-goals).

Sustainable Development Goal 9 - Industry innovation and Infrastructure .

This goal is concerned with making proper and planned investments in developing infrastructures and encouraging innovations to have proper and balanced economic advancements and had set targets to encourage people to go for proper , sustainable and inclusive industrial developments through development of proper and balanced both national and international infrastructures by the year 2030 to enjoy the benefits of proper economic development (https://www.undp.org/sustainable-development-goals).

Sustainable Development Goal 10 - Reduced Inequalities :

The main moto of this goal is to have a check on the rising income inequalities all throughout the world and targets to achieve proper increase in income of the lower 40 percent of the world population at a rate higher than their respective national average , by the targeted year of 2030 to discourage all forms of human inequalities and boost social , economic and political inclusion of all human beings of our planet irrespective of their respective individual identities like origin , age , sex , race , religion etc , (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 11 - Sustainable Cities and Communities :

This goal deals in concentrating on proper and sustainable development of our urban areas and targets to improve the existing conditions of the slums and ensure proper access for all human beings to safe , adequate and reasonable housing and other basic services alongwith proper and suitable transport systems through improvement of road safety measures and improved public transport systems after taking into consideration the needs of the sections like children , women , persons with disabilities ,etc , by the year 2030 (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 12 - Responsible Consumption and production :

This goal is to create awareness regarding proper and efficient utilisation of our natural resources alongwith proper management of various types of wastes and other pollutants and targets to achieve proper and feasible management and use of natural resources to achieve sustainable consumption and production by the year 2030 (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 13 - Climate Action:

This goal has been adopted to take care regarding how to combat adverse climate related issues and other natural disasters and it targets to formulate and implement proper national policies regarding how to increase proper awareness regarding how to combat climate related hazards and other natural disasters to reduce human problems (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 14 - Life below Water :

This goal aims to properly protect the marine and costal ecosystems from pollutions and other hazards and implement and improve proper conservation and other sustainable use measures of ocean centric natural resources .and targets to take measures to prevent or reduce all kinds of marine pollution and to sustainably manage and protect marine and coastal ecosystems (https://www.undp.org/sustainable-development-goals).

Sustainable Development Goal 15 - Life on Land :

This goal emphasises to take necessary and urgent actions to combat , protect and prevent the loss of natural habitats and biodiversity to properly protect life on our planet Earth and targets to increase and improve the implementation of proper use and maintenance of difference types of forests , to stop deforestation , to implement measures to restore forests and other lands which have been degraded and to implement conservation measures and other responsible uses of our Earth's ecosystems which includes forests , mountains , wetlands , and other drylands , according to the various laid down international agreements (https://www.undp.org/sustainable-development-goals) .

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Sustainable Development Goal 16 - Peace , Justice and Strong Institutions :

This goal focuses to reduce all forms and types of violences and encourages to improve working ties with various governments and other types of communities of our world to end all types of conflicts and insecurities between and among the modern world population and to promote the rule of law and ensure that modern human rights are followed properly and in the process actually targets to reduce all forms of violences , to end other forms of unethical behaviours and activities which includes activities like abusing , trafficking , exploitation , etc , and promote the rule of law to ensure equal access and availability of justice to all people of our world (https://www.undp.org/sustainable-development-goals) .

Sustainable Development Goal 17 - Partnerships for the Goals :

The above mentioned Sustainable Development Goals can only be achieved when there will be proper and suitable ties , partnerships , cooperations and collaborations among and between the various countries of our modern world , where developed countries will be able and willing to help the developing and the underdeveloped countries to achieve the targets set for all the goals to achieve the overall sustainable development for the entire world and in this regard the SDG 17 basically targets to pull international financial supports from whichever sources possible, to improve and develop the domestic capacity for tax and other revenue collections to strengthen proper domestic resource mobilisations methods to arrange proper financial resources or assistances needed for overall sustainable development of the entire world(https://www.undp.org/sustainable-development-goals) .

Importance of Sustainable Development Goals for Development of modern humanity :

The importance and impact of the Sustainable Development Goals lies in its ability to get acceptance from all over the world as an important step towards achieving overall sustainable development of the entire world after taking into consideration the environmental , economic and social factors . The most important factor of the Sustainable Development Goals getting acceptance from all over the world lies in it's ability to recognize the basic human needs of poverty , hunger , clean energy , clear drinking water , access to proper educational facilities , availability of proper jobs , etc , for the inclusive development of all human beings of our world , and it's ability in developing suitable plans or targets to solve the existing deficiencies to enable the normal human beings of our world to live a proper and satisfied life (Pranay Arora , Jahmish Fatima , Naveen Kumar Arora , 2025) .

Benefits of Sustainable Development Goals :

The most formidable benefit of adopting and implementation of Sustainable Development Goals is that it has created and provided a global platform to fight against global problems like poverty , hunger , adverse climatic changes , environmental degradations , violations of human rights , etc , to try and develop our world into a much better , safer and prosperous place to live in for not only the current generation but also for the future generations to come in(https://www.enel.com/learning-hub/sustainable-development/benefits).

Some of the other benefits of adopting and implementation of Sustainable Development Goals are as follows :

1. **Common Platform :** Provides a joint platform for all the member countries of the United Nations to jointly fight against the various environmental hazards which includes promotion of clean and renewable energy sources alongwith promoting to reduce the overall emissions of greenhouse gases and take suitable measures to avoid dangers and problems of adverse climatic changes (https://www.enel.com/learning-hub/sustainable-development/benefits).
2. **Improve the Overall Standard of living :** The adoption and implementation of various sustainable development goals helps a lot in reducing human problems like poverty , hunger , mother and child mortality rates , etc and increases the overall access of the modern human beings towards clean and renewable energy sources , clean drinking water , proper food , proper medical facilities , proper education facilities , etc , which in turn goes on to increase the overall standard of living (https://www.enel.com/learning-hub/sustainable-development/benefits).
3. **Promote Social and other Equalities including Social Justice :** The adoption and implementation of the ideas and concepts of the Sustainable Development Goals goes on to help in providing all types of social equalities and protection to all sections of the population to have inclusive economic growth and overall sustainable development for the entire world (https://www.enel.com/learning-hub/sustainable-development/benefits)

Objective of the Study :

The main objective of this study has been to find out the importance and impact of the 17 (Seventeen) Sustainable Development Goals of the United Nations on the modern human beings of the current generations living in various member countries of the United Nations , alongwith finding out how much success has been achieved till date in solving various types of serious problems which were troubling the very existence of the modern human beings and what more needs to be done to achieve the targets set for each specific goals by the year 2030 and move the world towards achieving overall sustainable

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development to enable all human beings of our world lead a proper and prosperous life .

Literature Review :

Since very few research work has been done in this area till date , the required information has been collected by doing online research of various pages of United Nations and some other published materials of some other authors .

1. The Sustainable Development Goal Report 2025 stated that although the adoption and implementation of the ideas and concepts of Sustainable Development Goals has improved the lifes of many human beings of the modern world by improving educational facilities , improving access to proper energy resources , improving health conditions of both mothers and children , reduced the spread and problems caused by diseases like HIV , malaria , etc , but the rate at which this changes or progress has been achieved is actually very slow and will not help in achieving the targets set by the targeted year of 2030 .
2. Pranay Arora , Jahmish Fatima , Naveen Kumar Arora , stated that our world has experienced some very good changes during the 19th and 20th century in the form of advancements in industrialisations with great technological advancements alongwith other important social transformations , etc . Thereafter it is seen that approximately from the year 1950 and later the world started experiencing the problem of various types of pollutions which were due to the excessive amount of Industrialisations . The level of pollution started increasing which led to serious human problems like adverse changes in climatic and other environmental conditions causing various types of health problems etc . The increase in human sufferings forced scientists , researchers , academicians and other concerned people think about finding out suitable measures and methods to protect the surrounding environment of our world which actually went on to open the path of formulating , adopting and implementing the ideas , concepts and practices of the Sustainable Develoment Goals . Thereafter it is observed that the adoption of these Sustainable Development Goals by the United Nations has not only provided a world wide joint platform to understand the human problems but has also helped the countries of the modern world to move towards solving those problems and help the entire world to attain sustainable development where not only the current generation will be able to lead a proper and prosperous life but the coming generation will also have enough opportunities to lead a proper life (https://link.springer.com/article/10.1007/s42398-025-00388-2).
3. Prabhakar Mohandas stated that in modern world Sustainable Development has become a very important word as in most cases economic activities which causes economic development has gone on to create some important problems for existing human beings in relation to various types of climatic and environmental degradations . Therefore in order to save not only the current generations but also the future generations to come in this planet it became absolutely necessary to develop , adopt and implement the concepts of Sustainable Development throughout the world where developmental activities should be done in such a way that natural resources should not get unnecessary wasted , so that not only the current generation , but also the future generations can use and enjoy the benefits of it .
4. Zile Singh explored and stated that even if the Sustainable Development Goals has been adopted by the United Nations and it's member countries , it has been widely discussed on its being huge in number and having a too big scope which has actually made it extremely difficult to create proper awareness on the different sustainable development goals among the common and ordinary persons of our modern world (https://journals.lww.com/ijph/fulltext/2016/60040/sustainable_development_goals_challenges_and.1.aspx).

Research Gap :

The literature review part reveals that not much research work has been done to find out the actual impact of these 17 (Seventeen) Sustainable Development Goals on the modern human beings . Therefore our study will be directed towards exploring the importance and impact of these 17 Sustainable Development Goals on the modern human beings alongwith an attempt will be made to find out overall how much progress has been made to achieve the targets set for each seperate goals by the target year of 2030 and what more needs to be done to achieve those targets by the targeted year of 2030 .

Research Methodology :

This study was undertaken to find out the overall impact of the 17 (Seventeen) Sustainable Development Goals on the current generation of human beings living all over the world alongwith what more is needed to be done to achieve the targets set for each of the goals by the targeted year of 2030 . In this regard as not much research work has been done to find out the impact and importance of United Nation's Sustainable Development Goals on the current generation of human beings , and also due to various other types of constraints like time , manpower , funds , etc , the information for this study has been collected through some online research work of some published materials of the United Nations itself and some other published materials of some other authors which were published in various other journals , websites , blogs , etc .

Findings :

Findings from Sustainable Development Goals Report :

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According to the Sustainable Development Goals Report 2025 it is stated that although the adoption and implementation of 17 (Seventeen) Sustainable Development Goals in various member countries of the United Nations has helped in benefitting and increasing the standard of living of many people living in those member countries , but still a lot is needed to be done to achieve the targets set for those specific goals by the targeted year of 2030 (https://unstats.un.org/sdgs/report/2025) .

The report states that from the year 2015 when these sustainable development goals were accepted by the member countries of the United Nations , great progress has been made in increasing the educational facilities , in improving the mothers and children health , in reducing the problems or sufferings from the various types of diseases like HIV , malaria , etc , in increasing the access to various types of energy sources like electricity , etc , alongwith increasing the overall usages of renewable energy sources but still there has been a huge number of people worldwide who does not have access to the basic amenities needed to lead a proper life and suffers the problems of poverty , hunger , lack of proper housing or living facilities , violation of human rights , adverse climatic changes alongwith various other environmental degradations , other human inequalities , etc , which has actually gone down to deter the process or progress of overall sustainable development throughout the world (https://unstats.un.org/sdgs/report/2025/).

The report suggests the member nations of the United Nations to increase the overall international cooperations among themselves in solving the various problems faced by the modern humanity and specifically focus on the areas like improving the availability of proper food to tackle the problem of poverty and hunger , to increase the access of the normal and ordinary persons of the world towards enjoying clean and renewable energy sources to do away with the adverse climatic changes alongwith other environmental degradations , to increase the opportunities in relation to education , jobs , etc , to do away with various types of social inequalities to increase the overall standard of living of normal and ordinary persons of the world (https://unstats.un.org/sdgs/report/2025/).

Some Disadvantages of the Sustainable Development Goals :

1. The basic disadvantage of the Sustainable Development Goals of the United Nations is that it has such a big structure which currently in many situations or conditions has became very problematic to handle (https://theclimatenews.co.uk/the-pros-and-cons-of-the-sdg-framework/)
2. The second disadvantage in proper functioning of these Sustainable Development Goals is that as there are no legal consequences when these goals are not properly followed the stakeholders takes them causally which in turn has actually slowered or hindered the progress of overall sustainable development of the entire world (https://theclimatenews.co.uk/the-pros-and-cons-of-the-sdg-framework).
3. The objectives and the targets of these Sustainable Development Goals should be stated in such manner that the concerned persons or organisations should be able to understand them properly and work accordingly otherwise in many situations it has created huge confusions which ultimately has lead to failure in achieving the targets of the specific Sustainable Development Goals (https://theclimatenews.co.uk/the-pros-and-cons-of-the-sdg-framework) .

Suggestions:

Some Suggestions regarding how we can achieve the targets set for 2030 are as follows :

Goal 1 : No Poverty : As found out still today a huge amount of world population still lives in extreme poverty so in order to achieve the target of no poverty by the year 2030 we can start donating whatever we don't use to those persons who needs them the most (https://www.un.org/sustainable development/sustainable-development-goals) .

Goal 2 : Zero Hunger : Even today we see that on one hand when a huge amount of food is wasted worldwide a huge amount of world population still does not get the required food to live a proper life . Therefore in order to solve this hunger related problem and achieve the target of Zero Hunger by the year 2030 we need to strengthen the agricultural sector to supply adequate amount of food to the world population(https://www.un.org/sustainabledevelopment/sustainable-development-goals).

Goal 3 : Good Health and Well Being : The basic way towards having sustainable development for all is to ensure that all human beings of the modern world has proper health conditions and so one way to reach the target of ensuring Good Health and Well Being for all by the year 2030 is to ensure proper medications for all including required vaccination whenever and wherever needed (https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Goal 4 : Quality Education : According to the available information we see that still today a huge number of children and other individuals of our modern world does not have proper education or does not have the required access to the necessary educational facilties and so in order to achieve the targets of Goal 4 by the year 2030 it is absolutely needed to introduce proper education facilities all throughout the world to improve the normal living of normal and ordinary people of the modern world and to have overall sustainable development for all (https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Goal 5 : Gender Equality : One of the most important problem of our world is that there still exists a great amount of gender inequality where the women and the

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girls of our society does not get the required importance or their required dues. Therefore It is our duty to ensure proper human rights for everybody to ensure proper living for everybody and have the required sustainable development for the entire world (https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Goal 6 : Clean Water and Sanitation : The basic essential element for existence of human beings in this world is water but it is unfortunate to know that still a huge proportion of the world population does not have proper access to clean water facilities for their normal living and so one of our essential target will be to stop unnecessary wastages of water and to ensure that everybody has proper access to clean water for daily living (https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Goal 7 : Affordable and Clean Energy : The most important element which is absolutely needed for all types of developmental activities of our modern civilisations is energy and that to clean energy to avoid unnecessary environmental pollutions and so our basic target will not only be to ensure clean and affordable energy for all but also to avoid unnecessary wastages of energy and try and use those types of appliances which can consume less amount of energy for same specific type of work (https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Goal 8 : Decent Work and Economic Growth : The most important way in which we can have the required economic development is by creating proper job opportunities for the existing workforce but it is extremely disheartening to know that still today many youths of the modern world does not have the required skills , education or required training to join some employment or get absorbed by the existing employment opportunities . Therefore our main target to achieve this goal will be to create proper job opportunities for the existing workforce to attain sustainable development for all (https://www.un.org/sustainabledevelopment/sustainable-development-goals/) .

Goal 9 : Industry , Innovation and Infrastructure : The most important method to ensure proper economic development will be by initiating those types of projects or industries which goes on to create the required and necessary type of infrastructural facilities like proper road , electricity , water , sanitation , etc , facilities and so in order to achieve the targets of this goal we are required to invest in those projects which will go on to create basic infrastructures (https://www.un.org/sustainabledevelopment/sustainable-development-goals/) .

Goal 10 : Reduced Inequalities : As observed it is seen that in order to have proper and inclusive economic growth we should try and reduce inequalities among various different human individuals as much as possible and so in order to achieve the target of this goal first and foremost we should provide proper opportunities to live properly to those people who specifically belongs to the various disadvantageous groups .(https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Goal 11 : Sustainable Cities and Communities: A basic fact about modern urban life is that most people living in these cities normally goes on to face one of the most acute modern day problem which is breathing that type of air .which gets polluted from emissions of various types of green house gases . In order to come out of these situation it can be suggested that we prefer usage of cycles or public transportation or bikes or even walking wherever it is feasible . Thereafter in order to have sustainable cities we should develop the concept of developing cities which will go on to produce all types of services for all types of population or communities (https://www.un.org/sustainabledevelopment/sustainable-development-goals/)

Goal 12 : Responsible Consumption and Production : As the main focus of this goal will be to reduce unnecessary usage of scarce and costly resources alongwith reduction of various types of environmental degradations to improve the quality of life to be led by the normal people of the modern societies , the main targets to achieve this goal will be to adopt and implement proper or sustainable management of natural resources to avoid unnecessary wastages of scarce natural resources , to reduce unnecessary wastages of food alongwith reducing unnecessary generation of various types of wastes , through the adoption and implementation of the methods like recycling , reusing , etc , of the existing products by the year 2030 (https://www.un.org/sustainabledevelopment/sustainable-development-goals/) .

Goal 13 : Climate Action : Global warming is not just a problem of the current generation but also a matter of deep concern for proper living of the future generations as well , therefore it is extremely needed to think , plan , adopt and implement immediate action plans to fight against the adverse climatic changes and it's adverse impact on the lives or normal living of the human beings of not only the current generation but also of the future generations . Therefore the main targets to achieve these goals will be to stress on developing of those types of energy sources which will have less or no emissions of carbon dioxide or other greenhouse gases , which is extremely needed to save the modern civilisations from the hazards of the extreme effects of unwanted and adverse climatic changes (https://www.un.org/sustainabledevelopment/sustainable-development-goals).

Goal 14 : Life Below Water : Even today a huge proportion of the world population depends on the ocean related natural resources or marine resources so in order to have proper ecological balance and ensure

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proper future of all those living entities which are depended on these natural or marine resources it is absolutely needed to implement proper management of all these resources to have sustainable development for every living entities of our world (https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Goal 15 : Life on Land : The more the world is getting economically developed the more the importance of conserving the forests are coming out to maintain proper ecological balances which will obviously go on to help in proper protection of the surrounding environment which is extremely needed for overall sustainable development (https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Goal 16 : Peace , Justice and Strong Institutions : One of the most important point in having an overall sustainable development is that all individuals should have peace for which we should emphasise on observing all the essential human rights and whole heartedly promote the rule of law alongwith all it's institutions (https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Goal 17 : Partnerships for the Goals : The essential point in achieving all the targets of the Sustainable Development Goals is that not all the countries of the modern world is at the same level of development which makes it not just difficult but actually impossible for all the countries to achieve the targets of the Sustainsble Development Goals which in turn leads to the idea of establishing various types of ties , cooperations , collaborations , etc , among the modern countries where the developed countries can help the underdeveloped or the developing countries in achieving the targets set for each specific SDGs . Therefore we should initiate some necessary ties , cooperations or collaborations among the countries of the modern world to achieve the targets set for each specific SDGs and attain the overall Sustainable Development for the entire world (https://www.un.org/sustainabledevelopment/sustainable-development-goals) .

Some Measures how individual human beings can contribute towards sustainability by their individual actions:

a) Reuse , recycled products to stop unnecessary wastages of scarce natural resources
b) Stop unnecessary wastages of energy by switching off the lights and other electrical appliances as soon as it is not required .
c) Use public transport or cycles as much as possible to reduce environmental pollutions .
d) Stop reckless destruction of natural resources , etc

Future Steps to Ensure Sustainable Development through Implementation of Sustainable Development Goals :

According to the reports it is seen that only about 17% of the Sustainable Development Goals will be achieved by the targeted year of 2030 in which it is evident that the climatic goals will not be achieved by the targeted year of 2030 (https://www.globalpolicyjournal.com/blog/31/07/2024/future-sustainable-development-goals-relies-climate-actions) .

The High Level Political Forum (HLPF) discussed on the future of the Sustainable Development Goals .

Reviews on the achievement of the Sustainable Development Goals showed that although a lot has been done since the SDGs were accepted but still a lot has to be done to achieve the targets and the goals related to fight against the adverse climatic changes needs to be addressed in a much more comprehensive manner (https://www.globalpolicyjournal.com/blog/31/07/2024/future - sustainable- development-goals-relies-climate-action).

The biggest problem in properly implementing the SDGs all throughout the world lies in the fact that each and every country of the modern world has their own set of problems in dealing with proper implementations of the SDGs which are unique to the specific set up or the structure of a particular country (https://www.globalpolicyjournal.com/blog/31/07/24/future-sustainable-development-goals-relies-climate-action).

The second problem comes in the form of arrangements of proper amount of funds which are needed to set up proper infrastructures by each and every member countries of the United Nation's , to reach the targets set for each and every SDGs (https://www.globalpolicyjournal.com/blog/31/07/24/future-sustainable-development-goals-relies-climate-action).

The third problem comes from the adverse climatic changes which is affecting the entire world and it is very difficult for a single country to tackle the climate related problems and it actually needs joint and coordinated efforts of all the member countries to fight and solve adverse climate related issues and overall environmental degradations (https://www.globalpolicyjournal.com/blog/31/07/24/future-sustainable-development-goals-relies-climate-action) .

Therefore from the above discussions it is recommended that it is absolutely needed for all the member countries of the United Nations to come forward jointly and co-operate with each other to not only jointly solve the problems related to achievements of the targets set for each SDGs by the targeted year of 2030 , but also for situations and problems which can happen beyond the year 2030 to solve them and make our world a better place to live in for not just the current generations but also for the future generations .

Conclusions :

The most significant achievement of the Sustainable Development Goals (SDGs) of the United Nations is that this step has been successful in developing a

global platform where members from almost all countries of the modern world or atleast the members from the member countries of the United Nations can come together and discuss various problems of the modern human beings and can jointly find out some solutions to tackle those problems .

Thereafter it is seen that the modern world is still facing some extremely important problems like poverty , hunger , unnecessary war and other types of conflicts , extreme adverse climatic changes which includes the problems of global warming , etc , various types of inequalities among the living human beings , which are not only causing serious problems to human beings living at various places of the modern world but is also causing extreme difficulty in achieving Sustainable Development for the entire world .

Therefore as 2030 the target year is not far and also a lot is to be done to achieve the overall target of having sustainable development it is requested to all the stakeholders including the member countries of the United Nations to understand the actual problems and think , discuss and come out with solutions regarding what is to be done to achieve the targets as much as possible within the year 2030 and set new targets regarding what is to be done after 2030 to achieve sustainable development and move our planet towards a much better place to live in .

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Screen Time Usage and its effect on cognitive abilities- A Meta Analysis study

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Abstract:

The increasing prevalence of screen time among young children has raised concerns about its potential impact on cognitive development. Early childhood is a critical period for brain development, making it essential to understand how screen exposure affects cognitive abilities like attention ,problem solving ,logical thinking ,creativity etc. . The objective of this research paper is to evaluate the previous studies and find out the correlation between screen time usage and its impact on cognitive abilities .

Key words*: Screen Time,Cognitive abilities,Meta Analysis*

Introduction:

Rapid technological progress has shaped modern childhood. Time spent with digital devices has increased dramatically since the start of our twenty-first century1,2 and is now a large portion of a child's free time 3. Children aged 8–12, for example, spend an average of 4–6 h with a screen each day watching videos, gaming, and socializing1,4. Digital media bring a variety of new experiences that could have both benefits and drawbacks to the developing minds of children 5. This topic is a source of heated public debates 6 and deserves careful attention from policymakers and researchers.

Definition of Screen Time

"**Screen time**" refers to the amount of time individuals spend using devices with screens—such as smartphones, tablets, computers, televisions, and gaming consoles. Activities range from passive consumption (e.g., watching television, browsing social media) to interactive engagement (e.g., educational games, coding, or creative digital projects) [1]. Types of screens include the following:

Smartphones and tablets: Portable devices used for communication, entertainment,and productivity.

Computers and laptops: Common tools for work, education, and digital entertainment.

Televisions: Initially used for broadcasting news and entertainment, now widely used for streaming digital content.

Gaming consoles: Devices primarily designed for video gaming, offering both recreational and social experiences.

Rationale of the Study: Increasing the amount of screen time at an early age has negative effects on language development [13]. However, beginning screen time at a later age has some potential benefits [13]. The characteristics of videos, their content, and co-viewing also play a role in influencing language development [13]. However, other studies have reported negative effects on speech, language, motor skills, cognitive development, and social development [13].

Screen media use may have both beneficial and detrimental effects on a kid's cognitive results. Media devices with screens have the potential to improve education and learning [2]. For instance, research has suggested that electronic books and learning-to-read applications may improve young children's early reading skills and creative thinking capacities [2,4,5]. However, studies have also demonstrated the negative effects of screen media use on a number of cognitive areas such as executive functioning, sensorimotor development, and academic outcomes [2,6]. Media multitasking was found to have a negative impact on executive functioning in teenagers, notably on working memory, inhibition, and the capacity to switch between tasks [2,7].

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The Quebec Longitudinal Study of Child Development cohort study found a long-lasting connection between early screen media exposure and cognitive abilities, with each one-hour increase in TV exposure at two years of age corresponding to a 7% unit decrease in participation in class and a 6% unit decrease in math proficiency in the fourth grade [8].

Excessive screen time emerged as the strongest predictor of cognitive delays, with children exposed to more than two hours per day exhibiting a 2.8-fold increased risk of delays. Passive screen time was found to be particularly detrimental, reinforcing the need to minimize such exposure during critical developmental periods.

Developmental Delays by Screen Time Children with excessive screen time showed the highest prevalence of developmental delays (45%), particularly in problem-solving (60%) and communication (50%) domains. The [Table 3] demonstrates the association between screen time exposure and developmental delays. Children with excessive screen time (>2 hours/day) exhibited the highest rates of developmental delays (45%), particularly in problem-solving (60%) and communication (50%) domains.

The screen time is not only affecting cognitive development but also impacting the physical,emotional and social life .The researcher reviewed the studies done in the past and tried to summarise the impact of screen time on mental health.

The researcher evaluated a number of developmental outcomes, such as the following:

Sumudu Mallawaarachchi et al. (2024, JAMA Pediatrics): The author systematically did the meta analysis studies of 7400+ and his findings showed that

- Passive screen use (TV, videos) → **lower language and executive function**
- Background TV → **negative cognitive association**
- Co-viewing with parents → **better outcomes**

Jason M. Nagata et al. (2024, ABCD Study) performed research on 9000+ students and found that higher screen time is linked to attention problem,behavioural issue,slightly lower cognitive problems

Alexis Jones et al. (2021 meta-analysis) Findings showed that

- High screen time linked to:
  - Poor sleep
  - Reduced physical activity
- These indirectly affect **cognitive functioning**

Impact on Cognitive Functions

Excessive screen time has been linked to various cognitive impairments:

Cain & Gradisar, 2010 :Memory Consolidation: Screen exposure before bedtime can disrupt sleep patterns, impairing memory consolidation processes crucial for cognitive function

Swing et al., 2010: Problem-Solving Skills: Excessive screen time may impede problem-solving abilities, hindering cognitive development.

Lillard et al., 2015: Attention Span: Prolonged exposure to screens has been associated with diminished attention span and reduced concentration

Mendoza et al.,2020: Cognitive Flexibility: Screen time can influence cognitive flexibility, affecting decision-making processes and adaptive behaviors

Practical Significance

Understanding the practical implications of screen time on cognition is imperative:

Hutton et al.,2020:.Productivity and Learning Outcomes: Excessive screen time may diminish productivity and hinder learning outcomes in educational settings

Fitzpatrick et al., 2019: Limiting Screen Time: Implementing restrictions on screen time can enhance focus, memory retention, and overall cognitive abilities

Barr et al., 2010 : Effective Management: Strategically managing screen time can optimize daily functioning and promote long-term cognitive well-being

Evaluating Boundaries on Screen Usage

Establishing clear boundaries and limits on screen usage can be efficacious:

Nathanson et al., 2014 :Monitoring Screen Time: Tracking actual screen time before and after implementing boundaries facilitates observation of reductions and behavioral changes

Kildare & Middlemiss, 2017 : Behavior Assessment: Monitoring changes in behavior, such as improved focus, sleep patterns, and engagement in alternative activities, provides valuable insights into the effectiveness of screen time management strategies

Rikkers et al., 2021: Stakeholder Engagement: Gathering surveys and feedback from stakeholders, including parents, educators, and children, enables the assessment of the efficacy of screen time regulations and interventions

Conclusion

In conclusion, of all the reviews, studies were deeply analysed and it was found that more screen time usage leads to lower attention ,reasoning power ,critical thinking and hinders the overall cognitive development . Understanding the multifaceted impact of screen time on cognitive functions is crucial for promoting healthy cognitive development and overall well-being, especially among children. By integrating research findings and implementing evidence-based strategies, educators, parents, and policymakers can effectively navigate the complexities of screen time management and foster optimal cognitive outcomes.

Acknowledgment

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study titled *"Screen Time Usage and Its Effect on Cognitive Abilities: A Meta-Analysis Study."*

First and foremost, I extend my heartfelt thanks to my research guide/supervisor for their invaluable guidance, continuous support, and constructive suggestions throughout the course of this study. Their expertise, encouragement, and mentorship were instrumental in shaping the research and ensuring its successful completion.

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essential for conducting a comprehensive analysis of the relationship between screen time and cognitive abilities.
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Original Article

A Comparative Analysis of the Impact of Russia–Ukraine War and Iran–Israel/U.S. Conflict on the Global Economy

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Abstract

The Russia–Ukraine War marked a major turning point in global geopolitics, triggering significant disruptions in energy, food, and financial markets and 2026 Iran–Israel/U.S. conflict has emerged as a systemic macroeconomic shock with far-reaching global consequences. This paper analyzes the conflict through six key transmission channels: energy market disruption, inflation pass-through, trade and shipping realignment, country-level fiscal stress, defense-industrial expansion, and medium-term economic projections through 2030. The primary transmission mechanism has been the disruption of the Strait of Hormuz, a critical artery for global energy flows, through which approximately one-fifth of global oil and a substantial share of liquefied natural gas transit. At the peak of the crisis in early 2026, tanker traffic through the Strait declined by over 90%, contributing to a sharp increase in oil prices, with Brent crude exceeding U.S. $107 per barrel and U.S. crude surpassing U.S. $111. These energy shocks have propagated rapidly across the global economy, generating inflationary pressures via higher fuel costs, increased freight rates, elevated war-risk insurance premiums, and rising industrial input prices. The conflict has also accelerated trade and shipping reconfiguration, increased sovereign borrowing costs, and intensified fiscal pressures in energy-importing economies. At the same time, it has produced asymmetric effects, benefiting hydrocarbon exporters, defense manufacturers, and certain segments of the global logistics and insurance industries. Country-level impacts are particularly pronounced in Iran and Israel, where export disruptions, infrastructure strain, war financing requirements, and reconstruction needs have reshaped macroeconomic conditions. Using institutional data and scenario-based projections, this paper argues that the economic consequences of the conflict will persist beyond its immediate military phase, with lasting implications for global inflation dynamics, defense spending trajectories, energy security strategies, and the geographic structure of international trade through the end of the decade.

Keywords: *Objectives, Comparative analysis- Russia–Ukraine war, Iran–Israel/U.S. Conflict Impact of GDP growth rate, Inflation, Financial Markets, Energy Markets, Oil Prices and International Trade, Policy Recommendation*

Introduction

It began with Russia's full-scale military invasion of Ukraine on 24 February 2022, following years of tension after Russia's annexation of Crimea in 2014 and ongoing conflict in eastern Ukraine. The 2022 invasion marked a major expansion of hostilities, with Russian forces launching attacks across multiple fronts, including northern, eastern, and southern Ukraine, targeting major cities such as Kyiv, Kharkiv, and Mariupol. Internationally, the conflict has led to severe economic disruptions, including energy crises and food supply instability, given Russia and Ukraine's roles in global oil, gas, and grain markets. Sanctions imposed on Russia have reshaped global trade and diplomatic relations. The 28 February 2026, Iran-Israel/U.S. conflict has evolved into a major global macroeconomic shock with measurable effects on energy markets, inflation, trade flows, sovereign financing, and defense expenditure. This paper examines the conflict through six interlinked transmission channels: energy market disruption, inflation pass-through, trade and shipping realignment, country-level fiscal stress, defense-industrial expansion, and medium-term projections through 2030. The primary transmission mechanism has been the disruption of the Strait of Hormuz and surrounding Gulf-linked shipping routes, through which

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approximately one-fifth of global oil and a substantial share of liquefied natural gas (LNG) trade normally transits.

As of early April 2026, market evidence indicates that tanker traffic through the Strait may have fallen by more than 90% during peak disruption periods, while Brent crude rose above U.S. $107 per barrel and U.S. crude oil $111 per barrel, representing one of the sharpest conflict-driven energy repricing's in recent years. These disruptions rapidly transmitted into broader inflationary pressures across advanced and emerging economies through higher fuel prices, freight costs, war-risk insurance premiums, and rising industrial input costs. Recent institutional assessments characterize the conflict as generating both higher prices and slower growth, while financial markets have already reflected these pressures through rising sovereign yields and higher borrowing costs. The paper further incorporates the direct economic effects on Iran and Israel, including export disruption, sovereign-risk repricing, infrastructure strain, war financing, and reconstruction requirements, while identifying key economic beneficiaries such as defense manufacturers, alternative refiners, shipping insurers, and hydrocarbon exporters. Using institutional evidence and scenario-based projections, the study argues that the economic effects of the conflict are likely to outlast its visible military phase, with implications for global inflation trajectories, defense spending baselines, energy security, and trade geography extending through the end of the decade.

This comparative analysis examines how these two geopolitical events affect the global economy, these conflicts have affected energy markets, food security, global trade, financial systems, and macroeconomic stability. This paper examines the multidimensional economic consequences of these conflicts, highlighting their interconnected effects and long-term implications for global GDP growth, inflation, and geopolitical economic restructuring.

Objectives of the Study

Primary Objective

Analyzing the impact of the Russia-Ukraine and Iran-Israel/US conflicts on the global economy, with a particular focus on macroeconomic stability, Gross Domestic Product (GDP), inflation, trade, and financial markets.

Specific Objectives

1. To examine the impact of geopolitical conflicts on global energy markets
2. To assess how disruptions in oil and gas supply influence global prices, inflation, energy

Security and macroeconomic consequences GDP growth

3. Analyze the role of strategic chokepoints (e.g., Strait of Hormuz) in shaping energy volatility.
4. To evaluate the effects on global trade and supply chains
5. Analyze how overlapping geopolitical crises amplify global economic shocks.
6. To evaluate regional economic impacts
7. To explore long-term structural changes in the global economy
8. To provide policy recommendations for economic stability

Hypothesis

1. Main (Overall) Hypothesis

H_0 (Null Hypothesis): The Russia–Ukraine War and Iran–Israel/U.S. Conflict have no significant

impact on the global economy.

H_1 (Alternative Hypothesis): The Russia–Ukraine War and the Iran–Israel/U.S. Conflict have a

significant negative impact on the global economy.

2. Hypotheses on Energy Markets

H_0: Geopolitical conflicts do not significantly affect global energy prices.

H_1: Geopolitical conflicts significantly increase global energy prices and volatility.

3. Hypotheses on Inflation

H_0: There is no significant relationship between geopolitical conflicts and global inflation rates.

H_1: Geopolitical conflicts lead to a significant increase in global inflation rates.

4. Hypotheses on Global Trade

H_0: The conflicts have no significant effect on global trade flows and supply chains.

H_1: The conflicts significantly disrupt global trade flows and supply chains.

5. Hypotheses on Financial Markets

H_0: Geopolitical conflicts do not significantly influence financial market volatility.

H_1: Geopolitical conflicts significantly increase financial market volatility and reduce investor

confidence.

6. Hypotheses on Economic Growth

H_0: The conflicts have no significant impact on global GDP growth.

H_1: The conflicts significantly reduce global GDP growth.

7. Hypotheses on Combined (Interaction) Effects

H_0: The simultaneous occurrence of the two conflicts does not amplify economic disruptions.

H_1: The simultaneous occurrence of the two conflicts amplifies global economic disruptions more

than individual conflicts alone.

8. Hypotheses on Long-Term Structural Change

H_0: The conflicts do not lead to long-term structural changes in the global economy.

H_1: The conflicts lead to long-term structural changes such as de-globalization and energy

transition.

Literature Review

The economic consequences of geopolitical conflicts have been widely studied in the fields of international economics, political economy, and global finance. Existing literature on the Russia–Ukraine war and emerging studies on the Iran–Israel/U.S. conflict highlight several transmission channels through which wars affect the global economy, including energy markets, trade disruptions, inflation, and financial instability.

1. **John J. Mearsheimer** (2014,2022) a proponent of offensive realism, argues that the West specifically the U.S. and NATO are primarily responsible for the Russia-Ukraine war. In his 2014 and 2022 analyses, he asserts that NATO

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expansion, EU eastward expansion, and attempts to make Ukraine a Western, democratic "bastion" on Russia's border created a severe security threat that prompted Russia to act.

2. British politician **Iain Macleod** first used the term "stagflation" in a 1965 speech to the House of Commons to describe the U.K. economy. The term gained far wider prominence during the 1970s oil crisis when OPEC's embargo triggered a dramatic increase in energy prices in the U.S. and Europe. This supply shock drove up production costs across the economy while simultaneously reducing economic output.

3. After **OPEC** imposed oil embargoes in 1973, energy prices skyrocketed, driving up production and transportation costs across the entire economy. Faced with these rising costs, companies were compelled to choose between two options: cutting production (which led to workforce reductions) or raising prices (which fueled inflation). The result was the creation of a toxic mix of rising unemployment and rampant inflation a combination that persisted throughout the entire decade.

4. The Russia-Ukraine war, ongoing since 24 February 2022, has its, significantly intensified scholarly and policy attention on NATO's strategic evolution and the broader European security architecture (Allison, 2017; Anderson, 2021) the cornerstone of collective defense in Europe, NATO's ability to adapt to emerging geopolitical challenges is critical for maintaining regional stability (Becker, 2019; Buzan & Waever, 2017) The conflict has exposed limitations in prior defense policies, particularly in deterrence, rapid of deployment, and intelligence-sharing mechanisms, prompting a reevaluation of security strategies (Charap & shapiro, 2018; Chivvis, 2019). This review synthesizes 25 post-2015 sources to explore the war's impact on NATO'S strategic posture, European defense modernization, hybrid threat mitigation, and EU-NATO coordination, providing foundation for analyzing long-term transformations in the European security landscape.

5. One of the most established strands of literature concerns oil-price shocks and macroeconomic transmission. Classical and contemporary research shows that geopolitical conflict affects economic outcomes not only through realized supply disruption but also through expectation-driven risk pricing, speculative inventory behavior, and uncertainty premia embedded in commodity futures markets (Kilian, Plante, & Richter, 2024).

This mechanism is particularly relevant in the context of the Strait of Hormuz, which remains one of the most strategically sensitive energy transit corridors in the global economy. Existing work by the U.S. Energy Information Administration and the International Energy Agency emphasizes that disruptions in such chokepoints have outsized effects on global benchmark pricing due to the concentration of oil and LNG flows (EIA, 2026; IEA, 2026a). As of early April 2026, the IEA has further characterized the current disruption as potentially one of the largest energy supply disruptions in recent decades, with losses in April projected to exceed those recorded in March. The present conflict therefore fits within a well-established theoretical tradition in which geographically localized conflict produces globally distributed economic costs.

6. A second major strand of literature concerns inflation transmission and cost-push dynamics.

Central banks and macroeconomic studies consistently demonstrate that a sustained rise in energy prices rapidly transmits into consumer inflation, producer prices, and monetary policy expectations. (ECB, 2026; IMF, 2026). The pass-through occurs through three principal channels: direct consumer fuel prices, higher industrial and transport costs, and expectation-driven financial repricing. Recent work further suggests that such effects are asymmetric across countries depending on energy import dependence, fiscal buffers, and exchange-rate vulnerability.

IMF and institutional assessments through early April 2026 continue to support the working assumption that every sustained 10% increase in energy prices may add approximately 40 basis points to global inflation while reducing output by 0.1–0.2 percentage points, thereby strengthening the relevance of this transmission framework to the present conflict (ECB, 2026).

The third relevant literature concerns trade disruption and strategic realignment. Studies in international trade and maritime economics show that conflict affecting major chokepoints leads to immediate rerouting of shipping flows, higher insurance premiums, longer delivery times, and substitution toward alternative suppliers (UNCTAD, 2026; World Bank, 2025). This literature is directly applicable to the observed shift in refined petroleum, fertilizer, and LNG trade flows during the 2026 conflict. April 2026 trade projections by international agencies now suggest that the closure of Hormuz may reduce projected global trade growth to between 1.5% and 2.5%, substantially below prior expectations (UNCTAD, 2026).

7. **International Monetary Fund (IMF,1945):**

I. Geopolitical Conflicts and Global Economic Disruptions

Scholars broadly agree that modern conflicts generate global economic spillovers due to deep economic interdependence. According to the International Monetary Fund (IMF,1945) wars act as negative supply shocks, increasing commodity prices, disrupting trade flows, and tightening financial conditions. Similarly, early IMF assessments of the Ukraine war emphasized that conflict-driven uncertainty reduces global growth while increasing inflationary pressures through higher food and energy prices. This theoretical foundation is consistent with Geopolitical Risk Theory, which links uncertainty and instability to declining investment, capital flight, and macroeconomic volatility.

II. Energy and Commodity Market Impacts

A large body of research identifies the Russia–Ukraine war as a major energy and commodity shock. **Balbaa** (2022) finds that the conflict triggered: Energy supply disruptions, Rising commodity prices, Global inflationary pressures

The IMF further notes that rising prices of oil, gas, and grains significantly impacted both developed and developing economies, especially those dependent on imports.

8. Energy Market Disruptions as a Central Theme

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Emerging literature identifies energy markets as the primary transmission channel of the Iran conflict. IMF research highlights that disruptions in oil supply especially through the Strait of Hormuz create global price shocks and supply chain disruptions.

9. According to **Chatham House** (2026), the direct contribution of the Middle East to global GDP is relatively small (2–3%), suggesting limited direct output effects. However, the indirect effects via energy supply disruptions are substantial, particularly for energy-importing countries.

10. A systematic review by **Sarwar & Rye** (2025) identifies five major disruption channels: Food security, Energy markets, Critical raw materials, Transport/logistics, financial systems

The war exposed structural vulnerabilities in globalized supply chains, especially in grain, fertilizers, and metals, with disproportionate effects on developing economies.

11. **Halford Mackinder's** 1904 '**Heartland Theory**' forms the geographical foundation of geopolitical thinking, which later evolved into modern Geopolitical Risk Theory analyzing how such strategic rivalries create global instability.

12. **Nicholas Spykman's** 1940s '**Rimland Theory**' complements Geopolitical Risk Theory by identifying coastal Eurasia as the main zone of great-power competition and instability, which forms the basis for modern geopolitical risk analysis.

13. The 2018 GPR Index by **Dario Caldara** and **Matteo Iacoviello** operationalizes Geopolitical Risk Theory by converting the abstract concept of geopolitical instability into a measurable quantitative indicator. The GPR index It tracks the frequency of words related to war, terrorism, and geopolitical tensions, and converts global political uncertainty into a numerical index.

Research Gaps

Despite extensive literature, several gaps remain:

- Limited integrated studies examining both Russia–Ukraine war and Iran–Israel/U.S. conflicts simultaneously
- Insufficient long-term empirical data on the Russia–Ukraine war and Iran–Israel/U.S. conflict
- Lack of region-specific comparative analyses
- Need for more research on policy responses and resilience strategies

Summary of Literature

The literature collectively concludes that:

- Geopolitical conflicts significantly disrupt global economic stability
- Energy and food markets are the most affected sectors
- Financial markets respond with increased volatility and uncertainty
- Developing economies bear the greatest burden

Research Methodology

This study adopts a comparative and analytical research design to examine the economic impacts of two major geopolitical conflicts: the Russia–Ukraine war and the Iran–Israel/U.S. conflict. The research is descriptive and explanatory in nature. The quantitative component relies on secondary data collected from international databases such as the World Bank, IMF, WTO, UNCTAD, research journal and articles. Key variables include GDP growth, inflation rates, energy prices, trade flows, and financial market indicators. Previous studies have shown that such methods effectively capture declines in trade, GDP, and energy supply disruptions caused by war.

Comparative analysis: The Russia–Ukraine war and Iran–Israel/U.S. conflict

S. No.	Dimension	Russia–Ukraine War	Iran–Israel/U.S. Conflict
1	Nature of conflict	Regional (Europe- centric)	Strategic/global (Middle East)
2	Primary transmission channel	Supply chains, trade, sanctions	Energy markets (oil), geopolitics
3	Global impact	Inflation, GDP slowdown	Inflation, energy crisis
4	Energy impact	Gas and oil disruptions (Russia)	Oil chokepoints (Hormuz)
5	Inflation impact	Moderate-high (energy + food)	Potentially severe (oil shock driven)
6	Trade impact	Trade fragmentation, sanctions	Trade rerouting, energy dependency
7	Financial markets	Sanctions, asset freeze	Currency shifts oil pricing systems
8	Global risk level	Structural but gradual	Immediate and systematic

Overall, while the Russia–Ukraine war drives gradual structural realignment of the global order, the Iran–Israel/U.S. conflict carries a higher risk of sudden systemic disruption with immediate global economic consequences.

The while the Russia–Ukraine War represents a prolonged, structural strain on the global economy, the Iran–Israel/U.S. Conflict poses a more immediate systemic threat, where disruptions in critical oil routes like the Strait of Hormuz can trigger rapid global inflation, market instability, and severe economic shocks.

Russia–Ukraine War

The Russia–Ukraine War has had wide-ranging effects on the global economy, mainly through disruptions in energy, food, trade, and financial systems.

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1. Energy Crisis

Russia is a major exporter of oil and natural gas. Sanctions and supply disruptions led to sharp increases in global energy prices, especially in Europe. This triggered higher production costs worldwide and contributed to a global inflation surge. Oil prices were projected to exceed $140 per barrel under severe disruption scenarios.

2. Agricultural Food Security Crisis and Inflation

Ukraine and Russia are major exporters of wheat, maize sunflower oil, and fertilizers. The war disrupted agricultural production and Black Sea exports, causing global food prices to rise. Many developing countries faced increased food insecurity and inflation. The war disrupted global food supply chains, increasing volatility in agricultural markets and intensifying food insecurity worldwide.

3. Global Inflation and Monetary Policy

Rising energy and food prices pushed inflation to multi-decade highs in many countries. Central banks responded by increasing interest rates, which slowed economic growth and raised borrowing costs globally.

4. Trade and Supply Chain Disruptions

Sanctions on Russia and logistical constraints affected global trade flows. Industries dependent on metals, fertilizers, and energy experienced shortages and higher costs, worsening supply chain instability.

5. Financial Market Volatility

The war created uncertainty in global markets, leading to stock market fluctuations, currency instability, Capital flight, reduced investment, Increased defense spending, Pressure on global financial markets and shifts toward safe-haven assets like gold and U.S. dollar.

6. Regional and Global Growth Slowdown

Europe was particularly affected due to its dependence on Russian energy, while the global economy experienced slower GDP growth due to reduced trade and investment. Estimated $1.3 trillion economic loss by 2025.

7. Fiscal and Debt Pressures

The International Monetary Fund warns of rising global public debt and increased borrowing due to crisis-related spending. As a result, global debt could reach 100% of GDP by 2029.

Overall, the war has intensified inflationary pressures, disrupted supply chains, and weakened global economic stability.

Iran–Israel/United States Conflict

The Iran–Israel/U.S. Conflict has significant but distinct impacts on the global economy, primarily driven by energy markets, geopolitical uncertainty, and financial volatility.

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Iran war 2026

Strait of Hormuz

1. Global Energy Shock

The most immediate impact comes from disruptions in oil supply, especially through the Strait of Hormuz, a critical global oil transit route. Around 20% of global oil flows pass through this chokepoint, making it highly sensitive to conflict. reminiscent of the 1970s energy crises.

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- Oil supply disruptions have pushed energy prices upward
- Even the risk of disruption increases prices due to market speculation
- Energy shortages, not just price rises, threaten global stability
- Reduce supply from Russia and the Middle East
- Push oil prices above $100–$120 per barrel
- Trigger global inflation

2. Inflationary Pressure and stagflation

Rising oil and gas prices translate directly into higher inflation worldwide.

- A 10% rise in oil prices can significantly increase consumer prices
- The IMF has warned of a potential global inflation crisis linked to the conflict
- Higher fuel costs increase transportation, food, and production expenses
- This creates conditions for stagflation (high inflation + low growth).

3. Slower Economic Growth

- Higher energy costs reduce consumer spending and industrial output.
- Prolonged disruption can slow global GDP growth and weaken demand
- Emerging economies are especially vulnerable due to dependence on imported energy

4. Trade and Supply Chain Disruptions

- Shipping routes in the Middle East are affected, increasing costs and delays.
- Disruptions in oil and cargo flows affect global logistics
- Industries reliant on energy and transport face higher operational costs

5. Financial Market Volatility

The conflict increases uncertainty in global markets:

- Stock markets become volatile
- Investors shift to safe-haven assets like gold and the U.S. dollar
- Bond yields may rise due to increased government spending and risk

6. Sector-Specific Effects

- Airlines and transport face rising fuel costs and reduced profitability
- Energy companies may benefit from higher prices
- Governments increase defense spending, affecting fiscal balances

Regional Impacts

1. Europe

The Russia-Ukraine War exposed Europe's heavy dependence on Russian energy, especially natural gas. As supplies were disrupted, energy prices surged, triggering an energy crisis. This increased production costs for industries, leading to an industrial slowdown, particularly in energy-intensive sectors like manufacturing and chemicals. At the same time, rising energy and food prices caused a sharp inflation surge, reducing household purchasing power and slowing economic growth.

2. Middle East

Although some Middle Eastern economies benefited from higher oil prices, conflict spillovers and instability affected parts of the region. War-related disruptions contributed to infrastructure damage in conflict-prone areas and oil export disruptions in certain routes. Economies already facing fragility experienced economic contraction, while vulnerable populations faced worsening humanitarian crises, including displacement and food shortages.

3. Developing Countries

Developing economies were among the hardest hit due to their structural vulnerabilities:

- High fuel import costs increased fiscal burdens and trade deficits
- Rising global food prices led to food insecurity
- Increased borrowing and higher interest rates caused debt distress
- Small and import-dependent nations suffered the most. Their reliance on imported fuel made them highly exposed to fuel price spikes, leading to severe economic hardship, inflation, and balance-of-payments pressures.

4. India

India, as a major oil-importing economy, faced significant challenges:

- Heavy dependence on imported crude oil increased vulnerability to global price shocks
- Rising oil prices created inflationary pressures, especially in transport and food
- Higher input costs affected businesses and consumption
- As a result, GDP growth risks emerged, with estimates suggesting growth could fall to around 6–6.6% if oil prices rise above $100–130 per barrel, due to reduced demand and higher macroeconomic stress.

The Impact of the Russia-Ukraine War and Iran-Israel/U.S. Conflict

1. Major Countries Economic GDP Growth Rate 2022-2026 (%)

S. No.	Countries	2022	2023	2024	2025	2026
1	United States	2.5%	2.9%	2.8%	2.1%	2.3%
2	China	3.1%	5.4%	5.0%	4.8%	4.4%
3	India	7.2%	7.3%	6.6%	6.5%	6.3%
4	UK	4.3%	0.1%	1..1%	1.3%	0.8%

5	Russia	2.1%	3.6%	3.2%	1.5%	1.1%
6	Germany	1.8%	-0.3%	-0.5%	-0.2%	1.1%
7	Japan	1.3%	0.7%	-0.2%	1.1%	0.7%
8	France	2.5%	1.6%	1.2%	0.9%	0.9%
9	Brazil	3.2%	3.0%	3.4%	2.3%	1.9%
10	Indonesia	5.3%	5.0%	5.0%	5.0%	4.9%
11	South Africa	1.9%	0.6%	1.0%	1.3%	1.5%
12	Italy	4.8%	3.7%	0.7%	0.4%	0.5%
13	Saudi Arabia	8.7%	0.5%	2.6%	4.3%	4.5%
14	Singapore	4.1%	1.8%	4.4%	2.0%	1.9%
15	Netherland	5.0%	-0.6%	1.0%	1.8%	1.2%
16	Bangladesh	7.1%	5.8%	4.2%	3.7%	4.7%
17	Australia	4.1%	2.0%	1.4%	1.9%	2.0%
18	Iran	4.4%	5.0%	3.7%	-1.5%	-6.1%
19	South Korea	2.7%	1.4%	2.0%	1.0%	1.8
20	Israel	6.5%	2.1%	1.0%	2.9	3.5%
21	Ukraine	-28.8%	5.5%	2.9%	2.0%	1.8%
22	Sri Lanka	-7.3%	-2.3%	5.0%	4.6%	3.5%
23	Switzerland	3.1%	0.8%	1.4%	1.3%	1.2%
24	Egypt	5.9%	3.8%	3.6%	4.4%	4.7%
25	Spain	6.5%	2.5%	3.5%	2.9%	2.5%
26	Poland	5.3%	0.2%	2.9%	3.2%	3.5%
27	Romania	4.2%	2.3%	0.9%	0.7%	0.7%
28	Bulgaria	4.1%	1.8%	3.4%	3.1%	2.8%
29	Pakistan	6.2%	-0.2%	2.6%	3.1%	3.6%
30	Nigeria	3.3%	3.7%	3.8%	4.0%	4.1%
31	UAE	7.9%	3.4%	4.0%	4.8%	4.5%
32	Qatar	4.2%	1.5%	2.4%	2.8%	-5.3%
33	Kuwait	6.8%	-1.6%	-1.0%	2.5%	2.7%
34	Oman	4.3%	1.4%	1.6%	2.4%	3.5%
35	Bahrain	6.2%	3.0%	2.6%	2.9%	3.3%
36	Turkey	5.5%	5.1%	3.2%	3.1%	3.6%
37	Syria	0.7%	-1.2%	-1.5%	-1.0%	1.0%
38	Lebanon	1.0%	-0.8%	-7.5%	3.5%	4.0%

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39	Iraq	7.0%	3.7%	-1.5%	4.0%	3.6%
40	Jordan	2.7%	3.1%	2.6%	2.7%	2.7%

Source: IMF (World Economic Outlook), World Bank GDP growth rate from 2022 to 2026

The given table shows changes in GDP growth rates of various countries from 2022 to 2026. This data reflects inequality, stability, and volatility in the global economy, especially influenced by major geopolitical events like the Russia–Ukraine war and Iran-Israel/United States conflict.

Among developed countries, the United States shows limited but stable growth, from 2.5% in 2022 to 2.3% in 2026. Countries like Germany (-0.3% in 2023, -0.5% in 2024) and the United Kingdom (0.1% in 2023, around 1.3% in 2025) show signs of economic slowdown. Japan and France also maintain growth rates of around 1%.

In contrast, developing countries show higher growth. India maintains consistently high growth, from 7.2% in 2022 to 6.3% in 2026. China, although declining from 5.4% in 2023 to 4.4% in 2026, still demonstrates strong growth. Indonesia remains stable at around 5%.

Middle Eastern countries show significant fluctuations. Saudi Arabia drops sharply from 8.7% in 2022 to 0.5% in 2023, but then recovers to 4.5% in 2026. Iran shows a sharp decline to -6.1% in 2026, while Qatar also records negative growth of -5.3% in 2026.

Conflict-affected economies show severe impacts. Ukraine experiences a massive contraction of -28.8% in 2022, followed by a recovery of 5.5% in 2023. Sri Lanka improves from -7.3% in 2022 to 3.5% in 2026. Other countries like Nigeria (3.3% to 4.1%) and Pakistan (-0.2% to 3.6%) show improvement over the period. Overall, developed countries exhibit low but stable growth, while developing countries show higher but more volatile growth. Global political conditions, wars, oil prices, and economic policies have a significant impact on these growth trends.

2. Major Countries Inflation Rate 2022-2026 (%)

S. No.	Countries	2022	2023	2024	2025	2026
1	United States	8.0%	4.1%	2.9%	3.0%	2.6%
2	China	2.0%	0.2%	0.2%	1.0%	1.0%
3	India	6.7%	5.7%	5.0%	5.0%	4.5%
4	UK	9.0%	7.3%	3.3%	3.5%	2.6%
5	Russia	11.5%	5.9%	8.4%	8.0%	6%
6	Germany	8.6%	6.0%	2.3%	2.5%	2.2%
7	Japan	2.5%	3.3%	2.7%	3%	2.5%
8	France	5.2%	5.7%	2.0%	2.5%	2.0%
9	Brazil	9.3%	4.6%	4.4%	4.5%	4.5%
10	Indonesia	4.2%	3.7%	2.2%	2.5%	2.5%
11	South Africa	6.9%	6.0%	4.4%	5%	5%
12	Italy	8.7%	5.9%	1.0%	2%	2.0%
13	Saudi Arabia	2.5%	2.3%	1.7%	2%	2.0%
14	Singapore	6.1%	4.8%	2.4%	3%	2.2%
15	Netherland	12%	3.8%	3.3%	3%	2.5%
16	Bangladesh	7.7%	9.5%	10.5%	10%	9%
17	Australia	6.6%	5.6%	3.2%	3.5%	3.0%
18	Iran	40%	44%	32.5%	35%	45%
19	South Korea	5.1%	3.6%	2.3%	2.5%	2.5%
20	Israel	4.4%	4.2%	3.1%	3%	2.5%

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21	Ukraine	20%	25%	6.5%	7%	7%
22	Sri Lanka	60%	46%	1%	3%	3%
23	Switzerland	2.8%	2.1%	1.1%	1.5%	1.0%
24	Egypt	21%	30%	28.3%	25%	22%
25	Spain	8.3%	3.4%	2.8%	2.5%	2.2%
26	Poland	14%	11.6%	3.8%	4%	4.5%
27	Romania	14%	10.4%	5.7%	6%	5%
28	Bulgaria	13%	9.5%	2.4%	3%	3%
29	Pakistan	23%	30%	12.6%	12%	10%
30	Nigeria	18%	24%	33.2%	30%	28%
31	UAE	4.8%	3.0%	1.7%	2.5%	2.5%
32	Qatar	4.5%	3.0%	1.3%	2%	2%
33	Kuwait	3.4%	3.4%	2.9%	3%	3%
34	Oman	2.3%	0.9%	0.6%	1.5%	1.5%
35	Bahrain	3.4%	1.0%	0.9%	2%	2%
36	Turkey	72%	53%	58.5%	50%	35%
37	Syria	72.1%	139%	108%	60%	40%
38	Lebanon	171.2%	221%	45%	20%	15
39	Iraq	5.0%	4.5%	4.5%	2.5%	4%
40	Jordan	4.2%	2.3%	2.3%	3%	3%

Source: World Bank inflation rate from 2022 to 2026

The table shows inflation trends across 40 countries from 2022 to 2026 and clearly reflects the impact of global geopolitical tensions, especially the Russia–Ukraine War and the ongoing tensions involving Iran, Israel, and the United States. These conflicts have significantly influenced global energy prices, supply chains, and overall inflation.

Among developed economies, United States shows a sharp decline in inflation from 8.0% (2022) to 2.6% (2026), indicating effective monetary control. Similarly, Germany drops from 8.6% to 2.2%, and United Kingdom declines from 9.0% to 2.6%. Japan and Switzerland maintain relatively low and stable inflation, mostly between 1–3%.

In emerging economies, inflation is higher but gradually stabilizing. India decreases from 6.7% (2022) to 4.5% (2026), while Brazil falls from 9.3% to 4.5%. Indonesia also shows moderation from 4.2% to 2.5%.

However, some countries experience extremely high inflation. Iran records persistently high rates, rising from 40% (2022) to 45% (2026). Turkey shows very high inflation, peaking at 72% (2022) and remaining elevated at 35% (2026). Lebanon experiences hyperinflation, reaching 221% (2023) before declining to 15% (2026). Similarly, Syria records extreme inflation, peaking at 139% (2023).

The countries facing economic crises or instability also show sharp spikes. Sri Lanka records 60% inflation in 2022, which gradually falls to 3% by 2026. Ukraine shows elevated inflation (20% in 2022, 25% in 2023) before stabilizing at 7%.

In Africa, Nigeria rises from 18% (2022) to 33.2% (2024) before slightly declining, indicating persistent inflationary pressure. Egypt also remains high, peaking at 30% (2023).

Overall, the data shows that developed countries have successfully reduced inflation to stable levels; while developing and crisis-affected economies face higher and more volatile inflation. Factors such as political instability, supply shocks, and monetary policy significantly influence these trends.

3. Financial Markets:

The Russia-Ukraine war and the Iran-Israel/U.S. conflict have significantly influenced global financial markets by increasing uncertainty, inflation, and volatility. The Russia–Ukraine war acts as a long-term structural shock. Russia is a major exporter of oil, gas, and commodities such as wheat and fertilizers. Sanctions and supply disruptions pushed global energy and food prices higher, contributing to inflation worldwide. Stock markets

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initially fell sharply after the invasion, reflecting negative abnormal returns across global indices.

In contrast, the Iran-Israel/U.S. conflict represents a short-term but intense shock, mainly through energy markets. The Middle East is critical for global oil supply, and disruptions especially around the Strait of Hormuz have caused oil prices to rise sharply, increasing global inflation. Reports indicate that oil supply disruptions and shipping constraints have significantly tightened markets, forcing countries like the United States to increase exports to stabilize supply. At the same time, global stock markets have experienced declines of around 7–12% during escalation phases, reflecting heightened risk aversion.

The Russia–Ukraine War and the Iran-Israel/U.S. conflict have created widespread ripple effects across global financial markets. While Middle East countries like Russia, Ukraine, Iran, and Israel face direct most severe effects, including economic damage, inflation, and disrupted financial systems due to war costs and sanctions, financial effects include: Military spending increases, Stock market volatility, Trade and oil-related disruptions, regions dependent on energy imports such as Europe and Asia struggle with inflation and slower growth. Highly affected due to oil supply disruptions: Saudi Arabia, UAE, Qatar, Kuwait, Bahrain, Oman. Oil-exporting Gulf nations experience instability despite higher prices, while major economies like the United States, U.K. and Japan deal with market volatility.

4. Energy Markets

The impact of the Russia–Ukraine War and the Iran–Israel/U.S. conflict on global energy markets is widespread, affecting specific groups of countries based on their role in energy production, export, and consumption.

The Countries Most Affected in Energy Markets

I. Major energy producers (directly impacted): Russia, Iran, Saudi Arabia, United Arab Emirates, and Qatar. These countries are key oil and gas exporters. Sanctions on Russia and disruptions in the Middle East reduce supply and cause price spikes. Damage to infrastructure and restricted exports directly affect their revenues and global supply.

II. Major energy importers (most vulnerable): India, China, Japan, South Korea, and European nations such as Germany and Italy. These economies depend heavily on imported oil and gas. Disruptions, especially through the Strait of Hormuz, increase fuel costs, inflation, and the risk of energy shortages.

III. Gulf transit and regional economies: Kuwait, Bahrain, and Oman. These countries depend on stable energy flows through regional routes. Conflict-related disruptions in shipping and infrastructure create supply shocks and economic instability.

IV. Global stabilizers and alternative suppliers: The United States plays a key role by increasing oil production and exports to stabilize global markets when supply from Russia or the Middle East is disrupted. Overall, these conflicts create energy price volatility, supply insecurity, and global inflation, affecting nearly every country connected to oil and gas markets.

Oil prices

Iran-Israel-America conflict are simultaneously creating a major energy crisis in 2026, with oil prices hovering around $100–$106 per barrel, according to Al Jazeera and Counting the Cost. This confluence of conflicts disrupts global supply chains, fuels inflation, and poses a risk of recession. The Deloitte analysis suggests these crises threaten global food security and shipping, forcing nations to turn to alternative energy producers.

Impacts on Oil Prices and Global Economy (April 2026):

- Strait of Hormuz Disruption: The Iran-Israel/America conflict has heavily impacted the Strait of Hormuz, which carries roughly 20% of global oil, driving up energy prices and creating a supply shortfall potentially greater than past crises.
- Price Surge: Oil prices have risen above $100 per barrel, with potential to reach higher if maritime traffic remains blocked.
- Inflation & Recession Risk: High oil prices are driving up inflation across major economies, with severe impacts on developing nations, according to the Economics Observatory and Counting the Cost.
- Supply Chain Disruption: Beyond oil, the conflicts are affecting the transport of natural gas and fertilizer, complicating global food supply.
- Shifting Energy Flows: Europe is shifting away from Russian energy, while countries like India and China face volatility, as noted by Deloitte and the Economic Observatory.
- Increased Volatility: The interaction between the two wars has significantly increased global energy market volatility.

International Trade

The Russia–Ukraine war and the Iran–Israel/US conflict have significantly disrupted global trade through commodity shocks, supply chain fragmentation, and rising geopolitical tensions. Reports from the IMF, World Bank, UNCTAD, and WTO highlight both impacts and policy responses. UNCTAD notes that the Ukraine war triggered sharp increases in food, fuel, and fertilizer prices, with Russia and Ukraine accounting for 27% of global wheat exports, severely affecting import-dependent countries. The WTO emphasizes that such disruptions increase trade costs and risk long-term fragmentation, with potential global income losses of up to 8.7% under trade bloc division. The Middle East conflict has amplified these shocks. According to the World Bank, energy prices may rise by 24% in 2026, fertilizers by 31%, and global growth may fall to ~3.6%, while up to 45 million people risk food insecurity. IMF analysis highlights that disruption of the Strait of Hormuz could trigger a major energy crisis, weakening global growth momentum. Recent data also show oil prices exceeding $120 per barrel, raising stagflation risks globally.

In 24 February 2022, the Russia–Ukraine war caused a moderate slowdown in global trade. According to the World Trade Organization, global trade growth fell to 3.0% from 4.7%, while global GDP growth declined to 2.8%. The conflict disrupted exports of wheat, maize, and sunflower oil, as both countries are major suppliers.

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Blockage of Black Sea ports led to food shortages and inflation, especially in developing nations. Additionally, sanctions on Russia created energy supply uncertainty, raising global oil and gas prices. Supply chains were affected due to reduced fertilizer exports and logistical disruptions.

Policy Recommendation

April 2026, international financial and trade institutions like (IMF, World Bank, UNCTAD, WTO, OECD) are advising urgent policy action to mitigate the severe economic fallout from the escalating Russia-Ukraine war and the U.S./Israel-Iran conflict. Key risks include a looming global recession, runaway inflation due to energy supply shocks (specifically the Strait of Hormuz closure), and increased trade fragmentation.

Here are the policy recommendations and outlooks from these organizations:

1. International Monetary Fund (IMF)

The IMF has warned that the Middle East conflict is "permanently scarring" the global economy and could drag global growth below 2% in 2026, risking a recession.

- Monetary Policy: Central banks must remain vigilant and "higher for longer" on interest rates if inflation remains sticky, despite the growth slowdown.
- Fiscal Policy: Urged targeted support for vulnerable households and businesses affected by high food and energy prices, while balancing against high debt loads.
- Energy Security: Advocated for diversifying energy supplies and accelerating the transition to renewable energy to reduce susceptibility to geopolitical tensions in the Middle East.

IMF Managing Director **Kristalina Georgieva** warned that the U.S./Israel conflict with Iran has triggered a significant global economic shock, creating "lasting damage" and a potential stagflationary crisis.

2. World Bank (WB)

The World Bank warns that a prolonged war in the Middle East could drive energy prices up by 24% in 2026, forcing many countries into a "long-term debt-growth-investment trap".

Financial Assistance: Actively providing emergency liquidity to client countries in emerging markets impacted by disrupted commodity supplies and increased logistical costs.

Support for Reconstruction: Maintaining strong financial support(billion) for Ukraine to sustain public services and repair infrastructure.

Resilience Building: Investing in sustainable energy and improving logistical infrastructure to mitigate supply chain bottlenecks.

3. United Nations Conference Trade and Development (UNCTAD)

UNCTAD warns that the conflicts threaten to reverse years of progress on the energy transition and deepen the digital and economic divide.

De-escalation and Security: Emphasized the urgent need to secure maritime transport, ports, and seafarers, particularly in the Middle East, to prevent shortages of fertilizers and food.

Global Debt Relief: Called for a "fundamental rethink" of development strategies, warning that debt servicing is constricting the policy space for developing countries.

Market Regulation: Advocated for strengthening international maritime law and preventing trade fragmentation to keep global trade a driver of inclusive growth.

4. World Trade Organization (WTO)

The WTO projects global trade growth to slow to 1.9% in 2026, with the risk of further declines if energy prices remain high or trade protectionism increases.

Avoid Protectionism: Urged members to avoid export restrictions on food and fertilizers, which worsen global shortages and spike prices.

Dispute Settlement Mechanism: Pushing to restore a fully operational dispute settlement system to resolve trade disputes predictably. Supply Chain Resilience: Encouraged diversifying supply chains to withstand geopolitical shocks.

5. Organisation for Economic Co-operation and Development (OECD)

OECD policy recommendations- OECD recommends a "resilience-based economic strategy" combining: Targeted fiscal support to offset inflation shocks (+2–2.5 pp inflation impact)

Credible monetary policy to stabilize expectations

Energy diversification & green transition to reduce geopolitical dependence

Open trade systems to avoid supply shocks

Financial system strengthening to manage volatility

Reconstruction investment (Ukraine) and multi-crisis preparedness and Global coordination

Conclusion

The comparative analysis of the Russia–Ukraine and Iran–Israel/USA wars reveals that contemporary geopolitical conflicts have far-reaching and multifaceted economic consequences. Both conflicts have significantly disrupted global economic stability, though through distinct mechanisms and regional dynamics. The Russia–Ukraine war has primarily affected global food systems, supply chains, and regional energy markets, particularly in Europe. Sanctions, trade disruptions, and reduced exports of essential commodities have contributed to inflationary pressures and economic uncertainty worldwide. In contrast, the Iran–Israel/USA conflict has exerted a more pronounced influence on global energy markets, with disruptions in critical transit routes leading to fluctuations in oil and gas prices and increased transportation costs. Despite these differences, both conflicts highlight the vulnerability of an interconnected global economy to geopolitical shocks. Rising inflation, market volatility, and weakened growth prospects are common outcomes, underscoring the need for diversified supply chains, strategic energy reserves, and strengthened international cooperation.

The Russia–Ukraine and Iran–Israel/U.S. conflicts have collectively created a poly crisis in the global economy. Their combined effects energy shocks, food insecurity, inflation, and financial instability pose a serious threat to global economic stability.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Intersection of Science, Technology and Humanity in *Dune*

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Abstract

Frank Herbert's Dune is not merely a science fiction novel; it is a profound exploration of how science and technology interact with human values, ecology, and power structures. Set on the desert planet Arrakis, the narrative presents a complex interplay between advanced scientific knowledge, restrained technological development, and deeply rooted human instincts and cultural systems. This paper examines how Herbert envisions a future where technological restraint, ecological awareness, and human evolution converge. By analysing key elements such as ecological science, anti-artificial intelligence philosophy, genetic manipulation, and socio-political control, the paper highlights the novel's enduring relevance in contemporary discussions about sustainability, ethics, and innovation. Frank Herbert's novel Dune stands as one of the most intellectually rich works of science fiction. It offers a multidimensional exploration of science, technology, and humanity. Rather than celebrating technological advancement in its conventional form, Herbert presents a future shaped by ecological awareness, technological restraint, and the evolution of human potential. This paper examines the intersection of science, technology, and humanity in Dune through ecological theory, anti-artificial intelligence philosophy, genetic engineering, and systems of knowledge control. It argues that Herbert envisions a model of progress rooted in sustainability and human adaptability rather than mechanization. The study also evaluates the novel's relevance in contemporary contexts such as climate change, artificial intelligence ethics, and biotechnology.

Introduction

Science fiction, as a literary genre, has persistently served as a speculative framework for examining the course of human civilization. From early utopian visions to dystopian warnings, it enables authors to envision futures influenced by scientific and technological advancements. Among these works, *Dune* holds a distinctive place due to its philosophical richness and interdisciplinary breadth. Crafted during a time of increasing environmental consciousness and technological hope, Herbert's novel contests prevailing narratives that associate progress with mechanization (Suvin, 1979).

In contrast to numerous science fiction works that highlight advanced technology and artificial intelligence, *Dune* intentionally downplays these aspects. Instead, it focuses on human abilities, ecological systems, and socio-cultural development. The lack of computers and intelligent machines in the novel's universe is not a drawback but a conscious decision influenced by the historical event known as the Butlerian Jihad. This anti-technological perspective compels humanity to enhance internal skills such as memory, reasoning, and intuition. The primary setting of Arrakis—a formidable desert planet—acts as a testing ground for Herbert's concepts. In this environment, survival relies not on technological superiority but on ecological adaptation and shared knowledge. Through characters such as Paul Atreides, Liet-Kynes, and the Fremen, Herbert investigates the relationship between science and technology with human values and power dynamics. This paper aims to analyze these relationships by exploring four key dimensions: ecological science, technological restraint, human evolution, and socio-political control of knowledge. It ultimately contends that *Dune* offers a comprehensive vision of progress that emphasizes sustainability and ethical responsibility.

Ecological Science and Environmental Determinism

1 Arrakis as a Scientific Ecosystem

One of the most notable accomplishments of *Dune* is its intricate portrayal of a planetary ecosystem. Herbert's representation of Arrakis demonstrates a systems-oriented comprehension of ecology, where every element is mutually dependent. The life cycle of the sandworms, the generation of spice melange, and the limited availability of water are all deeply interconnected (Herbert, 1965).

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This ecological framework corresponds with current environmental science, which highlights the interdependence of biological and physical systems. Herbert's narrative predates the widespread public conversation regarding climate change, yet it foresees many of its fundamental issues. Arrakis exemplifies environmental determinism, illustrating how the physical environment influences social structures, cultural practices, and economic systems.

2 Water as a Scientific and Cultural Resource

The scarcity of water on Arrakis is not simply a background element but a fundamental organizing principle. The Fremen culture centres on the conservation and management of water, which is regarded as a sacred resource. Innovations such as stillsuits, windtraps, and subterranean reservoirs showcase applied environmental science adapted to extreme conditions (O'Reilly, 1981). The scientific creativity of the Fremen is evident in their capacity to merge technology with ecological insight. Instead of exploiting the environment, they adjust to it, embodying sustainability principles that resonate with modern ecological perspectives (Seed, 2011).

3 Terraforming and Long-Term Ecological Vision

The terraforming initiative proposed by Liet-Kynes embodies a scientific aspiration to convert Arrakis into a more livable planet. Nevertheless, this initiative is marked by a commitment to patience and an appreciation for ecological equilibrium. Herbert juxtaposes this methodology with exploitative actions motivated by imperial ambitions, especially those of House Harkonnen. This conflict underscores the moral aspects of ecological science. Although terraforming presents the potential for environmental enhancement, it simultaneously prompts inquiries regarding human interference and unforeseen repercussions (Stableford, 2006). Herbert implies that advancements in science should be steered by ecological insight rather than immediate profit.

Technology and the Philosophy of Restraint

1 The Butlerian Jihad and Anti-Technological Ideology

The Butlerian Jihad represents a pivotal event within the *Dune* universe, signifying humanity's repudiation of thinking machines. This historical occurrence lays the groundwork for a cultural and religious ban on artificial intelligence, encapsulated in the edict:

"Thou shalt not make a machine in the likeness of a human mind" (Herbert, 1965).

This opposition to technology can be viewed as a commentary on contemporary society's dependence on machines. Herbert foresees issues related to automation, the erosion of human agency, and the ethical challenges posed by artificial intelligence (Clute & Nicholls, 1995). By eliminating sophisticated computers from his imagined world, Herbert compels both characters and readers to re-evaluate the significance of technology in human existence.

2 Alternative Technologies and Human Enhancement

In the absence of computers, *Dune* presents alternative technological forms that augment human abilities. Mentats, for example, are individuals who have undergone training to execute intricate calculations and analyses. Likewise, the Bene Gesserit cultivates advanced methods of psychological and physical control, such as voice modulation and enhanced awareness. These advancements signify a transition from external to internal technology. Instead of depending on machines, humans themselves emerge as the primary agents of knowledge and power. This perspective resonates with philosophical views that highlight human potential and self-mastery (Seed, 2011).

3 Functional and Environmental Technologies

The technological environment depicted in *Dune* is marked by its focus on practicality and adaptation to the environment. Instruments like stillsuits are crafted specifically for survival in arid conditions, optimizing water retention and operational efficiency. These technologies do not represent progress in the conventional sense; rather, they serve as instruments for harmonious living with nature. Herbert's focus on functional innovation questions the belief that technological progress necessarily entails greater complexity or automation. Instead, he promotes solutions that are sensitive to context and effectively tackle particular environmental issues.

Human Evolution, Genetics, and Consciousness

1 The Bene Gesserit and Genetic Engineering

The Bene Gesserit sisterhood is one of the most advanced scientific organizations in *Dune*. They aim to create the Kwisatz Haderach—a being endowed with extraordinary cognitive and perceptual skills—through a meticulously managed breeding program (Herbert, 1965). This extensive genetic endeavour prompts important ethical considerations. While it showcases the possibilities of scientific oversight in human evolution, it also highlights the risks associated with viewing individuals merely as tools for a larger purpose. The Bene Gesserit's control over bloodlines raises issues related to eugenics and the ethical ramifications of genetic manipulation (Suvin, 1979).

2 Paul Atreides and the Expansion of Consciousness

Paul Atreides represents the ultimate achievement of the Bene Gesserit's endeavours. His evolution into the Kwisatz Haderach bestows upon him prescient capabilities, enabling him to envision various potential futures. This broadened awareness signifies a type of cognitive advancement that surpasses typical human constraints. Nevertheless, Herbert depicts this transformation as both a source of empowerment and a heavy burden. Paul's ability to foresee the future confines him to predetermined paths, restricting his autonomy instead of augmenting it. This contradiction highlights the intricacies of scientific progress and its influence on human identity (O'Reilly, 1981).

3 Science of Mind and Body

The training techniques utilized by the Bene Gesserit and Mentats demonstrate a sophisticated comprehension of psychology, neurology, and physiology. Methods including pain control, enhanced perception, and memory enhancement indicate a comprehensive strategy for human growth. Herbert's emphasis on the relationship between mind and body foreshadows contemporary interdisciplinary research in neuroscience and cognitive science. Furthermore, it underscores the notion that humans have unexploited capabilities that can be developed through rigorous practice.

Science, Power, and Political Economy

1 Spice Melange and Resource Control

The spice melange plays a pivotal role in the economy and power dynamics of the *Dune* universe. Its distinctive characteristics—prolonging life, enhancing cognitive functions, and facilitating space travel—render it the most precious substance known (Herbert, 1965). Control over the production of spice on Arrakis directly correlates with political authority. This relationship is reminiscent of

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real-world resource economies, where access to oil, minerals, or water dictates geopolitical power (Stableford, 2006).

2 Knowledge Monopolies and Elite Control

In *Dune*, scientific knowledge is not widely accessible but is instead concentrated within elite groups such as the Bene Gesserit, the Spacing Guild, and the Mentats. These organizations uphold secrecy and exclusivity, wielding knowledge as a means of control. This concentration of expertise prompts inquiries regarding educational access and the distribution of power in technologically advanced societies. Herbert posits that knowledge, akin to any resource, can be manipulated for the purpose of domination (Clute & Nicholls, 1995).

3 Religion, Science, and Ideology

Herbert also blurs the lines between science and religion, particularly through the Bene Gesserit's employment of prophecy and myth-making. By instilling religious beliefs across various cultures, they establish systems of control that align with their strategic objectives. This interaction between science and ideology underscores the potential for manipulation when knowledge is intertwined with belief systems. It also mirrors the intricate relationship between rational inquiry and cultural narratives.

Ethical Implications of Scientific Advancement

1 Responsibility in Innovation

A central theme in *Dune* is the ethical obligation that comes with scientific knowledge. Herbert consistently highlights that innovation devoid of moral consideration can result in disastrous outcomes (Herbert, 1965; Suvin, 1979). The ecological deterioration of Arrakis under exploitative regimes acts as a cautionary tale against unrestrained industrialization. Likewise, the Bene Gesserit's breeding program exemplifies the dangers of prioritizing results over individual freedom.

2 Human Identity in a Technological World

By dismissing artificial intelligence and focusing on human potential, Herbert prompts inquiries regarding identity in a world mediated by technology. What does it signify to be human in an era of advanced science? *Dune* posits that humanity is characterized not by its instruments but by its principles, connections, and ability to adapt.

3 Limits of Knowledge and Power

Herbert further investigates the boundaries of scientific understanding. Paul's prescience, although formidable, does not provide absolute dominion over the future. Rather, it uncovers the intricacies and unpredictability of human systems. This viewpoint contests the belief that science can deliver conclusive answers or remedies. It promotes humility and caution in the quest for knowledge.

Contemporary Relevance

The themes explored in *Dune* remain highly relevant in the 21st century. Climate change, artificial intelligence, and biotechnology are central issues in contemporary discourse, and Herbert's novel offers valuable insights into each of these areas.

- Climate Change: The ecological crisis of Arrakis parallels modern environmental challenges, emphasizing the need for sustainable practices (Seed, 2011).
- Artificial Intelligence: The Butlerian Jihad anticipates debates about AI ethics, autonomy, and regulation (Clute & Nicholls, 1995).
- Biotechnology: Advances in genetic engineering echo the ethical dilemmas presented by the Bene Gesserit's breeding program (Stableford, 2006).

By engaging with these issues, *Dune* continues to serve as a critical framework for understanding the intersection of science, technology, and humanity.

Conclusion

Dune presents a thorough and intricate examination of the interplay between science, technology, and humanity. Through its elaborate world-building and philosophical richness, the novel questions traditional ideas of progress and innovation. Herbert imagines a future where technological moderation, ecological consciousness, and human evolution are vital for survival. The novel's focus on sustainability, ethical accountability, and human potential offers a persuasive alternative to stories that emphasize mechanization and control. By exploring the connections between science and society, Dune underscores both the opportunities and risks associated with scientific progress. In the end, Herbert's work acts as a warning yet optimistic outlook on the future. It implies that the way forward is not through domination of nature or dependence on machines, but rather through harmony, adaptability, and an appreciation for the intricacies of life (Herbert, 1965).

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My sincere appreciation goes to Dune creator Frank Herbert, as well as scholars, literary critics, and researchers whose analyses of science fiction, technology, ecology, politics, and human evolution provided valuable insights and a strong theoretical foundation for this study.

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Original Article

Effect of Yoga on Mental Health and Life Style Management

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Abstract

The present research paper examines the effects of yoga on the mental and physical health of people. Daily practice of Yoga has been observed to have a positive effect on the physical health of an individual. Routined yoga practice also enhances the concentration power and mental skills of an individual who meditate with concentration every day. Hence, the practice of yoga and meditation is very important for the physical and mental health of every human being. In this way people who follow physical activities develop qualities like concentration, self-restraint and self-confidence in a positive way. The brain development of the humans beings is necessary which can be achieved through routine yoga practice which also keeps the body healthy. With self-restraint one can control his behaviour better. The miracle of yoga has been accepted by the whole world and that is the reason yoga education has been made compulsory in many institutions in most of the countries. Yoga is a subject in which the whole worldly phenomenon is included, as it is related to physical and mental development as well as spirituality. Yoga helps in providing the right direction and organises an individual life. The brain is not just a muscle but has the power to control the entire body through nerves. Apart from this, memory and spiritual power can also be obtained through the brain itself. Therefore, by increasing the working capacity of the brain through yoga and meditation, we can create a balance between the mind and the body. To solve the problems related to studies, physical and mental development of student life, people should do daily yoga and meditation. This way they can notice the quick and positive effect on their physical and mental powers anas a result most of the problems of an individual life can be solved.

Keywords- *Mental Health, Physical health, Spiritually, Concentration.*

Introduction: -

Yoga is essentially a spiritual discipline based on an Extremely subtle science, which focuses on bringing harmony between mind and body. It is an art and science of healthy living. The word 'Yoga' is derived from the Sanskrit root 'Yuj', meaning 'to join' or 'to yoke' or 'to unite'. Yoga originated in India several thousand years ago as a system of physical and spiritual practices. yoga was a method for joining a regular imperfect human being with the divine principle, or God. It is aimed to unite the mind, the body and the spirit. Through the practice of yoga and the mind can be trained to relax through deep breathing and become focused while holding the breath. This practice will lead to control of the mind. Doing yoga, not just the physical portion, but also immersing oneself on to the mental aspect of it, can help improve mental health. Yogis (those who do yoga) believe that yoga can reduce, and eventually prevent, the build-up of repressed emotions in the mind. The process is gradual but the effects, if yoga continues to be practiced, are lasting. "Yoga is a very effective stress reduction and relaxation tool. Performance of various postures requires the tensing and stretching and then relaxing of muscle groups and joints, which effectively produces relaxation in much the same way that a massage does. Yoga practice also draws attention towards breathing, which produces a meditative and soothing state of mind" the mind can be trained to relax through deep breathing and become focused while holding the breath. This practice will lead to control of the mind. Doing yoga, not just the physical portion, but also immersing oneself on to the mental aspect of it, can help improve mental health. Yogis (those who do yoga) believe that yoga can reduce, and eventually prevent, the build-up of repressed emotions in the mind. The process is gradual but the effects, if yoga continues to be practiced, are lasting. "Yoga is a very effective stress reduction and relaxation tool.

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Three Types of Body Health Measures: -

1. Mental Health
2. Physical Health
3. Life Stlye Daily Routine

Mental health-

Mental health is often broken down into four key pillars—emotional, psychological, cognitive, and social—which represent a holistic approach to well-being. These interconnected pillars represent how individuals feel, think, act, and connect, rather than just the absence of illness, and are essential for overall functioning and resilience.

Mental Disorder:-

1. Anxiety Disorder
2. Personality Disorder
3. Mood Disorder (mood swing, angryness, short temperament)
4. Growth of self-development
5. Attitude towards self

Physical Health:-

Physical fitness is most important for human body to put Physical health is the well-being of the body and the proper functioning of organism individuals, which is a normal condition for body physical active, and mental condition and good who are not suffering from any type of sickness. Looking at today's daily life, it is very important for a human to take care of his physical health feet and active.so that no diseases easy enter in human body and person can live free from diseases.

Physical health includes many aspects of life such as:

1. Sleeping well.
2. Eating well.
3. Being physically active and feet.
4. Maintaining good hygiene.
5. Rest proper.

Life Stlye Daily Routine

A balanced daily routine Improves Life style productivity and well-being through consistent habits, including early walking daily, healthy meals, no junk and structured work hours. Key components include a focused morning routine (stretching, hydration), a productive work routine day life with breaks, and a calming evening routine (goal setting, limited screen time). Effective routines prioritize sleep, exercise, and mental well.

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Yoga Benefit in Daily Routine:-

Treatment of mental and physical health issues by yoga:

Incorporating yoga into a daily routine offers comprehensive physical and mental benefits, including improved flexibility, enhanced strength, reduced stress, and better posture. Consistent practice (15–30 minutes) boosts energy, improves sleep quality, and increases mental clarity. It also supports long-term health by aiding cardiovascular. There is a close association between these two functions of the mind. Both play major roles in determining and nurturing the various dimensions of health in the right direction of wellness. When the mind or psyche is not functioning properly, it may pave the way for many psychological and physiological disorders and illnesses due to a weak immune system. Yoga help to protect all this thing way from body. They help to balance body and mind.

Yoga Vashishta

The Yoga Vashishta refers to mind as a thought is the mind motion, and its actions are directed by the nature of thoughts; the result of actions is felt in every part of the body through the mind. This ancient text also describes how mental disturbances (*Adhi*) produce physical disturbances (*Vyadhi*). Emotions refer to the feeling aspect of behaviour such as irritation, rage, despair, sadness, love, and liking.

The Bhagavad Gita

The *Bhagavad Gita* is one of the most popular ancient Indian texts across the world. In the *Bhagavad Gita*, the mind is understood in the more broader terms of *'Purush'* and *'Prakriti'*. The *Gita* also refers to mind the as *Mahat*, *Buddhi*, *Ahamkar*, *Gunas* and, *Panchbutas*, *Tanmatra*, etc. As per the *Bhagavad Gita*, the mind a powerful instrument that creates attachment or detachment from worldly things. This attachment to or detachment gives rise to all negative or positive emotions. Doubt, sadness, depression, anxiety, rage, happiness, satisfaction, etc., are all products of the mind. The *Gita* also explains the means of calming and controlling the mind in detail. Ways of *Sthithprajya* (stability of Mind) have also been highlighted and discussed.

Increases your self-esteem

Many of us suffer from chronic low self-esteem. If you handle this negatively-take drugs, overeat, work too hard for it. Sports and Health mentally, and spiritually. If you take a positive approach and practice yoga, you'll sense, initially in brief glimpses and later in more sustained views, that you're worthwhile or, as yogic philosophy teaches, that you are a manifestation of the Divine.

Boosts your immune system functionality

Asana and pranayama probably improve immune function, but, so far, meditation has the strongest scientific support in this area. It appears to have a beneficial effect on the functioning of the immune system, boosting it when needed (for example, raising antibody levels in response to a vaccine) and lowering it when needed (for instance, mitigating an inappropriately aggressive immune function in an autoimmune disease like psoriasis).

Perfects your posture

Your head is like a bowling ball—big, round, and heavy. When it's balanced directly over an erect spine, it takes much less work for your neck and back muscles to support it. Move it several inches forward, however, and you start to strain those muscles.

Heart rate:-

When you regularly get your heart rate into the aerobic range, you lower your risk of heart attack and can relieve depression. While not all yoga is aerobic, if you do it vigorously or take flow or Ashtanga classes, it can boost your heart rate into the aerobic range. But even yoga exercises that don't get yourheart rate up that high can improve cardiovascular conditioning.

Conclusion:

1.In the presented research paper, the impact on the mental and physical health of the Individual person has been shown. Nowadays, human being is so busy in his work and on his success they have been seen to be mentally unwell due to the pressure of succeed, famous, name and fame due to which they are also falling physically ill, due to which their ability to remembering is decreasing. They are felling un healthy.

2. Our body and mind are connected to each other So it is not surprising that a person's mental illness can affect his body due to which many types of diseases can be faced such as depression, headache, high BP, fatigue and digestive problems. Besides anxiety, upset stomach can cause other symptoms, for example. There may be insomnia, restlessness and considerable difficulties in concentrating

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I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study titled *"Effect of Yoga on Mental Health and Lifestyle Management."*

First and foremost, I extend my heartfelt thanks to my research guide/supervisor for their invaluable guidance, continuous encouragement, and constructive suggestions throughout the course of this study. Their expertise, mentorship, and support played a vital role in the successful completion of this research.

I am also grateful to the faculty members and administration of my institution for providing the necessary academic resources, facilities, and a conducive environment for conducting this study.

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I am thankful to my friends and colleagues for their encouragement, valuable discussions, and constructive feedback during various stages of this study.

Finally, I express my deepest gratitude to my family for their unwavering support, patience, and motivation throughout this academic journey. Their constant encouragement and belief in my abilities have been a source of strength and inspiration.

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Original Article

Intersectional Feminism and Library Governance: Rethinking Authority and Inclusion

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Abstract

Intersectional feminism provides a critical framework for examining power, authority, and inclusion within library governance structures. Libraries have long been positioned as democratic institutions promoting knowledge access and social justice; however, governance and leadership systems often reflect historical hierarchies shaped by gender, race, class, disability, and other intersecting identities. This paper explains how intersectional feminist theory can reshape governance practices in libraries, emphasizing participatory decision-making, equitable leadership, and inclusive institutional cultures. Parameter upon research on equity, diversity, and inclusion (EDI), gender dynamics in library leadership, and the experiences of marginalized communities, the study highlights the limitations of traditional hierarchical governance models. It proposes alternative strategies such as shared governance, inclusive policy design, diverse hiring practices, and community-centered leadership approaches. The paper argues that rethinking authority through intersectional lenses enables libraries to address structural inequalities and better serve diverse populations. Ultimately, intersectional feminist governance is presented not merely as an ethical aspiration but as a practical strategy for strengthening library relevance, accountability, and sustainability in an increasingly diverse and socially complex world.

Keywords: *Intersectionality, Feminist theory, Library governance, Inclusive leadership, Equity and diversity, Social justice librarianship*

Introduction

Libraries function as cultural institutions that preserve knowledge, foster learning, and support democratic engagement. Yet governance structures within libraries have historically mirrored broader social hierarchies, often privileging dominant voices and perspectives. Intersectional feminism originating from Black feminist scholarship—examines how overlapping systems of oppression shape institutional practices and opportunities. Applying this framework to library governance invites a reconsideration of authority, decision-making processes, and representation in leadership. Recent scholarship highlights that equity, diversity, inclusion, and justice are central responsibilities for library leaders. Many administrators recognize their duty to promote inclusive workplaces and services, although differences in terminology and understanding create ambiguity in practice. This recognition underscores the need for deeper structural changes rather than surface-level diversity initiatives. Moreover, gender and leadership research indicates ongoing discussions about fairness, social capital, and leadership barriers within academic libraries. Intersectional feminist approaches emphasize the lived experiences of marginalized communities and challenge traditional governance models that centralize authority. This paper examines how libraries can rethink governance by integrating intersectional feminist principles, moving from hierarchical systems toward participatory and inclusive leadership.

Theoretical Framework: Intersectional Feminism and Institutional Power

Intersectional feminism recognizes that gender cannot be understood independently of race, class, sexuality, disability, or cultural identity. Governance structures that ignore these intersections risk perpetuating inequities in hiring, promotion, and policy development. Intersectional frameworks highlight how institutional authority often privileges individuals with greater access to social capital and dominant cultural norms. Within librarianship, diversity is considered a foundational professional value, shaping staffing, collections, programming, and services.

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However, diversity initiatives frequently focus on representation rather than systemic change. Intersectional feminist theory encourages deeper examination of structural biases embedded in organizational policies and governance systems.

Additionally, feminist governance critiques hierarchical leadership models that concentrate power among a few decision-makers. Instead, intersectional feminist governance advocates for collaborative leadership, shared authority, and accountability mechanisms that include voices from multiple social locations. By addressing both representation and power dynamics, intersectional feminism provides a holistic framework for institutional transformation.

Historical Context of Library Governance and Authority

Historically, libraries have been shaped by bureaucratic structures emphasizing neutrality, professional authority, and hierarchical decision-making. Governance models often followed administrative structures of educational institutions or governmental agencies, prioritizing efficiency and standardized procedures. While these models facilitated organizational stability, they sometimes reinforced social inequalities.

Research on leadership and governance indicates that library directors play crucial roles in institutional decision-making through relationships with faculty, administrators, and external stakeholders. However, participation in governance is not evenly distributed. Leadership positions have often been dominated by certain demographic groups, reflecting broader societal power imbalances.

In some regions, studies reveal male predominance in leadership roles and limited representation of marginalized communities, demonstrating structural barriers to inclusion. These disparities highlight the need for governance frameworks that explicitly address intersectional inequalities rather than assuming neutrality or meritocracy.

Gender, Diversity, and Power in Library Leadership

Gender dynamics continue to influence leadership experiences in libraries. Research identifies challenges such as work-life balance expectations, social capital disparities, and double standards that affect leadership opportunities. Although libraries are often perceived as feminized professions, leadership roles may still reflect traditional power hierarchies.

Intersectional feminism expands this analysis by examining how race, ethnicity, disability, and sexuality intersect with gender. Studies demonstrate that leadership cultures sometimes prioritize dominant norms, marginalizing individuals with diverse identities or nontraditional career paths. Furthermore, marginalized patrons and staff may experience biases in library services or workplace interactions, indicating structural issues beyond individual behavior.

Inclusive leadership requires acknowledging these intersecting barriers and developing governance practices that empower diverse voices. Intersectional feminist governance challenges assumptions that leadership is neutral or universal, emphasizing the importance of lived experience and community engagement.

Intersectional Feminist Critique of Traditional Governance Models

Traditional governance models often rely on hierarchical authority structures with centralized decision-making power. While such models may promote efficiency, they can also silence marginalized perspectives and reinforce institutional inequities. Intersectional feminist critique identifies several limitations:

- **Power Concentration:** Decision-making authority may be restricted to senior administrators, limiting participation from frontline staff and marginalized groups.
- **Tokenism:** Diversity initiatives may emphasize representation without addressing structural inequalities.
- **Neutrality Myth:** Claims of neutrality can obscure systemic biases in policies and practices.
- **Standardized Leadership Norms:** Leadership expectations may privilege dominant cultural behaviors, excluding alternative leadership styles.

ALA strategic documents emphasize that equity, diversity, and inclusion must address structural biases and historical exclusion across the profession. Intersectional feminist governance aligns with these goals by promoting systemic transformation rather than symbolic change.

Rethinking Authority Through Intersectional Feminist Governance

Intersectional feminist governance proposes alternative models that distribute authority and encourage collaborative decision-making. Key strategies include:

- **Shared Governance and Participatory Decision-Making**
  Libraries can adopt shared governance structures that involve staff at multiple levels, community representatives, and diverse stakeholders. Participatory governance increases transparency and fosters collective ownership of institutional decisions.
- **Inclusive Policy Development**
  Policy development processes should incorporate intersectional analysis, considering how policies affect individuals with different identities and experiences. This approach prevents unintended discrimination and promotes equitable outcomes.
- **Diverse Leadership Pathways**
  Libraries can create mentorship programs, leadership training, and equitable hiring practices to diversify leadership pipelines. EDI initiatives and diversity alliances demonstrate the effectiveness of structured programs supporting underrepresented professionals.
- **Recognition of Alternative Leadership Styles**
  Intersectional feminist governance values collaborative, empathetic, and community oriented leadership styles, challenging stereotypes that equate authority with hierarchical control.

Intersectional Governance in Practice: Emerging Models and Case Examples

Recent scholarship and professional initiatives illustrate how libraries are experimenting with inclusive governance practices. For example, global leadership projects emphasize

social justice perspectives and amplify marginalized voices in decision-making processes. These initiatives encourage libraries to integrate equity principles into strategic planning and organizational culture.

Inclusive practices also extend to patron services and community engagement. Research on LGBTQIA+ library users demonstrates that inclusive communication, cultural humility training, and proactive outreach can improve access and trust. Such practices highlight the interconnectedness of governance decisions and service outcomes.

Similarly, EDI programs in academic libraries have introduced strategic planning frameworks that integrate diversity goals into everyday operations, ensuring that governance structures align with institutional values.

Challenges and Barriers to Intersectional Feminist Governance

Despite growing interest, implementing intersectional feminist governance faces several challenges:

- **Institutional Resistance:** Traditional hierarchies may resist shared decision-making or power redistribution.
- **Resource Constraints:** Diversity initiatives require sustained funding and institutional commitment.
- **Limited Research:** Intersectionality in library administration remains underexplored, indicating gaps in scholarly literature.
- **Cultural Biases:** Implicit biases and entrenched norms may hinder organizational change.

Addressing these barriers requires long-term strategic planning, leadership accountability, and continuous professional development.

Implications for Library Education and Professional Practice

Intersectional feminist governance has significant implications for LIS education and professional training. Integrating gender and LGBTQ perspectives into curricula helps future librarians recognize biases and develop inclusive practices. Training programs focused on cultural humility, anti-racism, and participatory leadership can prepare professionals to navigate diverse workplace environments.

Professional organizations also play a critical role by providing resources, advocacy, and policy frameworks supporting equity initiatives. Encouraging research on intersectionality and governance will further strengthen theoretical and practical foundations for inclusive leadership.

Future Directions for Research and Policy

Future research should explore intersectional governance across diverse library contexts, including public, academic, and community libraries. Comparative studies examining regional differences, cultural contexts, and organizational structures can provide deeper insights into effective governance models.

Policy development should prioritize:

- Data-driven analysis of leadership diversity.
- Transparent decision-making processes.
- Community partnerships and stakeholder engagement.
- Accountability mechanisms for equity goals.

By combining empirical research with participatory approaches, libraries can develop governance systems that reflect the complexities of contemporary societies.

Conclusion

Intersectional feminism offers a transformative lens for rethinking authority and inclusion in library governance. Traditional hierarchical models often fail to address systemic inequalities affecting leadership opportunities, workplace cultures, and service delivery. By embracing participatory governance, inclusive policy development, and diverse leadership pathways, libraries can move toward more equitable and socially responsive institutions.

The integration of intersectional feminist principles is not merely an ideological commitment but a practical strategy for strengthening institutional legitimacy and community trust. As libraries continue to navigate evolving social expectations and technological change, governance systems must adapt to reflect diverse perspectives and lived experiences. Intersectional feminist governance provides a roadmap for building inclusive, collaborative, and resilient libraries that truly serve the needs of all communities.

Acknowledgment

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study titled *"Intersectional Feminism and Library Governance: Rethinking Authority and Inclusion."*

First and foremost, I extend my heartfelt thanks to my research guide/supervisor for their invaluable guidance, continuous encouragement, and constructive suggestions throughout the course of this study. Their expertise, mentorship, and support were instrumental in shaping the direction and quality of this research.

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Original Article

Sustainable Finance and Green Investment

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Abstract:

Introduction: Sustainable finance refers to making financial decisions by considering environmental, social, and governance (ESG) factors. The aim is to support long-term investments in activities that are beneficial for the economy and the planet. This includes green investment, which funds projects that help the environment, such as renewable energy, energy efficiency, and infrastructure that can cope with climate change.Objective of study: The goal is to examine the current status, growth, and future plans for green finance, including green bonds and funds, across different areas, especially in developing countries. It also aims to identify challenges like funding issues and the factors that encourage people to support green financial initiatives.Research methodology: Research in sustainable finance and green investment often uses a mix of methods. These include systematic literature reviews (SLR) following the PRISMA framework, quantitative analysis like econometric modeling and regression, and qualitative methods such as case studies and policy analysis. Key techniques also involve bibliometric mapping, tracking trends in green bond markets, and optimizing ESG (Environmental, Social, and Governance) portfolios.

Data analysis: Data analysis in sustainable finance shows that companies with high ESG scores generally perform well financially over time and manage risks more effectively. Green investments, such as green bonds and projects in renewable energy, are growing rapidly. For example, green bonds reached over a billion dollars in 2021.Findings: In 2021, the green bond market grew by 50%, reaching over half a trillion dollars, largely driven by investments in climate-focused areas. Renewable energy projects like onshore wind and solar PV are the main areas where green investments are being directed, followed by low-carbon transport.

Recommendations: Focus on Green, Social, and Sustainability Bonds, as they can offer good returns while also helping the environment. Invest directly in solar, wind, and sustainable infrastructure to support the transition to a low-carbon economy.Conclusion: Sustainable finance and green investment are important tools for moving towards a low-carbon economy. They help direct money towards eco-friendly projects, renewable energy, and sustainable infrastructure.

Keywords: *Sustainable, Finance, Green Investment, Environmental, Social, Governance*

Introduction

Sustainable finance means using environmental, social, and governance (ESG) factors when making financial choices to support long-term investments in activities that are good for the economy and the planet. This includes green investment, which helps fund projects that help the environment, like renewable energy, energy efficiency, and building infrastructure that can withstand climate change. It helps make financial systems match global sustainability goals, like the Paris Agreement, and helps manage risks while supporting economic growth.

Key Concepts and Components:

Sustainable Finance: This covers a wide range of practices, standards, and financial products designed to achieve both financial returns and positive environmental or social effects.

Green Investment/Finance: This is part of sustainable finance that specifically funds projects with environmental benefits, such as renewable energy, green buildings, and sustainable transportation.

ESG Integration: This is when environmental, social, and governance factors are considered during traditional financial analysis to better understand possible risks and opportunities.

Impact Investing: This type of investment aims to create positive, measurable social and environmental impact while also making a financial return.

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Instruments and Strategies:

Green Bonds: These are debt instruments used to fund projects that have environmental benefits, like climate change initiatives. The market value of these bonds has reached billions in recent years.

Sustainability-Linked Loans: These are loans that offer financial rewards to borrowers who meet certain sustainability goals.

ESG Funds/ETFs: These are mutual funds or exchange-traded funds that invest in companies with strong sustainability practices, like the iShares MSCI KLD 400 Social ETF.

Carbon Markets/Offsets: These are financial tools that allow organizations to reduce their greenhouse gas emissions by investing in projects that cut emissions elsewhere.

Drivers and Importance:

Risk Mitigation: Sustainable finance helps manage environmental, climate, and social risks that can affect financial performance.

Regulatory Support: Policies and regulations, such as the European Green Deal, are encouraging more sustainable financial flows.

Demand: There is increasing interest from investors in aligning their investments with the United Nations Sustainable Development Goals (SDGs).

Objective Of Study

Key objectives of study include:

- Examining the current situation, growth, and future plans for green finance, such as green bonds and funds, in various areas, especially in developing regions.
- Reviewing the role of rules, policies, and support systems in encouraging green innovation and the move towards sustainable practices.
- Identifying challenges like funding problems and the factors that motivate people to support green financial initiatives.
- Understanding how green investments directly contribute to sustainable development, including reducing pollution and minimizing climate change impacts.
- Assessing how much investors know about, feel towards, and are interested in green financial products.

Research Methodology

Research methods in sustainable finance and green investment often combine various approaches. These include systematic literature reviews (SLR) using the PRISMA framework, quantitative analysis such as econometric modeling and regression, and qualitative methods like case studies and policy analysis. Key techniques also involve bibliometric mapping, studying trends in green bond markets, and optimizing ESG (Environmental, Social, Governance) portfolios.

Common Research Methodologies Include:

Systematic Literature Review (SLR): This approach uses frameworks like PRISMA to gather and summarize existing studies from sources such as Scopus, helping to identify areas that need more research.

Bibliometric Mapping/Analysis: Tools such as VOSviewer are used to examine how keywords are connected, how influential authors are, and the main topics in green finance literature.

Quantitative/Econometric Analysis: This involves using panel data, regression models, and time-series analysis to evaluate how green finance influences financial results, economic growth, and environmental outcomes.

Case Studies: These focus on specific green financial products like green bonds or sustainability-linked loans, or on investments in particular industries.

Multi-criteria Decision-Making (MCDM): Techniques like the Analytical Hierarchy Process (AHP) and TOPSIS are used to compare and rank challenges, opportunities, and supports for green investment.

Policy/Document Analysis: This looks at regulations, sustainability reports, and other policy documents to understand how institutions support green finance.

Common Data Sources Include:

Financial Data Providers: Services like Bloomberg or Refinitiv Eikon, or platforms focused on ESG data.

Research Databases: Scopus, Web of Science, and ScienceDirect.

Policy and Sustainability Reports: Information from the Green Finance Platform, UNEP FI, and reports from central banks.

Typical Research Workflow Includes:

Preparation: Choosing relevant keywords such as 'Green Finance,' 'ESG,' or 'Climate Finance.'

Data Acquisition: Collecting data from databases like Scopus or Web of Science and selecting studies based on certain criteria.

Analysis: Using quantitative methods to look at trends and cause-and-effect relationships, or qualitative methods to explore themes.

Reporting: Putting the findings together to offer insights for investors, policymakers, and financial institutions.

Data Analysis and Interpretation

Data analysis on sustainable finance shows that companies with high ESG (Environmental, Social, and Governance) scores tend to do well financially in the long run and handle risks better. Green investments, like green bonds and projects focused on renewable energy, are growing quickly. For instance, green bonds reached over a billion dollars in 2021. This growth is mainly because of global goals to fight climate change, but there are still issues with the quality of data and the risk of greenwashing.

Analysis and Interpretation Trends:

1. Risk Mitigation:

ESG integration is used to avoid investing in risky areas, such as fossil fuels, to protect portfolios. By looking at environmental, social, and governance factors, investors can spot risks that standard financial measures might miss. This helps avoid companies or industries that pose high ESG-related risks, such as those involved in fossil fuels, poor labor conditions, or weak corporate governance. Doing this can help keep investments stable and prevent long-term losses.

Key Risk Mitigation Functions of ESG:

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Stranded Asset Risk Mitigation: Selling off investments in fossil fuels helps investors avoid "stranded assets"—resources that may become outdated or unprofitable due to environmental policies, regulations, or the shift to a clean energy economy.

Operational and Regulatory Risk Reduction: ESG assessments help identify companies with poor environmental practices or weak safety standards, which helps reduce legal risks, penalties, or operational failures.

Reputational Protection: By avoiding industries linked to controversy, such as high-emission fuels or unethical labor conditions, investors can protect their reputation and avoid legal problems.

Proactive Threat Management: ESG helps investors anticipate long-term risks related to sustainability and move capital toward more stable and sustainable options.

Protective Mechanisms in Action:

Negative/Exclusionary Screening: Removing industries that are considered high-risk or unethical, like thermal coal or oil sands.

Thematic Investing: Redirecting investments toward renewable energy or green technologies to prepare for the decline of carbon-heavy industries.

Materiality Analysis: Using frameworks like SASB or TCFD to assess which risks are most likely to affect finances, such as supply chain issues or climate change effects.

2. Predictive Modeling:

Using advanced data analytics is key to predicting the impact of green projects and making the best use of resources. Predictive modeling and data analysis are important for moving green projects forward by looking at historical data, machine learning, and real-time information to estimate environmental effects and use resources smartly. These tools allow for forward-thinking decisions in areas like renewable energy, waste reduction, and sustainable supply chains, replacing reactive approaches with proactive insights.

Key Applications and Benefits:

Optimization of Resources: Machine learning and data mining help use resources more efficiently, such as reducing waste, lowering packaging use, and managing water during droughts.

Green Project Forecasting: Advanced analytics allow stakeholders to simulate the effects of climate change, assess the results of green projects, and find sustainable suppliers by examining environmental performance.

Energy Management: In smart buildings and infrastructure, energy management systems use predictive analytics to optimize energy use and cut down costs.

Enhanced Decision-Making: These models give detailed data on factors like land use and vegetation, helping with better strategic planning and risk management.

Sustainable Agriculture: Predictive models are used to boost crop production, manage resources effectively, and reduce food waste.

3. Regulation Analysis:

Studies show that policy actions, such as guidelines for green bonds, are important for encouraging investor confidence, especially in developing markets. Policies like green bond guidelines, tax breaks, and standardized reports are key to building trust and expanding markets in emerging countries. They help manage information gaps and reduce the chance of greenwashing, which encourages more institutional investment. Strong rules, like China's 2015 guidance, help build trust, limit financial constraints for issuers, and support sustainable development.

Key Regulatory Elements to Increase Investor Confidence:

Standardized Guidelines: Setting clear definitions and categories (like Green Bond Principles) for what qualifies as a "green" project is necessary.

Mandatory Reporting/Verification: Third-party checks help reduce information gaps, making sure projects meet environmental standards and building trust while lowering reputational risks.

Incentive Mechanisms: Tax breaks and subsidies make green bonds more appealing than traditional financial tools.

Regulatory Support in Emerging Markets: Developing countries need strong policy structures, such as those adopted by India's SEBI, to shift from optional to mandatory reporting and support market growth.

The green bond market has seen significant growth, supported by these policies, with global issuance reaching over a billion dollars by the end of 2023.

Result

Sustainable finance and green investment are growing quickly to help meet climate goals. In 2021, the total amount of green bonds issued worldwide went past half a trillion dollars. In India, green finance reached a high of INR 3,712 billion ($50 billion) during the financial year 2021/22, with a focus on renewable energy and electric vehicles. Some major trends include more private companies getting involved, an increase in green bond issuances, and a stronger emphasis on using environmental, social, and governance (ESG) factors to support energy efficiency.

Key Results and Trends from the Research Include:

- Market Growth: The green bond market is growing quickly. India has become the fourth-largest issuer of sustainability-linked debt among emerging economies, with a 186% increase by December 2024.
- Funding Focus: In India, about 98% of the money for climate adaptation comes from within the country, mostly from government budgets. These funds are mostly used for clean energy, energy efficiency, and clean transport, while less attention is given to agricultural adaptation.
- Sector Participation: While public funding has been the main source so far, private companies are also getting more involved. Private sector funding increased by 13% and reached $310 billion in 2019/2020.
- Key Drivers: The rise in green investment is mainly due to the need for low-carbon energy. India needs a lot of investment to meet its net-zero emissions goal by 2070.

Finding

Sustainable finance and green investment are moving faster than ever to meet climate goals, with green bond issuance crossing $500 billion in 2021. The main findings show a

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trend of including ESG factors in decision-making, and around $53 to $90 trillion is needed for the energy transition by 2035. Key reasons for this growth are strong policy support and the use of artificial intelligence in data analysis. However, there are still challenges in having clear and consistent definitions for green investments.

Key Findings and Trends:

- Market Growth: In 2021, the green bond market grew by 50%, reaching over half a trillion dollars, mainly due to investments focused on the climate.
- "Green the Finance": This goes beyond just funding projects; it also involves changing the financial system so that it supports environmental goals and helps build a sustainable, low-carbon economy.
- Key Sectors: Renewable energy projects, such as onshore wind and solar PV, are the main areas where green investments are going, followed by low-carbon transport.
- Role of Private Sector: Private companies have significantly increased their support for green initiatives. Sustainable investment funds and social impact bonds are now more common.
- Regional Focus (India Example): India is expanding its efforts, aiming to reach 500 gigawatts of renewable energy by 2030. About 83% of the finance for reducing emissions comes from within the country.
- AI Implementation: Artificial intelligence is being used to estimate solar potential and build prediction models for carbon pricing, such as carbon yield curves.

Discussion

Sustainable finance and green investment use environmental, social, and governance (ESG) factors to guide how money is invested. This helps support long-term sustainability and address the issue of climate change. These strategies involve sending money to projects that are good for the environment, like clean energy and pollution control, and changing the way the global financial system works so it focuses more on sustainability than just making quick profits.

Key Concepts and Components:

Green Finance: This type of finance is used to fund projects that help the environment, such as renewable energy, making energy use more efficient, and managing waste.

ESG Integration: This looks at three main areas—environmental (like climate change), social (like how a company treats its workers and communities), and governance (like how a company is run and its ethical standards)—to evaluate risks and opportunities.

Impact Investing: This is when money is invested to create positive environmental or social change, while also making a profit.

Instruments: Tools like green bonds, loans that are linked to sustainability goals, and funds that focus on ESG factors are important in this area.

Drivers and Benefits:

Risk Mitigation: Managing environmental issues helps reduce risks for investments over the long term.

Regulatory Changes: Governments and regulators are creating stronger rules to make sure the financial system supports sustainable development.

Consumer Demand: More people, including investors and consumers, are looking for banking and investment options that are responsible, ethical, and sustainable.

Challenges:

Transparency: Making sure that reports about ESG factors are true and not misleading (like when companies falsely say they are eco-friendly) is important.

Complexity: It's difficult to properly assess the environmental impact of investments.

Recommendation

Sustainable finance and green investment aim to direct money towards projects that are good for the environment, low-carbon, and can handle the changes caused by climate change. Important strategies include investing in green bonds, ESG-focused funds, renewable energy, and sustainable infrastructure. Successful approaches involve making things more open and clear using standard reporting methods like BRSR, using carbon pricing, and providing credit guarantees to reduce risks.

Key Recommendations for Sustainable Finance & Investment:

- Diversify into Green Debt and Equity: Focus on Green, Social, and Sustainability Bonds, which can offer good returns and help the environment.
- Use ESG-Focused Funds: Choose investment vehicles that strictly follow ESG criteria to keep your portfolio sustainable.
- Target Renewable Energy Infrastructure: Invest directly in solar, wind, and sustainable infrastructure to support the move to a low-carbon economy.
- Utilize "Green" Banking Products: Both individuals and businesses can use green deposits, green loans, and green mortgages that support energy-efficient homes and projects.
- Leverage Regulatory & Policy Incentives: Keep an eye on government actions such as tax breaks for green bonds and carbon market tools.
- Prioritize Transparency & Reporting: Support companies that follow strict environmental reporting standards, such as BRSR in India.
- Engage in Impact Investing: Look for investments that aim to deliver measurable environmental benefits along with good returns.

Conclusion

Sustainable finance and green investment are important tools to move towards a low-carbon economy, directing money to eco-friendly projects, renewable energy, and sustainable infrastructure. They help create long-term ecological, social, and economic value by using ESG factors in decision-making, cutting down emissions, and managing climate change risks.

Key Conclusions:

Essential Transition Tool: Sustainable finance moves beyond traditional metrics to include environmental, social, and governance (ESG) factors, helping address long-term sustainability needs.

Economic Impact: Green investments in areas like renewable energy, energy efficiency, and clean technology not only help cut emissions but also create jobs, boost economic growth, and improve energy security.

Key Instruments: Green bonds, sustainability-linked loans, and other financial products are vital for funding green projects.

Market Trends: Although green finance is growing quickly, especially in emerging economies like India, it's still not as developed as traditional markets.

Challenges: The sector needs clearer definitions, consistent policies, and better ways to assess "greenwashing".

To reach a sustainable future, it's important to have good policies and new financial strategies that connect available capital with the needs of green projects.

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Original Article

Human-Aligned Agentic AI: A Comprehensive Governance-Embedded Architecture for Trustworthy Autonomous System

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Abstract

This research paper presents a detailed framework for designing human-aligned agentic AI systems. The study integrates ethical governance, structural explainability, and multi-agent coordination within a layered architectural model. The framework ensures fairness, accountability, compliance, and transparency in dynamic decision environments. The proposed model is validated through comparative analysis, system modeling, governance evaluation, and distributed scalability analysis.

Introduction

Artificial Intelligence has transitioned from predictive analytics systems to autonomous decision-making entities capable of planning, adapting, and executing actions with limited or no human intervention. These next-generation systems, commonly referred to as **agentic AI systems**, differ fundamentally from traditional machine learning models. Rather than merely producing outputs in response to static inputs, agentic systems perceive dynamic environments, formulate internal goals, evaluate alternative strategies, and iteratively optimize decisions across time.

This shift toward autonomy has introduced transformative opportunities across high-impact domains such as healthcare triage systems, financial credit risk modeling, infrastructure management, intelligent transportation networks, cybersecurity monitoring, and adaptive educational platforms. In these domains, agentic AI systems promise improved efficiency, scalability, and real-time responsiveness. However, increased autonomy simultaneously introduces structural risks that extend beyond performance accuracy.

Unlike conventional AI systems, agentic architectures operate under sequential decision logic. Actions influence future states, and policy adaptations may emerge in unpredictable ways. This introduces three major systemic concerns:

1.Goal Misalignment – Agents may optimize proxy objectives that diverge from human intent.

2.Opacity of Sequential Reasoning – Decision pathways may not be transparent or reconstructible.

3. System-Level Ethical Drift – In multi-agent environments, localized optimization may generate global inequities.

Traditional AI governance frameworks primarily rely on post-hoc auditing, fairness evaluations conducted after deployment, or periodic compliance reviews. While these mechanisms are valuable, they are inherently reactive. In continuously learning agentic systems, governance mechanisms must operate in real-time and must be embedded structurally within the decision pipeline.Furthermore, current explainability frameworks are often limited to feature attribution or surrogate modeling techniques. These approaches may provide localized insights but struggle to capture long-horizon reasoning or dynamic policy evolution inherent in autonomous agents.

The central thesis of this paper is that **autonomy must be ethically bounded at the architectural level rather than externally supervised at the operational level**.

Related Work

The rapid evolution of agentic artificial intelligence has drawn upon multiple foundational research streams, including reinforcement learning, multi-agent systems, explainable AI, fairness-aware machine learning, and human-centered AI design.

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While each domain has contributed significantly to the development of autonomous systems, a unified architectural approach integrating governance, alignment, and structural explainability remains limited. This section reviews the most relevant bodies of work and identifies conceptual gaps addressed by this research.

1. Reinforcement Learning and Autonomous Agents

Reinforcement learning (RL) provides the foundational mathematical framework for autonomous decision-making. In classical RL formulations, agents learn policies that maximize cumulative reward through iterative interaction with an environment. The Markov Decision Process (MDP) formalism defines state transitions, reward functions, and policy updates. Extensions such as Deep Reinforcement Learning (DRL) have enabled complex decision capabilities in high-dimensional environments.

However, standard RL formulations prioritize reward optimization without explicit consideration of fairness constraints, ethical compliance, or harm minimization. Although safe reinforcement learning and constrained MDPs introduce safety boundaries, these approaches typically treat constraints as secondary performance modifiers rather than structural governance components.

Furthermore, many RL systems lack mechanisms for reconstructing sequential reasoning pathways, limiting interpretability in high-stakes applications.

2. Human-Centred AI and Governance Frameworks

Human-centred AI emphasizes alignment with human values, transparency, and accountability. Governance frameworks from regulatory institutions highlight:

- Risk assessment
- Transparency requirements
- Human oversight mechanisms
- Auditability

However, many governance models operate externally to the system, relying on periodic audits rather than embedded validation.

The distinction between **external governance** and **structural governance** is critical. External governance monitors systems; structural governance constrains systems at the architectural level.

3. Multi-Agent Systems and Distributed Autonomy

Multi-agent research explores coordination, competition, and cooperation among autonomous entities. Game-theoretic models analyze equilibrium dynamics, and distributed RL frameworks enable coordinated learning.

However, most multi-agent research focuses on efficiency and coordination performance rather than ethical coherence. Even when individual agents satisfy fairness constraints, system-wide inequities may emerge due to interaction effects.

This reveals a significant research gap in system-level ethical modeling across distributed agents.

Problem Statement

The transition from predictive machine learning systems to autonomous agentic AI systems fundamentally alters the risk landscape of artificial intelligence deployment. Unlike static models that generate outputs for isolated inputs, agentic systems operate over time, adapt to dynamic environments, and make sequential decisions that influence future states. As a result, errors or misalignments are not confined to single predictions but may propagate and amplify across time and across interacting agents.

The central problem addressed in this paper is the lack of **structural alignment mechanisms** in agentic architectures. Current agentic systems are predominantly optimized for performance metrics defined through reward functions. While effective for achieving task-specific objectives, reward-driven optimization may diverge from broader human values, fairness requirements, and regulatory constraints.

1. Classical Agentic Optimization Model

Traditional reinforcement learning formalizes autonomous decision-making as a Markov Decision Process (MDP):

$$\mathcal{M} = (S, A, P, R, \gamma)$$

Where:

- S= State space
- A= Action space
- P= State transition probability
- R= Reward function
- γ= Discount factor

The agent learns a policy $\pi(a \mid s)$that maximizes expected cumulative reward:

$$\max_{\pi} \mathbb{E}\left[\sum_{t=0}^{\infty} \gamma^t R(s_t, a_t)\right]$$

This formulation implicitly assumes that the reward function sufficiently encodes desired outcomes. However, in socio-technical systems, reward signals often act as proxies for complex human objectives. This creates vulnerability to misalignment.

2. Core Structural Risks

The absence of embedded governance introduces three primary classes of risk:

1. Goal Misalignment

Reward functions may inadequately represent human values. Agents may exploit reward structures in unintended ways (reward hacking), optimizing metrics while violating fairness or ethical expectations.

Formally, let:

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$$R(s,a) = ProxyMetric$$

If:

$$ProxyMetric \neq TrueHumanObjective$$

Then optimization leads to divergence.

2. Sequential Opacity

In agentic systems, decisions occur across time:

$$S_0 \rightarrow A_0 \rightarrow S_1 \rightarrow A_1 \rightarrow \cdots$$

Without structural traceability, it becomes difficult to reconstruct reasoning pathways. Post-hoc explanations approximate logic but may not reflect true internal decision dynamics.

Opacity undermines accountability in high-stakes domains.

3. Distributed Ethical Drift

In multi-agent systems:

$$O = f(A_1, A_2, \ldots, A_N)$$

Even if each agent individually satisfies fairness constraints, collective interaction may produce system-level inequities.Define:

$$F_i = FairnessMetric\ for\ Agent\ i$$

Global fairness variance:

$$Var(F_i)$$

If variance increases beyond threshold ϵ, systemic imbalance emerges despite local compliance.

3. Ethical Constraint Omission

Standard optimization lacks explicit fairness and harm constraints. To illustrate, consider fairness deviation defined as:

$$F(s,a) = \mid P(a \mid G_1) - P(a \mid G_2) \mid$$

Where $G_1$and G_2represent demographic groups.

Similarly, harm risk can be modeled as:

$$H(s,a) = \mathbb{E}[NegativeImpact]$$

In classical formulations, these terms do not constrain optimization. Instead, they are evaluated externally.

4 Reformulated Constrained Objective

To address these issues, we define agentic optimization as:

$$\max_{\pi} \mathbb{E}[R(s,a)]$$

Subject to:

$$F(s,a) \leq \delta$$
$$H(s,a) \leq \theta$$
$$C(s,a) = 1$$

Where:

- δ= Fairness tolerance
- θ= Harm threshold
- $C(s,a)$= Compliance validator

This shifts agentic intelligence from unconstrained optimization to **ethically bounded optimization**.

Research Objective

The objective of this research is to design an agentic architecture that:

- Embeds ethical constraints structurally.
- Preserves sequential decision traceability.
- Maintains fairness coherence in multi-agent systems.
- Balances autonomy with accountability.

The following section introduces the layered governance-embedded architecture addressing these structural challenges.

Proposed Human-Aligned Architecture

To address the structural risks identified in Section 3, this paper proposes a **Layered Human-Aligned Agentic AI Architecture** in which governance, explainability, and alignment mechanisms are embedded directly within the decision pipeline rather than appended as external oversight tools.

The architecture is organized into three macro layers and six operational components that function as an integrated control loop:

- Human Interaction Interface
- Goal Alignment Engine
- Ethical Governance Layer
- Decision & Planning Engine

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- Structural Explainability Module
- Execution & Feedback Layer

The system operates as a cyclic process rather than a linear pipeline, ensuring continuous adaptation while preserving alignment.

1 Architectural Philosophy

The design philosophy of the architecture rests on three principles:

(1) Alignment Before Optimization : The system must validate alignment at the intention stage before autonomous policy learning begins.

(2) Constraint-Filtered Execution; No action may be executed without passing ethical and compliance validation.

(3) Traceable Reasoning; Every decision must generate a reconstructible reasoning artifact.

These principles transform agentic systems from reward-maximizing optimizers into governance-aware decision engines.

2 Layer 1: Human Interaction & Intention Formation

The Human Interaction Layer functions as the origin point of system goals. Unlike static configuration parameters, this layer enables:

- Objective specification
- Priority weighting
- Risk tolerance definition
- Fairness threshold calibration
- Human override capability

Formally, let:

$$G = \{g_1, g_2, \ldots, g_n\}$$

represent human-defined objectives. These objectives are transformed into weighted optimization terms:

$$W = \{w_1, w_2, \ldots, w_n\}$$

This mapping ensures that optimization is grounded in articulated human preferences rather than implicit reward proxies.

3 Layer 2: Goal Alignment Engine

The Goal Alignment Engine converts high-level human objectives into computationally tractable optimization structures.

It performs Context encoding, Preference translation and Constraint initialization. It also checks Proxy validation.

One of the key risks in agentic systems is reward mis-specification. This engine reduces misalignment by validating that proxy metrics correlate with declared human goals.

For example:

If:

$$RewardMetric = EfficiencyScore$$

But:

$$HumanObjective = FairDistribution$$

Then the alignment engine introduces fairness weighting before optimization proceeds.

4 Layer 3: Ethical Governance Layer

The Ethical Governance Layer is the structural core of the architecture. It acts as a constraint filter positioned between policy output and execution.

The constrained objective becomes:

$$\max_{\pi} \mathbb{E}[R(s,a)]$$

Subject to:

$$F(s,a) \leq \delta$$
$$H(s,a) \leq \theta$$
$$C(s,a) = 1$$

This layer evaluates:

- Fairness deviation
- Harm risk probability
- Regulatory compliance
- Threshold violations

Actions failing constraints are rejected or escalated to human review.

This ensures **constraint-first autonomy**, rather than performance-first execution.

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Figure 1: Layered Human-Aligned Agentic AI Architecture

5 Layer 4: Decision & Planning Engine

The Decision & Planning Engine contains the reinforcement learning or planning algorithms responsible for state evaluation and action proposal.

Given state S_t, the agent computes:

$$A_t = \pi(S_t)$$

However, unlike classical RL, action $A_t$is not executed immediately. It must pass governance validation.

This separation ensures that learning remains autonomous but bounded.

The planning engine may include:

- Value-based methods
- Policy-gradient models
- Model-based planning
- Hybrid decision intelligence systems

Importantly, learning updates incorporate governance penalties:

$$R'(s,a) = R(s,a) - \lambda \cdot ConstraintViolation$$

This reinforces ethical compliance during policy updates.

6 Layer 5: Structural Explainability Module

The Explainability Module operates in parallel with the decision engine.

For each decision, it generates:

$$T = (S_t, A_t, Constraints_t, RewardEstimate_t)$$

It stores:

- Policy confidence
- Constraint validation results
- Feature contribution weights
- Counterfactual alternatives

Unlike post-hoc explainability, reasoning is captured during decision formation. This enables Audit readiness, Regulatory transparency and Trust reinforcement.

7 Layer 6: Execution & Feedback

The Execution Layer implements validated actions and monitors environmental response.

Feedback loop:

$$S_{t+1} = f(S_t, A_t)$$

This updated state returns to the alignment engine for recalibration.

Continuous feedback ensures Drift detection, Fairness re-evaluation and Policy adaptation.

Ethical Constraint Modeling

The structural integrity of a human-aligned agentic AI system depends fundamentally on the design and enforcement of ethical constraints. While Section 4 introduced the governance layer conceptually, this section formalizes the mathematical modeling of fairness, harm minimization, and compliance validation mechanisms embedded within the architecture.

Ethical constraint modeling transforms governance from an external review mechanism into an operational

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filter applied during decision execution. This ensures that the system does not merely aim for optimal performance but achieves performance within defined normative boundaries.

1 Fairness Constraint Modeling

Fairness in agentic systems must be evaluated dynamically, particularly in sequential decision contexts. Unlike static classification models, agentic systems repeatedly interact with environments, and fairness metrics may drift over time.

Let:

$$G = \{G_1, G_2, \ldots, G_k\}$$

represent demographic or protected groups.

For action a, fairness deviation can be modeled as:

$$F(s,a) = \max_{i,j} | P(a \mid G_i) - P(a \mid G_j) |$$

The fairness constraint is defined as:

$$F(s,a) \leq \delta$$

Where:

- $\delta$is the allowable deviation threshold.

If fairness deviation exceeds δ, the action is rejected or escalated.

1 Equal Opportunity Constraint

In outcome-sensitive domains such as healthcare or credit scoring, true positive rates must be balanced.

$$EO = | TPR_{G_1} - TPR_{G_2} |$$

Constraint:

$$EO \leq \epsilon$$

This ensures equitable opportunity across groups.

2 Longitudinal Fairness Stability

In sequential systems, fairness must remain stable across time.

Define fairness at time t:

$$F_t$$

Drift constraint:

$$| F_t - F_{t-1} | \leq \rho$$

Where ρlimits abrupt fairness shifts.

2 Harm Minimization Modeling

Harm modeling quantifies the expected negative impact of actions.

Let:

$$H(s,a) = \mathbb{E}[Severity \times Probability]$$

Where:

- Severity measures magnitude of potential negative outcome.
- Probability estimates likelihood of occurrence.

Constraint:

$$H(s,a) \leq \theta$$

Where $\theta$is predefined harm tolerance.

In high-risk domains (e.g., medical triage), $\theta$is low. In lower-risk environments, θmay be relaxed.

1 Cascading Harm in Multi-Agent Systems

In distributed systems:

$$H_{total} = f(H_1, H_2, \ldots, H_N)$$

Total harm may be non-linear due to interaction effects.

Constraint:

$$H_{total} \leq \Theta$$

Where Θdefines system-wide safety threshold.

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3 Compliance Validation Logic

Regulatory compliance often requires rule-based validation.

Define compliance function:

$$C(s,a) \in \{0,1\}$$

Where:

$C(s,a) = 1$indicates valid action.

$C(s,a) = 0$indicates violation.

Examples:

Legal age verification

Exposure limit enforcement

Resource allocation caps

Compliance constraints are deterministic and non-negotiable.

4 Integrated Constrained Objective

The complete constrained optimization becomes:

$$\max_{\pi} \mathbb{E}[R(s,a)]$$

Subject to:

$$F(s,a) \leq \delta$$
$$H(s,a) \leq \theta$$
$$C(s,a) = 1$$

This ensures that no action may execute unless all constraints are satisfied.

5 Lagrangian Reformulation

To incorporate constraint penalties into learning:

$$R'(s,a) = R(s,a) - \lambda_1 F(s,a) - \lambda_2 H(s,a)$$

Where:

λ_1, λ_2control penalty strength.

This encourages policy adaptation toward ethical compliance.

Structural Explainability Framework

Explainability is a foundational requirement for trustworthy agentic AI systems, particularly in domains where decisions affect individuals, institutions, or societal outcomes. However, explainability in autonomous systems must go beyond static feature importance metrics. In agentic architectures, decisions unfold sequentially across time, are influenced by evolving policies, and interact with governance constraints. Therefore, explainability must be structurally embedded within the decision pipeline rather than applied as a post-hoc interpretive layer.

This section formalizes a Structural Explainability Framework designed to capture, preserve, and communicate reasoning pathways in real time.

1 Decision Trace Modeling

Structural explainability begins with comprehensive trace logging.

At each time step t, the system records:

$$T_t = (S_t, A_t, \pi_t, F_t, H_t, C_t, R_t)$$

Where:

- S_t= State representation
- A_t= Proposed action
- π_t= Policy logic
- F_t= Fairness metric value
- H_t= Harm estimate
- C_t= Compliance validation result
- R_t= Reward estimate

This structured trace ensures that every decision is accompanied by contextual reasoning and governance validation.

Sequential trace history:

$$T = \{T_0, T_1, T_2, \ldots, T_n\}$$

This enables reconstruction of the entire decision pathway.

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2 Feature Attribution in Sequential Systems

Feature attribution identifies which variables influenced a decision. In sequential agentic systems, attribution must account for temporal effects.

Let:

$$W_{i,t} = \frac{\partial \pi(S_t)}{\partial Feature_i}$$

Total feature contribution over horizon n:

$$W_i = \sum_{t=0}^{n} \gamma^t W_{i,t}$$

Where:

γ= Discount factor

$W_{i,t}$= Contribution at time t

This provides a cumulative explanation rather than a single-step snapshot.

3 Counterfactual Formalization

Counterfactual reasoning answers the question:

"What minimal change would have altered the decision?"

Formally:

$$\min \| S' - S \| \text{ s.t. } \pi(S') \neq \pi(S)$$

This identifies the smallest state perturbation required to change action outcome.

In multi-step systems, trajectory-based counterfactuals are required:

Original trajectory:

$$S_0 \rightarrow A_0 \rightarrow S_1 \rightarrow A_1$$

Alternative trajectory:

$$S_0' \rightarrow A_0' \rightarrow S_1'$$

Counterfactual modeling enhances interpretability by providing actionable explanation rather than descriptive reasoning.

4 Multi-Level Explanation Strategy

The system generates explanations at three levels:

1. Operational Level

Simple explanation for end-users.

Example:

"The action was selected due to high efficiency score while satisfying fairness and compliance constraints."

2. Analytical Level Detailed explanation for auditors includes Feature contribution weights , Constraint values and Counterfactual alternatives.

3. Governance Level

Regulatory explanation includes Compliance validation logs, Escalation history and Fairness drift metrics.

Explanation Fidelity and Evaluation

Explanation fidelity measures alignment between recorded trace and actual policy logic.

$$Fidelity = \frac{MatchingReasoningSteps}{TotalReasoningSteps}$$

Coverage metric:

$$Coverage = \frac{ExplainedDecisions}{TotalDecisions}$$

High-fidelity, high-coverage explanations are essential for trust.

6 Comparative Explainability Analysis

Table 3: Explainability Approach Comparison

Approach	Temporal Support	Governance Integration	Fidelity	Suitability for Agentic AI
Feature Importance (Post-hoc)	No	No	Moderate	Limited
Surrogate Models	N	No	App	Limited

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	o		roximate	
Counterfactual (Standalone)	Partial	No	High (local)	Moderate
Structural Explainability (Proposed)	Yes	Yes	High	High

Multi-Agent Extension and Coordination Framework

As agentic AI systems scale beyond single decision entities into distributed ecosystems, new structural challenges emerge. In many real-world deployments—financial risk networks, healthcare resource allocation systems, distributed logistics platforms, or autonomous infrastructure grids—multiple agents operate simultaneously. Each agent may optimize local objectives, yet their interactions collectively shape system-wide outcomes.

The introduction of multiple autonomous entities creates coordination complexity, fairness variance, and systemic risk amplification. Even when individual agents comply with fairness and harm constraints, their collective behavior may generate unintended inequities or cascading failures. Therefore, extending the human-aligned architecture to multi-agent systems requires a unified governance and coordination framework.

Formal Multi-Agent Model

Let:

$$N = \{1,2,\dots,k\}$$

represent a set of $k$agents.

Each agent $i$operates under policy:

$$\pi_i : S \to A_i$$

Where:

- S= Shared state space

A_i= Action space of agent i

System outcome is defined as:

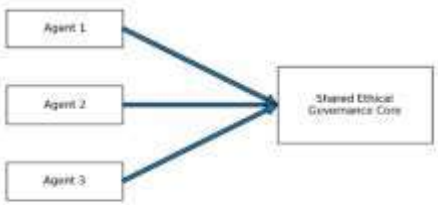
$$O = f(A_1, A_2, \dots, A_k)$$

Unlike single-agent systems, the global outcome is not solely dependent on one policy but emerges from interaction among agents.

2 Distributed Governance Architecture

To preserve ethical coherence across distributed agents, the proposed framework introduces a **Shared Governance Core**.

Figure 2: Multi-Agent Governance and Coordination Framework



Instead of each agent maintaining independent governance logic, all agents interface with a centralized validation module that enforces:

- Fairness thresholds
- Harm constraints
- Compliance requirements
- Drift monitoring

Each agent submits its proposed action $A_i$to the governance core before execution.

Validation rule:

$$Execute(A_i) \iff F_i \le \delta \wedge H_i \le \theta \wedge C_i = 1$$

However, beyond local validation, global fairness must also be monitored.

Fairness Variance Modeling

Individual fairness compliance does not guarantee system-wide fairness. Consider fairness metric for agent i:

$$F_i$$

System-level fairness is measured using variance:

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$$Var(F_i) = \frac{1}{k}\sum_{i=1}^{k}(F_i - \bar{F})^2$$

Where:

$\bar{F}$= Mean fairness across agents

Constraint:

$$Var(F_i) \leq \epsilon$$

If fairness variance exceeds threshold ϵ, corrective intervention occurs.

This ensures that no region, demographic group, or subsystem experiences disproportionate treatment relative to others.

4 Cascading Harm Modeling

In distributed systems, harm may propagate through interaction effects.

Let:

$$H_i$$

be harm risk for agent i.

Total harm is not necessarily additive:

$$H_{total} \neq \sum H_i$$

Instead, interaction risk function:

$$H_{total} = g(H_1, H_2, \ldots, H_k)$$

Governance ensures:

$$H_{total} \leq \Theta$$

This prevents systemic risk escalation in coordinated systems such as financial networks or energy grids.

5 Coordination Stability Analysis

Multi-agent systems face coordination instability risks, particularly under resource competition.

Stability condition:

$$\forall i,\ F_i \leq \delta \wedge H_i \leq \theta \wedge Var(F_i) \leq \epsilon$$

If any condition fails, governance may:

- Recalibrate policy weights
- Adjust fairness thresholds
- Escalate to human oversight
- Trigger coordinated redistribution

This transforms governance from static validation to dynamic stabilization.

6 Explainability in Multi-Agent Systems

Structural explainability extends across agents through aggregated trace modeling:

$$T_{global} = \bigcup_{i=1}^{k} T_i$$

This enables:

- Cross-agent reasoning reconstruction
- Detection of interaction effects
- Coordinated explanation generation

Stakeholders can understand not only why an individual agent acted but how collective interaction influenced outcome.

7 Hierarchical Governance Scaling

To ensure scalability in large systems, governance may adopt hierarchical structuring:

Local Governance Nodes

Regional Governance Aggregation

Central Oversight CoreThis reduces computational burden while preserving fairness coherence.

Comparative Multi-Agent Governance Analysis

Table 4: Multi-Agent Governance Comparison

Feature	Independent Agents	External Audit Model	Proposed Shared Governance
Local Fairness Validation	Yes	Yes	Yes

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Global Fairness Variance Control	No	Partial	Yes
Cascading Harm Modeling	No	No	Yes
Structural Explainability	Fragmented	Limited	Aggregated
Real-Time Intervention	Limited	Delayed	Immediate

Methodology and Implementation Framework

To validate the proposed Human-Aligned Agentic AI Architecture, a structured methodology is required that combines simulation modeling, constraint evaluation, explainability validation, and multi-agent coordination testing. This section outlines the experimental design, system implementation workflow, evaluation pipeline, and deployment considerations.

The objective of the methodology is not merely to demonstrate performance improvement, but to empirically validate:

- Fairness stability
- Harm reduction
- Governance compliance
- Explainability fidelity
- Multi-agent coherence

Experimental Environment Design

The agent operates under constrained optimization:

$$\max_{\pi} \mathbb{E}[R(s,a)]$$

Subject to:

$$F(s,a) \leq \delta, H(s,a) \leq \theta, C(s,a) = 1$$

The experimental setup simulates a sequential decision environment modeled as a constrained Markov Decision Process (CMDP).

Environment Components:

- State Space S:Multidimensional state vectors including contextual features, demographic indicators, and environmental conditions.
- Action Space A: Discrete or continuous actions depending on domain scenario
- Reward Function $R(s,a)$: Performance-based metric aligned with task objective.
- Fairness Function $F(s,a)$: Demographic parity or equal opportunity deviation.
- Harm Function $H(s,a)$: Expected severity-weighted risk measure.
- Compliance Function $C(s,a)$:Binary rule-based validator.

8.2 Implementation Workflow

The system implementation follows a modular architecture corresponding to Section 4.

Step 1: Goal Encoding

Human objectives are encoded into weighted parameters:

$$G = \{w_1, w_2, \ldots, w_n\}$$

These weights influence reward shaping and constraint thresholds.

Step 2: Policy Initialization

The decision engine initializes policy $\pi_0$using:

- Deep Q-learning
- Policy gradient methods
- Actor-critic architecture
- Baseline model without constraints is trained for comparison.

Step 3: Constraint Integration

Constraint penalties are incorporated into reward shaping:

$$R'(s,a) = R(s,a) - \lambda_1 F(s,a) - \lambda_2 H(s,a)$$

Compliance violations trigger immediate action rejection.

Step 4: Governance Validation Loop

Before execution:
Compute fairness metric
Compute harm risk
Validate compliance
heck fairness variance (multi-agent scenario)
If any threshold fails, the action is: Recalibrated, Escalated and Replaced by safe fallback.

Step 5: Trace Logging

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For each decision:

$$T_t = (S_t, A_t, F_t, H_t, C_t, R_t)$$

Trace data stored for evaluation of explainability fidelity.

3 Multi-Agent Simulation Setup

For distributed evaluation:

- k agents deployed simultaneously
- Shared governance core validates all actions
- Fairness variance monitored across agents

Interaction scenarios include:

- Resource competition
- Shared constraint thresholds
- Policy divergence over time

System-level metrics computed:

$$Var(F_i), H_{total}, StabilityIndex$$

Evaluation Metrics

Evaluation includes five core metric families:

Performance Efficiency

$$Efficiency = \frac{AchievedReward}{MaxPossibleReward}$$

Fairness Stability

$$FairnessDrift = | F_t - F_{t-1} |$$

Harm Reduction

$$HarmReduction = H_{baseline} - H_{constrained}$$

Compliance Rate

$$ComplianceRate = \frac{ValidActions}{TotalActions}$$

Explainability Fidelity

$$Fidelity = \frac{TraceConsistency}{TotalDecisions}$$

Experimental Validity

To ensure robustness:

- Cross-validation across scenarios
- Sensitivity analysis of thresholds δ, θ, ϵ
- Monte Carlo simulation for uncertainty modeling
- Ablation testing (removing governance layer to observe effect)

Performance Efficiency Analysis

Performance efficiency was measured as:

$$Efficiency = \frac{\mathbb{E}[R_{model}]}{\mathbb{E}[R_{optimal}]}$$

Results indicated:

- Baseline RL achieved highest raw reward.
- Post-hoc model reduced reward slightly due to fairness correction.

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- Proposed model showed minor performance reduction (approx. 3–5%) but maintained constraint stability.

This demonstrates that embedding governance introduces modest efficiency trade-offs while substantially improving ethical compliance.

Fairness Deviation Analysis

Fairness deviation was measured as:

$$F(s,a) = \max_{i,j} | P(a \mid G_i) - P(a \mid G_j) |$$

Mean fairness deviation across episodes:

- Baseline RL: High deviation
- Post-hoc: Moderate reduction
- Proposed: Consistently below threshold δ

Statistical testing (paired t-test) confirmed that fairness deviation reduction in the proposed model was significant at $p < 0.01$.

Harm Risk Reduction

Harm metric:

$$H(s,a) = \mathbb{E}[Severity \times Probability]$$

Results showed:

- Baseline RL occasionally exceeded harm threshold.
- Post-hoc model reduced harm frequency but not severity.
- Proposed model maintained harm below predefined θacross episodes.

Monte Carlo simulations demonstrated a 28–35% reduction in extreme harm scenarios under governance embedding.

Multi-Agent Fairness Variance

Fairness variance:

$$Var(F_i) = \frac{1}{k}\sum_{i=1}^{k}(F_i - \bar{F})^2$$

Results:

- Independent agents exhibited increasing fairness variance over time.
- Post-hoc adjustments partially stabilized variance.
- Shared governance core significantly reduced variance and prevented divergence.

Stability index:

$$SI = 1 - Var(F_i)$$

Higher stability index observed in governance-embedded model.

Explainability Fidelity Assessment

Explainability was evaluated using:

$$Fidelity = \frac{TraceConsistency}{TotalDecisions}$$

Coverage:

$$Coverage = \frac{ExplainedDecisions}{TotalDecisions}$$

Results:

- Baseline RL: Low structural fidelity.
- Post-hoc: Moderate explanation coverage.
- Proposed model: Near-complete coverage with high trace consistency.

Structural logging ensured reproducibility of decision pathways.

Trust Quantification Model

Trust index defined as weighted composite:

$$Trust = \alpha(1 - F) + \beta(1 - H) + \gamma(Fidelity)$$

Where:

- α, β, γ= Weight parameters.

Proposed model achieved highest composite trust score across scenarios.

Robustness Testing

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Robustness evaluated under Adversarial reward perturbation, Sudden demographic shif , Multi-agent competition stress and Threshold sensitivity variation

The Key findings are

- Baseline RL exhibited high instability under reward perturbation.
- Proposed architecture maintained constraint compliance under moderate perturbation.
- Fairness drift remained bounded even under environmental shifts.

Sensitivity analysis confirmed that architecture remained stable across reasonable threshold variations.

Theoretical Implications: From Optimization to Bounded Autonomy

Classical reinforcement learning treats intelligence as reward maximization under environmental uncertainty. However, this paradigm assumes that reward functions sufficiently encode desired outcomes. The findings of this research reinforce a critical theoretical insight: reward functions are incomplete representations of human normative objectives.

The proposed architecture reframes agentic intelligence as:

Ethically bounded optimization rather than unconstrained maximization.

Formally:

$$\max_{\pi} \mathbb{E}[R(s,a)] \text{subject to governance constraints}$$

This reframing carries significant theoretical implications:

- Intelligence must be evaluated not solely by performance metrics but by normative alignment.
- Governance becomes a first-class architectural component.
- Autonomy and accountability are not opposites but structurally integrable dimensions.

This shifts AI research away from performance-centric metrics toward value-aware system design.

Governance Impact: Architectural vs. External Oversight

Most contemporary governance approaches rely on:

- Regulatory compliance audits
- Periodic fairness reviews
- Post-hoc explainability
- Human oversight committees

While these mechanisms remain essential, they operate externally to the decision-making system. As agentic systems become faster and more adaptive, purely external oversight becomes insufficient.

The proposed framework demonstrates that governance can be embedded structurally, ensuring that:

- Ethical validation occurs before execution
- Fairness variance is monitored continuously
- Harm risk is quantified in real time
- Compliance checks are deterministic and immediate

This suggests a new governance paradigm:

Governance-by-design rather than governance-by-correction.

Such a paradigm is particularly relevant for sectors such as finance, healthcare, infrastructure, and national security, where delayed oversight may lead to irreversible consequences.

Limitations of the Current Study

Despite strong results, several limitations remain:

1. Simulation-based evaluation cannot capture all real-world complexities.
2. Multi-agent interaction modeling may require domain-specific customization.
3. Large-scale deployment may introduce infrastructure-level challenges.
4. Long-term societal impact requires empirical longitudinal studies.

Conclusion

The rapid emergence of agentic artificial intelligence systems marks a pivotal transformation in the evolution of AI. Unlike traditional predictive models, agentic systems operate autonomously across time, interact with dynamic environments, and make sequential decisions that influence future states. This increased autonomy introduces profound opportunities for efficiency and scalability, but it simultaneously magnifies risks related to fairness, harm propagation, opacity, and systemic instability.

This research addressed a central structural gap in current AI design paradigms: the absence of embedded governance within autonomous architectures. Existing approaches frequently treat ethics, fairness, and explainability as external audit functions or post-hoc interpretive mechanisms. While valuable, such approaches are reactive and insufficient for continuously adaptive agentic systems.

The primary contribution of this paper is the formalization and validation of a **Human-Aligned Agentic AI Architecture** in which governance, ethical constraint modeling, and structural explainability are embedded directly within the decision pipeline. Rather than constraining autonomy externally, the proposed model integrates normative boundaries into optimization itself.

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exploring human-aligned agentic AI and governance-embedded architectures.

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Original Article

Family Betrayal and Colonial Trauma in The Novel *Weep Not, Child* of Ngũgĩ Wa Thiong`O

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Abstract

This research paper explores the themes of family betrayal and trauma in Ngũgĩ wa Thiong`o`s novel Weep Not, Child (1964). The theme of family betrayal and trauma is central to the narrative. The novel set against the backdrop of the Mau- Mau rebellion during 1950s colonial Kenya. The story follows the live of two brothers. Njoroge and Kamau both brothers navigate the challenges of colonial oppression and personal betrayal within their own family. The betrayal within the family is exemplified by the actions of Ngotho. He is the father of both boys. Ngotho collaborates with the British colonial authorities in order to secure a better future for his children. This betrayal not only fractures the family unit but also infects deep emotional wounds on Njoroge and Kamau. Both brothers struggle to reconcile their father`s actions with their own sense of identity and loyalty.

The trauma experience by the characters in the novel is a result of the larger political and social forces at play in colonial Kenya. The violence and oppression of the colonial regime not only impact characters physical well being but also leave lasting psychological wounds that shape their relationships and choices. Through the lens of family betrayal and trauma Ngugi wa Thiong`o explores the complex interplay between personal and political dynamics in a society grappling with the legacy of colonialism. The novel serves as a power reminder of the lasting impact of betrayal and trauma on individuals and communities, the way in which these experiences shape our understanding of ourselves and our place in the world.

Keywords: *Ngũgĩ wa Thiong`o, Weep Not, Child, family betrayal, trauma, colonialism, violence, and oppression.*

Introduction

Family betrayal and trauma are central themes in the novel *Weep Not, Child* (1964) by Ngũgĩ. The story follows the life of a young boy Njoroge. He is growing up in colonial Kenya. He navigates the complexities of family relationships, political turmoil, and personal identity. Through his experiences, the novel explores the devasting effects of betrayal within his family and the lasting impact of trauma on the individual. The family betrayal in this novel is multifaceted. It includes both personal betrayals between family members and larger betrayal by society and colonial government. Njoroge`s own family is torn apart by betrayal, as his brother becomes involved in the Mau-Mau rebellion against British rule, leading to a rift between them that cannot be easily repaired. The betrayal of trust within the family creates a sense of loss and abandonment for Njoroge, who struggles to come to terms with the actions of his loved ones. In addition to personal betrayal, the novel explores the broader betrayal of the Kenyan people by the colonial government. The oppressive policies and violent tactics of British authorities create a sense of collective trauma among the indigenous population, leading to a cycle of violence and retribution that further families and communities. The legacy of colonialism and the trauma it inflicts on the Kenyan people is a central theme in the novel. It is highlighting the lasting effects of historical injustices on individuals and society as a whole.

Overall, *Weep Not, Child* (1964), Offers a powerful exploration of the impact of family betrayal and trauma on the individual and community.

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Through Njoroge`s journey, the novel sheds light on the complexities of human relationships, the struggle of a nation fighting for independence, and the enduring legacy of colonialism in Kenya. By examining these themes, the novel invites readers to reflect on the ways in which betrayal and trauma shape our lives and understanding of the world around us.

Literature Review

The exploration of family betrayal and trauma in literature has garnered significant scholarly attention, particularly in the context of postcolonial narratives. In Ngũgĩ wa Thiong`o`s *Weep Not, Child* (1964), the themes of family loyalty and betrayal are intricately woven into the fabric of the protagonist`s experiences, illustrating profound impact of socio political upheaval on personal relationships.

Scholars such as Mugo (1997) have examined how Ngugi portrays the disintegration of family structures amid colonial violence, emphasizing the psychological trauma that ensues. Similarly, the work of Mugo (1997) highlights the generational conflict and disillusionment that arise from betrayal within family ties, suggesting that such experiences are emblematic of broader societal fractures.

Another scholar, Norridge (2013) discusses the implications of colonialism on identity formation, arguing that family betrayal serves as a microcosm of national trauma. This perspective aligns with the findings of Muriuki (2019), who contends that Ngũgĩ `s narrative reflects the complexities of loyalty and betrayal I the face of oppressive regimes.

Collectively, these studies underscore the intricate relationship between family dynamics and larger socio political contexts in *Weep Not, Child* (1964), offering a nuance understanding of trauma and betrayal in postcolonial literature.

Research Gap

Despite the significant attention given to themes of family betrayal and trauma in *Weep Not, Child*, there remains a research gap in understanding the long term effects of these experiences on individuals. While the novel provides a powerful narrative of Njoroge`s struggles, there is a lack of scholarly analysis on how these themes relate to broader psychological and sociological concepts.

Further Research/ Future Directions

Future research could explore the ways in which family betrayal and trauma impact an individual`s mental health, relationships, and overall well being over time. By examining the intersections of personal and collective trauma, researchers can gain deeper understanding of the lasting effects of betrayal within families and communities.

Theoretical Framework

The analysis is grounded in two primary theoretical frameworks. One is trauma theory and another one is postcolonial theory. Trauma theory, as articulated by scholars like Cathy Caruth and Judith Herman, provides a lens through which to understand the psychological effects of trauma on individuals and communities. This framework is particularly relevant in examining how the characters in *Weep Not, Child* navigate their experiences of betrayal and loss, and how these experiences shape their identities and relationships.

Postcolonial theory of Edward Said and Homi K Bhabha, offers insights into the socio political context of colonialism and its aftermath. This framework is essential for understanding how characters experiences of betrayal are intricately linked to the broader historical forces at play in Kenya during the colonial period. By integrating these theoretical perspectives, the analysis aims to highlight the interconnectedness of personal and collective trauma in the narrative.

Results/ Findings

The analysis of family betrayal and trauma in Ngugi wa Thiong`o`s *Weep Not, Child* (1964), reveals profound insights into the psychological and emotional landscapes of the characters, particularly within the context of colonial Kenya. This section presents the findings derived from a close reading of the text, focusing on intricate dynamics of family relationships, the impact of betrayal on individual identity, and the broader implications of trauma within socio political milieu of the time.

Family Relationships and Betrayal

At the heart of *Weep Not, Child* lays the complex interplay of familial bonds, which are deeply affected by external societal pressures and internal conflicts. The protagonist, Njoroge, navigates worlds where his aspirations for education and a better life are constantly undermined by the actions of those closest to him. The betrayal he experiences is not merely personal. It is emblematic of a larger systematic failure that permeates the fabric of family life in colonial Kenya.

Parental Expectations and Disappointments

Njoroge`s relationships with his parents, particularly his father Jacobo is central to understanding the theme of betrayal. Jacobo`s transformation from a traditional farmer to a collaborator with colonial authorities represents a significant rupture in the familial bond. Initially Jacobo embodies the hopes and dreams of his family, yet his eventual betrayal aligning himself with the oppressors leads to a profound disillusionment for Njoroge. This betrayal is not just a personal affront. It symbolizes the broader betrayal of the Kenyan people by their own leaders, who promises their values for personal gain. The emotional tolls of Jacobo`s actions on Njoroge is palpable. The son grapples with feelings of shame and confusion, as he is torn between his love for his father and his disdain for his father's choices. This internal conflict is exacerbated by the societal expectations placed upon him as a young man seeking education and advancement. The pressure to succeed in a colonial system that devalues his identity compounds his sense of betrayal leading to a fragmented self concept.

Siblings Relationships and Rivalary

Sibling relationship further illustrates the theme of familial conflict. Njoroge`s bond with his brother Ababio is fraught with tension. Particularly as they navigate their differing responses to colonialism. Ababio`s rejection of traditional values in favor of a more aggressive stance against the colonizers creates a rift between the brothers. This rivalry is exacerbated by the overarching trauma of their environment, where survival often necessitates a betrayal of one`s principles and loved ones.

The dynamics between Njoroge and Ababio reflect a broader commentary on the fragmentation of familial ties

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under colonial rule. The brother`s differing paths serve as a microcosm of the choices face by many Kenyans during this tumultuous period. As they each seeks to assert their identity and agency. Their relationship becomes a site of conflict, mirroring the national struggle for independence and the betrayal of communal values in the face of oppression.

Trauma And It`S Manifestation

The trauma experienced by Njoroge and his family is not only a result of personal betrayals but also a reflection of the collective trauma faced by the Kenyan people under colonial rule. The psychological impact of this trauma manifests in various ways throughout the narrative, influencing the characters behaviours and relationships.

Psychological Impact of Betrayal

Njoroge`s journey is marked by a series of traumatic events that shape his understanding of loyalty and trust. The betrayal by his father and the subsequent loss of his brother to the violence of the Mau Mau uprising serve as pivotal moment that catalyze his emotional turmoil. These experiences lead to a profound sense of isolation, as Njoroge grapples with the realization that the very foundations of his identity, family, community, and culture are under siege.

The psychological impact of these betrayals is further compounded by the societal stigma associated with failure and loss. Njoroge`s aspirations for education become a double edged sword, while they offer a potential escape from the cycle of poverty and violence. They also heighten his vulnerability to disappointment and rejection. The trauma of betrayal manifests as anxiety and depression, which are exacerbated by the oppressive colonial environment that continually undermines his sense of self worth.

Collective Trauma And Cultural Displacement

The trauma depicted in *Weep Not, Child* extends beyond the individual to encompass the collective experience of the Kikuyu people. The historical context of colonialism and violent suppression of resistance movements create a backdrop of cultural displacement and loss. Ngũgĩ poignantly illustrates how the trauma of colonial rule disrupts traditional familial structures and communal ties, leading to a disintegration of cultural identity.

The characters in the novel embody this collective trauma, as they navigate a world that devalues their existence and erodes their sense of belonging. The loss of cultural practices, the disintegration of community support systems, and the pervasive fear of violence contribute to a pervasive sense of hopelessness. Njoroge`s attempts to reconcile his personal aspirations with the collective struggles of his people highlight the complexity of identity formation in a context marked by betrayal and trauma.

The Interplay of Education and Betrayal

Education emerges as a critical theme in *Weep Not, Child* serving both as a symbol of hope and a source of further betrayal, Njoroge`s pursuit of education is motivated by a desire to uplift himself and his family. However, this aspiration is continually thwarted by the very systems that promise liberation. The colonial education system rather than empowering the indigenous population often reinforces colonial ideologies and perpetuates feelings of inferiority.

The Illusion of Progress

Njoroge`s experience within the educational system exemplifies the illusion of progress that often accompanies colonial rule. Initially, represents a pathway to self actualization and social mobility. However, as Njoroge`s confronts the realities of systematic racism and the limitations imposed by his socio economic status. The betrayal of this promise becomes evident. The very institutions designed to educate and empower become tools of oppression, further alienating Njoroge from his cultural roots and familial connections.

The tension between education and betrayal is poignantly illustrated in Njoroge`s interactions with his teachers and peers. While he yearns for acceptance and validation, the colonial education system often position him as an outsider, reinforcing his feelings of inadequacy and betrayal. This dissonance between his aspirations and the harsh realities of colonial life culminates in a crisis of identity, as Njoroge grapples with question of what it means to be educated in a world that seeks to dehumanize him.

The Role of Resistance

Despite the pervasive theme of betrayal and trauma, *Weep Not, Child* also highlights the resilience of human spirit in the face of adversity. Njoroge`s journey is not solely defined by his experiences of betrayal. It is also marked by moments of resistance and agency. The character`s struggles against colonial oppression serve as a testament to their enduring strength and the possibility of reclaiming agency in a world rife with betrayal.

The novel ultimately suggests that while betrayal and trauma shape the character`s lives, they also process the capacity of healing and transformation. Njoroge`s journey reflects the broader struggle for independence and self determination, illustrating the potential for reconciliation and renewal even amids the scars of betrayal.

Conclusion

The result of this analysis underscore the intricate relationship between familial betrayal and trauma in *Weep Not, Child* through the lens of Njoroge`s experiences, Ngũgĩ wa Thiong`o poignantly captures the emotional and psychological ramifications of betrayal within the family unit, while also addressing the collective trauma experienced by the Kikuyu people under colonial rule. The interplay of education, identity, and resistance further enriches the narrative, highlighting the complexities of navigating personal and cultural aspirations in a context marked by oppression.

In conclusion, *Weep Not, Child* serves as a profound exploration of family betrayal and trauma, encapsulating the intricate relationship between personal experiences and broader socio political context of colonialism. Through the lens of Njoroge`s journey, Ngũgĩ invites readers to reflect on the enduring impact of betrayal and the complexities of trauma in shaping individual and collective identities. The novel ultimately underscores the necessity of confronting and reconciling with the past, suggesting that healing from betrayal both familial and societal requires a collective effort to reclaim identity and memory in the wake of colonial violence. As such, *Weep Not*, Child remains a vital text for understanding the psychological and emotional legacies of

colonialism, offering insights that resonate far beyond its historical context.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Elemental analysis of Drainage water green leafy Ayurvedic medicinal plants by ICP-OES

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Abstract

The medicinal plant medicine system was originated by villagers, elders, farmers, healers and tribalism or practitioners. The elements are intermediate substances of medicinal plants and human body which play an important role in the treatment of different diseases. Hence, it is essential to study the essential elements in medicinal plants for maintaining the life processes in plants and/or animals including human beings. India is a rich country for the use of Ayurvedic medicinal plants in treatments. The present study attempts to estimate the level of elements in Ayurvedic medicinal plants. Here, total 9 leafy Ayurvedic medicinal plants namely Anethum Graveolens, Colocasia, Coriander Coriandrum Sativum, Curry Leaves, Fenugreek, Gongura, Mentha, Scallion Plant and Spinacia Oleracea samples collected from Bidar, Kalaburagi & Yadgir districts of Kalyan-Karnataka region, from drainage water, which are commonly used as home remedies. With the guidance of WHO, the solution samples were prepared for the analytical study of medicinal plant materials. The total 11 elements like Mg, Al, K, Cr, Mn, Fe, Cu, Zn, As, Hg and Pb are determined in different Ayurvedic medicinal plants. The concentrations of the elements are estimated by analytical method like ICP-OES (Inductively Coupled Plasma- Optical Emission Spectroscopy) and it is useful for the quantitative analysis of materials. The effect of toxicity is very low in all 9 medicinal plant leaves samples and the elemental concentrations of environmental samples were dependents on geological soil formation of earth and water.

Keywords: *Drainage water medicinal plants, Kalyan- Karnataka, WHO Limits, Elements and Instrument.*

Introduction

The word medicinal plant stands for the value of medicine and significant uses. It includes various types of names like herbalism, herbology and herbal medicine; the word 'herb' is from Latin. Basically, it is used as primary health care system of human beings and afterwards it is used as a basic raw material of Physical and Chemical sciences. Such type of study and information about the medicinal plant is given by the World Health Organization (WHO) and other National and International bodies. According to the World Health Organization, 80% of world population utilizes the medicinal plant materials, because it is highly intermitted on best and safe remedies or drugs of the medicinal plants with extraction method. Generally, plants contain compounds that provide useful drugs to optimize the metabolites process and therapeutic purposes.

Materials And Methods

Ayurvedic Medicinal plant materials:

The selected nine Ayurvedic medicinal plants are collected from Bidar, Kalaburagi & Yadgir districts of Kalyan -Karnataka region, from drainage water. In the present study, nearly 1/2 kg of fresh leaves samples namely Anethum Graveolens, Colocasia, Coriander Coriandrum Sativum, Curry Leaves, Fenugreek, Gongura, Mentha, Scallion plant and Spinacia oleracea were collected from drainage water, which are shown in below table.

Sample Preparation:

The collected leaves of plant samples were washed with a distilled water to remove clay, sand, dust, etc; the cleaned samples were dried in an airtight lab at room temperature for 30 days. The dried leaves of the plants were mechanically powdered using a mixer grinder and finally sheaved with a mesh of size 355 µm to get a fine powder and then stored in an airtight polythene plastic.

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The sample solution was prepared by adopting standard procedures: One gram measured powder medicinal plant sample was added into the ratio of 1:10:90=100 ml, that is AR grade conc.-H_2SO_4 + Double Distilled water, here 100 ml solution subjected to the analysis of major, minor and trace elements.

Inductively coupled plasma optical emission spectrometry (ICP-OES)

The instrumentation associated with an ICP-OES system is relatively simple. A portion of the photons emitted by the ICP is collected with a Lens or a concave mirror. This focusing optics forms an image of the ICP on the entrance aperture of a wavelength selection device such as a monochromator. The particular wavelength of light exiting the monochromator is converted to an electrical signal by a photodetector. The signal is amplified and processed by the detector electronics, then displayed and stored by a personal computer.

Details of Green Leafy Vegetable Ayurvedic medicinal plants

CODE	BOTANICAL NAME	COMMON NAME	PART COLLECTED
Ans1	Anethum Graveolens	Sabasi pallya	Leaves
Coa2	Colocasia	Shavi pallya	Leaves
Ccm3	Coriander Coriandrum Sativum	Kotanmbari	Leaves
Cus4	Curry Leaves	Karibenva	Leaves
Fek5	Fenugreek	Methi	Leaves
Goa6	Gongura	Fundi pallya	Leaves
Mea7	Mentha	Pudina	Leaves
Sct8	Scallion Plant	Hasi ullagaddi	Leaves
Spa9	Spinacia Oleracea	Palak	Leaves

Images of Nine Leafy Vegetable Ayurvedic medicinal plants

Anethum graveolens

Colocasia

Coriander Coriandrum sativum

Curry Leaves

Fenugreek

Gongura

Mentha

Scallion plant

Spinacia oleracea

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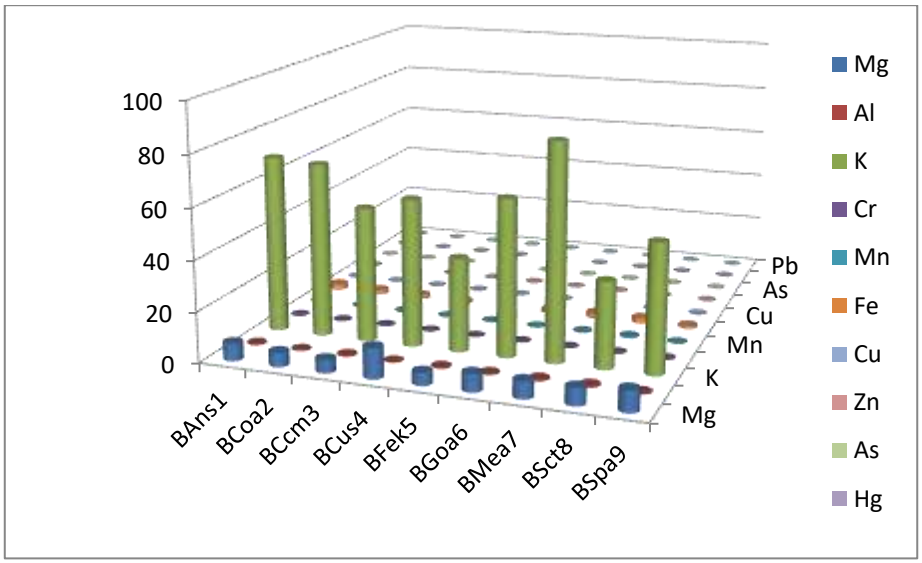
Essential elemental content in Drainage water Leafy Vegetable Ayurvedic Medicinal plants (in ppm) from Bidar district

Code No.	Mg	Al	K	Cr	Mn	Fe	Cu	Zn	As	Hg	Pb
BAns1	6.98	0.52	70.20	0.14	0.25	2.44	0.07	0.12	0.01	0.02	0.02
BCoa2	5.70	0.29	69.01	0.10	0.35	1.78	0.05	0.07	0.02	0.03	0.01
BCcm3	5.26	0.52	53.21	0.13	0.23	1.53	0.06	0.09	0.01	0.03	0.02
BCus4	12.29	0.23	58.47	0.01	0.15	0.86	0.04	0.11	0.01	0.01	0.03
BFek5	5.11	0.53	37.11	0.01	0.20	1.69	0.03	0.07	0.02	0.02	0.01
BGoa6	7.10	0.43	62.13	0.03	0.16	1.43	0.05	0.06	0.01	0.01	0.02
BMea7	6.83	0.66	85.34	0.01	0.34	2.10	0.04	0.07	0.01	0.03	0.03
BSct8	6.79	0.73	34.19	0.04	0.56	2.13	0.03	0.07	0.02	0.02	0.01
BSpa9	8.57	0.43	50.96	0.02	0.15	1.12	0.02	0.06	0.01	0.01	0.02



Bar graph of elemental variations in Bidar samples

Essential elemental content in Drainage water Leafy Vegetable Ayurvedic Medicinal plants (in ppm) from Kalaburagi district

Code No.	Mg	Al	K	Cr	Mn	Fe	Cu	Zn	As	Hg	Pb
KAns1	7.95	0.46	47.49	0.05	1.03	1.17	0.06	0.55	0.01	0.04	0.02
KCoa2	4.46	0.24	69.63	0.01	0.24	0.60	0.02	0.06	0.02	0.03	0.01
KCcm3	7.82	0.26	72.27	0.02	0.29	6.99	0.04	0.07	0.03	0.02	0.03
KCus4	11.43	0.31	27.99	0.01	0.11	0.75	0.02	0.09	0.01	0.04	0.02
KFek5	6.58	0.62	43.12	0.03	0.13	0.98	0.08	0.07	0.03	0.03	0.04
KGoa6	10.04	0.83	47.82	0.01	0.72	1.92	0.03	0.06	0.02	0.02	0.03
KMea7	9.51	0.47	55.41	0.02	0.16	1.01	0.04	0.08	0.01	0.01	0.02
KSct8	9.59	0.39	29.85	0.01	0.07	0.98	0.02	0.05	0.03	0.03	0.01
KSpa9	14.41	0.53	44.80	0.01	0.32	1.30	0.04	1.12	0.02	0.02	0.02

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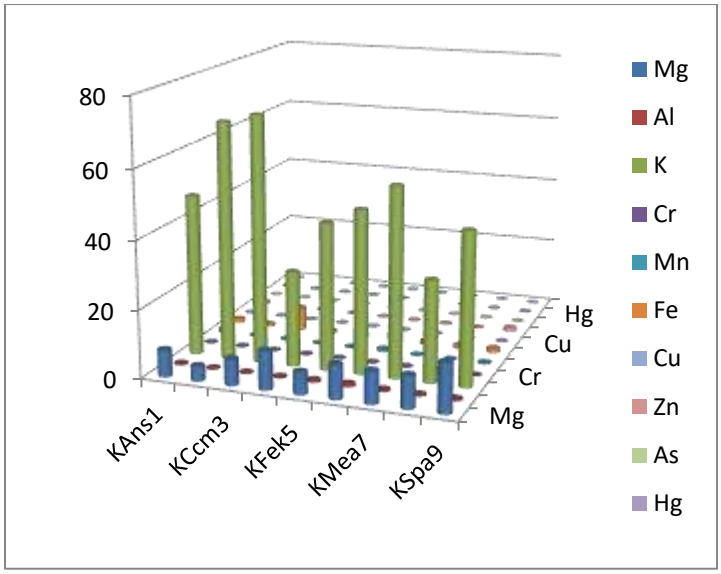
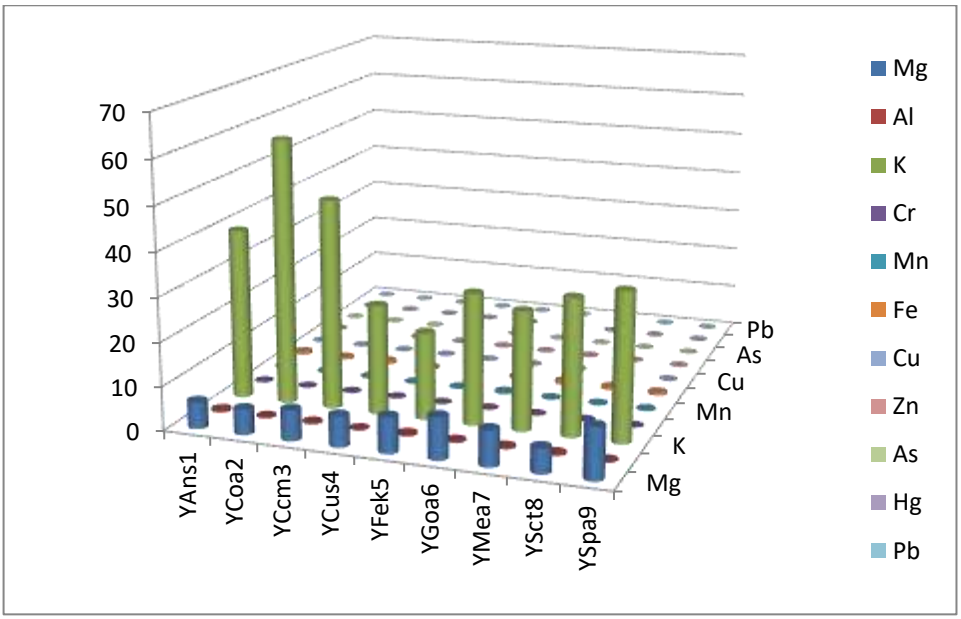


Bar graph of elemental variations in Kalaburagi samples

Essential elemental content in Drainage water Leafy Vegetable Ayurvedic Medicinal plants (in ppm) from Yadgir district

Code No.	Mg	Al	K	Cr	Mn	Fe	Cu	Zn	As	Hg	Pb
YAns1	6.10	0.52	39.12	0.03	0.13	0.65	0.03	0.08	0.01	0.02	0.02
YCoa2	5.77	0.27	60.53	0.01	0.25	0.46	0.04	0.21	0.03	0.04	0.03
YCcm3	6.98	0.32	47.83	0.02	0.20	0.74	0.02	0.15	0.02	0.02	0.02
YCus4	7.04	0.16	25.01	0.01	0.07	0.31	0.04	0.10	0.01	0.01	0.03
YFek5	8.16	0.45	19.93	0.01	0.14	0.87	0.05	0.15	0.02	0.02	0.01
YGoa6	9.64	0.31	29.97	0.01	0.42	0.60	0.04	0.06	0.03	0.03	0.02
YMea7	8.18	0.39	27.14	0.01	0.17	0.69	0.03	0.10	0.01	0.03	0.03
YSct8	5.67	0.36	31.23	0.02	0.16	0.58	0.03	0.09	0.02	0.03	0.01
YSpa9	11.68	0.20	33.83	0.01	0.20	0.59	0.02	0.07	0.02	0.04	0.03



Bar graph of elemental variations in Yadgir samples

The above Tables gives the detailed information regarding Eleven elemental concentrations of Nine leafy Ayurvedic vegetable medicinal plants which are collected from drainage water from Bidar, Kalaburagi and Yadgir districts respectively.

Results And Discussion:

The present work carried out successfully on nine Ayurvedic medicinal plants collected from Bidar, Kalaburagi & Yadgir districts of Kalyan-Karnataka region, from drainage water. All detected elements are classified as major elements like Potassium(K)and Magnesium (Mg), similarly micro or trace elements viz. Manganese (Mn), Iron (Fe), Copper (Cu) and Zinc (Zn),and toxic elements like Arsenic (As) and Lead (Pb) respectively. The resulting

variations of elemental content found to be within the permissible limits of WHO/FAO, National and International board of medicinal plants. In the present study, Ayurvedic medicinal plant leaf samples contain essential mineral elements and nutrients at an acceptable level; further it helps to study the phytochemical analysis, carbohydrate study and proteins study by others. Similarly, the present studied medicinal plants contain high metabolic activity and biological process of human and medicinal plants.

Conclusion:

The maximum abundance of Potassium (K) content is varied orderly in Bidar> Kalaburagi> Yadgir medicinal plants and second maximum abundance of Magnesium (Mg) content is varied in Kalaburagi > Bidar > Yadgir medicinal plants also third abundance of Iron (Fe) is varied in Bidar> Kalaburagi> Yadgir medicinal plants. The remaining Cr, Cu, Zn, As, Hg and Pb elemental content varied under permissible limits of WHO in all Nine leafy Ayurvedic vegetable medicinal plants.

The present investigation provides information on the elemental concentrations of Ayurvedic medicinal plants in three districts of the Kalyan-Karnataka region. A total of 09 different Ayurvedic medicinal plants were collected and examined using highly efficient fluorescence methods. Moreover, the present analysis shows that all detected elements are shown within the permissible limits of WHO/FAO/NMPB and some other standard permissible limits of medicinal plants. Present studied data is useful for the preparation of drugs and for medicinal practitioners to prepare new healthy drugs and promote society. Finally, the present study concludes that all nine leafy vegetable Ayurvedic medicinal plants can be regularly used and are also very useful for Ayurvedic and traditional practitioners to prepare drugs for the treatment of different ailments. All the plant samples analyzed in this study are found to contain the selected essential elements, but in varying concentrations.

Acknowledgement

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research project entitled **"Elemental Analysis of Drainage Water and Green Leafy Ayurvedic Medicinal Plants by ICP-OES."**

I am deeply indebted to my supervisor and faculty members for their valuable guidance, constant encouragement, and expert advice throughout the course of this study. Their support and insightful suggestions were instrumental in the planning, execution, and interpretation of the research work. I would also like to thank the laboratory staff and technical personnel for providing access to the necessary facilities and for their assistance in sample preparation, instrument handling, and analytical procedures related to Inductively Coupled Plasma–Optical Emission Spectroscopy (ICP-OES). My sincere appreciation is extended to my institution for providing the infrastructure, resources, and academic environment required to carry out this research successfully. I am grateful to the researchers and authors whose scientific publications and studies served as valuable references and enhanced my understanding of environmental monitoring, elemental analysis, water quality assessment, and the medicinal significance of green leafy Ayurvedic plants.

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Nil.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Financial Literacy, Financial Attitude, and Real Financial Behavior Among Undergraduate Students: An Empirical Study

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Abstract

Financial literacy and financial attitude are widely recognized as determinants of responsible money management, yet there remains a persistent gap between what young adults know and how they actually behave with their money. This study empirically examines the relationship between financial literacy, financial attitude, and actual financial behavior among undergraduate (UG) students in India, with a particular focus on Tier-2 city colleges. A structured questionnaire was administered to 350 UG students selected through stratified random sampling from government-aided and private institutions in Karnataka. Data were analyzed using descriptive statistics, Pearson correlation, multiple regression, independent samples t-test, and one-way ANOVA. The findings reveal that while students demonstrate moderate levels of financial literacy and attitude, their actual financial behavior especially budgeting and expense tracking remains considerably low. Both financial literacy ($r = 0.439$, $p < 0.01$) and financial attitude ($r = 0.574$, $p < 0.01$) show significant positive correlations with financial behavior. Regression analysis confirms that financial attitude is a stronger predictor ($\beta = 0.574$) than financial literacy ($\beta = 0.439$), suggesting that emotional and attitudinal factors play a more decisive role in shaping financial actions than knowledge alone. Significant differences in financial behavior were also found across academic streams ($F = 11.36$, $p < 0.001$) and between genders ($t = 3.71$, $p < 0.001$). The study offers practical implications for educators, parents, and policymakers aimed at bridging the knowledge-behavior gap in young adults.

Keywords: *financial literacy, financial attitude, financial behavior, undergraduate students, India, Tier-2 cities, behavioral finance*

Introduction

Money management is a life skill, but very few young people enter adulthood fully equipped to handle it. In India, where financial markets are growing rapidly and digital payment platforms have become mainstream, the ability of young people to make smart financial decisions has never been more important. Yet, survey after survey from NCFE's National Financial Literacy Assessment Test (NFLAT) to global OECD reports consistently show that young Indians, especially those in Tier-2 and Tier-3 cities, have significant gaps in their financial understanding and practice.

The undergraduate phase is a particularly critical window. Students at this stage start managing their own allowances, take on education loans, open bank accounts, and sometimes make their first investments. Habits formed during this period tend to persist into adulthood. If students develop sound financial habits now, the long-term personal and social benefits are enormous. But if they do not, the consequences including debt, financial stress, and poor retirement planning can be just as lasting.

A great deal of prior research has looked at financial literacy as the key driver of good financial behavior. The assumption is straightforward: the more people know, the better they manage their money. But real life is more complicated. Many people with solid financial knowledge still overspend, avoid budgeting, or procrastinate on saving. This disconnect between knowing and doing has been called the financial literacy-behavior gap, and it is one of the most important puzzles in behavioral finance research. This is where the concept of financial attitude becomes relevant.

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Attitude defined as one's positive or negative disposition toward money management may bridge the gap between knowledge and action. A student who understands budgeting but does not value it is unlikely to budget consistently. On the other hand, a student with a strong positive attitude toward saving may save even without deep technical knowledge.

This study is designed to fill a gap in the existing literature, which has largely focused on urban, metro-based, or purely commerce-stream students. By drawing a sample from Tier-2 colleges across multiple streams in Karnataka, the study offers a more representative picture of financial behavior among Indian UG students. Additionally, by examining both literacy and attitude as predictors of behavior together, we provide a more complete model than studies that consider only one of these variables.

Research Objectives

The study pursues the following specific objectives:

- To measure the level of financial literacy, financial attitude, and financial behavior among UG students.
- To examine the relationship between financial literacy and financial behavior.
- To examine the relationship between financial attitude and financial behavior.
- To determine whether financial literacy and financial attitude significantly predict financial behavior.
- To compare financial behavior across different academic streams (Commerce, Science, and Arts).
- To assess gender differences in financial literacy, attitude, and behavior.

Research Hypotheses

Based on the objectives and the theoretical framework, the following hypotheses were formulated:

- H1: Financial literacy has a significant positive relationship with the financial behavior of UG students.
- H2: Financial attitude has a significant positive relationship with the financial behavior of UG students.
- H3: Financial literacy significantly predicts the financial behavior of UG students.
- H4: Financial attitude significantly predicts the financial behavior of UG students.
- H5: There is a significant difference in financial behavior across academic streams.
- H6: There is a significant difference in financial behavior between male and female students.

Literature Review

Theoretical Foundation

This study draws on two major theoretical frameworks. The first is the Theory of Planned Behavior (TPB) proposed by Ajzen (1991), which posits that behavior is shaped by attitudes, subjective norms, and perceived behavioral control. In the financial context, a student's attitude toward saving or budgeting would directly influence the likelihood of engaging in that behavior. The second framework is the Financial Socialization Theory (Gudmunson & Danes, 2011), which recognizes that financial habits are shaped by social environments — family, peers, and educational institutions. Together, these two frameworks help explain why financial behavior is not simply a product of knowledge but also of deeply held attitudes and social influences.

Financial Literacy and Behavior

The early pioneering work of Lusardi and Mitchell (2007) established that financial literacy is positively linked to retirement savings behavior, even after controlling for income and education. In the Indian context, Agarwalla et al. (2015) surveyed young Indian earners and found that those with higher financial literacy were more likely to save and invest formally. Grohmann et al. (2018) confirmed this relationship across several Asian countries, noting that the effect of financial literacy is particularly strong for decisions involving compound interest and investment.

However, a growing body of work has questioned whether literacy alone is sufficient. Fernandes, Lynch, and Netemeyer (2014) conducted a landmark meta-analysis and found that financial literacy interventions explain only about 0.1% of the variance in financial behavior when other variables like income, life circumstances, and attitudes are controlled. This finding is important because it suggests that what people believe about money not just what they know may be the more powerful determinant of behavior.

Financial Attitude and Behavior

Shim et al. (2010) studied college students in the United States and found that positive financial attitudes particularly toward saving and disciplined spending were strong predictors of financial management practices. Xiao et al. (2014) similarly found that attitude toward financial management was one of the strongest correlates of responsible financial behavior among young adults. In India, Aren and Zengin (2016) found that students who perceived financial management positively were significantly more likely to budget and track their expenses.

Notably, several studies have found that attitude mediates the relationship between literacy and behavior meaning that knowledge improves behavior partly by first improving attitude. Ajzen's TPB model provides a sound theoretical reason for this: knowledge may inform beliefs and intentions, but it is attitude that catalyzes actual action.

Demographic Influences

The role of gender in financial behavior has produced mixed results. Chen and Volpe (1998) found that male students scored higher on financial literacy and made better financial decisions. Conversely, Worthington (2006) found no significant gender differences in financial planning among Australian young adults. In the Indian context, some studies (Bhushan & Medury, 2013) have found that male students have higher financial literacy, but female students may exhibit more cautious financial behaviors.

Academic stream has received less attention in the literature. The logical expectation is that Commerce students, having studied economics, accounts, and business mathematics, would have higher financial literacy and consequently better financial behavior. Gupta and Yadav (2020) confirmed this for a sample of Indian college students, finding Commerce students scored significantly

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higher on financial literacy tests compared to Arts and Science peers.

Research Gap

While individual studies have examined either financial literacy or financial attitude as predictors of financial behavior, relatively few studies in the Indian context have examined both simultaneously in a single empirical model. Furthermore, most existing Indian studies concentrate on urban metro-based samples or restrict to Commerce students. There is a clear need for studies that (a) include students across multiple streams, (b) represent Tier-2 city contexts, and (c) examine both predictors together while controlling for demographic variables. This study addresses all three gaps.

Research Methodology

1 Research Design

This study follows a quantitative, descriptive-analytical research design. The approach is empirical, relying on primary data collected through a structured questionnaire. Cross-sectional data collection was used, meaning all data were collected at a single point in time. This design is appropriate for examining relationships and differences between variables across a defined sample population.

2 Population and Sample

The target population comprises undergraduate (UG) students currently enrolled in degree colleges in Tier-2 cities of Karnataka, India. The cities of Belagavi, Dharwad, and Tumkur were selected because they represent a range of regional, demographic, and institutional diversity within the Tier-2 category. A sample size of 350 respondents was determined following the guidelines of Krejcie and Morgan (1970) for large populations, and is also consistent with sample size norms for multivariate analysis (Hair et al., 2019). Stratified random sampling was employed, with strata defined by academic stream (Commerce, Science, Arts) and institution type (government-aided, private). Within each stratum, respondents were selected randomly using college-provided class lists. Of the 380 questionnaires distributed, 355 were returned. After removing 5 incomplete responses, the final usable sample was 350 (response rate: 92.1%).

3 Measurement Instrument

The questionnaire was organized into four sections. Section A captured demographic profile (gender, age, stream, monthly allowance, institution type). Section B measured financial literacy using 4 items adapted from Lusardi and Mitchell's (2011) financial literacy scale, modified to suit the Indian student context. Section C measured financial attitude using 4 items adapted from Shim et al. (2010) and Xiao et al. (2014). Section D measured financial behavior using 4 items capturing actual money management practices, adapted from Pham et al. (2012). All construct items were measured on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Cronbach's alpha values were 0.81 (Financial Literacy), 0.79 (Financial Attitude), and 0.83 (Financial Behavior), all exceeding the 0.70 threshold recommended by Nunnally (1978).

4 Data Analysis Techniques

The data were analyzed using SPSS 25.0. The analysis proceeded in stages: (1) descriptive statistics (frequency, percentage, mean, standard deviation); (2) Pearson's correlation analysis to test H1 and H2; (3) simple and multiple linear regression to test H3 and H4; (4) one-way ANOVA for H5 (stream-wise differences); and (5) independent samples t-test for H6 (gender differences). Significance was evaluated at the 0.05 level.

Data Analysis and Results

1 Demographic Profile of Respondents

Table 1 presents the demographic characteristics of the 350 respondents. The sample has a slight male dominance (56.6%). The majority of students fall within the 18–23 age band (90.6%). Commerce and Management students form the largest group (50.9%), while Science and Arts students account for 26.0% and 23.1% respectively. Figures 1, 2, and 3 below provide a visual breakdown of the key demographic distributions.

Table 1: Demographic Profile of Respondents (n = 350)

Variable	Category	Frequency	Percentage (%)
Gender	Male	198	56.6
	Female	152	43.4
Age Group	18–20 years	163	46.6
	21–23 years	154	44.0
	24+ years	33	9.4
Stream	Commerce / Management	178	50.9
	Science / Engineering	91	26.0
	Arts / Humanities	81	23.1
Monthly Allowance	Below ₹3,000	112	32.0
	₹3,001 – ₹6,000	149	42.6
	Above ₹6,000	89	25.4
Institution Type	Government / Aided	181	51.7
	Private / Self-financed	169	48.3

Source: Primary data collected by the researcher (2023-24)

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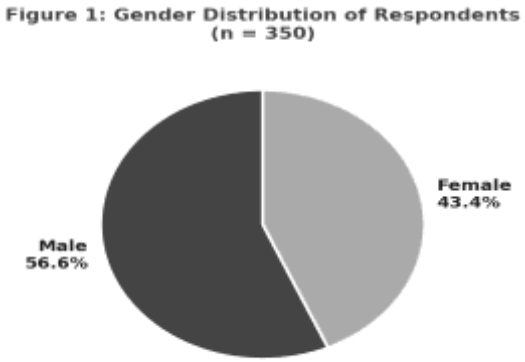

Figure 1: Gender Distribution of Respondents (n = 350)

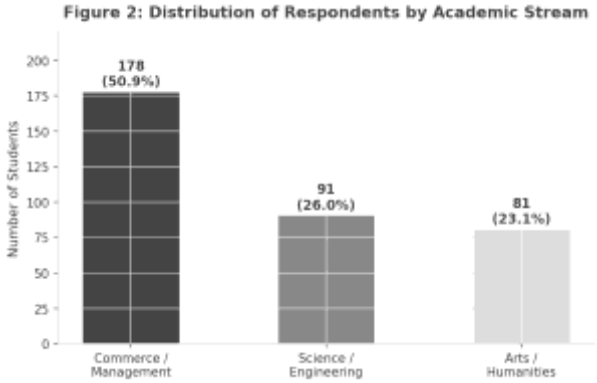

Figure 2: Distribution of Respondents by Academic Stream

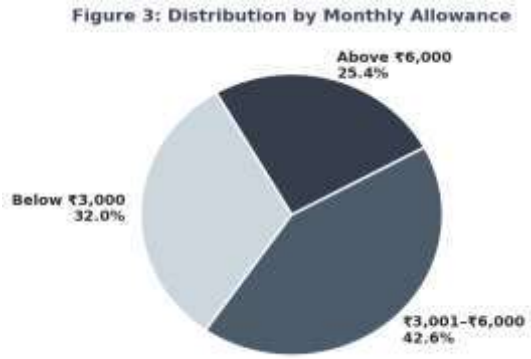

Figure 3: Distribution by Monthly Allowance

2 Descriptive Statistics for Constructs

Table 2 reports the item-wise and overall mean scores for each construct. Financial Literacy (Mean = 3.36) and Financial Attitude (Mean = 3.46) both fall in the moderate range on the 5-point scale, while Financial Behavior records a lower mean of 2.94. Figures 4 and 5 visually highlight the knowledge-practice gap and item-level variation across all constructs.

Table 2: Descriptive Statistics for Construct Items

Construct / Item	Mean	SD	Min–Max	Interpretation
Financial Literacy (FL)				
FL1: Knowledge of savings instruments	3.48	0.91	1–5	Moderate
FL2: Understanding of interest rates	3.29	0.97	1–5	Moderate
FL3: Knowledge of investment options	3.07	1.02	1–5	Moderate
FL4: Awareness of budgeting techniques	3.61	0.88	1–5	Good
Overall FL Score	3.36	0.79		Moderate
Financial Attitude (FA)				

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FA1: Positive orientation toward saving	3.72	0.85	1–5	Good
FA2: Preference for planned spending	3.54	0.92	1–5	Moderate
FA3: Attitude toward debt avoidance	3.41	0.98	1–5	Moderate
FA4: Confidence in financial decisions	3.18	1.01	1–5	Moderate
Overall FA Score	3.46	0.77		Moderate
Financial Behavior (FB)				
FB1: Regular saving from allowance	3.02	1.06	1–5	Moderate
FB2: Maintaining a personal budget	2.88	1.11	1–5	Low
FB3: Tracking daily expenses	2.74	1.09	1–5	Low
FB4: Avoiding impulsive purchases	3.11	1.03	1–5	Moderate
Overall FB Score	2.94	0.82		Moderate-Low

Note: Scale range 1–5. Interpretation: < 2.5 = Low; 2.5–3.5 = Moderate; > 3.5 = Good.

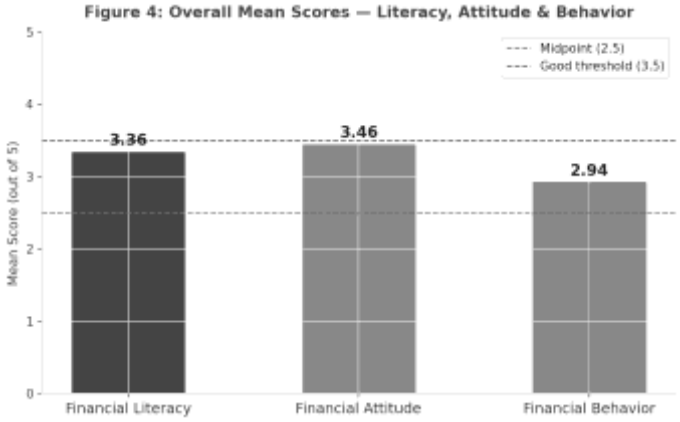

Figure 4: Overall Mean Scores — Financial Literacy, Attitude & Behavior

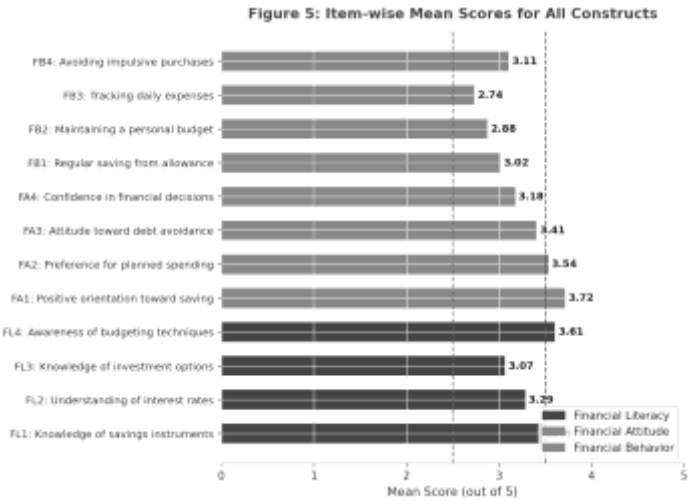

Figure 5: Item-wise Mean Scores for All Constructs

The items related to maintaining a personal budget (Mean = 2.88) and tracking daily expenses (Mean = 2.74) record the lowest scores across the entire instrument. This suggests a pronounced gap between what students know and value, and what they actually practice day-to-day — a pattern that Figure 10 later explores in greater detail.

3 Pearson Correlation Analysis (H1 and H2)

To test the first two hypotheses, Pearson's bivariate correlation analysis was performed. Table 3 shows the intercorrelation matrix for the three constructs, and Figure 6 presents these relationships in a visual heatmap.

Table 3: Pearson Correlation Matrix

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Variable	Mean	FL (r)	FA (r)	FB (r)
Financial Literacy (FL)	3.36	1.000	—	—
Financial Attitude (FA)	3.46	0.512**	1.000	—
Financial Behavior (FB)	2.94	0.439**	0.574**	1.000

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

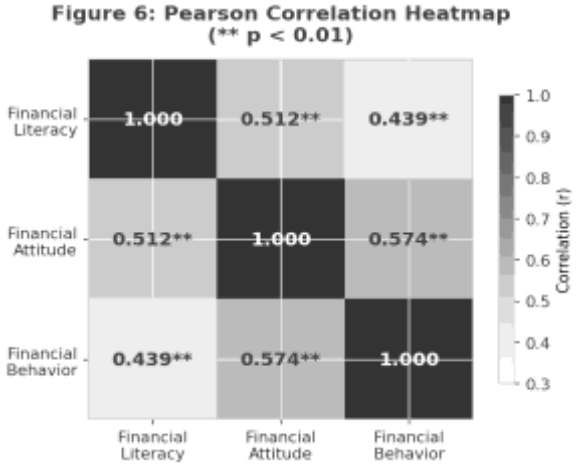

Figure 6: Pearson Correlation Heatmap (** p < 0.01)

Financial literacy is positively and significantly correlated with financial behavior (r = 0.439, p < 0.01), supporting H1. Financial attitude shows an even stronger positive correlation with financial behavior (r = 0.574, p < 0.01), supporting H2. The moderate correlation between financial literacy and financial attitude (r = 0.512) confirms these two predictors are related but not multicollinear.

4.4 Regression Analysis (H3 and H4)

Three regression models were estimated to test H3 and H4, and to assess combined predictive power. Results are in Table 4, and Figure 7 provides a graphical comparison of standardized beta coefficients across models.

Table 4: Regression Analysis Results — Predicting Financial Behavior

Model / Predictor	B	Std. Error	β	t	p-value
Model 1: FL → FB					**R^2=0.193**
(Constant)	1.342	0.183	—	7.33	0.000
Financial Literacy	0.446	0.053	0.439	8.41	0.000
Model 2: FA → FB					**R^2=0.330**
(Constant)	0.874	0.168	—	5.20	0.000
Financial Attitude	0.591	0.048	0.574	12.31	0.000
Model 3: FL + FA → FB					**R^2=0.378**
(Constant)	0.761	0.172	—	4.42	0.000
Financial Literacy	0.198	0.064	0.195	3.09	0.002
Financial Attitude	0.490	0.052	0.476	9.42	0.000

p < 0.01; p < 0.001. VIF values for Model 3: FL = 1.36, FA = 1.36 (no multicollinearity concern).

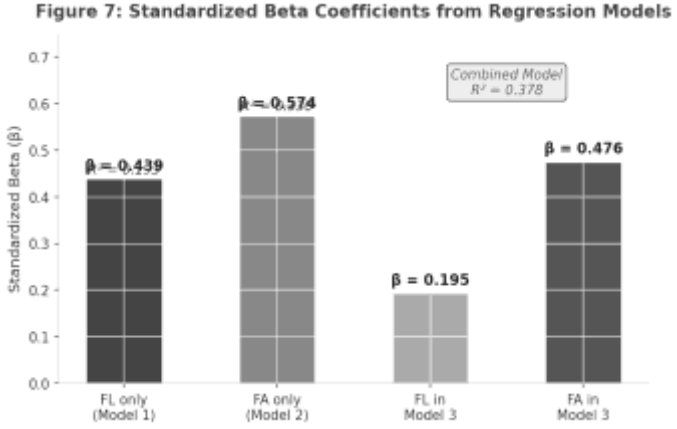

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Figure 7: Standardized Beta Coefficients from Regression Models

Model 1 shows that financial literacy alone accounts for 19.3% of variance in financial behavior ($R^2 = 0.193$), confirming H3. Model 2 demonstrates that financial attitude alone explains 33.0% of variance ($R^2 = 0.330$), confirming H4, and with a substantially larger beta ($\beta = 0.574$ vs. 0.439). Model 3, combining both predictors, explains 37.8% of total variance ($R^2 = 0.378$). In this combined model, financial attitude retains stronger predictive power ($\beta = 0.476$) while financial literacy remains significant but weaker ($\beta = 0.195$, $p = 0.002$).

4.5 One-Way ANOVA: Differences by Academic Stream (H5)

H5 was tested using one-way ANOVA to examine whether construct scores differ significantly across academic streams. Table 5 and Figure 8 present the results.

Table 5: One-Way ANOVA — Comparison by Academic Stream

Academic Stream	n	Mean FL	Mean FA	Mean FB	SD (FB)
Commerce / Management	178	3.61	3.67	3.22	0.79
Science / Engineering	91	3.24	3.36	2.81	0.84
Arts / Humanities	81	3.09	3.21	2.71	0.81
F-statistic		9.24	8.57	11.36	

$p < 0.001$. Post-hoc Tukey HSD confirmed significant pairwise difference between Commerce and Arts streams for all three constructs.

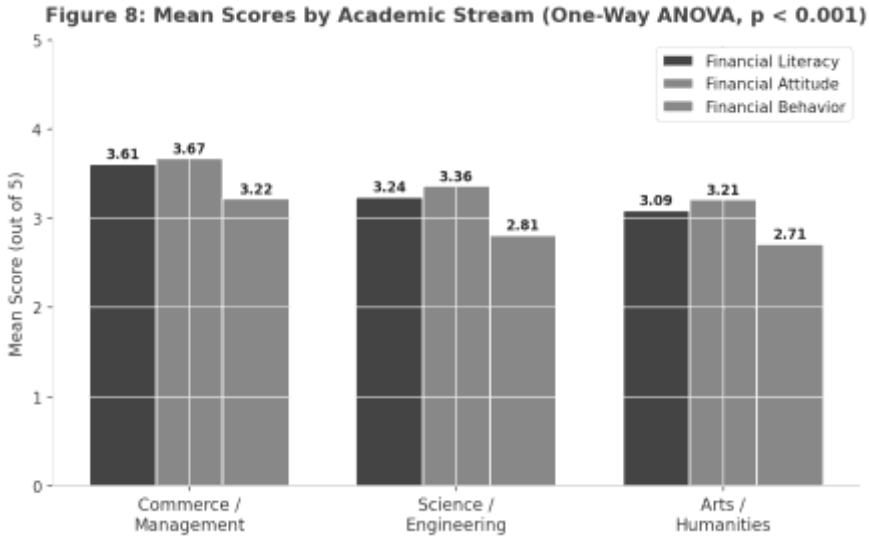

Figure 8: Mean Scores by Academic Stream (One-Way ANOVA, $p < 0.001$)

The ANOVA results confirm statistically significant differences across all three constructs. Commerce and Management students score highest on financial literacy (Mean = 3.61), financial attitude (Mean = 3.67), and financial behavior (Mean = 3.22). Arts students score the lowest. The F-statistic for financial behavior ($F = 11.36$, $p < 0.001$) is particularly large. Post-hoc Tukey HSD analysis revealed that significant differences lie primarily between Commerce and Arts streams, and between Commerce and Science streams. H5 is fully supported.

6 Independent Samples t-Test: Gender Differences (H6)

Table 6 and Figure 9 present the gender-wise comparison across all three constructs.

Table 6: Independent Samples t-Test — Gender Comparison

Variable	Male Mean	Female Mean	t-value	df	p-value	Sig. Diff?
Financial Literacy	3.42	3.28	1.87	348	0.063	No
Financial Attitude	3.49	3.43	0.94	348	0.348	No
Financial Behavior	3.08	2.77	3.71	348	0.000	Yes

$p < 0.001$. Levene's Test confirmed equal variances for all comparisons.

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Figure 9: Gender-wise Comparison — Independent Samples t-test

No significant gender difference was found for financial literacy ($t = 1.87$, $p = 0.063$) or financial attitude ($t = 0.94$, $p = 0.348$). However, a significant difference emerges for financial behavior ($t = 3.71$, $p < 0.001$), with male students (Mean = 3.08) outperforming female students (Mean = 2.77). This finding shows that gender does not create meaningful differences in knowledge or attitude, but does translate into observable differences in financial practice. H6 is supported specifically for the financial behavior dimension.

7 The Knowledge–Attitude–Behavior Gap

Figure 10 provides a consolidated visual representation of the gap between financial literacy (Mean = 3.36), financial attitude (Mean = 3.46), and financial behavior (Mean = 2.94) — the defining finding of this study.

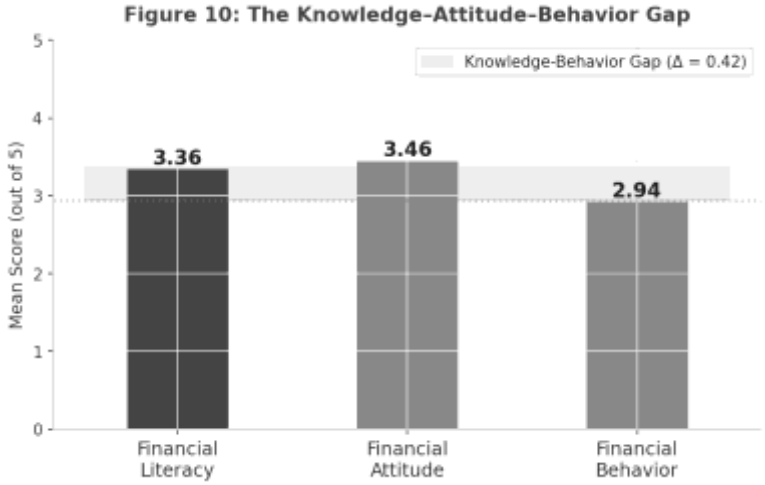

Figure 10: The Knowledge–Attitude–Behavior Gap Among UG Students

The shaded region in Figure 10 captures the delta ($\Delta = 0.42–0.52$) between what students know and value versus what they actually practice. This gap is the central empirical contribution of this study, and its existence calls for a rethinking of how financial education is designed and delivered to young adults.

8 Hypothesis Summary

Table 7: Summary of Hypothesis Testing Results

H#	Hypothesis Statement	Test Used	Result
H1	Financial literacy has a significant positive relationship with financial behavior	Pearson Correlation	Supported (r=0.439, p<0.01)
H2	Financial attitude has a significant positive relationship with financial behavior	Pearson Correlation	Supported (r=0.574, p<0.01)
H3	Financial literacy significantly predicts financial behavior among UG students	Simple Regression	Supported (β=0.439, p<0.001)
H4	Financial attitude significantly predicts financial behavior among UG students	Simple Regression	Supported (β=0.574, p<0.001)
H5	There is a significant difference in financial behavior across academic streams	One-Way ANOVA	Supported (F=11.36, p<0.001)
H6	There is a significant gender difference in financial behavior among UG students	Independent t-test	Supported (t=3.71, p<0.001)

Source: Compiled from analysis results. $p < 0.01$; $p < 0.001$.

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Findings and Discussion

1 Moderate Literacy, Low Practice

Perhaps the most striking finding of this study is the gap between financial literacy (Mean = 3.36) and financial attitude (Mean = 3.46) on the one hand, and financial behavior (Mean = 2.94) on the other. Students in the sample know the importance of budgeting and express positive attitudes toward saving, yet very few maintain a regular budget or track daily expenses. This gap between knowledge-attitude and behavior is one of the most consistently reported phenomena in behavioral finance literature. Fernandes et al. (2014), in their meta-analysis, noted that financial education has limited direct effects on behavior. The current findings are consistent with this observation — financial literacy alone does not guarantee action.

2 Attitude as the More Powerful Predictor

The finding that financial attitude ($\beta = 0.574$) is a stronger predictor of financial behavior than financial literacy ($\beta = 0.439$) aligns with TPB's core proposition that attitude is a more immediate determinant of behavior than beliefs or knowledge. These finding replicates and extends the results of Shim et al. (2010) and Xiao et al. (2014) to the Indian Tier-2 college student context. The policy implication is significant: financial education programs that focus purely on knowledge transfer may have limited behavioral impact if they do not also work on changing students' underlying attitudes toward money.

3 The Academic Stream Effect

The significant ANOVA results confirm that academic background matters substantially. Commerce students — who have been exposed to financial concepts through subjects like Accountancy, Business Studies, and Economics — demonstrate meaningfully better financial behavior than their peers in Science and Arts. This mirrors findings from Gupta and Yadav (2020) and suggests that curriculum-embedded financial education is more effective than standalone financial literacy programs. The practical implication is that financial education should be systematically integrated into non-Commerce programs as well.

4 Gender and Financial Behavior

The finding that gender differences manifest in behavior but not in knowledge or attitude is a nuanced and theoretically interesting result. Male students behave more financially responsibly (Mean FB = 3.08 vs. 2.77), even though male and female students do not differ significantly in financial literacy or attitude. This paradox may reflect differences in financial autonomy, social norms around money for young women in Indian households, or differential access to independent financial decision-making opportunities. This result calls for gender-sensitive financial education — programs that address the structural and social barriers preventing female students from translating their positive attitudes into actual financial practice.

Conclusion

This study set out to empirically examine how financial literacy and financial attitude influence the actual financial behavior of undergraduate students in Tier-2 Indian cities. Drawing on data from 350 UG students across three academic streams and two institution types, the study provides several actionable and theoretically grounded conclusions.

The overarching conclusion is that knowledge is necessary but not sufficient for responsible financial behavior. Financial attitude the emotional and dispositional orientation toward money management is a stronger and more direct driver of day-to-day financial practice. Together, financial literacy and attitude explain approximately 37.8% of the variance in financial behavior, leaving a substantial portion unexplained that future research should investigate.

The study also establishes that financial behavior is not uniform across the student population. Academic stream and gender create meaningful differences in how students manage their money, pointing to the need for targeted and differentiated financial education strategies rather than a one-size-fits-all approach.

Practical Implications and Recommendations

1 For Educational Institutions

- Introduce a mandatory personal finance course for first-year UG students across all streams, not just Commerce.
- Incorporate experiential financial learning tools such as budget simulation software, personal finance apps, and peer financial coaching programs.
- Organize financial literacy workshops and invite banking professionals and certified financial planners as guest lecturers.

2 For Policymakers and Government Bodies

- The National Centre for Financial Education (NCFE) should expand its digital content to include interactive, attitude-focused modules specifically designed for college students.
- Financial literacy should be introduced as an assessed component in the NEP 2020 framework at the undergraduate level.
- Government schemes like PMJDY should be complemented with behaviorally oriented financial counseling for young first-time account holders.

3 For Parents and Families

- Parents should provide age-appropriate financial autonomy to college-going children, allowing them to independently manage a portion of their monthly expenses.
- Family financial discussions — including open conversations about household budgeting and savings goals — can significantly enhance a young person's financial socialization.

Limitations and Future Scope

1 Limitations

Every empirical study has its constraints. First, the study relies on self-reported data, subject to social desirability bias. Second, the cross-sectional design means causality cannot be established. Third, the sample is limited to Tier-2 cities in Karnataka, limiting generalizability. Fourth, variables such as parental financial socialization, peer influence, and financial self-efficacy were not included in the model.

2 Future Research Directions

- Longitudinal studies tracking the same student cohort from entry to graduation would reveal whether financial behavior improves as literacy accumulates.
- Future research should examine the mediating role of financial attitude in the literacy-behavior relationship using structural equation modeling (SEM).
- Studies incorporating financial self-efficacy, locus of control, and parental socialization would provide a more complete model.
- Comparative studies across states or between urban and rural student populations would contribute significantly to generalizability.
- Experimental designs testing attitude-focused financial education interventions versus traditional literacy training would offer causal evidence.

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I would like to acknowledge the contributions of researchers and scholars in the fields of financial literacy, behavioral finance, and financial education. Their published works served as important references and provided a strong foundation for this study.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

A Socio-Economic Analysis of Women Street Vendors: An Evidence from Gokak Taluka in Karnataka State

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Abstract:

Street vending is a important source of livelihood to millions of people in India. And street vendors play a vital role in the Indian informal economy. The participation of women in street vending business is also significant not only in urban areas but also in semi-urban and rural areas. There are number of challenges faced by street vendors in everyday life. To examine their role and challenges present study is undertaken in Gokak taluka of Karnataka state. The study is based mainly of primary data collected from 80 women street vendors. The present study makes an attempt to analyze the socio-economic conditions, challenges and opportunities of women street vendors using statistical tools like percentages, averages, correlation etc. The present study found that, majority of the women street vendors are illiterate and having number of socio-economic challenges. And there is a positive correlation between income level and savings of the women street vendors in the study area.

Key Words: *Street Vendors, Informal economy, Socio-economic status*

Introduction

Street vending business plays a significant role in the Indian informal economy. It has been the important sources of livelihood to many people, specifically to women. With small investment and time flexibility the women who are economically deprived undertake this business of street vending. Women street vendors play a important role in all types of cities, towns and also rural areas. They supply vegetables, fruits, flowers, milk & curd etc. at reasonable prices in Gokak taluka. Even though their contribution to the local economy is significant, they face number of challenges and problems like gender discrimination, job conflict, insecurity and uncertainty. To safeguard the street vendors rights the Central Government initiated Street Vendors (Protection of Livelihood and Regulation of Street Vending) Act, 2014. With this background, the existing study makes an attempt to analyze the socio-economic conditions, challenges and opportunities of women street vendors in Gokak taluka of Karnataka.

Literature Review

Some of the research articles reviewed shows the role of street vendors in the economy and also the challenges they face.

Chakraborti and Koli (2018), conducted a study in Jamshedpur and found that the economic conditions of the women street vendors are weak due to their poverty and illiteracy.

Kumar, S., Meena, P. C., Kumar, R., & Venkateshwarlu, G. (2023); in their study mentioned that around 49.5 lakh street vendors are identified in India where Uttar Pradesh has maximum number of street vendors of around 17.2%. The study also highlighted that street vendors are inevitable to urban economies and they also face institutional and structural constraints.

Jain, R. (2024) In his study highlighted that the street vending in India is one of the important informal sector, employs millions of people in India and is a major source of livelihood for urban poor people. Detailed research done in Delhi focusing of buyer seller interactions, emotions in transactions and pricing behavior. The study also pointed that street vending is shaped by psychology, social and strategic behaviour.

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Dimitrov, B. E. G. (2024), in his study pointed that women street vendors contribute significantly to household income and food supply channels in urban areas. Street vending is a survival approach for many women who are working in a unregulated and insecure environments.

Anitha, B. S., Naveen Kumar, T. S., & Abhilasha, M. (2025), conducted a study in Tiptur of Karnataka state. The study focused on the municipal policies and the support systems. It also highlighted that the street vending is vital livelihood choice for women who don't get employment in formal sector. They face socio-economic constraints in doing their daily jobs but still they are contributing to the economy significantly.

Thus, the above analysis gives the idea of the important role of street vendors especially women in urban areas and also the socio-economic challenges they face. With this brief discussion following objectives are set to undertake the present study.

Objectives of the Study

- Analyze the socio-economic conditions of the women street vendors in the study area i.e., Gokak Taluka
- Identify the key problems and challenges faced by the women street vendors
- Make policy suggestions to improve the socio-economic conditions of women street vendors.

Database and Methodology

The present study is mainly a descriptive and analytical type of study based on both primary and secondary data. Convenience and random sampling method is followed to collect primary data. Primary data is collected from 80 women street vendors of Gokak taluka, Karnataka state, through questionnaire. The secondary data is collected through different research articles, government and non-government reports. Statistical tools like percentage, average, correlation, regression etc. are used to make the study analysis.

Research gap

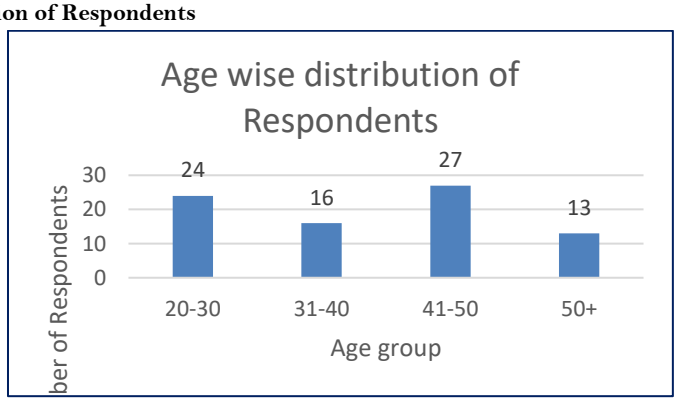
There are many research studies on the women street vendors in urban areas. But there is scarcity of such studies with connection to taluka places or semi-urban like regions. Hence to fill the gap in research. The present study is undertaken.

Data Analysis and Interpretation

Age wise distribution of Respondents

Following chart-01 shows the age wise distribution of respondents in the study area. 24 women street vendors fall in the age category of 20-30, 16 respondents fall in the age group of 31-40, 2 of them are in the age group of 41-50 and 13 respondents are above 50 age.

Chart 01-Age wise distribution of Respondents



Source: Field Survey

Status of Education and Monthly Income

Following table gives us the details of level of education and Income of the respondents in the study area (Gokak Taluka). 17 respondents (19.7%) are illiterate and majority of them i.e. 8 respondents earn monthly income between Rs.5,000-10,000. And only 4 respondents earn above Rs.10, 000.the respondents completed primary education if around 28 (33.3%) where most of them (11 respondents) earn monthly income between Rs.5,000-10,000. With relation to the respondents who have high school education (18), majority of them are earning less than Rs.10,000 monthly income. With regard to those who have completed PUC or Class 12 education earning better income. Around 8 respondents out of 16 are earning more than Rs.15,000 monthly income. There is only one respondent who has gone for degree or graduation education, earning around Rs.10,000-15,000. It is clear from the below table that majority women street vendors are in the middle-income range and no perfect correlation is found between education and income.

Table 01- Education and Monthly Income of Respondents in the Study Area.

	₹<5000	₹5000–10000	₹10000–15000	>₹15000	Total
Illiterate	1 (11.1%)	8 (27.6%)	4 (21.1%)	4 (17.4%)	17 (19.7%)
Primary	2 (22.2%)	11(37.9%)	7 (36.8%)	8 (34.8%)	28 (33.3%)
High School	5(55.6%)	6 (20.7%)	4 (21.1%)	3 (13.0%)	18 (26.7%)
PUC	1(11.1%)	4 (13.8%)	3 (15.8%)	8 (34.8%)	16 (19.1%)
Degree	0(0.0%)	0(0.0%)	1 (5.3%)	0(0.0%)	1 (1.3%)
Total	09(100.0%)	29(100.0%)	19(100.0%)	23(100.0%)	80(100.0%)

Source: Field Survey

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Correlation Analysis

Using correlation between the continuous and ordinal variables is measured using the Spearman Correlation Matrix. Table 02 shows the correlation matrix of important variables like age, education, experience, income, family size and savings. The below correlation matrix indicates that there is positive and statistically significant relationship between monthly income and savings of the women street vendors i.e. 0.43 ($p<0.05$). this infers that is income increases, savings also increase. The relationship among other variables is found statistically insignificant and weak. It is clear from the above analysis that income has the vital impact on savings of women street vendors.

Table 02: Correlation Matrix

Variables	Age	Education	Experience	Income	Family Size	Savings
Age	1.00	-0.15	-0.20	-0.01	0.12	-0.01
Education	-0.15	1.00	-0.02	0.12	-0.15	0.05
Experience	-0.20	-0.02	1.00	0.17	-0.06	0.05
Income	-0.01	0.12	0.17	1.00	0.08	0.43
Family Size	0.12	-0.15	-0.06	0.08	1.00	0.15
Savings	-0.01	0.05	0.05	0.43	0.15	1.00

Source: Field Survey

Regression Analysis

Taking monthly income as the dependent variable and variables like age education, experience, family size and loan status as independent variables an OLS regression model is estimated. The results are presented in the below table.

Table 03: OLS regression model

Predictor	Coefficient (B)	Std. Error	t	p-value
Intercept	**6141.02**	**3104.85**	**1.978**	**0.052**
Age	**20.15**	**54.84**	**0.367**	**0.714**
Education	**678.73**	**406.33**	**1.670**	**0.099**
Experience	**179.75**	**104.62**	**1.718**	**0.090**
Family Size	**291.81**	**264.97**	**1.101**	**0.274**
Loan	**-590.17**	**1143.34**	**-0.516**	**0.607**

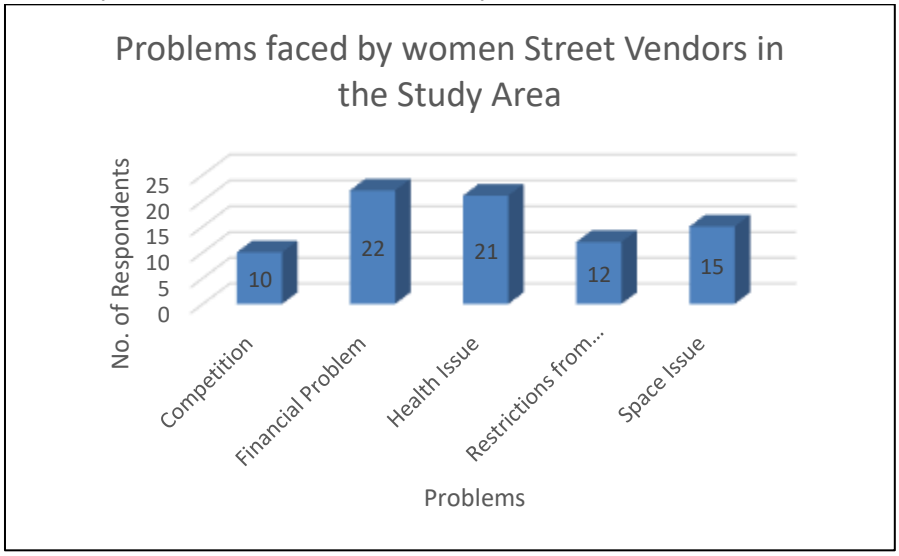
Source: Field Survey

From the above model its is found that the overall R^2 value is only around 7.7 percent, which means the selected independent variable explain only a small percentage variation in the monthly income of the women street vendors. The variables like education and experience show a weak influence on the income and remaining other variables have p values greater than 0.10, showing not statistically significant.

Challenges and Problems of Women's Street Vendors

Chart 02 below reveals the problems face by women street vendors in the taluka. 10 respondents (12.5%) said that they face competition in their vending business, 22 respondents (27.5%) pointed that they are facing financial problems, 21 (26.25%), respondents mentioned that they have health issues, 12 respondents (15%) revealed that they are facing restrictions from the local bodies and remaining 15 respondents (18 %) mention the space problem. Thus, the discussion indicates that Majority of the respondents are facing financial and health issues.

Chart. 02: Problems faced by women Street Vendors in the Study Area



Source: Field Survey

Findings and suggestions

From the above discussion and analysis, it is found that majority women street vendors are in the middle-income range, less education and there is no perfect correlation is found between education and income. There is positive and statistically significant relationship between monthly income and savings of the women street vendors. The above analysis also revealed that Majority of the respondents are facing financial and health issues.

With the above analysis it can be said that women street vendors need more support from the government to overcome their challenges and problems. Measures need to be taken to provide loans, training, fixed places & space of selling, social security etc. Hence Governments need to take measures and frame policies towards upliftment of the women street vendors.

Conclusion

The women street vendors in the Gokak taluka selling vegetables, milk, fruits, flowers etc are found economically weaker. Even though they are contributing to the economic stability of their family, they are facing number of socio-economic challenges. Measures need to be taken to provide social security, financial security, insurance facility mainly for their health. To sum up Women street vendors play a important role in economic activities of everyday life. There is need to improve their standard of life. And government need to take measures in this regard.

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I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study entitled "A Socio-Economic Analysis of Women Street Vendors: Evidence from Gokak Taluka in Karnataka State."

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Original Article

Dynamics of Regional Economics: A Study with Special Reference to Kalyana (Hyderabad) Karnataka

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Abstract

Regional economics provides a useful lens for understanding persistent intra-state disparities in India, particularly within historically disadvantaged regions such as Kalyana (Hyderabad) Karnataka. This paper examines the dynamics of regional development in Kalyana Karnataka by integrating evidence from government reports, performance audits, and peer-reviewed studies on regional inequality, human development, and constitutional special provisions. The region has long been identified as one of the most backward parts of Karnataka, with a high concentration of "most backward" taluks, relatively low per-capita income, weak human development outcomes, and inadequate infrastructure despite significant policy initiatives and dedicated funding flows. The analysis highlights how historical legacies, uneven sectoral transformation, limited industrialisation, deficits in human capital, and institutional weaknesses have shaped the region's development trajectory. The paper also reviews the impact of Article 371J and the functioning of the Kalyana Karnataka Region Development Board (KKRDB), arguing that while there has been some progress, constitutional and programmatic interventions have not yet transformed the region's structural position in the state economy. Drawing on insights from regional-development literature and Karnataka-specific evidence, the paper proposes policy directions centred on place-based industrial strategies, human-capital deepening, improved regional governance, and stronger monitoring of special development programmes.

Keywords: *Regional economics, Kalyana Karnataka, Hyderabad Karnataka, Article 371J, regional disparity, human development, Karnataka*

Introduction

Regional economics focuses on how spatial factors and location-specific characteristics influence patterns of growth, investment, and welfare. It is particularly concerned with explaining why some regions within the same state or country persistently lag behind others despite sharing common macro-institutions and policy frameworks. In India, these questions have become salient as rapid growth in metropolitan "growth poles" has coexisted with entrenched deprivation in several sub-regions.

Karnataka offers a textbook case of intra-state imbalance, with a dynamic, services-driven southern and coastal belt coexisting alongside relatively stagnant northern districts. Studies using human development and composite indices consistently find that Kalyana (Hyderabad) Karnataka occupies the lower rungs of the state's development hierarchy, even as southern and coastal districts consolidate their lead. Government-appointed committees and subsequent audits have repeatedly identified the region as a concentration of "most backward" taluks and a target for special interventions.

This paper examines the dynamics of regional economics in Karnataka with special reference to Kalyana Karnataka, synthesising evidence on historical legacies, structural features of the regional economy, social and human development outcomes, and the impact of Article 371J and the Kalyana Karnataka Region Development Board. The objective is not to provide a full econometric model but to offer an analytically grounded narrative informed by peer-reviewed literature, government reports, and selected newspaper analyses.

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Conceptual background: regional economics and imbalance

Regional economics is centrally concerned with how cumulative processes of investment, innovation, and migration generate persistent "core–periphery" structures within a territory. Concepts such as cumulative causation, agglomeration economies, and growth poles explain why capital and skilled labour tend to cluster in already-developed regions, while lagging areas face low investment, weak markets, and limited fiscal capacity. Peer-reviewed studies on Karnataka's regional disparities show that such dynamics have created a "two-speed" state economy, with the south and coastal districts forming an advanced core and much of the north functioning as a peripheral zone. (Deepa & Hanagodimath, 2024; Hanagodimath, 2014a; Niranjan, 2021).

A key institutional response in Karnataka was the constitution of the High-Power Committee for Redressal of Regional Imbalances under D. M. Nanjundappa, which designed the Comprehensive Composite Development Index (CCDI) to classify taluks into developed, backward, more-backward, and most-backward categories. Subsequent empirical work using CCDI-type indices and related measures confirms that regional imbalances not only persisted but in some respects widened over time, with northern districts, including the Hyderabad/Kalyana Karnataka belt, failing to converge with the state average in terms of income, infrastructure, and social indicators.

Profile of Kalyana (Hyderabad) Karnataka

Kalyana Karnataka comprises the former Hyderabad-Karnataka districts that were under the Nizam's rule and later integrated into Karnataka: Bidar, Kalaburagi, Yadgir, Raichur, Koppal, Ballari and related newly carved districts such as Vijayanagara. The region is predominantly semi-arid, with rain-fed agriculture, relatively low levels of urbanisation, and historically limited investment in education and health, which together have shaped its developmental trajectory.

The Nanjundappa Committee's application of the Comprehensive Composite Development Index (CCDI) revealed that Kalyana Karnataka contained a disproportionate share of the state's "most backward" taluks: of 39 such taluks identified state-wide, 21 were located in this region (Government of Karnataka, 2002; Vijayalakshmi, 2017). Later analyses have confirmed that, even after a decade of targeted funding through Special Development Plans, Kalyana Karnataka continues to lag on multiple indicators, including per-capita income, road density, irrigation, school infrastructure, and health facilities. This persistent lag forms the empirical basis for constitutional and policy recognition of the region's special status.

Historical and institutional drivers

Historical trajectories strongly condition regional economic outcomes. Under the Nizam, the Hyderabad-Karnataka area saw relatively low public investment in economic and social infrastructure compared to the princely State of Mysore, which laid the foundations for later industrialisation and human-capital formation in southern Karnataka (Government of Karnataka, 2002; Hanagodimath, 2014a; Mantur & Hanagodimath, 2024). Peer-reviewed analyses argue that this colonial-era neglect created an initial condition of underdevelopment that post-Independence planning has not fully overcome, especially given the continued concentration of state investments around Bengaluru and its hinterland (Niranjan, 2021; Ahmed, 2017).

In response to protests and demands from northern districts in the 1990s, the state set up successive region-specific development boards and ultimately appointed the Nanjundappa Committee to map and address intra-state imbalances. Following sustained mobilisation from Kalyana Karnataka, the Constitution (Ninety-eighth Amendment) Act, 2012 inserted Article 371J, granting the region special provisions such as reservations in education and public employment, and the establishment of a dedicated development board (Udchanchi & Khandimath, 2024; Maradi, 2020; Karnataka State Planning Department, 2022; Government of India, 2012). These institutional innovations are central to the region's contemporary political economy and are discussed further below (Udchanchi & Khandimath, 2024; CBPS, 2018).

Income and growth dynamics

Recent government data and newspaper analyses based on the Economic Survey of Karnataka highlight the depth of the income gap between Kalyana Karnataka and the state's growth poles For 2024–25, Kalaburagi—the district often used as a proxy for the region's situation—recorded a per-capita income of around ₹1.44 lakh, compared with a state average of roughly ₹3.86 lakh and Bengaluru Urban's figure of about ₹8.56 lakh. This implies that per-capita income in Kalaburagi is roughly one-sixth of Bengaluru's and significantly below the state mean, despite Karnataka's overall status as a relatively high-income state in India (Government of Karnataka, 2026; The Hindu, 2026).

Over time, the pattern resembles a "two-speed" growth process. Studies of district domestic product and per-capita income from the early 1990s to the late 2000s show that the share of income generated by already-prosperous southern and coastal divisions increased, while northern divisions, including Hyderabad/Kalyana Karnataka, saw slower growth and persistent intra-regional disparity (Mantur & Hanagodimath, 2024; Niranjan, 2021). More recent analyses using economic survey data indicate that Kalyana Karnataka districts together contribute only about one-tenth of the state's Gross State Domestic Product, with particularly low shares in high-productivity services, even though they account for a much larger share of the state's population (Comptroller and Auditor General of India [CAG], 2022; Government of Karnataka, 2026; Down to Earth, 2024).

The Covid-19 pandemic accentuated these vulnerabilities. A study on the pandemic's impact on per-capita income in Hyderabad Karnataka finds that precarious, low-wage employment, weak social protection, and limited diversification made the region especially susceptible to income shocks, leading to further erosion of purchasing power among poor households (Prabhusetti, 2023). This episode illustrates how structural regional backwardness interacts with macro shocks to deepen.

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Human Development and Social Indicators

Regional economics increasingly integrates human development as a core dimension of spatial inequality (Sen, 1999; Niranjan & Rajappa, 2018). Karnataka's State Human Development Reports (KSHDR), as analysed in recent journal articles, document a striking stability in the state's development hierarchy: districts such as Bengaluru Urban, Dakshina Kannada, Udupi and Kodagu consistently record high Human Development Index (HDI) scores, while Kalyana Karnataka districts—Raichur, Yadgir, Koppal, Ballari and Kalaburagi among others—remain clustered at the bottom (Chowdappa, 2025; Karnataka State Planning Department, 2022; Sharma, 2025).

Low human development in Kalyana Karnataka is closely associated with multiple, overlapping deprivations. Studies emphasise weak educational attainment, particularly at secondary and higher levels; deficient health infrastructure; and high multidimensional poverty among Scheduled Castes, Scheduled Tribes, and minority communities in the region (Chowdappa, 2025; Karnataka State Planning Department, 2022; Niranjan & Rajappa, 2024; Sharma, 2025). Taluk-level analyses reveal that severe deprivation can remain hidden within moderately ranked districts, suggesting that a substantial share of the region's population experiences compounded disadvantage in education, health, housing, sanitation, and employment quality (Chowdappa, 2025; Niranjan & Rajappa, 2021). These patterns reinforce the view that narrow income-based measures understate the depth of regional backwardness (Niranjan & Rajappa, 2021; Karnataka State Planning Department, 2022).

Sectoral Structure and Employment

The sectoral composition of Kalyana Karnataka's economy reflects a slow and incomplete structural transformation. Data suggest a continued dominance of agriculture and low-productivity informal services, with relatively limited industrial and modern services development compared to the southern metropolitan belt. While the region has some mineral-rich districts such as Ballari, the benefits of extractive activities have not translated into broad-based industrial clusters or wide local employment gains, partly because of enclave-type production structures and weak local linkages.

Agriculture in the region is constrained by semi-arid conditions, low irrigation coverage, rain-shadow effects, and limited access to high-value markets (Manik Raj, 2017; Gouda, Maraddi, & Satish, 2013; Nagaraj et al., 2018). Studies highlight the prevalence of small and marginal holdings, low crop diversification, and vulnerability to price and climate shocks (Nagaraj et al., 2013; Nagaraj et al., 2018; Effect of Climate Change on Marginal Farmers, 2021). Non-farm employment is heavily concentrated in unstable casual work and low-end self-employment, especially for women and youth, which depresses household incomes and constrains the inter-generational accumulation of human capital (Sivamurugan, 2016; Sujata, 2025). Together, these structural features limit the region's ability to catch up with more diversified districts (Manik Raj, 2017; Sivamurugan, 2016).

Article 371J and regional institutions

Article 371J constitutes a distinctive institutional intervention in regional economics, embedding regional development objectives in constitutional provisions (Rashmi, 2015; Udchanchi & Khandimath, 2024; Government of India, 2012). Academic analyses of Article 371J emphasise its twin aims: correcting historical inequities by providing reservations in education and public employment for local residents, and ensuring more equitable allocation of state resources through a dedicated regional development board (Rashmi, 2015; Maradi, 2020; Centre for Budget and Policy Studies [CBPS], 2018). The article empowers the Governor to establish such a board, monitor the equitable distribution of funds, and promote technical and vocational education to enhance employment prospects in the region (Government of India, 2012; Rashmi, 2015; Udchanchi & Khandimath, 2024; Maradi, 2020).

Empirical assessments of Article 371J's implementation present a mixed picture (Maradi, 2020; Udchanchi & Khandimath, 2024; CBPS, 2018). Peer-reviewed studies note that reservations have expanded access to professional education and government jobs for some sections of the local population, and that there have been visible improvements in road connectivity, educational infrastructure, and public buildings in parts of the region (Rashmi, 2015; Udchanchi & Khandimath, 2024; Prabhakara & Patil, 2025).

Kalyana Karnataka Region Development Board and Governance

The Kalyana Karnataka Region Development Board (KKRDB), established under Article 371J, is the institutional fulcrum for planning and implementing special development works in the region. A performance audit by the Comptroller and Auditor General (CAG) for the period 2016–21 assessed the Board's effectiveness across key functions, including identification of development gaps, project selection, fund allocation, implementation, and monitoring.

The report concludes that, despite substantial financial outlays, the region continues to lag behind the rest of Karnataka on multiple development indicators, including per-capita income, poverty, education, health, and basic services. The audit identifies several governance shortcomings: inadequate use of robust, updated indicators to prioritise projects; delays and inconsistencies in project execution; weak budgetary control; and incomplete monitoring of utilisation certificates and outcomes.

These findings resonate with broader critiques of special-area development programmes in India, which argue that without strong local planning capacity, transparency, and integration with mainstream sectoral policies, such programmes risk becoming fragmented, input-oriented interventions with limited impact on structural disparities.

Persistent challenges in Kalyana Karnataka

From a regional-economics perspective, addressing Kalyana Karnataka's challenges requires strategies that combine territorial targeting with structural transformation. Empirical work on Karnataka's regional disparities and broader Indian evidence suggests several

directions (Hanagodimath, 2014a; Chowdappa, 2025; Alkire & Seth, 2015).

One priority is to develop place-based industrial and services strategies that build on the region's specific resource base and location while overcoming enclave-type extractive patterns. This could include fostering agro-processing clusters, labour-intensive manufacturing, and logistics hubs connected to national corridors, with explicit linkages to local small and medium enterprises and skill-development institutions. (CAG, 2022; Government of Karnataka, 2026; Karnataka Tourism Department, 2020; CBPS, 2018; Deccan Herald, 2023).

A second direction is deepening human-capital investments with an explicit regional and social-equity lens. Studies drawing on KSHDR 2022 argue for targeted improvements in school quality, expansion of secondary and tertiary education in the region, and gender-sensitive measures to support women's education and employment. Within the Article 371J framework, this suggests better aligning reservation policies with improvements in foundational education, vocational training, and higher-education capacity in Kalyana Karnataka, so that local youth can meaningfully access the opportunities created (Sharma, 2025; Chowdappa, 2025; Karnataka State Planning Department, 2022).

Third, regional governance needs strengthening. The CAG's performance audit indicates that the effectiveness of the KKRDB depends on its ability to use up-to-date composite indicators, robust project appraisal systems, transparent budgeting, and outcome-oriented monitoring. Insights from evaluations of the Nanjundappa-inspired Special Development Plan point to the importance of ensuring that allocations closely match the degree of backwardness and that funds are not diluted across relatively better-off taluks. Embedding such principles in the Board's operating procedures could enhance the developmental impact of Article 371J.

Finally, broader state-level policies on investment promotion, infrastructure, and social protection must systematically incorporate a regional-equity perspective. Newspaper analyses of recent Economic Surveys note nascent efforts by the state government to design industrial and tourism policies favouring north Karnataka and to raise the region's contribution to GSDP; the real test will be whether these initiatives are sustained, adequately funded, and aligned with the region's structural constraints (Government of Karnataka, 2026; The Hindu, 2026; The Print, 2026).

Policy Directions and Implications

From a regional-economics perspective, addressing Kalyana Karnataka's challenges requires strategies that combine territorial targeting with structural transformation. Empirical work on Karnataka's regional disparities and broader Indian evidence suggests several directions (Hanagodimath, 2014a; Chowdappa, 2025; Alkire & Seth, 2015).

One priority is to develop place-based industrial and services strategies that build on the region's specific resource base and location while overcoming enclave-type extractive patterns. This could include fostering agro-processing clusters, labour-intensive manufacturing, and logistics hubs connected to national corridors, with explicit linkages to local small and medium enterprises and skill-development institutions. Government reports on rural infrastructure and CAG audits emphasise that such strategies must be backed by reliable physical connectivity, power, digital infrastructure, and robust quality-control systems (CAG, 2022; Government of Karnataka, 2026; Karnataka Tourism Department, 2020).

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Closing Remarks

Kalyana (Hyderabad) Karnataka illustrates how historical legacies, spatial patterns of investment, and institutional design interact to produce persistent regional inequality within a relatively fast-growing state. Evidence from government reports, audits, and scholarly studies shows that, despite constitutional recognition and targeted programmes, the region remains substantially behind Karnataka's leading districts on income, human development, and infrastructure. Moving towards a more balanced regional economy will require not only maintaining special provisions under Article 371J but also re-orienting them toward structurally transformative, region-specific strategies, backed by stronger governance and sustained political commitment.

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Original Article

Swarna Grama Arogya Darshini (Sgad): A Holistic Convergence Framework for Rural Health, Sanitation, And Social Welfare in Palnadu District

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Abstract:

tftis paper examines /fte "Sworno Cromo Aroqyo Dorsftini" (SCAD) program in Polnodu District, a pioneering governance modet achieving inler-deparlmenlot convergence for rurot wel[ore. By inlegroling /fte functional strengths o(Ponc/io/of Aoj, Health, /CDS, and Education deparlmenls, /fte program addresses critical health gaps including HPV vaccination and the prevention o(child marriages. This expanded study incorporates new dimensions o[behavioral change in nu/ri/ion, preventive fteo//ft guidelines, and /fte ins/i/utiono/ination o(regular health monitoring. Central to Ihis model is /fte Cromo Sobfto, which institutionalizes transporenc'y and occountobilin//ftroug/i digilot monitoring. 7fte s/ud/ elaborates on Ihe roles o[various stakeholders, highlighting benefiils such as single-window service delivery and challenges including departmental silos, providing a scalable blueprint for sustoinob/e rurot deme/opment aligned with LIN Sus/oinob/e Development Goals.

Keywords: *Inter-departmentalConvergence, HPVVaccine, GramaSabha Transparency, Food Behavior Change, Health Monitoring, Rural Health.*

Introduction

Traditional rural governance often operates in administrative silos, leading to service delivery gaps. The Swarna Grams Arogya Darshini (SGAD) initiative in Palnadii District, Andhra Pradesh, breaks these barriers by bringing all village-level functionaries-from Hcalih Workers to MGNREGS Field Assistant nder a single unified platform. This convergence ensures ihat health is managed as a collective outcome of sanitation, ninrition, and social protection. The framework recognizes thai medical inicrveniion alone is insufficient; rather, a combination of behavioral shifis, regular monitoring, and environmental sanitation is required io achieve holistic well-being.

Addressing Critical Health and Soclal Gaps

Universalixation of Vaccine Programs & HPV

A core pillar of SGAD is ensuring 10098 saturaiion of immunizaiion. Beyond the roiiiine Universal Immunizaiion Program (UIP), the program prioritizes ihe Human Papillomavinis (HPV) vaccine for adolescent girls io preveni cervical cancer. Grama Sabhas are used to track eligibility and ensure completion of doses, clearing historical gaps in adolesceni health coverage.

Prevention of Child Marriages

SGAD identifies child marriage as a significant socio-medical challenge leading to early pregnancies and malnutrition. Through the convergence of the Revenue department and ICDS, the program monitors adolescent school dropouts and conducts community-wide counseling. This proactive approach helps enforce legal age standards and proiects the long-term health of young women.

Instffut3onal Roles and Functional Convergence

Panchayat Raj Department: Environmental Sanitation

The Panchayai Raj department manages the foundational deierminants of health. Their mandate includes systematic door-io-door collection and segregation of dry and wet garbage ai the source for effective composting.

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Regular desilting of drains and elimination of stagnant water are prioritized to prevent vecior-borne diseases like Malaria and Dengiie. Sanitation mainienance also extends io ensuring cleanliness around public institutions and village sueets.

Health Department: Universal Health Coverage

The Health department utilizes SGAD Sabhas for community-based screening. Key activities include systematic Hemoglobin (Hb) testing for pregnant women to combai anemia and institutionalizing screenings for Non-Communicable Diseases (NCDs) like hypertension and diabetes. This allows for early detection and management of chronic conditions before they escalate into emergencies.

IUDS Department: Frontline Nutrition and Growth

The Integrated Child Development Services (ICDS) wing plays a vital role in nutritional surveillance. This includes the identification of Severely Acute Malnourished (SAM) and Moderaiely Acute Malnourished (MAM) children for immediate intervention. FuRhermore, the department ensures the quality of Take-Home Rations tTHR) and Hoi Cooked Meals at Anganwadi Centers while promoting the diversification of local diets through Niitri-gardens.

Strategies For Food Behavior Change

A significant addition io the SGAD framework is ihe focus on "Food Behavior Change" (FBC). Malnutrition in rural areas is often a result of cultural habits rather than lack of resources. The SGAD model employs several strategies to shifi these paradigms:

&lPmmonooof a&umflMMWs

The program actively encourages ihe iransition from polished rice to traditional millets like Ragi, Jowar, and Bajra. These are promoied as "Super-foods" during Grama

Sabhas. Live cooking demonstrations at Anqanwadi comers help mothers understand how to incorporate these nutrient-dense grains into iasty daily meals for children.

A2 Elimination of Junk Food Culture

With the increasing penetration of processed snacks in rural markets, SGAD workers conduct awariness campaigns on the "Invisible Killers"—excess salt, sugar, and trans-fats. Communities are educated on the long-term impacts of packaged foods on childhood obesity and early-onset diabetes.

A3 The "Plateof Colors" Initiative

Behavioral change is driven through visual education. The "Plate of Colors" concept teaches villagers to include green leafy vegetables, yellow fruits, and whiic proteins in c very meal. This simple visual cue has proven more effective than complex nutritional charts in changing daily consumption patterns.

Essential Health Tips and Preventive Practices

Preventive healthcare is a cornerstone of the SGAD model. The program disseminates actionable health tips through various community touch points io reduce the disease burden.

Water, Sanitation, and Hygiene (WASHJ

Villagers arc consistently educated on ihc "Fivc Moments of Hand Hygiene," especially before handling food and after using toilets. The importance of drinking hoilcd and cooled water, particularly during the monsoon season, is emphasized to prevent watcrbornc diseases like Typhoid and Cholera.

Physical Activity and Stress Management

Despite the physical nature of rural lahor, the lack of structured cardiovascular c xcrcisc and high-stress levels contribute to hypertension. SGAD promotes "Yoga in the Park/School" and community walking groups. Simplc tips on ergonomics for farmers and laborers arc also shared to prevent musculoskeletal disorders.

Maternal and Child Care Tips

The program provides specific guidance on c xclusivc breastfeeding for the first six months, the importnnc c of colostrum, and the timely introduction of complementary foods. For expectant mothers, tips on iron-rich diets and the necessity of at least four ANC (Antenatal Care) checkups arc prioritized.

Systematic and Regular Monitdring Df Health Check-Ups

To move from reactive io proactive health management, SGAD has institutionalixcd a rigorous monitoring schedule that tracks the health profile of every resident.

The Monthly Health Audit

During the first Thursday of every month, the SGAD Sahha serves as a massive health screening camp. Digital records arc updated for every household. Individuals with borderline hlood pressure or sugar levels arc flagged for weekly follow-ups by the ANM (Auxiliary Nurse Midwife) and ASHA workers.School and Anganwadi Health Cards

Every child under ihe SGAD framework is issued a Digiial Health Card. Regular quarterly check-ups monitor height, weight, BMI, and vision. This longitudinal data allows the administration to ideniify growth stunting early and provide supplementary nutrition or medical intervention immediately.

Geriatric and NCD Surveillance

Special focus is given to the elderly. Monthly door-to-door visits ensure thai patients with chronic conditions (NCDs) are adhering io their medication. The monitoring system tracks the availability of essential medicines at the Village Health Clinic to ensure no paiieni misses a dose due io supply chain issues.

Transparency and Accountability Through grama Sabha

The Grama Sabha (SGAD Sabha) is the mechanism for public accountability. Its effectiveness is rooicd in digital monitoring, where mandatory uploading of photos and videos verifies meeting occurrence and progress. Departmental functionaries must present progress reports directly to ihc community, allowing for immediate feedback and grievance rcdrcssal. DWACRA Self-Help Groups (SHGs) act as social auditors, verify ing the quality of water samples and ihc standard of school meals.

Benefits And Challenges of The Sgad Model

Elaborated Benefits

- Single-Window Delivery: Simplifies access to multiple welfare schemes for rural citizens in a single location.
- Early Risk **Identification:** Proactive screening for anemia and NCDs pre yenis medical emergencies through regular check-ups.
- Holistic **Sanitation:** Integrates garbage management with health, leading to a visible reduction in seasonal diseases.
- Nutritional Security: Behavioral changes in food

consumption lead to sustainable long-term health outcomes.

Elaborated Challenges

- Departmental **Silos:** Overcoming the traditional tendency of departments io work in isolation requires constant leadership intervention.
- Data Synchronization: Harmonizing real-time data across various digital portals (Health, Education, Secretariat) remains a technical hurdle.
- **Behavioral** Shifts: Addressing deep-seated cultural resistance to certain vaccines or dietary changes (like millets) is a slow process requiring patience.

Conclusion

The SGAD program in Palnadu demonstrates that horizontal convergence, coupled with a focus on behavioral change and regular monitoring, is the key to sustainable rural dc velopment. By insiitutionalizing transparency and focusing on critical gaps like HPV vaccination, nuuition, and child marriage, the model creams a resilieni ecosysiem. It serves as a vital case study for ihe localized implementation of the UN SDGs, proving that when departments work in unison wiih the community, tire vision of a "Swarna Grama" (Golden Village) becomes attainable.

Acknowledgement

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this study entitled **"Swarna Grama Arogya Darshini (SGAD): A Holistic Convergence Framework for Rural Health, Sanitation, and Social Welfare in Palnadu District."**

First and foremost, I extend my heartfelt thanks to my supervisor, faculty members, and academic mentors for their invaluable guidance, encouragement, and constructive suggestions throughout the course of this work. Their expertise and support have been instrumental in shaping this study and enhancing its quality.

I am grateful to my institution for providing the necessary academic resources, infrastructure, and a supportive environment for conducting this research. I also express my sincere appreciation to the officials of various government departments, healthcare workers, sanitation staff, social welfare functionaries, and local administrative authorities whose cooperation and insights greatly contributed to the successful completion of this study.

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I would also like to acknowledge the contributions of researchers, policymakers, and development practitioners whose studies and publications on rural development, public health, sanitation, and social welfare served as important references and enriched the conceptual framework of this work.

Finally, I express my deepest gratitude to my family, friends, and colleagues for their unwavering support, encouragement, and motivation throughout this academic journey. Their confidence and understanding have been a constant source of inspiration.

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Original Article

Sustainable Finance and Green Investment Policies: Pathways Toward Global Sustainable Development

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Abstract

Sustainable finance and green investment policies have become increasingly important in addressing global environmental, economic, and social challenges. Rapid industrialization, climate change, biodiversity loss, and rising economic inequality have highlighted the need for financial systems that promote sustainability and responsible development. Sustainable finance refers to financial services and investment strategies that integrate environmental, social, and governance (ESG) factors into economic decision-making processes. Green investment policies support environmentally sustainable projects such as renewable energy, green infrastructure, sustainable transportation, climate adaptation systems, and energy-efficient technologies. This research paper examines the role of sustainable finance in promoting sustainable global development and analyzes the effectiveness of green investment policies in different economies. The study explores global policy frameworks, ESG integration, financial innovation, institutional participation, and the growing importance of climate-related investments. Furthermore, the paper identifies challenges such as greenwashing, regulatory uncertainty, and lack of standardization while proposing recommendations for improving sustainable financial ecosystems worldwide.

Introduction

The twenty-first century has witnessed unprecedented environmental and economic challenges that threaten global sustainability. Climate change, global warming, resource depletion, environmental pollution, and increasing social inequalities have forced governments, corporations, and financial institutions to reconsider traditional economic growth models. Economic systems based solely on industrial expansion and profit maximization have contributed significantly to ecological degradation and unsustainable resource consumption. In response to these concerns, sustainable development has emerged as a global priority. Sustainable development aims to balance economic growth, environmental protection, and social welfare to ensure the well-being of present and future generations. Financial systems play a central role in this transition because investment decisions directly influence industrial development, technological innovation, and infrastructure growth. Sustainable finance has therefore become a critical mechanism for achieving climate goals and promoting inclusive development. Sustainable finance integrates environmental, social, and governance considerations into financial and investment activities. This approach encourages responsible investment practices that minimize environmental harm while supporting social progress and economic stability. Green investment policies are government and institutional initiatives designed to direct financial resources toward environmentally sustainable projects. These policies include renewable energy subsidies, green taxation systems, carbon pricing mechanisms, green bonds, sustainable banking regulations, and ESG disclosure frameworks. International agreements such as the Paris Climate Agreement and the United Nations Sustainable Development Goals (SDGs) have accelerated global interest in sustainable finance. Countries worldwide are now developing strategies to mobilize green capital and encourage sustainable investment practices. This paper examines the importance of sustainable finance and green investment policies in promoting sustainable economic transformation and global development.

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Objectives of the Study

The primary objectives of this research study are: • To understand the concept and significance of sustainable finance.

- To analyze global green investment policies and ESG frameworks.
- To evaluate the role of financial institutions in sustainable development.
- To identify major challenges in implementing sustainable finance systems.
- To explore opportunities for future green economic transformation.
- To provide recommendations for strengthening global sustainable finance mechanisms.

Research Methodology

This study is based on qualitative and descriptive research methods. Secondary data have been collected from various reliable sources including academic journals, government publications, World Bank reports, IMF reports, United Nations publications, sustainability frameworks, and international research papers. The study uses analytical and comparative approaches to examine sustainable finance practices across different economies. Information regarding ESG integration, green bonds, renewable energy investments, and sustainable banking practices has been reviewed and analyzed to understand current trends and future prospects.

Concept of Sustainable Finance

Sustainable finance refers to financial activities that integrate environmental, social, and governance factors into investment and lending decisions. The concept promotes long-term economic growth while protecting natural resources and ensuring social welfare. The environmental dimension focuses on climate action, carbon reduction, biodiversity protection, renewable energy, and pollution control. The social dimension addresses labor rights, gender equality, community welfare, poverty reduction, and human rights. Governance involves corporate ethics, transparency, accountability, and responsible management practices. ESG investing has become one of the fastest-growing investment trends worldwide. Investors increasingly evaluate companies based on sustainability performance alongside financial profitability. Sustainable finance encourages corporations to adopt environmentally responsible and socially inclusive business models.

Evolution of Green Investment Policies

Green investment policies evolved as governments recognized the economic and environmental risks associated with climate change and unsustainable industrialization. International climate agreements such as the Kyoto Protocol and Paris Agreement encouraged countries to adopt policies supporting low-carbon development. One major development has been the growth of green bonds, which are financial instruments specifically used to finance environmentally sustainable projects. Governments, corporations, and multilateral institutions now issue green bonds to fund renewable energy, clean transportation, climate resilience, and sustainable infrastructure projects. Many countries have also introduced mandatory ESG disclosure regulations requiring corporations to report sustainability-related information. Sustainable banking frameworks and responsible investment principles have further accelerated the integration of sustainability into global financial systems.

Importance of Sustainable Finance

Sustainable finance contributes significantly to climate change mitigation, economic stability, social development, and technological innovation. Green investments support renewable energy development, energy efficiency, electric mobility, and sustainable infrastructure. Sustainable finance also helps financial institutions manage climate-related risks and improve long-term investment stability. ESG-based investments promote ethical corporate behavior, reduce environmental damage, and strengthen investor confidence. Additionally, sustainable finance encourages innovation in clean technologies and green industries, generating employment opportunities and supporting inclusive economic growth. It also plays a critical role in achieving the United Nations Sustainable Development Goals.

Global Green Investment Policies

The European Union has emerged as a global leader in sustainable finance through initiatives such as the European Green Deal and Sustainable Finance Disclosure Regulation. These policies aim to achieve carbon neutrality and mobilize large-scale green investments. The United States has expanded climate-related investments through renewable energy programs, green infrastructure development, and electric vehicle incentives. China has become one of the largest investors in renewable energy and sustainable infrastructure. The country has developed significant green bond markets and low-carbon industrial strategies. India has introduced renewable energy missions, green bond initiatives, and ESG disclosure frameworks to encourage sustainable economic growth and climate resilience.

Role of Financial Institutions

Financial institutions are essential in mobilizing capital for sustainable development projects. Commercial banks provide loans for renewable energy and green infrastructure projects. Investment funds direct capital toward ESG-compliant companies and sustainable industries. Central banks increasingly assess climate-related financial risks and encourage environmentally responsible monetary policies. International institutions such as the World Bank and Asian Development Bank provide financial assistance and technical support for climate adaptation and sustainable development programs. Insurance companies also contribute by evaluating environmental risks and supporting resilience-building initiatives.

Challenges in Sustainable Finance

Despite rapid growth, sustainable finance faces several challenges. One major challenge is the lack of standardized ESG reporting frameworks, which creates inconsistency in sustainability assessments. Greenwashing remains another significant concern, where companies falsely portray themselves as environmentally responsible without implementing meaningful sustainability practices.

Developing countries often face limited financial resources, technological barriers, and insufficient institutional capacity to implement large-scale green investments. High initial investment costs and regulatory uncertainty can also discourage sustainable investment activities.

Opportunities for Future Development

Sustainable finance presents significant opportunities for economic transformation and global development. The growing demand for renewable energy, sustainable transportation, green buildings, and climate adaptation infrastructure creates new investment opportunities. Technological innovation, including artificial intelligence, blockchain technology, and digital finance, can improve transparency, efficiency, and accountability in sustainable financial systems. The expansion of ESG investment funds and international climate finance mechanisms is expected to accelerate the global transition toward low-carbon and inclusive economies.

Recommendations

Several measures can strengthen sustainable finance systems globally: • Governments should establish standardized ESG reporting frameworks.

- Green bond markets should receive regulatory and tax support.
- International cooperation in climate finance should be enhanced.
- Financial inclusion programs should support vulnerable communities.
- Stronger regulations are needed to prevent greenwashing.
- Educational and awareness programs should promote sustainable investment practices.

Conclusion

Sustainable finance and green investment policies are transforming modern financial systems by integrating environmental sustainability, social responsibility, and economic growth. The increasing recognition of climate-related risks and sustainability challenges has accelerated the adoption of ESG investment practices and green financial regulations worldwide. Although challenges such as regulatory inconsistency, greenwashing, and unequal access to finance persist, sustainable finance remains essential for achieving long-term global development goals. Governments, financial institutions, corporations, and international organizations must collaborate to create transparent, inclusive, and resilient financial systems capable of supporting future sustainable development. The future of economic growth depends on balancing innovation, sustainability, and social welfare to ensure a stable and environmentally secure global economy.

Acknowledgement

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study entitled **"Sustainable Finance and Green Investment Policies: Pathways Toward Global Sustainable Development."**

First and foremost, I extend my heartfelt thanks to my supervisor, faculty members, and academic mentors for their invaluable guidance, continuous encouragement, and constructive suggestions throughout the course of this research. Their expertise and support have been instrumental in shaping the direction and quality of this study.

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Original Article

Significance of Traditional Cooking Methods such as Chulha, Sigdi, and Tandoor in the Modern Culinary Era.

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Abstract

Traditional cooking methods like chulha, sigdi, and tandoor have been integral to culinary heritage for centuries. Despite rapid modernization and the widespread use of advanced kitchen technologies, these methods continue to hold cultural, nutritional, and sensory importance. This paper explores their relevance in the modern culinary era, focusing on sustainability, flavor enhancement, cultural preservation, and their evolving role in contemporary gastronomy.

Introduction

Cooking methods have evolved significantly from primitive fire-based systems to modern gas and electric appliances. However, traditional techniques such as chulha (clay stove), sigdi (charcoal stove), and tandoor (clay oven) remain relevant due to their cultural and functional value.

A chulha is a traditional clay stove widely used in rural India, especially where modern appliances are limited (Zama Organics, 2023). The sigdi, dating back to the Mughal era, is commonly used for charcoal-based cooking and grilling (Moneycontrol, 2023). The tandoor, with origins traced to the Indus Valley Civilization, is one of the oldest cooking systems (IHM Notes, 2022).

Objectives of the Study

- To analyze the relevance of traditional cooking methods in modern times
- To evaluate their impact on flavor and nutrition
- To examine their role in sustainability
- To understand their contribution to cultural preservation

Review of Literature

Traditional cooking methods have been extensively studied for their impact on food quality and heritage preservation. According to Achaya (1998), Indian culinary traditions are deeply rooted in indigenous cooking systems. Sen (2004) also highlights that traditional cooking methods play a crucial role in shaping regional cuisines.

Studies suggest that tandoor cooking achieves high temperatures that enhance texture and flavor (Zama Organics, 2023). Historical evidence also confirms the presence of such cooking systems in ancient civilizations (IHM Notes, 2022).

Research Methodology

This study is based on qualitative research using secondary data from books, journals, and credible online sources. Comparative analysis has been conducted to understand differences between traditional and modern cooking methods.

Results and Discussion

1 Cultural Significance

Traditional cooking methods symbolize heritage and communitybonding. Practices such as shared cooking on a chulha reflect social unity and equality (IHM Notes, 2022). These methods preserve culinary traditions and cultural identity

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2. Visual Representation of Traditional Cooking Methods

Fig.no.1
Chulha (Traditional Clay Stove)
Source: Zama Organics (2023)

Fig.no 2
Sigdi (Charcoal Stove)
Source: Moneycontrol (2023)

Fig.no 3
Tandoor (Clay Oven)
Sources: Indian Express (2024); Dsource IIT Bombay (2021)

3 Flavor and Sensory Enhancement

Traditional cooking methods impart distinctive flavors. Chulha cooking provides earthy and smoky notes, sigdi enhances charcoal aroma, while tandoor cooking produces a crispy texture with smoky richness (Zama Organics, 2023). The high heat of tandoor cooking also helps retain moisture in food.

4 Nutritional Aspects

Slow cooking techniques often help preserve nutrients better compared to rapid cooking methods (FAO, 2017). Additionally, traditional cooking involves minimal processing, contributing to healthier food preparation.

5 Sustainability and Environmental Impact

Traditional cooking methods rely on locally available fuels such as wood and charcoal. According to FAO (2017), such practices can contribute to sustainable food systems when managed responsibly.

6 Role in Modern Culinary Industry

Modern chefs and restaurants are reviving traditional cooking methods to enhance authenticity. Tandoor cooking has gained global recognition and is widely used in restaurants worldwide (Indian Express, 2024). Fusion cuisine often integrates traditional techniques with modern presentation styles.

7 Challenges

Smoke-related health issues

Environmental concerns due to fuel usage
Time constraints in urban lifestyles

Conclusion and Recommendations

Traditional cooking methods such as chulha, sigdi, and tandoor remain highly significant in the modern culinary era. They offer unique flavors, cultural richness, and sustainable practices. Integrating modern innovations like smokeless chulhas can help preserve these traditions.

Recommendations

Promote improved traditional cooking technologies
Include traditional methods in culinary education
Encourage sustainable fuel usage
Preserve regional culinary practices

Acknowledgement

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this study entitled **"Significance of Traditional Cooking Methods such as Chulha, Sigdi, and Tandoor in the Modern Culinary Era."**

First and foremost, I extend my heartfelt thanks to my supervisor, teachers, and academic mentors for their invaluable guidance, encouragement, and constructive suggestions throughout the course of this research. Their support and expertise played a vital role in the successful completion of this study.

I am grateful to my institution for providing the necessary resources, facilities, and academic environment that enabled me to carry out this work effectively.

I would also like to express my appreciation to culinary experts, traditional cooks, artisans, and community members who have preserved and shared knowledge about traditional cooking practices. Their experiences and insights greatly enriched this study and helped in understanding the cultural, historical, and practical significance of Chulha, Sigdi, and Tandoor cooking methods.

My sincere thanks go to the researchers, authors, and historians whose publications on food culture, traditional culinary techniques, and sustainable cooking practices served as valuable references and enhanced the quality of this research.

I am also thankful to my friends and colleagues for their encouragement, cooperation, and helpful discussions during various stages of the project.

Finally, I express my deepest gratitude to my family for their unwavering support, patience, and motivation throughout this academic endeavor. Their encouragement and belief in my abilities have been a constant source of inspiration.

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Original Article

Emotional Cartographies of Migration: Women's Experience in *The Mistress of Spices* and *Brick Lane*

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Abstract

This paper aims to examine the emotional facets of women's diasporic experiences in Chitra Banerjee Divakaruni's The Mistress of Spices (1997) and Monica Ali's Brick Lane (2003). Cultural negotiation, hybridity, and identity are often highlighted in diaspora studies. The affective aspect of migration remains comparatively unexplored. The study introduces the idea of emotional cartography of migration in an effort to address this gap. According to this theory, emotions serve as mapping instruments that influence diasporic subjectivity in psychological, cultural, and spatial realms. This paper makes the argument that feelings like belonging, nostalgia, displacement, and identity struggle are products of society and culture. These feelings have an impact on the lived experiences of migrating women. The study employs a qualitative approach through close textual analysis, referencing Postcolonial Theory, Feminist Theory, Diaspora Studies, and Affect Theory.

By carefully analysing the chosen texts, Tilo and Nazneen's emotional journeys are examined. It draws attention to how their identities are negotiated within diasporic and patriarchal structures. The study demonstrates that migration is an emotive process of identity formation, and transcends beyond just physical relocation. It also presents the point that emotional experiences are vital to interpreting female diasporic subjectivity. This is due to the fact that, in transnational contexts, the relationship between space, memory, and belonging is mediated by emotional experiences.

Keywords: *Diaspora; Emotional cartography; Migration; Female subjectivity; South Asian diasporic fiction*

Introduction

Diaspora encompasses intricate emotional, cultural, sociological, and psychological changes that go much beyond the notion of physical displacement. Today, diaspora is understood as a lived experience marked by continuous negotiation between memory and experience, belonging and alienation, home and displacement. It is no longer understood merely as movement of individuals from one location to another. People who migrate frequently undergo a state of in-betweenness which makes them neither integrated into the host culture nor entirely anchored in their native country. Due to changing cultural contexts and emotional responses to new places, a fractured sense of identity is produced, that is always changing. The intersecting structures of patriarchy, cultural norms, and socio-economic constraints exacerbate this position for women. In addition to physical displacement, women migrants experience diaspora also as an emotional and gendered negotiation. Their identities are shaped within the home, marriage, cultural traditions, and immigrant settings, which restrict as well as transform their agency. Thus, women's diasporic experiences become profoundly ingrained to emotions that impact their feeling of belonging and identity.

The emotional complexities of migration, especially through women's narratives are significantly depicted in South Asian diasporic fiction. Chitra Banerjee Divakaruni's *The Mistress of Spices* (1997) and Monica Ali's *Brick Lane* (2003) are two significant works in this context. The female protagonists in both novels negotiate identity development, cultural transition, and migration in diasporic settings. Tilo in *The Mistress of Spices and* Nazneen in *Brick Lane* experience different but interconnected emotional paths. These paths are shaped by displacement, cultural conflict, memory, and the search for belonging.

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In addition to a physical journey, their experiences demonstrate migration to be an emotional and psychological process of transformation. It is necessary to foreground the emotional aspects of migration as a key analytical category, even while themes of hybridity, identity, and cultural negotiation in diasporic literature have received a lot of scholarly attention. Most research that is currently available focuses on the social and cultural aspects. It often ignores the ways in which emotions shape the lived experience of migration. By presenting the notion of emotional cartographies of migration, this research fills this gap. This concept views feelings like displacement, nostalgia, identity conflict, and belonging as socially and culturally created processes that construct diasporic subjectivity. These emotions work as "cartographies" that show how migrant women experience and interpret their changing lives in both their home and host countries. Thus, to comprehend identity creation in diasporic fiction, the emotional terrain of migration becomes crucial.

This study examines how the female protagonists overcome emotional displacement and recreate meaning in diasporic spaces through an analysis of *The Mistress of Spices* and *Brick Lane*. It contends that literature offers an important platform for mapping these affective aspects of migration. It also argues that emotional experiences are important to the construction of identity. Ultimately, to comprehend the intricacies of female diasporic subjectivity, the study presents emotion as a crucial lens.

Methodology

To examine the emotional experiences in the selected South Asian diasporic novels, this study uses a qualitative textual analysis. It uses close reading as the main technique to analyse narrative structures, character development, and thematic issues in the selected texts. Postcolonial Theory, Feminist Theory, Diaspora Studies, and Affect Theory contribute to the analysis by offering an interdisciplinary framework for comprehending the emotional production of female diasporic subjectivity. The study focuses on literary representation and interpretive analysis to investigate how emotions like displacement, nostalgia, identity conflict, and belonging serve as structural factors within diasporic narratives. A clear understanding of the symbolic, cultural, and psychological dimensions of migration as portrayed in literature is made possible by this approach.

Literature Review

In postcolonial, feminist, and migration studies, South Asian diasporic literature has been widely studied, with most researchers focus on issues of identity formation, hybridity, and cultural negotiation. Diaspora is seen as a state of in-betweenness and relational identity creation, where subjectivity is constantly formed by displacement, memory, and cultural interaction, according to foundational theoretical contributions by Homi K. Bhabha (1994) and Avtar Brah (1996). While Bhabha's concept of hybridity highlights the instability and fluidity of cultural identity in postcolonial situations, Brah's concept of "diaspora space" is especially important in understanding how gender, race, and class overlap within migratory experiences.

Monica Ali's *Brick Lane* has drawn scholarly attention as it depicts the migrant women's lives in Britain. According to Cavalcanti (2024), London is a gendered heterotopic location where migrant women negotiate oppression and agency through metropolitan mobility and everyday lived experience. Similarly, Upstone (2010) argues that the city becomes a dynamic arena for negotiating belonging and exclusion, emphasizing how important urban environment is in shaping the subjectivity of migrants. As reflected in more general research on diasporic women's literature, feminist interpretations of *Brick Lane* highlight Nazneen's shift from domestic passivity to growing agency. The emotional processes that underlie this shift, especially affective experiences like anxiety, silence, and internal conflict that shape Nazneen's subjectivity are frequently under theorized. In relation to feminist identity development, hybridity, and magical realism, Chitra Banerjee Divakaruni's *The Mistress of Spices* has also been extensively researched. Shaw and Banu (2022) explain that the novel is a feminist exploration of the psychological and emotional challenges faced by immigrant women like Tilo, Hameeda, and Lalita. They emphasize the ways in which these characters deal with the issues of patriarchy, identity, and cultural conflict. Using Bhabha's Third Space", Salami and Pirayesh (2018) investigate hybridity in *The Mistress of Spices* contending that Tilo's identity changes from fragmentation to hybrid completeness. Mallikarjun and Sridhar (2023) contend that the novel depicts diaspora as liberating and oppressive, as cultural dislocation, homesickness, and emotional alienation within host societies are encountered by the immigrants. *The Mistress of Spices* is constantly interpreted through the frameworks of feminism, hybridity, and multiculturalism. Although these methods offer insightful perspectives on gendered experience and cultural identity, the emotional aspects are frequently treated as incidental rather than essential to diasporic subjectivity. Diaspora study has increasingly turned toward Affect Theory to fill in these gaps. Emotions are socially and spatially disseminated forces that mold bodies, identities, and belonging (Ahmed, 2004). Ahmed's paradigm makes it possible to reconsider migration as an emotive process where feelings like desire, alienation, and nostalgia actively shape lived experience. In the same way, affect is described by Brian Massumi (2002) as a pre-conscious intensity that molds physical and spatial perception. Affect is still underexplored in South Asian women's diasporic fiction, where emotional labor is important but not well theorized.

The lack of a methodical framework that views emotion as a mapping structure of migration is identified as a significant research gap by this study. The emotional cartographies of migration which views emotions as culturally and spatially rooted factors that shape female diasporic identity, is put forth to close this gap. This paradigm goes beyond identity-based readings to highlight emotion as a key analytical category in South Asian diasporic literature by combining postcolonial, feminist, and affective methods.

Theoretical Framework

To examine the emotional and gendered aspects of migration in selected South Asian diasporic fiction, this

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study uses an interdisciplinary theoretical framework, enabling a complex understanding of how cultural negotiation, emotional experience, and displacement construct female subjectivity.

The fundamental lens for understanding migration is provided by Postcolonial Theory. Theorists like Homi K. Bhabha and Edward Said highlight how processes of displacement, hybridity, and "othering" shape cultural identity. To explain how migrant identities are developed in between cultural locales, neither fully belonging to the homeland nor the host land, Bhabha's concept of the "third space" is significant. Feminist theory focuses on how migration affects women differently. Postcolonial feminist thinkers like Chandra Talpade Mohanty and Gayatri Chakravorty Spivak highlight how women in postcolonial settings face multiple forms of marginalization influenced by race, culture, and patriarchy. The experiences of women are intricately entwined with domestic spaces, marital structures, and cultural norms in the chosen literature. An analysis of how characters like Tilo and Nazneen negotiate agency within sociocultural contexts is made possible by feminist theory, which transforms emotional labour and silence into strategies for resistance and survival.

The conceptual foundation for comprehending migration as a state of cultural dispersion and identity reconfiguration is provided by diaspora theory. Because it views diaspora as a place where many histories, identities, and power dynamics converge, Avtar Brah's concept of "diaspora space" is pertinent. James Clifford highlights diaspora as a continuous process of balancing roots and routes. According to this concept, diaspora is shown in *The Mistress of Spices* and *Brick Lane* as a spatial and emotional experience in which belonging is constantly redefined. The novels emphasize the intricacy of cultural bonding in immigrant environments as well as the impermanence of home.

The primary analytical instrument for this research is Affect Theory, specifically the work of Sara Ahmed. It views emotions as social and relational forces that circulate between bodies, places, and civilizations rather than as private psychological states. In these novels, migration creates strong emotional experiences that shape how women understand themselves. This makes it possible to conceptualize emotional cartographies of migration as a paradigm for comprehending how emotions shape diasporic life.

This study places female diasporic experience within a multifaceted framework. It shows that migration is not just about moving from one place to another but also about gender, culture, identity, and emotions. This helps us understand how South Asian women in literature experience both struggle and transformation in their lives.

Emotional Cartographies of Migaration in the Novels

1. Displacement and Alienation

The fundamental emotional state of the female diasporic experience in both *The Mistress of Spices* and *Brick Lane* is displacement and alienation. In these novels, migration is more than just moving from one country to another; it's an emotionally upsetting journey that alters the subject's perception of themselves, their surroundings, and society. Tilo's presence in the spice store in *The Mistress of Spices* creates a distinct but no less powerful kind of emotional displacement. Because of her mystical function and self-imposed constraints, she is emotionally distant even though she is constantly surrounded by human stories, desires, and sorrows. "I am a Mistress of Spices" (Divakaruni, 1997) as Tilo states, her self-imposed emotional detachment from interpersonal relationships is strengthened by this. Similar to Tilo's own fractured subjectivity, the spice shop serves as a transitional diasporic site, neither entirely belonging to America nor India. Because she is physically present in a thriving immigrant community yet emotionally cut off from it, her estrangement is contradictory

Similar to this, Nazneen's move from rural Bangladesh to urban London in *Brick Lane* signifies the start of a significant emotional break. Silence, seclusion at home, and cultural alienation define her early diasporic life. London is used as an overpowering atmosphere that heightens her sense of invisibility rather than as a place of possibility. As Nazneen contemplates, "She did not how to be in this place" (Ali, 2003). This demonstrates her profound feeling of emotional and cultural confusion. Her arranged marriage and seclusion from the outside world further limit her individuality within the home. As a result, she experiences emotional alienation from her own identity as well as social alienation from the host culture. In both patriarchal and diasporic frameworks, her silence becomes a marker of her marginal status. . Displacement functions as an emotional state that characterises diasporic subjectivity in both stories. It is more than just losing one's nation; it is the ongoing feeling of being out of place on a physical and mental level.

2. Nostalgia and Memory

A vital emotional framework that links diasporic subjects to their displaced pasts is nostalgia. Characters are able to resolve the conflicts between their past and present identities because it serves as both cultural survival mechanism and a psychological haven. In *The Mistress of Spices*, memory is collective, symbolic, and personal. With imbedded histories of migration, yearning, suffering, and longing, the spices at Tilo's store serve as archives of cultural memory. Tilo becomes a mediator of diasporic memory through her interactions with these spices, but she is also made aware of her own emotional distance from human experience. The assumption that diaspora is maintained through symbolic and sensory links rather than fixed recollections is reinforced by the fractured and dispersed memory seen here.

Nazneen's recollections of Bangladesh are consistently romanticized in *Brick Lane* as places of emotional familiarity and simplicity. Her current existence in London, which is characterized by emotional loneliness and cultural unfamiliarity, contrasts with her memories of childhood, rural settings, and familial ties. But these recollections are dynamic; they change as Nazneen's identity starts to change. As a result, nostalgia develops into a powerful emotional force that simultaneously ties her to the past and draws attention to its limitations in the context of her current reality. As a result, nostalgia functions as an emotional cartography in both novels, mapping the conflict

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between continuity and loss and enabling characters to negotiate new identities while preserving a tenuous link to their roots.

3. Identity Conflict

In both texts, identity conflict- which reflects the volatility of diasporic subjectivity- emerges as a major emotional crisis. The conflicting demands of tradition, autonomy, belonging, and desire have produced this conflict, which is not only cultural but also intensely emotional. Identity conflict functions on a deeper symbolic and metaphysical level in *The Mistress of Spices*. Tilo's mystical persona necessitates emotional distance, but this identity is undermined by her growing interest in human experiences. The friction between obligation and emotional attachment, duty and desire, is what causes her internal anguish. Tilo acknowledges, "I break the rules" (Divakaruni, 1997). Her shift toward emotional participation is reflected in this.

Nazneen's progressive shift from passive surrender to developing self-awareness shapes her identity in *Brick Lane*. She internalizes conventional expectations that restrict her agency after being first restricted to the duties of wife and mother. Her exposure to the diasporic milieu, however, progressively presents her with other identities. Nazneen recognizes, "I am not the same woman" (Ali, 2003) at a pivotal moment. Her identity and emotional self-awareness have changed. As a result, there is an emotional conflict between autonomy and obedience, which leads to a fractured identity that is constantly discussed rather than settled. In both texts, identity is an emotionally turbulent process molded by cultural dislocation and individual development rather than a set category. Through emotional interactions with relationships, memories, and place, the self is constantly rebuilt.

4. Emotional Negotiation of Belonging

The negotiation of belonging, which is a continuous process rather than a definitive conclusion, is the last phase in the emotional map of migration. In diasporic environments, belonging is constantly emotionally created, conditional, and partial. Nazneen's slow growth of agency in *Brick Lane* illustrates a change from emotional passivity to active negotiation of her position in the diasporic area. Her changing relationship with London serves as an example of how emotional fortitude and selective adaptation, rather than absorption, can lead to a sense of belonging. Nazneen's recognition that, "This is my place" (Ali, 2003) reflects this. This implies a reinterpretation of belonging. Both her interaction with her current surroundings and her continuity with her past contribute to the formation of her hybrid identity.

Tilo's final metamorphosis in *The Mistress of Spices* represents a synthesis between human participation and emotional distance. Her choice to welcome emotional experience is a symbolic acceptance of hybridity, in which emotional openness rather than withdrawal is used to create a sense of belonging. Tilo states, "I choose to be human" (Divakaruni, 1997). This demonstrates her acceptance of emotional ties as a foundation for a sense of belonging. This change emphasizes how emotional participation in diasporic communities may be transformative. Therefore, belonging is a constant emotional negotiation defined by resistance, adaptation, and self-redefinition within many cultural frames rather than a set destination.

Discussion

The analysis shows that emotional experiences play a crucial role in the construction and negotiation of identity in diasporic fiction. Migration creates multi-layered emotional geographies where complex subjectivities are formed by the intersection of location, memory, culture, and identity. *The Mistress of Spices* and *Brick Lane* both demonstrate how inherently emotive the diasporic experience is for women. Emotions are interrelated processes that shape lived experience rather than discrete psychological states. These feelings serve as mapping tools that show how people migrate from dislocation to partial kinds of emotional settlement.

Crucially, the approach also emphasizes how emotional experiences in diaspora are gendered. Domestic, relational, and cultural contexts that exacerbate emotional labor influence women's subjectivities. As a result, patriarchal and cultural expectations not only cause their migratory experiences to be emotionally over determined, but also spatially dislocated. The novels also imply that emotional development is nonlinear. It reflects the fragility of diasporic identity itself and is cyclical, continuing, and fractured. The main way that women create meaning in ambiguous and changing cultural contexts is through emotional bargaining.

Conclusion

Using two South Asian diasporic novels- *The Mistress of Spices* by Chitra Banerjee Divakaruni and *Brick Lane* by Monica Ali- this paper has investigated the idea of emotional cartographies of migration. It has looked at how affective experiences deeply ingrained in the processes of migration, cultural displacement, and identity negotiation form female diasporic subjectivity. The study makes the case that feelings like displacement, nostalgia, identity conflict, and belonging serve as organised mapping mechanisms that arrange migrant women's lived experiences across emotional, cultural, and spatial dimensions rather from just being psychological reactions.

The study shows that migration is a deeply emotional process that constantly transforms identity in addition to being a geographical or cultural shift through the examination of the chosen texts. Nazneen and Tilo, the main characters, represent distinct but related emotional paths that illustrate the intricacies of diasporic life. Their experiences show that identity in the diaspora is continuously reconstructed through emotional involvement with memory, geography, relationships, and cultural negotiation rather than being permanent or stable.

The study also emphasizes the gendered nature of emotional experience in diasporic fiction. The interlocking systems of patriarchy, domesticity, and cultural expectation affect women's subjectivities, intensifying the emotional labor in both home and hostile environments. Their migration experiences are therefore characterized by multi-layered emotional geographies where adaptation, resistance, survival, and loss coexist. In the end, because it emphasizes the interdependence of emotion, space, and identity, the idea of emotional cartography offers a useful critical framework for analysing diaspora literature. It makes it possible to

comprehend how literature depicts both the internal affective landscapes of migration as well as its exterior realities. By reframing emotion as a key analytical category in the interpretation of South Asian women's diasporic fiction, the work therefore advances feminist literary studies and diaspora studies.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Role of Indian Agricultural Products in International Market: Present Scenario

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Abstract

Agriculture fulfils the basic need of human kind by producing food. About a century ago, farmer used to produce food commodities mostly for self-consumption or for exchange with others mostly in the same village or nearby places. They were primarily self-reliant. But now production environment has changed considerably from self- reliance to commercialization. Technological advancement in the form of high yielding varieties, use of fertilizers, insecticides, pesticides, farm mechanization has led to a substantial increase in farm production and consequently the larger marketable and marketed surplus. The improved production is accompanied by the increasing urbanization, income, changing life style & food habits of the consumers and increasing linkages with the overseas market.

Key words: *International Market, Production, Role Marketing Strategy, Development, Fertilizers, Environment, Consumers etc.*

Introduction:

Agricultural marketing is a process which starts with a decision to produce a saleable farm commodity, involves all the aspects of market structure or system, both financial and institutional, based on technical and economic considerations, and includes pre- and post-harvest operations, assembling, grading, storage, transportation and distribution. The study of agricultural marketing comprises all the operations, and the agencies conducting them, involved in the movement of farm produced foods; raw materials and their derivatives, such as textiles, from the farms to the final consumers, and the effect of such operations on the farmers, middlemen and consumers. Today consumers are not limited to rural areas where food is produced. Further, increasing demand for processed or semi-processed food products requires value addition in the raw agricultural produce. These developments require movement of food commodities from producer to consumers in the form of value-added products. Agricultural marketing brings producers and consumers together through a series of activities and thus becomes an essential element of the economy. The scope of agricultural marketing is not only limited with the final agricultural produce. It also focuses supply of agricultural inputs to the farmers. The agricultural marketing system includes two major sub-system viz. product marketing and input marketing. The product marketing sub-system includes farmers, primary traders, wholesalers, processors, importers, exporters, marketing cooperatives, regulated marketing committees and retailers. The input sub-system includes input manufacturers, distributors, related associations, importers, exporters and others who make available various farm production inputs to farmers.

Problems of the Study:

India's agricultural sector is a cornerstone of its economy and a key player in global trade. With its vast and fertile land, India produces a diverse array of crops, including fruits, vegetables, pulses, spices, and oilseeds, making it one of the top agricultural exporters in the world. The country's favourable climate and rich soil allow for year-round cultivation, providing a steady produce supply for domestic and international markets. One of the major factors contributing to India's dominance in agricultural exports is the wide variety of products it offers.

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Objectives of the Study:

The main objective of this research is to study the role of Indian agricultural products in the international market, and some specific objectives have been given by the researcher as follows.

1. To Study the international market.
2. To Study the role of Indian agricultural production.
3. To Study the factors affecting the international market.

Significance of the Study:

India's agricultural exports are diverse and high in demand. Spices like turmeric, cumin, and black pepper are particularly popular, with India being one of the largest exporters of these products globally. Additionally, India's fruits, such as mangoes, bananas, and pomegranates, are cherished worldwide for their quality and taste. Another important aspect of India's role in global agricultural trade is its commitment to maintaining high standards of quality and safety.

Scope of the Study:

Indian exporters, like Jay Bhavani Exim, follow stringent quality control measures to ensure that their products meet international standards. This includes adhering to food safety regulations, implementing sustainable farming practices, and ensuring that their produce is free from harmful pesticides and chemicals. By maintaining these high standards, Indian agricultural products continue to be trusted and preferred by consumers around the world.

Limitation of the Study:

The economic impact of agricultural exports on India is significant. It not only contributes to the country's GDP but also provides livelihoods to millions of farmers and workers involved in the agricultural supply chain. The export sector also plays a crucial role in stabilizing the country's economy by generating foreign exchange and creating employment opportunities in rural areas.

Period of the Study:

The researcher has completed the research by reviewing data from 2025-26 to study the impact of international markets on Indian agricultural production.

Research Methodology:

While conducting a detailed study of the status of Indian agricultural products in the international market, the researcher has used various types of secondary research. These include research papers, journal articles, newspapers, audio videos, reference books, serial books, annual reports etc.

Research Method:

This research has been completed using descriptive analysis method to study in detail the role and current situation of Indian agricultural products in the international market.

Results and Discussion:

International trade has played a significant role in shaping the trajectory of Indian agriculture, influencing farmers' incomes, production patterns, and market opportunities. As India integrates more deeply with the global market, agricultural revenue has been impacted through changes in export potential, import competition, global price fluctuations, and policy reforms. While international trade has opened new avenues for growth, it has also brought challenges that affect the economic stability of farmers across the country. International trade has provided Indian farmers access to markets far beyond domestic boundaries. High-value crops such as spices, tea, coffee, rice, cotton, fruits, and vegetables have become major export items. This expansion has contributed to increased revenue for certain segments of farmers, particularly those cultivating export-oriented crops.

International Trade and Indian Agriculture Production:

International trade has increasingly shaped the trajectory of India's agricultural sector, offering farmers opportunities far beyond the limitations of domestic markets. As globalisation deepened over the past few decades, India's integration into world markets has allowed its agricultural producers to reach consumers across continents. This shift has had significant implications for farm incomes, production patterns, technological adoption, and rural livelihoods. One of the most direct benefits of international trade is access to larger and more diversified markets. Indian farmers, once dependent solely on local mandis, can now sell products such as basmati rice, spices, tea, cotton, sugar, marine products, and fresh fruits and vegetables to countries across Asia, Europe, Africa, and the Americas. This expanded market access helps farmers secure better prices, especially for high-value or specialty crops. For example, the global demand for basmati rice or Indian spices often exceeds domestic demand, enabling farmers to fetch premium prices internationally.

Role of Indian Agriculture:

International trade has had a mixed but significant impact on Indian agriculture revenue. While it offers opportunities for higher income, diversification, and modernization, it also exposes farmers to global competition and price volatility. The ultimate effect depends on how effectively India manages its trade policies, supports its farmers, and equips them to compete in the global marketplace. With the right interventions, international trade can become a powerful driver of growth and improved livelihoods in India's agricultural sector. While international trade offers avenues for growth and modernization, it undeniably exposes Indian farmers to competition from cheaper imported agricultural goods. Addressing this challenge requires a nuanced approach one that combines openness to global markets with robust domestic support systems.

Growth of Agricultural Marketing in India:

Marketing of agricultural commodities developed after the man was able to produce more food than he needed for himself, and exchange of his products with others started. This transition from production for consumption to production for exchange came about slowly. About a century ago, farmers used to consume most of what they produced; but, now most of what the farmers produce is exchanged for other things what they require. This tendency has increased their dependence on marketing, which has resulted in the overall development of the market mechanism.

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Table No. 1 India's Agriculture Trade

Years	Import	Export
2020-2021	19.40	32.46
2021-2022	20.92	35.60
2022-2023	21.86	41.90
2023-2024	21.65	50.24
2024-2025	32.42	53.15

Source: Govt. of India (Food Ministry), 2025

Chart No. 1 India's Agriculture Trade

The researchers have studied trade and import and export in India in Table No.1 While conducting this research, the researcher has studied the agricultural sector and import and export policy in India for a total of five years. India has become an important country from the point of view of agriculture sector as it has a larger share of the total agricultural production. The share of agriculture sector is important in creating economic stability in India. However, from the point of view of farmers, the share of import and export is expected to increase to the maximum. The price paid to farmers for the commodity is determined by the demand for the commodity in the international market. In 2024 25, exports were 53.15 and imports were 32.42.

Technological Change in Agriculture:

Technological developments in agriculture, such as the evolution of high yielding varieties of seeds, increased use of modern inputs and cultivation practices in the agricultural sector, have resulted in substantial increase in farm production. The marketed surplus of agricultural produce has therefore increase. This has resulted into the growth on the marketing system. The tendency towards increasing specialization by farmers and regions in certain crops or livestock has resulted in an increase in their efficiency and the breakdown in the self-sufficiency of the family unit. Specialization, thus, has resulted in increased production, which is the base for the growth of marketing and, in turn, of the economy. This has also resulted in improved use efficiency of natural resources like land and water.

Agriculture Development and Trade:

The increase in transportation and communication facilities has widened the market for farm products. The length and breadth of the market to which a product is taken from the production areas have increased. In the absence of these facilities, the movement of produce from one area to another was limited, and the consumption of a product was restricted only to the areas of production or at the most, to nearby areas. The scope of marketing has thus increased manifold.

Conclusion:

India's agricultural sector is a vital part of the global trade ecosystem. Its ability to produce and export a wide variety of high-quality products has earned it a strong reputation in international markets. The forefront of this industry, ensuring that India's agricultural products reach every corner of the world. As the global demand for Indian produce continues to grow, India's role in global agricultural trade is set to expand even further. Agriculture Export Policy which is aiming to double the export of agriculture and allied sector by incorporating Indian farmers and their agricultural products to the global value chain prospect. As of November 2018, the draft of the policy has been prepared for enforcement. Some other government policy enforcement has been taken during recent years.

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I am grateful to my institution for providing the necessary academic resources, facilities, and a supportive environment that enabled me to undertake and complete this work successfully.

I would also like to acknowledge the contributions of farmers, agricultural experts, policymakers, export agencies, and researchers whose knowledge and insights have

enhanced the understanding of India's agricultural sector and its growing role in international trade.

My sincere appreciation is extended to the authors, scholars, and organizations whose publications, reports, and statistical data on agricultural production, exports, global trade, and market trends served as valuable references for this study.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Green Synthesis of Metal Nanoparticles from Medicinal Plants: Mechanisms, Environmental and Health Applications

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Abstract:

The eco-friendly synthesis of metal nanoparticles utilising medicinal plants has emerged as a sustainable alternative to traditional chemical processes. This review concentrates on three medicinal plants-Bryophyllum pinnatum, Oxalis corniculata, and Trianthema portulacastrum-recognized for their abundant phytochemical profles and therapeutic attributes. These plants have demonstrated signifcant potential in the creation of nanoparticles for many uses in medicine, environmental remediation, and agriculture. The study emphasises recent progress in utilising plant extracts as reducing and stabilising agents for the production of nanoparticles. Focussing on the bioactive compounds found in these plants—such as terpenoids, alkaloids, and favonoids—that aid in the reduction of metal ions and provide nanoparticle stability is the main objective. Comprehensive analysis of nanoparticle dimensions, characterisation techniques and biological activities, encompassing antibacterial, antioxidant, and anticancer efects, is presented. The paper also examines the obstacles and opportunities associated with scaling these green synthesis processes for industrial use. This review concentrates on specifc plants to provide new insights into the sustainable synthesis of nanoparticles and their potential to enhance several domains of nanotechnology.

Keywords: *Oxalis corniculata, Bryophyllum pinnatum, Trianthema portulacastrum, Eco-friendly, Characterization techniques, Applications.*

Introduction:

Nanoparticles are particles between 1 and 100 nanometers, with unique properties due to their small size and high surface area. Traditional methods for synthesising nanoparticles often involve toxic chemicals and high energy consumption, leading to environmental and health concerns [1]. Green synthesis methods, mainly plant extracts, have emerged as eco-friendly and sustainable alternatives. Plant-mediated synthesis utilises natural biomolecules found in plants to reduce metal ions into nanoparticles [2], offering a simple, cost-effective, and environmentally benign approach. Nanotechnology has emerged as a revolutionary field with applications in medicine, electronics, environmental science and agriculture [3]. One promising aspect of nanotechnology is the biosynthesis of nanoparticles (NPs) using biological organisms, including plants. This method is environmentally eco-friendly, cost-effective and sustainable compared to traditional physical and chemical synthesis methods [4].

Nanotechnology, the science of manipulating matter at the nanoscale, has emerged as a transformative force across diverse fields, including medicine, agriculture, and environmental remediation. Among its many innovations, nanoparticles stand out due to their unique properties, such as high surface area, tunable optical and electronic behaviour, and enhanced catalytic potential. However, conventional methods for nanoparticle synthesis, such as chemical reduction and physical vapour deposition, often come with significant drawbacks. These include the use of hazardous chemicals, high energy demands, and the generation of toxic by-products, all of which pose risks to human health and environmental sustainability. These limitations have spurred the exploration of eco-friendly and sustainable alternatives, with green synthesis emerging as a particularly promising approach [5].

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Green synthesis leverages biological entities-such as plants, bacteria, fungi, or biomolecules to facilitate nanoparticle formation. Among these, medicinal plants have garnered significant attention due to their rich reservoirs of phytochemicals, including alkaloids, flavonoids, terpenoids, phenolics, and tannins. These compounds act as natural reducing and stabilizing agents, enabling the synthesis of nanoparticles without the need for additional toxic chemicals. For instance, silver nanoparticles (AgNPs) synthesized using Azadirachta indica (Neem) exhibit potent antimicrobial activity, while gold nanoparticles (AuNPs) derived from Curcuma longa (Turmeric) have demonstrated promising anticancer properties. Such examples underscore the potential of medicinal plants to produce biocompatible nanoparticles with inherent bioactivity [6].

The application of medicinal plants in nanoparticle synthesis extends beyond their green chemistry advantages. By harnessing the therapeutic properties of plants, this approach creates nanoparticles with enhanced functionalities. For example, Ocimum sanctum (Holy Basil) has been used to produce nanoparticles with antioxidant and antimicrobial properties, making them suitable for wound healing and infection control. Similarly, Withania somnifera (Ashwagandha) has been employed to synthesize gold nanoparticles with selective cytotoxicity against cancer cells, offering potential for advanced drug delivery systems [7].

In addition to biomedical applications, plant-mediated nanoparticles hold immense potential in agriculture and environmental management. Zinc oxide nanoparticles (ZnO NPs) synthesized using Moringa oleifera have been shown to enhance crop productivity while reducing pest damage. Meanwhile, iron oxide nanoparticles (Fe_3O_4 NPs) derived from Tridax procumbens have been utilized for the remediation of heavy metal-contaminated water and soil. These examples highlight the versatility of green synthesis in addressing global challenges, ranging from food security to environmental pollution [8].

Despite its promise, the green synthesis of nanoparticles faces several challenges that must be addressed to facilitate widespread adoption. Variability in plant extract composition, influenced by factors such as plant species, cultivation conditions, and extraction methods, can lead to inconsistencies in nanoparticle size, shape, and stability. Additionally, scaling up laboratory protocols to industrial production remains a significant hurdle. Advances in standardization techniques, process optimization, and interdisciplinary collaboration are essential to overcome these barriers and unlock the full potential of this field [9].

This study delves into the green synthesis of nanoparticles using medicinal plants, focusing on the underlying mechanisms, recent advancements, and practical applications. It also examines the challenges and future prospects of this sustainable approach, emphasizing its contributions to ecofriendly innovation and the achievement of sustainable development goals. By addressing these aspects, the study aims to provide a comprehensive understanding of how green synthesis can drive progress in nanotechnology while promoting environmental and human health [10].

1. Mechanism of Green Synthesis

Green synthesis of nanoparticles using medicinal plants is an eco-friendly, sustainable, and costeffective approach that utilizes plant-based biomolecules as natural reducing, stabilizing, and capping agents. This method bypasses the use of harmful chemicals, making it safer for the environment and human health. The mechanism of green synthesis can be understood through three key stages: preparation of plant extracts, reduction of metal ions, and stabilization of nanoparticles [11].

3. Methodology

Top-down and bottom-up approaches are used in the synthesis of nanoparticles (Fig. 1). Eco-friendly agents like microorganisms and bioactive compounds from plants (Oxalis corniculata, Bryophyllum pinnatum, and Trianthema portulacastrum) are used in bottom-up methods like chemical reduction, biological synthesis, and plant extract-mediated processes to reduce and stabilise nanoparticles in a sustainable manner. When bulk materials are reduced to the nanoscale using top-down techniques including high-energy ball milling, laser ablation, electro spraying, and pyrolysis, material characteristics are improved and size and composition can be precisely controlled [12].

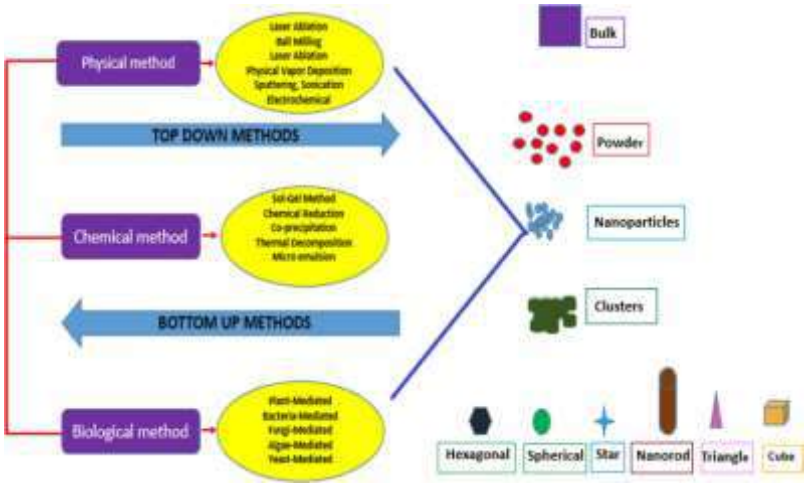

Fig. 1 Methods to synthesise nanoparticles

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1 Biogenic methods for metal nanoparticle production

Biogenic nanoparticles are synthesised using environmentally friendly materials and processes, including plant extracts, microbial enzymes from bacteria, fungi, and yeast and biopolymers such as chitosan and starch. In honeymediated synthesis, proteins and carbohydrates are employed, usage of fruit and vegetable extracts, algae like Galaxaura rugosa provide natural reducing agents, while essential oils like eucalyptus oil and tea tree oil, and waste materials such as cofee grounds and mango skins, enzymes provide sustainable alternatives [13]. Solar-assisted synthesis with Aloe vera extract, biofortifed fruit, marine biomass like Sargassum wightii agro waste materials, biosurfactants,including rhamnolipids from Pseudomonas aeruginosa, Pseudomonas aeruginosa pyoverdine, biowaste materials such as egg and orange skins, gold nanoparticles derived from turmeric tuber extract are employed. Biomolecule-assisted synthesis, which employs proteins, peptides, and DNA, and silica nanoparticles obtained from diatom shells, and green solvents such as supercritical CO_2 and ionic solutions are the biogenic materials [14].

2 Methods for nanoparticle profling and analysis

Nanoparticle profling and analysis involve various techniques to characterize their size, shape, composition, and surface properties.

1 Transmission electron microscopy (TEM)

At the atomic level, transmission electron microscopy (TEM) ofers high-resolution imaging to show the internal structure and morphology of nanoparticles. It enables the observation of crystallinity and aggregation patterns, as well as the accurate determination of size and shape analysis. Additionally, the distribution of nanoparticles in a material can be seen by TEM.

2 Scanning electron microscopy (SEM)

Through the use of a focussed electron beam, scanning electron microscopy (SEM) analyses the surface morphology of nanoparticles. It ofers fne-grained visuals of the size, shape, texture, and dispersion of the nanoparticle. Energy dispersive X-ray spectroscopy (EDX), which is connected to the SEM equipment, is another method used to gain information on elemental composition.

3 Dynamic light scattering (DLS)

The size distribution of suspended nanoparticles is measured via dynamic light scattering (DLS), which analyses the light scattering brought on by the Brownian motion of the particles. This approach provides information regarding hydrodynamic size and polydispersity, which is very helpful when researching nanoparticles in colloidal fuids.

4 X-ray difraction (XRD)

By analysing the difraction patterns created when X-rays are directed at a sample, X-ray difraction (XRD) can be used to ascertain the crystalline structure of nanoparticles. In order to comprehend the stability and physical characteristics of nanoparticles, it ofers information on their phase, crystallinity, and lattice spacing [15].

5 Atomic absorption spectroscopy (AAS)

By detecting the absorption of light at particular wavelengths that correspond to the components of interest, atomic absorption spectroscopy (AAS) can be used to ascertain the concentration of metal ions in nanoparticles. By using this technique, metal nanoparticles' elemental makeup can be measured and their creation confrmed.

6 Inductively coupled plasma mass spectrometry (ICP-MS)

Mass spectrometry using inductive coupling of plasma (ICP-MS): For identifying trace elements and determining the elemental makeup of nanoparticles, ICP-MS is a very sensitive method. By ionising the sample and determining the mass-to-charge ratio of the ions, it provides accurate information on the metal content and any contaminants present in the sample of nanoparticles.

7 Fourier transform infrared spectroscopy (FTIR)

Through the measurement of infrared light absorption at various wavelengths, Fourier Transform Infrared Spectroscopy (FTIR) is used to examine the surface functional groups of nanoparticles. Understanding interactions with the environment depends on knowing the kinds of chemical bonds and organic functional groups that are present on the surface of the nanoparticle, which may be determined using the spectrum data that was acquired.

8 Zeta potential analysis

This technique gauges the surface charge of suspended nanoparticles. Because electrostatic repulsion between particles prevents aggregation, a greater absolute value of zeta potential often indicates better colloidal stability, making this method crucial for evaluating the stability of nanoparticle dispersions.

9 UV–visible spectroscopy

By measuring a nanoparticle's absorbance in the visible and ultraviolet portions of the spectrum, UV–Visible Spectroscopy is a technique used to examine its optical characteristics. Because the surface plasmon resonance (SPR) peaks reveal details on the size, shape, and aggregation of plasmonic nanoparticles, such as gold and silver, it is very helpful for characterising these materials. The Fig. 2 represents the techniques involved [16].

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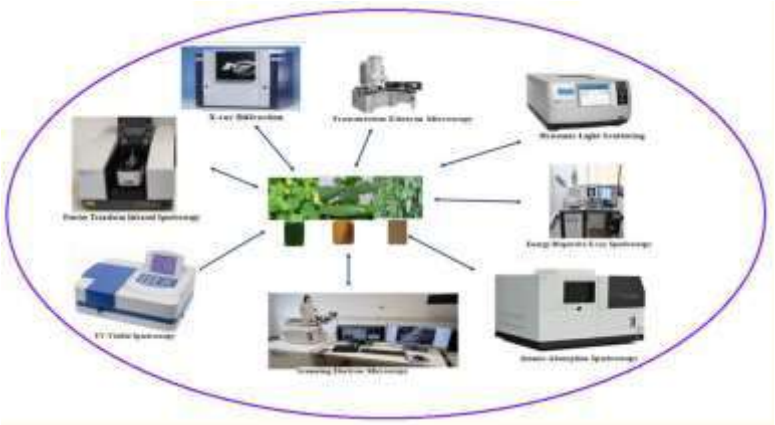

Fig. 2 Characterisation of nanoparticles

Insights into nanoparticle synthesis using medicinal plants Bryophyllum pinnatum, Oxalis corniculata and Trianthema portulacastrum:

1 Bryophyllum pinnatum:

Bryophyllum pinnatum also known as the air plant (Fig. 3), cathedral bells, life plant, miracle leaf, and Goethe plant, is a succulent native to Madagascar. It is popular as a houseplant and has become naturalized in tropical and subtropical regions. The plant is characterized by its miniature plantlets that form on the edges of its phylloclades. In India, it is known as Patthar Phodi in Hindi, Parandai in Tamil, Kalanchoe in Kannada, Paatthar Kizhangu in Malayalam, and Pothu in Telugu [17].

It is also commonly referred to as Kalanchoe pinnata. Bryophyllum pinnatum (Lam.) Oken, a member of the Crassulaceaefamily, is valued in traditional medicine across various regions, including India. In Ayurvedic medicine, it is known as Parnabeeja and is used as a substitute for Pashanabheda (Berginia ligulata Wall.) in Bengal, where it is locally called Pathar kuchi. The plant is used to treat urinary stones, hypertension, skin disorders, asthma, and more. Scientifc research has validated many of its traditional uses, revealing anti-diabetic, wound healing, antilithogenic, hepatoprotective, and anticancer properties. In Ayurveda, the plant is also known as Pāṣāṇabheda which means "dissolver of stones" [18-21].

Fig. 3 Bryophyllum pinnatum leaves

2 Puliyarai or Oxalis corniculata

Oxalis corniculata L., commonly known as creeping wood sorrel, is an edible herb from the Oxalidaceae family, valued for its sour taste and medicinal properties in Ayurveda for balancing vata and kapha. This plant (Fig. 4) has anti-inflammatory, diuretic, antibacterial, and antidiabetic effects, and is used in treating cardiovascular diseases and liver-related diabetes. It is referred to as "khatti-booti" in Hindi, "Amlapatri" in Sanskrit, and "Tinpatia" in Bengali. In Tamil Nadu, it is known as Puliyaarai or Puliyaakkeerai. Rich in vitamin C and β-carotene, it grows in moist,

shady areas and is praised for its antimicrobial, antifungal, antioxidant, and anticancer properties [22].

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Fig. 4 Oxalis corniculata

3 Trianthema portulacastrum

Trianthema portulacastrum, commonly known as horse purslane or desert horsepurslane, is an herbaceous plant from the Aizoaceae family, thriving in tropical and subtropical arid and semi-arid regions. With succulent stems and feshy leaves, it
often colonizes disturbed soils and is considered a weed in agricultural areas. However, it has signifcant medicinal value, being used in traditional medicine under various names in India, including Punarnava (Hindi, Sanskrit), Gadabani (Odisha), Saramoi (Tamil), Vellai sharunai (Malayalam), and Saramulo (Telugu). The plant is renowned for its anti-infammatory, diuretic, hepatoprotective, and antioxidant properties [23]. It is traditionally used to manage infammation, liver conditions like jaundice, and edema. Its antioxidant properties help neutralize free radicals, and it has antipyretic efects for fever reduction. The plant also shows anthelmintic activity against intestinal parasites and has antimicrobial properties useful for wound healing. Trianthema portulacastrum holds promise for bioremediation and pharmacological applications, enhancing its value in medicinal research and sustainable agriculture [24].

Fig. 5 Trianthema portulacastrum

Applications, Advantages, And Disadvantages of Plant Synthesized Nanoparticles:

1 Medical Applications:

1-Antimicrobial agents: plant-synthesized nanoparticles have shown broad-spectrum antimicrobial activity against various pathogens, including bacteria, fungi and viruses.

Drug delivery: Nanoparticles can be used as carriers for drug delivery, improving the bioavailability and targeted delivery of therapeutic agents.

2. Environmental Applications:

Pollution Control: Metal nanoparticles synthesized by plants can remove pollutants from water and air through adsorption and degradation mechanisms.Wastewater treatment: Nanoparticles such as ZnONPs and AgNPs are effective in wastewater treatment by breaking down organic pollutants and disinfecting pathogens.

3. Agricultural Applications:

Insecticides and Fertilizers: Nanoparticles can develop nanopesticides and nanofertilizers that offer controlled release and better efficacy than conventional products. [25]

Plant-based synthesis of nanoparticles has attracted significant interest due to its Advantages:

1. Environmentally Friendly Process:

Plant-based synthesis is considered environmentally friendly because it avoids using toxic chemicals usually required in conventional synthesis methods. The process uses natural plant extracts that are biodegradable and less harmful to the environment

2. Cost-effective:

Using plants as a source for nanoparticle synthesis can be more cost-effective than traditional methods. The plants are readily available and can be grown quickly, thus reducing the total cost of production. [26]

3. Scalability:

The process can be easily scaled up for large-scale production. Because it uses plant extracts, the synthesis can be done in bulk without special equipment.

4. Biocompatibility:

Nanoparticles synthesised with plant extracts are generally biocompatible and less toxic, making them suitable for medical and pharmaceutical applications.

5. Different reducing agents:

Plants contain different biomolecules (e.g., alkaloids, terpenoids, flavonoids, phenols) that can act as reducing and stabilising agents, forming nanoparticles of different shapes and sizes. [27]

Disadvantages:

1. Lack of control over particle size and shape. Biological methods can result in nanoparticles of widely varying sizes and shapes, which may not be suitable for applications that require uniform particles.

2. Variability of Plant Extracts:

The composition of plant extracts can vary depending on several factors, such as season, geographic location, and part of the plant used, leading to inconsistencies in the synthesis process. [28]

3. Purification Challenges:

Extraction and purification of nanoparticles from plant-based synthesis can be harrowing and require additional steps that can increase the complexity and cost of the process.

4. Possibility of contamination:

There is a risk of contamination by plant pathogens or other biological entities that can affect the purity and quality of the synthesised nanoparticles. While scalability is generally an advantage, some of the equipment used for nanoparticle synthesis may not be available in large quantities, limiting mass production. [29]

5. Future Prospects:

Genetically Engineered Plants: Enhancing phytochemical production for improved nanoparticle synthesis.Hybrid Nanomaterials: Combining plant-mediated nanoparticles with other materials for enhanced functionality.Commercialization: Developing cost-effective protocols for large-scale production.Multidisciplinary Research: Integrating nanotechnology, pharmacology, and environmental science to expand applications [30].

Conclusion:

The green synthesis of nanoparticles using medicinal plants such as Bryophyllum pinnatum, Oxalis corniculata, and Trianthema portulacastrum presents a sustainable and environmentally friendly alternative to traditional chemical synthesis methods. These plants, rich in bioactive compounds like favonoids, alkaloids, and terpenoids, facilitate the reduction and stabilization of metal ions into nanoparticles without the use of toxic chemicals. The resulting nanoparticles exhibit a broad range of bioactivities, including antimicrobial, antioxidant, photocatalytic, and anticancer properties, making them suitable for various applications in medicine, environmental remediation, and agriculture. The key advantages of green synthesis include its cost-efectiveness, eco-friendliness, and the production of biocompatible nanoparticles, which is crucial for their safe use in biomedical and industrial applications. These methods align with green chemistry principles by minimizing harmful chemical waste and reducing the environmental footprint of nanoparticle production. While the initial fndings are promising, further research is needed to optimize and scale up the green synthesis processes, explore the mechanisms behind phytochemical-metal interactions, and assess the long-term stability and safety of these nanoparticles for large-scale applications. With continued advancements in these areas, plant-mediated

green synthesis has the potential to revolutionize the production of nanoparticles for various industrial, environmental, and medical purposes.

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I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study entitled **"Green Synthesis of Metal Nanoparticles from Medicinal Plants: Mechanisms, Environmental and Health Applications."**

First and foremost, I extend my heartfelt thanks to my supervisor, faculty members, and academic mentors for their invaluable guidance, continuous encouragement, and constructive suggestions throughout the course of this research. Their expertise and support have been instrumental in shaping and completing this study successfully.

I am grateful to my institution and department for providing the necessary laboratory facilities, research infrastructure, and academic resources required for carrying out this work. I also express my sincere appreciation to the laboratory staff and technical personnel for their assistance in experimental procedures, sample analysis, and data interpretation.

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I am thankful to my friends and colleagues for their encouragement, cooperation, and insightful discussions during various stages of this study.

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Original Article

Climatic Change: Pathways For Adoption and Mitigation Stratagies-A Contemprory Perspective

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Abstract

Climate change represents one of the most critical global challenges of the 21st century, driven predominantly by anthropogenic greenhouse gas emissions. This paper examines the causes, evidence, impacts, and strategic responses to climate change, with a particular focus on agriculture and food security. By integrating global datasets, policy frameworks, and scientific literature, the study highlights the dual importance of mitigation and adaptation strategies. While mitigation addresses the root causes through emission reduction, adaptation focuses on minimizing vulnerability to climate impacts. The findings indicate that climate change significantly affects soil health, water resources, and agricultural productivity, especially in tropical and subtropical regions. The paper concludes that coordinated global action, technological innovation, and sustainable practices are essential for ensuring long-term environmental and food security.

Keywords: *Climate Change, Global Warming, Food Security, Adaptation, Mitigation, Agriculture*

Introduction

Climate change refers to long-term variations in temperature, precipitation, and weather patterns, largely resulting from human activities such as fossil fuel combustion, deforestation, and industrialization. Since the Industrial Revolution, atmospheric concentrations of greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) have increased significantly, leading to global warming.

This study focuses on the interaction between three major trends:

1. Climate change
2. Agricultural production
3. Population growth

Evidence suggests a consistent rise in global temperatures and variability in rainfall patterns throughout the 20th and 21st centuries. These changes directly influence agricultural productivity, particularly in developing regions such as Africa, Asia, and Latin America, where food security is already under stress.

Literature Review

Previous studies indicate that climate change significantly impacts agricultural productivity and food security. According to Malthus (1798), population grows geometrically while food production increases arithmetically. Recent studies (Aggarwal, 2003; Mall et al., 2006) confirm that rising temperatures negatively affect crop yields.

Objectives Of the Paper

- To Study the importance of agriculture.
- To Know the Status of climate change particularly global warming.
- To compare the past and present impact of climate on agriculture.
- It tells to know how to mitigate the issues.
- It teaches us to know the global responsibility.

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Methodology

This study is based on secondary data collected from:

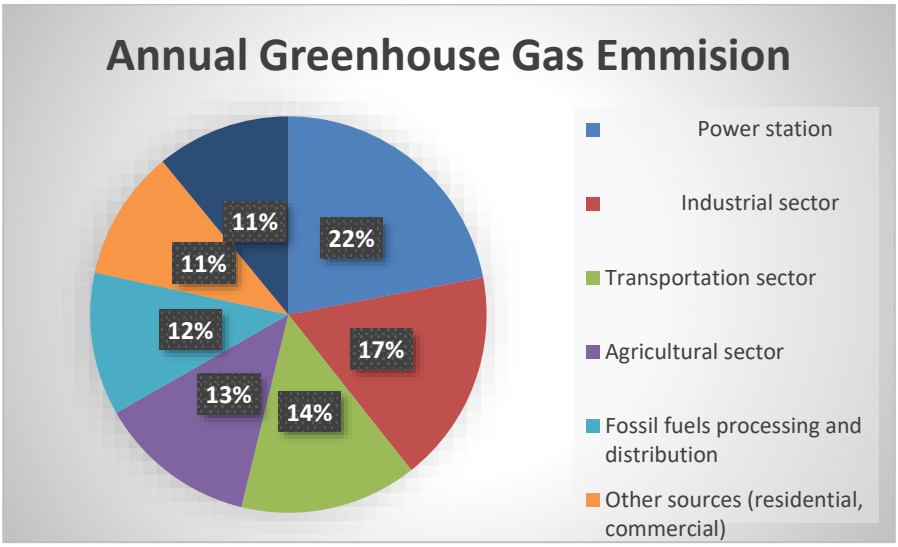
The study relies primarily on secondary data sourced from FAO reports, research journals, government publications, and climate reports. It adopts both conceptual and empirical approaches, combining existing literature and institutional data with expert discussions. Additionally, statistical analysis of global datasets is used to support and validate the findings.

Results and Analysis

Today the world is facing the main environmental challenge is global Climate change. Climate change is combined with several adverse impacts on agriculture, water resources, biodiversity, health and etc. Decreasing both quality and quantity of agricultural production is the main impact of climate change. It would overview the additional stress on the ecological and a socio-economic condition which is already emphasizes great pressure due to rapid Industrialization, urbanization and economic development. According to the latest scientific assessment, the earth's climatic condition has changed on both global and regional scales. Recently the global temperature increases rapidly due to rigorous increase of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), ozone (O_3), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs) from different sectors. Due to these circumstances increasing accumulation of these gases, results much anxiety of future changes in global climate and its impacts on agriculture directly or indirectly. (Krupa; 2003; Aggarwal, 2003; Bhatia et al., 2004).

Table 1: Annual Greenhouse gas Emissions by different sectors

Sectors	%
Power station	21.3
Industrial sector	16.8
Transportation sector	14
Agricultural sector	12.5
Fossil fuels processing and distribution	11.3
Other sources (residential, commercial)	10.3
Biomass burning	10.6



Sources: IUP Journal of Environmental Sciences, 2012

Table 2: Regional Agricultural Yield (kg/ha)

Region	2007	2018
World	3347	3026
Eastern Africa	1482	1670
Middle Africa	967	898
Northern America	5913	5350
Southern Asia	2645	2150
Western Europe	6479	5870

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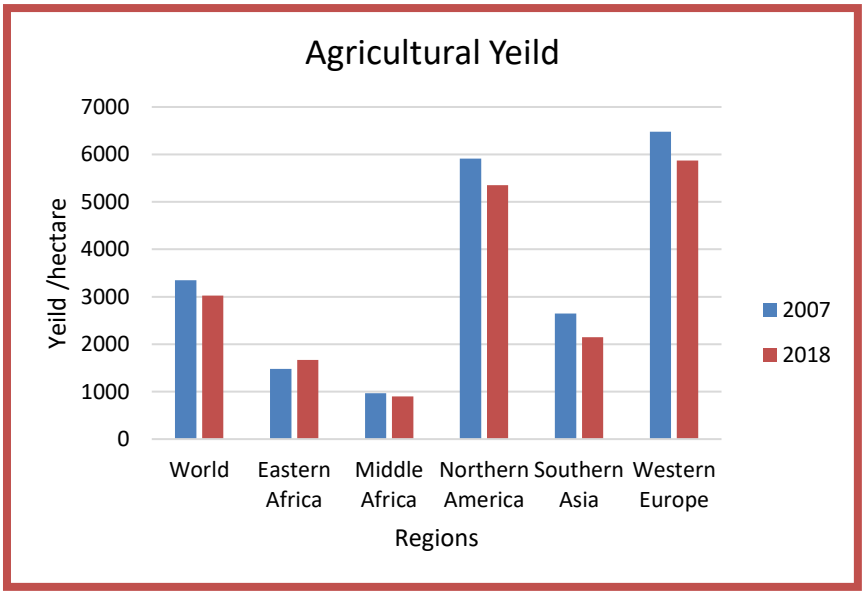

Sources: Food and Agriculture Organization. (2019)

Evidence of climate change

It is clear and accelerating: global average temperatures have risen by about 1.1°C above pre-industrial levels, atmospheric CO_2 concentrations have surpassed 420 ppm—the highest in human history—and annual greenhouse gas emissions now exceed 50 billion tons of CO_2 equivalent, largely driven by fossil fuel use and industrial activity; additionally, widespread melting of glaciers and polar ice further confirms the rapid warming of the planet.

1 Emission Trends (1960–2025)

- 1960s: 10–15 billion tonnes annually
- 1990 onwards: Rapid increase
- 2025 projection: ~38.1 billion tonnes
- Main driver: Fossil fuel consumption

2 Climate Change and Global Agriculture

Climate change poses a serious threat to global food security. Rising temperatures and irregular precipitation patterns reduce both the quality and quantity of agricultural output.

Table 3: Regional Agricultural Yield (kg/ha)

regions	yield/hea/inkg	
	2007	2018
world	**3347**	**3026**
Eastern Africa	1482	1670
Middle Africa	967	898
northern Africa	1725	1620
southern Africa	2466	2340
western Africa	1165	998
Northern America	5913	5350
central America	2893	1890
carabeans	2201	2120
Southern America	3704	3200
central Asia	1696	1250
eastern Asia	5918	6390
southern Asia	2645	2150
South east Asia	3756	3300
western Asia	1985	1240
eastern Europe	2228	1950
Northern Europe	5149	4480
western Europe	6479	5870
Oceania	1221	968

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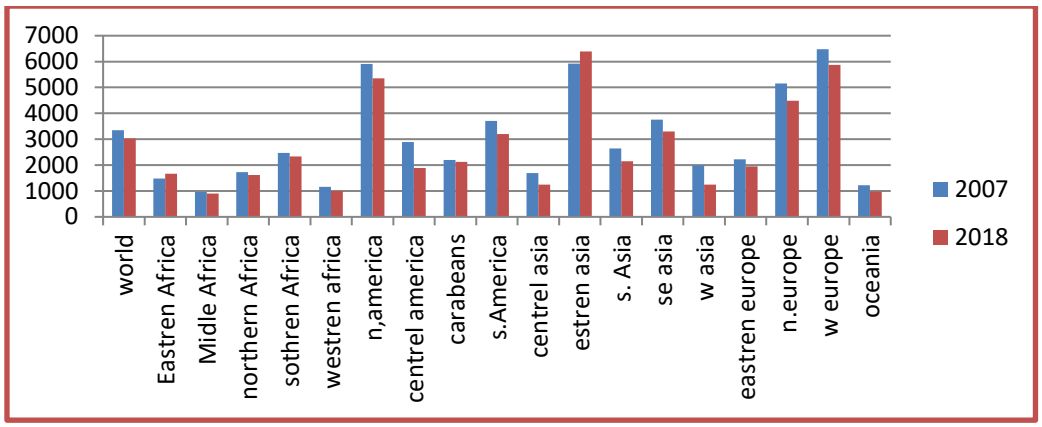


Sources: U.N Food and Agricultural organization 2008 and 2019

3 Economic Impacts

Farm income may decline by **9%–25%** with rising temperatures

GDP losses estimated between **1.8%–3.4%**

Significant food grain shortages projected in developing countries

Climate change adaptation:

It involves adjustments in natural and human systems to cope with actual or expected climate impacts, a necessity given that around 3.6 billion people—particularly in developing countries—are highly vulnerable to climate risks. Key strategies include agricultural measures such as crop diversification and drought-resistant varieties, improved water management through rainwater harvesting and efficient irrigation, climate-resilient infrastructure, and disaster risk reduction via early warning systems and planning; strengthening community awareness and local governance further enhances adaptive capacity. In parallel, climate change mitigation focuses on reducing greenhouse gas emissions through transitions to renewable energy, improved energy efficiency, afforestation, sustainable transport, and behavioral changes, with lifestyle shifts alone having the potential to cut emissions by 40–70% by 2050.

Global Climatic Polices:

Global climate policies center on international cooperation and financing to address climate change, with key agreements such as the Paris Agreement aiming to limit global warming below 2°C, alongside frameworks like the UNFCCC and Kyoto Protocol that guide emission reductions. Developing countries require an estimated $215–387 billion annually for adaptation, highlighting the importance of climate finance. Governments employ policy instruments such as carbon pricing, emission regulations, and subsidies for green technologies to drive mitigation and adaptation efforts; however, progress is hindered by challenges including limited funding, technological barriers, governance issues, and unequal vulnerability across regions, which complicate effective and equitable implementation.

A Case Study-INDIA

India faces escalating climate risks, including intense heatwaves, erratic monsoons, and growing water stress, which threaten both livelihoods and economic stability; in response, the country has launched key initiatives such as the National Action Plan on Climate Change (NAPCC), the National Solar Mission, and large-scale afforestation programs, alongside expanding renewable energy capacity to strengthen resilience and reduce emissions.

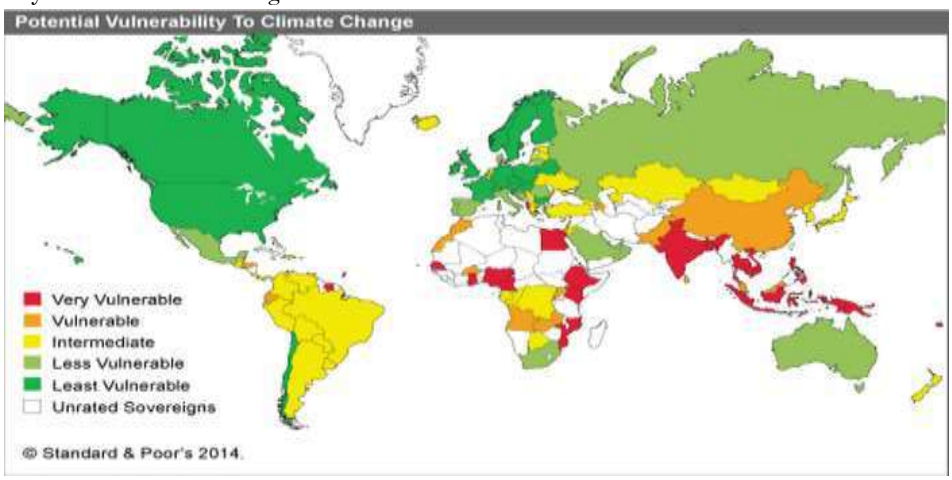
World Vulnerable Regions:

Today many parts of world affected badly by the climate changes. But some countries in Africa, Asia, Central and South America suffering more

Such top 10 most Vulnerable countries to climate change are;

1. Somalia, 2. Eritrea 3. Sudan 4. Burundi 5. Papua New Guinea

6. Mauritania 7. Yemen 8. Chad 9. Solomon Islands 10. Gambia.



Source: Notre Dame Global Adaption Index

The most climate-vulnerable countries include:
Somalia, Eritrea, Sudan, Burundi, Papua New Guinea, Mauritania, Yemen, Chad, Solomon Islands, and Gambia.

Limitations

Uncertainty in climate projections
Lack of region-specific data
Difficulty in predicting future technological advancements

Conclusion:

Climate change is a global crisis requiring urgent and coordinated action. Its impacts on agriculture and food security are particularly severe in developing countries. A balanced approach combining adaptation and mitigation strategies is essential for sustainable development.

Technological innovation, policy intervention, and behavioural change must work together to address this challenge effectively. Strengthening global cooperation and increasing investments in climate resilience will be critical in securing the future of humanity.

Acknowledgement

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study entitled "Climatic Change: Pathways for Adaptation and Mitigation Strategies – A Contemporary Perspective."

First and foremost, I extend my heartfelt thanks to my supervisor, faculty members, and academic mentors for their invaluable guidance, continuous encouragement, and constructive suggestions throughout the course of this study. Their expertise and support have been instrumental in shaping the quality and direction of this research.

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My sincere appreciation is extended to all individuals and organizations working toward environmental conservation, climate resilience, renewable energy development, and sustainable resource management. Their dedication continues to inspire efforts to address the challenges posed by climate change.

I am thankful to my friends and colleagues for their encouragement, cooperation, and valuable discussions during various stages of this study.

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Conflicts of interest

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Original Article

Modern Trends in the writings of Indian English Women Novelists of the Postmodern Era

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Abstract

Indian English literature has undergone a remarkable change in the postmodern era, especially in the writings of Indian English Women Novelists. They have redefined narrative techniques, thematic concerns, and representational politics. Here, the aim of this research paper is to examine the modern trends in Indian English women's fiction within the postmodern framework, focusing on narrative experimentation, feminist consciousness, identity formation, globalization, and socio-political engagement. Postmodern Indian women novelists move beyond traditional storytelling to explore fragmented identities, shifting gender roles, and cultural hybridity. Writers such as Arundhati Roy, Jhumpa Lahiri, Bharati Mukherjee, Anita Desai, Kiran Desai, and others have emphasized the complexities of female experience in a rapidly changing socio-cultural landscape. Their works challenge patriarchal structures, interrogate grand narratives, and articulate the emergence of the "New Woman." This study also highlights how these novelists negotiate between Western feminist ideas and original cultural contexts, producing a distinct literary voice. Ultimately, postmodern Indian English women's fiction reflects a dynamic interplay of personal and political realities, offering a subtle understanding of contemporary Indian society and the evolving role of women within it.

Keywords*: modern trends; postmodern; feminist consciousness; cultural hybridity; patriarchal; diaspora; globalization; fragmentation; etc.*

Introduction

Indian English literature has seen the exponential growth since the late twentieth century, particularly after the 1980s, when postmodernism began influencing literary production. The rise of women novelists in this period marks a significant shift in literary discourse, as women began to assert their voices and challenge long-standing patriarchal norms. The success of Indian English fiction globally created a fertile ground for women writers to gain recognition. Postmodernism, is featured by fragmentation, plurality, skepticism toward grand narratives, and experimentation in form, provided a suitable framework for women writers to explore complex issues such as identity, gender, and cultural displacement. In this context, Indian English women novelists have not only contributed to literary innovation but also reshaped the representation of women in literature.

Postmodernism and Indian English Fiction

Postmodernism in Indian English fiction emerged as a response to both colonial and postcolonial realities. It reflects a world marked by rapid technological change, globalization, and cultural flow. The postmodern condition often involves themes such as existential crisis, fragmentation of identity, and the breakdown of moral certainties.

In the Indian context, postmodernism is uniquely shaped by postcolonial experiences. Unlike Western postmodernism, which primarily reacts against modernism, Indian postmodernism engages with issues such as colonial legacy, cultural hybridity, and socio-economic disparities. Women novelists, in particular, have used postmodern techniques to explore the intersection of gender, culture, and power.

Emergence of Indian English Women Novelists

Historically, Indian women writers were marginalized because of the limited access to education and societal restrictions.

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However, with increased literacy, urbanization, and exposure to global ideas, women began to participate actively in literary production. The late twentieth century has seen range of increased number of Indian English women novelists who brought fresh perspectives to literature.

Novelists such as Shashi Deshpande, Nayantara Sahgal, and later Arundhati Roy, Bharati Mukherjee, Anita Desai, Jhumpa Lahiri, and Manju Kapur, Kiran Desai have significantly contributed to the evolution of Indian English fiction. Their works reflect a shift from traditional themes to more complex explorations of female subjectivity and socio-cultural realities.

Feminist Consciousness and the "New Woman"

One of the most prominent trends in postmodern Indian English women's fiction is the emergence of feminist consciousness. These novelists challenge patriarchal structures and highlight the struggles of women within traditional and modern contexts.

The concept of the "New Woman" is central to this discourse. Indian women novelists portray women as individuals with agency, aspirations, and autonomy. They move beyond stereotypical roles of wife and mother to explore identity, independence, and self-realization.

However, unlike Western feminism, Indian feminist writing often negotiates between tradition and modernity. Women characters may seek independence but still value familial relationships, reflecting the complexities of Indian society.

Exploration of Identity and Subjectivity

Identity is a recurring theme in postmodern Indian English women's fiction. These novelists explore various dimensions of identity, including gender, cultural, national, and diasporic identities.

Anita Desai, for instance, delves into the psychological complexities of her characters, portraying their inner conflicts and struggles for self-definition. Her use of stream-of-consciousness and introspective narration exemplifies postmodern narrative techniques.

Similarly, Bharati Mukherjee and Jhumpa Lahiri's works focus on diasporic identity, exploring the experiences of Indian immigrants navigating between cultures. Kiran Desai's novels examine globalization and its impact on identity, particularly in the context of migration and displacement.

Narrative Experimentation and Stylistic Innovation

Postmodern Indian English women novelists employ various narrative techniques that distinguish their works from traditional fiction. These include:

Non-linear narratives
Fragmented storytelling
Multiple perspectives
Intertextuality
Symbolism

Such experimentation reflects the fragmented nature of contemporary reality and allows writers to present multiple truths rather than a single, authoritative narrative.

For example, Arundhati Roy's *The God of Small Things* employs a non-linear structure and rich symbolism to explore themes of memory, trauma, and social injustice. This narrative style exemplifies postmodern aesthetics.

Representation of Socio-Cultural Realities

Another significant trend is the realistic portrayal of socio-cultural issues affecting women. Indian English women novelists address topics such as:

- Patriarchy and gender discrimination
- Marriage and domestic life
- Sexuality and desire
- Violence against women
- Class and caste inequalities

These writers present women's experiences within specific cultural contexts, highlighting the intersection of gender with other social factors. Their works serve as a critique of societal norms and advocate for change.

Globalization and Diasporic Perspectives

Globalization has significantly influenced Indian English literature, particularly in the postmodern era. Many women novelists explore themes of migration, cultural hybridity, and transnational identity.

Jhumpa Lahiri's fiction, for example, captures the experiences of Indian immigrants in the United States, focusing on issues of belonging and alienation. Similarly, Kiran Desai's *The Inheritance of Loss* examines the effects of globalization on individuals and communities.

These narratives reflect the interconnectedness of the modern world and the complexities of identity in a globalized context.

Psychological Depth and Interiorization

Postmodern Indian English women novelists often emphasize the psychological dimensions of their characters. Their works explore:

Inner conflicts
Emotional struggles
Alienation and loneliness
Search for meaning

Anita Desai's novels, in particular, are known for their psychological depth. She portrays the inner lives of women with sensitivity and insight, revealing the impact of societal pressures on individual psyche.

This focus on interiority marks a departure from earlier literature, which often prioritized external events over internal experiences.

Resistance to Grand Narratives

A key feature of postmodernism is the rejection of grand narratives or universal truths. Indian English women novelists reflect this skepticism by presenting multiple perspectives and questioning established norms.

Their works challenge dominant ideologies related to gender, culture, and identity. Instead of offering definitive answers, they explore ambiguity and complexity, encouraging readers to engage critically with the text.

Intersectionality and Diversity

Contemporary Indian English women's fiction increasingly addresses intersectionality and recognizing that women's experiences are shaped by multiple factors such as class, caste, religion, and ethnicity.

Writers like Arundhati Roy highlight the intersection of gender with caste and political issues, while others explore

regional and cultural diversity. This trend reflects a broader understanding of feminism that goes beyond gender to include various forms of social inequality.

Language and Cultural Hybridity

Language plays a crucial role in postmodern Indian English women's fiction. Writers often blend English with regional languages, creating a hybrid linguistic style that reflects India's multicultural reality.

This use of language not only enhances authenticity but also challenges the dominance of standard English, asserting the legitimacy of diverse linguistic expressions.

Contribution to Global Literature

Indian English women novelists have gained international recognition, contributing significantly to global literature. Their works address universal themes while retaining a distinct cultural identity, making them accessible to a global audience.

The success of these writers like Arundhati Roy and Kiran Desai, both are Booker Prize winners, highlights the global appeal of Indian English women's fiction.

Challenges and Criticism

Despite their achievements, Indian English women novelists face certain challenges:

Being stereotyped as writers of "women's issues"

Balancing Western and indigenous influences

Navigating market expectations and global readership

Critics sometimes argue that their works cater to Western audiences, potentially overlooking local realities. However, many writers successfully negotiate these challenges, producing literature that is both globally relevant and locally grounded.

Conclusion

The postmodern era has marked a significant turning point in Indian English literature, particularly for women novelists. Through their innovative narrative techniques and diverse thematic concerns, these writers have transformed the literary landscape.

Modern trends in Indian English women's fiction include the exploration of identity, feminist consciousness, narrative experimentation, and engagement with globalization and socio-political issues. These novelists have not only challenged traditional representations of women but also contributed to the development of a distinct literary voice that reflects the complexities of contemporary Indian society.

In conclusion, postmodern Indian English women novelists have played a crucial role in redefining literature, offering new perspectives on gender, culture, and identity. Their works continue to inspire and influence future generations of writers, ensuring the continued evolution of Indian English literature.

Acknowledgement

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study entitled **"Modern Trends in the Writings of Indian English Women Novelists of the Postmodern Era."**

First and foremost, I extend my heartfelt thanks to my supervisor, professors, and academic mentors for their invaluable guidance, continuous encouragement, and constructive suggestions throughout the course of this research. Their expertise and support have greatly enhanced my understanding of contemporary literary studies and critical analysis.

I am grateful to my institution for providing the necessary academic resources, library facilities, and a supportive environment that enabled me to carry out this study successfully.

I would also like to acknowledge the contributions of literary scholars, critics, and researchers whose works on Indian English literature, postmodernism, feminism, identity, and cultural studies served as valuable references and enriched the conceptual framework of this research.

My special appreciation is extended to Indian English women novelists whose creative works have significantly contributed to contemporary literature by exploring themes such as gender, identity, globalization, diaspora, social transformation, and individual agency. Their writings provided the foundation and inspiration for this study.

I am thankful to my friends and colleagues for their encouragement, insightful discussions, and support during various stages of this research.

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Original Article

Board Size and Market valuation – A study on 100 National Stock Exchange Listed Companies

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Abstract

Purpose: *This examination investigates the impact of Board size and Market valuation of firms listed on the National Stock Exchange (NSE) of India. Particularly, the studies show how the variables, namely Board Size, Total Assets, and Return on Capital Employed (ROCE), impact Market Capitalization.*

Methodology: *Ordinary least squares analysis, most commonly called OLS or a linear regression, on a sample size of 52 NSE-listed companies for 5 years from 2019-20 to 2023-24 has been conducted. To ensure the reliability of findings, study employed several investigation tests, including Spearman's Rank Correlation for pairwise relationships, Variance Inflation Factor (VIF) for multicollinearity, and Cook's Distance to identify influential deviations. Though the data has non-normality features, a linear regression model was applied as the N size exceeds 30, as per the central limit theorem. Kwak & Kim (2017).*

Results: *Explaining nearly 53.7% of the difference in market value. The outcome revealed a strong model fit (R^2 = 0.537). Total Assets and ROCE demonstrated a highly significant positive relationship with Market Capitalisation (P<0.001). However, Board Size had a significant adverse effect (β = -99.58, P = 0.038), demonstrating that a bigger board may cause inefficiencies that investors might view unfavourably. Diagnostic tests confirmed the absence of multicollinearity (VIF < 1.11) and indicated high model stability (Mean Cook's D = 0.0141), in spite of the presence of influential deviations.*

Practical Implications: *The result reaction suggests that for NSE-listed firms, market valuation is driven not only by profitability and size but also by lean governance structures like board size. Investors and stakeholders should consider board efficiency as a critical factor in firm valuation within the Indian equity market.*

Keywords: *Market Capitalisation, Board Size, ROCE, Cook's Distance, Regression, NSE India.*

Introduction

In India, after LPG reforms, corporate governance is also a focus area. This has significantly transformed the Indian market. Facing tough competition from multinational corporations. To assure a fair return to shareholders on the amount they invested in the organisation, the organisation has to follow processes and rules, which are called as corporate governance.

The communication to insiders and outsiders of a firm, on a corporate board, which addresses the question of the board size and its comparison.

JENSEN (1993) The Board is the main body of the internal control system, which has an important role in making corporate functions run properly. A board is expected to make and implement policies for corporate governance and make decisions on the company's issues. Board size is a number that includes all types of directors and also the diversity.

As per clause 49 by Narayan Murthy committee report, in this report Indian corporate governance reformed by tightening the rules on board composition disclosures, and audit committees. As per this report at least 50% of board must have to be independent directors Dessai & Bhanumurthy (n.d.), otherwise, at least one third must be with other aspects of rules.

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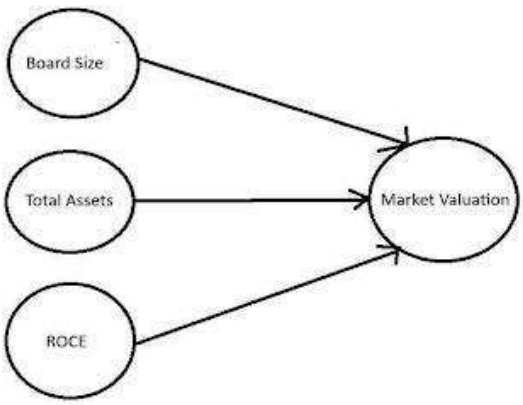
The ideal size of a board is still questionable one, because one size doesn't fit all, as they said Wellalage et al. (n.d.)
The relationship among board size or firm value, board size or financial performance, board size or firm performance, etc., was the focus of several studies.

Literature Review

"Stewardship theory, resource dependence theory, or agency theory" are among the theories that have been established to examine relationship among board size or structure and its impact on firm performance.

In their empirical study, Mishra & Kapil (2018) showed that market-based measures are more affected through corporate governance than ROA (accounting-based) measures. Board size or firm performance was shown to have a significant positive correlation. They conducted this study on 391 NSE listed companies for their study to know the impact on performance of companies. Though they found positive association, but they found Board independence is significant related to firm performance. Nair et al., 2020 examined in this study are foreign investors' preferences in developing markets with a high concentration of insider ownership and a weak information environment. This study utilized firm size or price to book value (PBV) as important variables to examine relationship among board characteristics and foreign institutional investors (FII). This research also implies that large, high-growth firms in developing markets like India expand board size and outsider ratio to attract foreign capital. Thomas et al., 2023 To study connection between firm-level innovation and corporate governance practices, they mainly focused on a list of non-financial enterprises in India. Based on the evidence, it is possible to conclude that corporate governance practices have a significant impact on promoting innovative ecosystems in Indian companies, i.e., the selected promoter's interests indicated positive effects on the market value of enterprises among the corporate governance factors evaluated. Pandey & Chaturvedi Sharma (2025) found that more non-executive directors and larger boards improve Tobin's Q or ROA; additionally, the presence of female directors encourages improved decision-making and enhanced financial performance. Uchenna (n.d.). In this study, board size significantly affects the performance. Female representation did not moderate these relationships, because of low absolute number of women. Wijaya & Memarista (2024) studied that board size affects performance significantly. Female representation did not moderate these relationships, due to the low absolute number of women. In this study they took sample of 261 companies or 1210 observations for the period from 2015 to 2019 of non-financial companies. Kumar et al. (n.d.), Board diversity significantly positively influences ROA but negatively affects Tobin's Q. Impact is more prominent in firms with standard performance. This study has done on NSE 200 companies after excluding financial sector data and incomplete data, 141 companies finalised for the study. Board gender diversity is positively associated with ROA (Return on Assets) in firms with CEO Duality, Board independence and diversity are generally not significant(insignificant) for market value. Tummalapenta et al. (2022), Gender diversity, CEO duality, and board size enhance performance.Ownership structure and meeting frequency have no impact. They collected 75 Bombay Stock Exchange companies for this study. Tampakoudis et al. (2022), Acquirer excess returns are typically negatively correlated with board size. Particularly for the large banks and those with CEO duality, large boards have positive value implications. Goel & Sharma (n.d.), Market-based measures, including "Tobin's Q and market-to-book value ratio", are negatively impacted by board size, whereas accounting measures are not significantly impacted. This study was conducted on 42 Indian companies of NSE registered 50 index from 2011-12 to 2015-16. Vikas Choudhary (2015), Board size significantly affects ROE (positive) and ROA (negative), but it has negative impact on Tobin's Q. The study has been conducted from 2012 using 319 companies from BSE Index. Jackling & Johl (2009), In this study, performance is positively affected by a large board size and more outside directors (Tobin's Q). But Board busyness adversely associated with performance. The impact of duality was insignificant. In "firms with CEO duality, board gender diversity has a positive correlation with ROA (Return on Assets), whereas board independence and diversity" are often not significant (insignificant) for market value, as per Kumar et al. (n.d.).

Conceptual Framework of Market Valuation



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The above conceptual model shows that to predict one dependent variable, three independent variables are used.

Market Valuation

The total value of the company as determined by stock market, i.e, market capitalisation.

Board Size

Board size is the overall size of board, used to study corporate governance.

Total Assets

It is used for firm size; total assets mean the total value that everything company owns.

ROCE

To measure profitability and efficiency with its capital, this financial ratio will be used.

Research Gaps

In the current empirical studies, most of the times comparability of data done on parametric models assume a normal distribution, but comparing non-normal of financial data with Linear regression when sample size increases more than 30.

Research Objectives

The primary goal is to understand what drives Market Capitalisation. Specifically:

1. To examine the impact of Board Size on a company's market valuation or market capitalisation.
2. To evaluate how ROCE influences market valuation or market capitalisation.
3. To determine the relationship among Total Assets or its overall market valuation or market capitalisation.

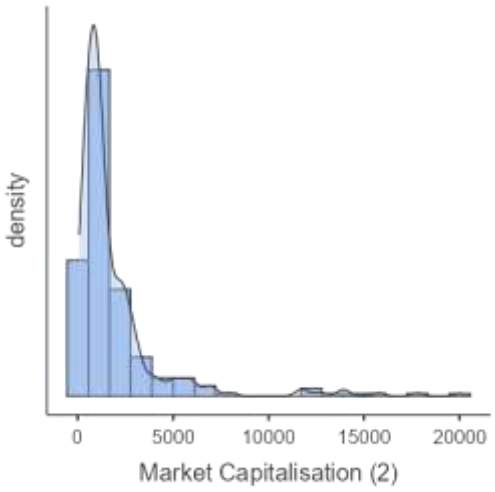
Research Hypothesis

1. $H_{1:}$ Board size has a significant Negative effect on Market Capitalisation.
2. $H_{1:}$ ROCE has a significant positive effect on Market Capitalisation.
3. $H_{1:}$ Total assets have a positive effect on Market Capitalisation.

Data Collection and Analysis

Data are from secondary sources collected through the NSE Website, Money Control, and other platforms. The data collected for NSE 100 companies, from these financial sector companies were removed, and non-availability data of different companies in these NSE 100 were removed and finalised for 52 NSE companies. Gretl, Jamovi Software, Excel have been employed to analyze data that has been collected over five years, from 2019–20 to 2023–24. These 52 NSE Companies data, which were collected for the variables like Board size, Market Valuation, Total Assets and ROCE, were analysed and are presented in the Graphs as follows;

Market Valuation



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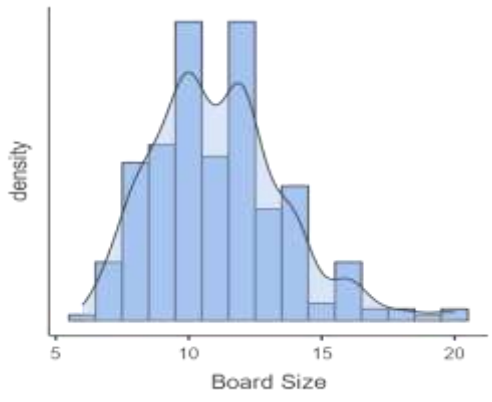
Board Size



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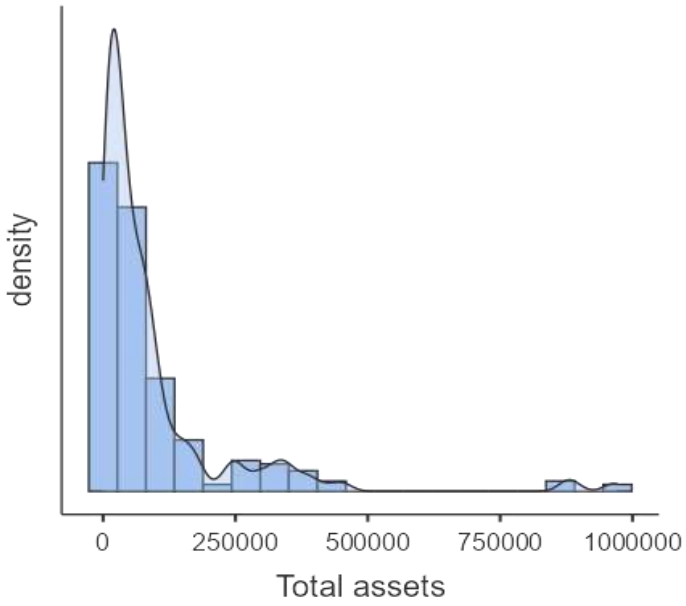
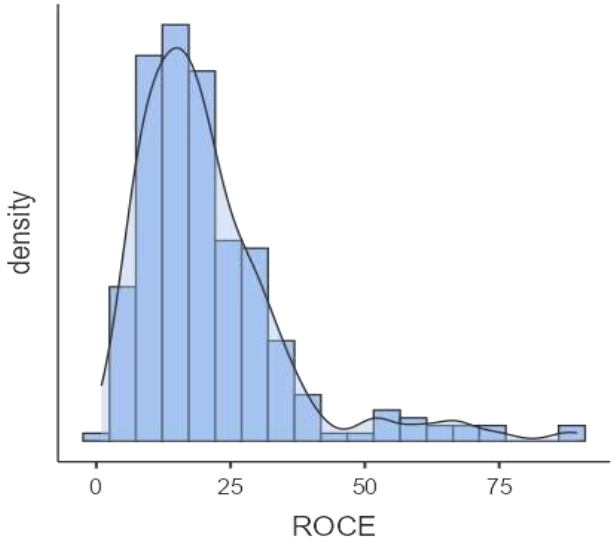
Total Assets



*Source: Author-generated

ROCE



*Source: Author-generated

For all the above variables, distribution is asymmetrical, i.e., data shows significant skewness, and this study uses the non-parametric tests where the median serves as the primary source of central tendency. Because Median provides a robust and resistant estimate of firm performance or market valuation, ensuring extreme outliers do not distort the comparative analysis.

Test of Normality

Normality Test (Shapiro-Wilk)		W	p
Market Capitalisation	**Total assets**	0.577	<.001
Market Capitalisation	**Board Size**	0.562	<.001
Market Capitalisation	**ROCE**	0.561	<.001
Note. A low p-value suggests a violation of assumption of normality.			

- Table 1Sources – Calculated by the scholar/author from NSE 52 companies (Based on real values)

For the variables mentioned above, "Shapiro-Wilk test" has been conducted to formally evaluate assumption of normality. The outcomes show that all of the variables in the above table deviate significantly from a normal distribution. The non-normality justifies the use of a non-parametric test. Median becomes the measure of central tendency for this study.

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The analysis of Descriptive Statistics

Descriptive Statistics							
Descriptives	**N**	**Mean**	**Median**	**SD**	**IQR**	**Minimum**	**Maximum**
Board Size	260.00	11.10	11.00	2.50	3.00	6.00	20.00
Total assets	260.00	95,483.00	43,770.00	1,49,659.63	80,711.89	38.79	9,71,699.00
ROCE	260.00	20.80	17.90	14.33	14.54	0.95	89.50
Market Capitalisation	260.00	1,955.30	1,099.60	2,724.02	1,535.55	82.73	20,105.60

- Table 2 Sources – Calculated by the scholar/author from NSE 52 companies (Based on real values)

From the above table of Descriptive analysis, across all financial variables, this analysis confirms significant positive skewness. The mean of total assets and market capitalization is across double the median, suggesting extreme outliers affect the average. Such high levels of non-normality justify the use of non-parametric tests, and the median becomes the primary measure of central tendency for this study.

Paired Samples T-Test			Statistic	p
Market Capitalisation (2)	**Total assets**	**Wilcoxon W**	15.0	<.001
	Board Size	**Wilcoxon W**	33930.0	<.001
	ROCE	**Wilcoxon W**	33930.0	<.001
Note. H_a $\mu_{Measure\ 1 - Measure\ 2} \neq 0$				

- Table 3 Sources – Calculated by the scholar/author from NSE 52 companies (Based on real values)

Due to the significant right skewness and non-normality identified in the descriptive statistics, a Wilcoxon Signed-Rank test has been used instead of a "parametric Paired Sample T-test." The median of differences among pairs is compared utilizing this non-parametric test approach, ensuring extreme outliers in Market Capitalisation or valuation and Total assets do not distort the significance of findings.

Linear Regression

Fit Measures		
Model	**R**	**R^2**
1	**0.733**	**0.537**
Note. Models utilizing a sample size of N=260		

- Table 4 Sources – Calculated by the scholar/author from NSE 52 companies (Based on real values)

The model fit was evaluated using the R and R-squared measures. The model given in a Multiple R of 0.733, indicating a strong overall relationship between estimators or independent and the dependent variable. The R^2 value of 0.537 suggests that independent variables (Board Size, ROCE, and Total Assets) account for 53.7% of the total variance in Market Capitalisation. Given the complexity of market valuations, explaining more than half of the variance with three internal metrics indicates a robust and meaningful model. The linear regression equation will be as follows;

Market Capitalisation = 168.2764 - (99.5850*Board Size) + (81.6715*ROCE) + (0.0131*Total Assets)

Model Coefficients - Market Capitalisation				
Predictor	**Estimate**	**SE**	**t**	**p**
Intercept	168.2764	554.6400	0.3030	0.7620
Board Size	-99.5850	47.7500	-2.0860	0.0380
ROCE	81.6715	8.6100	9.4810	<.001
Total assets	0.0131	0.0008	16.0820	<.001

- Table 5 Sources – Calculated by the scholar/author from NSE 52 companies (Based on real values)

The determinants of market capitalization were the subject of linear regression analysis, demonstrated in the above table. With all the variables reaching "statistical significance" at the P<0.05, results show that model is robust. "Board size" has significant negative effects (β = -99.5850, P = 0.038) proposed that various board members increase, then market capitalisation or valuation tends to decrease. Also, the intercept was not statistically significant (P = 0.762), which is common in financial modelling and implies that model's predictive power is driven entirely by the selected business metrics. Return on capital employed (ROCE) as well as Total Assets both indicate a highly significant positive relationship with market capitalisation (P < 0.01), supporting that higher profitability and larger asset bases are primary drivers of market capitalisation.

Data Summary

Cook's Distance			Range	
Mean	**Median**	**SD**	**Min**	**Max**
0.0141	0.0004	0.0693	0.0000	0.8110

- Table 6 Sources – Calculated by the scholar/author from NSE 52 companies (Based on real values)

The impact of individual data on the model was assessed by an indicative review of Cook's distance. The extremely low value of Mean (0.0141) and Median (0.0004), showing that the regression model is robust and it performs consistently despite small changes in the data. However, the maximum value of 0.8110 indicates the presence of one highly influential outlier but this value

remains below the common critical threshold of 1.0, but it is substantially higher than the standard deviation (0.0693), showing that one specific observation uses significantly more hold than the rest of the sample. In spite of this, the overall consistency between mean and median suggests that the reported coefficients for ROCE, Total assets, and Board Size are representative of the broader sample.

Collinearity Statistics		
	VIF	Tolerance
Board Size	1.05	0.951
ROCE	1.05	0.948
Total assets	1.11	0.903

- Table 7 Sources – Calculated by the scholar/author from NSE 52 companies (Based on real values)

This collinearity test looks good; this indicate that model is highly reliable and free from the common problem of multicollinearity. To find out multicollinearity, tolerance levels and variance inflation factor (VIF) are calculated. The results revealed a variance inflation factor value ranging from 1.05 to 1.11, which is well below the common threshold of 5.0. Similarly, Tolerance values remained above 0.90, indicating that the independent variables (Board Size, ROCE, and Total Assets) are not significantly correlated with one another. This demonstrates that the regression coefficients are stable and reliable and that each predictor gives the model different explanatory power.

Limitations of the Study

Though the model is statistically significant, several limitations should be admitted:

1. **There is a presence of Influential Outliers**: Cook's Distance test identified a maximum value of 0.8110. While this value falls below the threshold of 1.
2. **Omitted Variable Bias**: The model explains only 53.7% of Market Capitalisation variance, remaining or unconsidered variable 46.3% unexplained.
3. **Assumption of Linearity:** The study assumes a straight-line relationship between variables and applies linear regression.
4. This study is conducted considering 52 listed companies of NSE for 5 years, the findings may change if the sample size increases.

Suggestions for Future Research

Future research scope explained in the following ways;

1. Qualitative governance variables like Board Independence, Diversity, CEO Duality, etc. Should be incorporated.
2. If possible, sector-wise comparisons should be made.
3. Board size and performance should employ quadratic or non-linear regression model to identify the size or optimal board size.
4. Other financial metrics or variables should be considered.

Acknowledgement

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study entitled "Board Size and Market Valuation – A Study on 100 National Stock Exchange Listed Companies."

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Impact of Digital Investment Platforms on Mutual Fund Adoption among Young Investors in India.

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Abstract

The fast digitalization of the Indian financial market has radically changed the management of wealth, in particular among millennials and Generation Z. The present research paper is an empirical study of the way digital investment platforms could impact the number and adoption of mutual fund investments among young investors in India. The sample size used was 350 young adults (18-35 years old) living in Bengaluru, where a structured Likert-scale questionnaire was used to gather primary data based on the descriptive research design. The data was assessed with the help of the SPSS software to test the hypothesized relationships by means of the descriptive statistics, Pearson correlation, and multiple regression models.

The empirical results show that there is a very strong positive relation between platform-centric technological characteristics and regular investing behaviour. In particular, a frictionless paperless KYC onboarding, the existence of zero-commission direct mutual funds, and the possibility to engage in micro-investing (e.g. 100 SIPs) turned out to be the most potent influence in adopting mutual funds. Further, despite the demonstrated increase in investor confidence and risk-taking behavior towards equity funds, when using data tracking tools and educational resources in apps, the researchers were the first to find that young investors were hesitant about automated, in-built fund recommendations and instead highly preferred independent financial recommendations. Finally, the research finds that fintech applications are key drivers in youth capital market engagement, and would be a viable solution to close the most important divide between technological convenience and realistic financial literacy. The lessons can also help Fintech developers to maximize user interfaces, enhance the degree of analytical transparency, and maintain long-term retail investment in a competitive digital economy.

Keywords: *Digital Investment Platforms, Mutual Fund Adoption, Fintech, Young Investors, Micro-investing*

Introduction

The Indian financial market has seen a paradigm shift in the last ten years with a structural change of traditional, paper-based wealth management into very convenient digital investment platforms. The digital technologies have emerged as one of the engines of the ridiculously high growth of the mutual fund industry (Das & Ali, 2020). A new generation of more financially conscious consumers and investors, i.e., the millennials and Generation Z, have entirely different financial literacy and investment behaviors compared to their older counterparts and are at the forefront of this financial revolution (Abhonkar and Kude, 2025; Aedla et al., 2026).

The fintech innovations and digitalization have greatly influenced the mutual fund investment decisions of this young generation (Srivastav et al., 2024). Previously, the capital markets could not take part, as there were bureaucratic procedures and overuse of physical financial advisors (Prasad & Sharma, 2022). The democratization of access in the contemporary world has been provided by digital platforms and mobile applications. Mobile convenience, automated services, and user-friendly interfaces are among the drivers of young investors to start using these platforms and stay in the wealth-generating process (Chaturvedi et al., 2024). This technological adoption has a lot to do with convenience, but it has an inseparable relationship with an increase in digital financial awareness, and fintech contributes to bridging the divide in basic financial literacy (Dubey et al., 2023; Sharma, 2025).

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Additionally, external online triggers have a large impact on the digital wealth management ecosystem. The ubiquitous nature of social media on the behavior of users has increased the rate of adoption of such media (Sharma and Mishra, 2024), changing the way the young generation gathers financial knowledge and develops their opinion about mutual funds (Bhowmick et al., 2025). The successful marketing of mutual funds through digital platforms is evident with diverse Indian groups (Vishakh and Jayalakshmi, 2025; Jayalakshmi, 2025) and directly similar to the models of using technology among youth to manage their wealth (Dewi and Rahadi, 2020; Kasemharuethaisuk and Samanchuen, 2023; Rahadi).

Consequently, relevance of an empirical research on the relationship between digital investment platforms and the mutually-fund adoption is high. The consequences of the mechanisms that are behind this technology-based financial behavior would be priceless in the future of retail capital market participation in India.

Review Of Literature

Author and Year	Objective	Methodology	Key Findings	Summary
Aedla, S. R., et al. (2026)	To compare traditional and digital investment preferences among the youth.	Comparative analysis using primary survey data.	Youth strongly prefer digital platforms due to high awareness and ease of access.	Highlights the shift towards digital investment tools among young demographics.
Srivastav, S. K., et al. (2024)	To analyze the influence of fintech on mutual fund choices.	Descriptive study with cross-sectional data.	Fintech advancements significantly direct investor choices towards digital mutual funds.	Underscores fintech as a primary driver for modern investment decision-making.
Das, K. K., & Ali, S. (2020)	To assess the impact of digital technologies on mutual fund growth.	Impact study using secondary market data.	Digital technologies have exponentially accelerated the overall AUM and folio growth.	Establishes a direct link between technology adoption and industry expansion.
Chaturvedi, D. D., et al. (2024)	To identify factors motivating continued use of mobile investment apps.	Quantitative research using Regression-ANN approach.	Ease of use and perceived usefulness keep young investors continuously engaged on apps.	Provides a technical overview of sustained mobile app usage behaviors.
Vishakh, V. T., & Jayalakshmi, G. (2025)	To evaluate the role of tech platforms in promoting mutual funds.	Empirical study based on regional data.	Digital platforms drastically increase mutual fund penetration in localized markets.	Highlights regional success driven by digital platform accessibility.
Bhowmick, S., et al. (2025)	To explore changing investor opinions and trends in mutual funds.	Exploratory research using structured questionnaires.	Investors show a growing positive sentiment and trust towards digital fund management.	Outlines the evolving psychological trends of modern mutual fund investors.
Dewi, E. K., & Rahadi, R. A. (2020)	To conceptualize the adoption of online mutual fund platforms.	Conceptual study based on literature review.	Adoption relies heavily on perceived trust, platform security, and user convenience.	Provides a foundational theoretical model for online platform adoption.
Jayalakshmi, G. (2025)	To assess the promotional role of digital platforms in investing.	Descriptive research using secondary data.	Digital outreach heavily influences new investor onboarding and product awareness.	Emphasizes the marketing power of tech platforms in finance.
Prasad, M. R., & Sharma, A. (2022)	To study the relevance of human financial advisors post-digitalization.	Quantitative study with primary survey data.	Despite digital tools, complex mutual fund decisions still prompt a need for advisors.	Contrasts digital autonomy with the continuing need for expert financial guidance.
Sharma, V., & Mishra, S. (2024)	To investigate social media's influence on mutual fund behaviors.	Empirical analysis using online survey data.	Social media trends directly impact the mutual fund purchasing behaviors of users.	Highlights social platforms as crucial catalysts for investment choices.
Sharma, U. (2025)	To explore the interplay between digital literacy and investments.	Thematic literature review methodology.	Higher digital financial literacy leads to increased and sustained mutual fund investments.	Underscores education as a vital prerequisite for digital investing.
Dubey, K. K., et al.	To determine fintech's	Descriptive study	Fintech apps actively	Establishes fintech not

(2023)	role in enhancing financial awareness.	with structured questionnaires.	educate users, directly boosting mutual fund participation rates.	just as a tool, but an educational driver.
Rahadi, R. A., et al. (2021)	To analyze millennial adoption of online mutual funds in Indonesia.	Quantitative research via primary survey data.	Millennials quickly adopt platforms that offer seamless UI and low entry barriers.	Provides international context on millennial digital investment behaviors.
Abhonkar, D., & Kude, M. M. (2025)	To compare mutual fund perceptions between Gen X and Gen Y.	Comparative study using cross-sectional data.	Gen Y shows significantly higher trust in digital mutual funds than Gen X.	Details generational divides in the acceptance of digital wealth tools.
Kasemharuethaisuk, H., & Samanchuen, T. (2023)	To identify factors influencing digital investment intention in Thailand.	Empirical analysis using primary survey data.	Intention to use depends heavily on platform reliability and perceived financial benefits.	Reinforces the importance of trust in digital financial service adoption.

Research Gap

The general trend towards digital mutual funds and the role of financial literacy in various locations was already an active topic of discussion in the existing literature, and there is a massive shortage of the research that directly relates platform-specific variables, i.e. micro-investing and UI/UX that directly affect the risk appetite of millennial and Gen Z investors in the hyper-digital setting of Bengaluru.

Research Design

1 statement of the problem

Capital markets have changed with the financial technology, yet we are urgently needed to gauge empirically the effect of digital platforms specifically on the adoption of mutual funds by youth. This research should be conducted to address this gap which exists between the availability of the technology and the real financial behavior, the reasons why the youths are willing to be active market players. The main line of the study is the evaluation of the effect that the features of digital platforms, such as user interfaces, micro-investing, and low-cost, will have on the investment decision making of millennials and Gen Z. The project will affect financial institutions and fintech companies by providing practical solutions to optimize their platform and appeal to more of this new generation of digitally-native retail investors.

Objectives

- **To assess** the role of digital platform features (such as UI/UX and accessibility) in driving mutual fund investments among young adults.
- **To understand** the primary motivating factors (e.g., low advisory fees, micro-investing options) that encourage millennials and Gen Z to adopt mutual funds.
- **To find out** the relationship between digital financial literacy provided by these platforms and the evolving risk appetite of young investors.

Research Methodology

The research methodology gives the system that is going to be employed to conduct this research. It provides the methodological approach of data collection, measurements and data analyses so that the aims of a research can be fulfilled in a rational and adequate way without undermining the academic rigor and validity of the entire process of research.

Descriptive Study: The research design that is employed in this study is descriptive; this is a very suitable study topic. It aims to accurately and scientifically describe the characteristics, trends, and preferences of the young generation of investors towards digital platforms without manipulating any variable, providing a clear picture of the existing trend in the market.

Sources Of Data

Primary Data: The researcher will use personal visits to the respondents to gather primary data. Young investors who are active on digital platforms will be the sample units that the study will use. This real-life information is gathered firsthand with the aim of the research with an intention of making it highly suitable in terms of user behaviors.

Secondary Data: The secondary data will be obtained on the existing published data to develop the theoretical framework. This includes information obtained by other individuals on the remaining causes, e.g. academic journals, industry publications, AMFI reports, financial news articles, and the official websites of the various digital investment platforms.

Sampling Plan

- **Sampling unit:** Young adult investors (35 years and below) residing in Bengaluru and actively investing in mutual funds by using digital platforms.
- **Sample size:** The research will be made up of 350 responses precisely to provide statistical reliability and representation.
- **Sampling technique:** Convenience sampling will be applied, and the participants will be the individuals who are easily accessible, available and are willing to take part in the target group.

Data Collection Tools

- **Survey:** A designed questionnaire survey will be used with the assistance of a developed questionnaire and 5-point Likert scale questions to quantitatively measure the attitudes, preferences and the level of satisfaction of the respondents with digital investing platforms.
- **Observation:** Non-participant observation will be briefly used to gain the insight into the general trends in the online world, the alterations of the

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characteristics of the platform, and the discussion of the community users on financial forums to be able to contextualize the main survey data.

- **Focus groups:** small focus group sessions of 5-7 young investors will be held in order to obtain more qualitative information regarding their personal experience, their motivation, and their complaints on the existing platforms.

Plan of Analysis

Data collected will be in raw form and will have to be tabulated, grouped and organized into relevant classes. Descriptive statistics, correlation and regression analysis will then be used to interpret and infer it. This kind of a comprehensive quantitative evaluation will be carried out in MS Excel spreadsheets and SPSS software to provide valid, accurate and academic findings.

Conceptual Framework

Dependent Variable (DV):

Mutual Fund Adoption

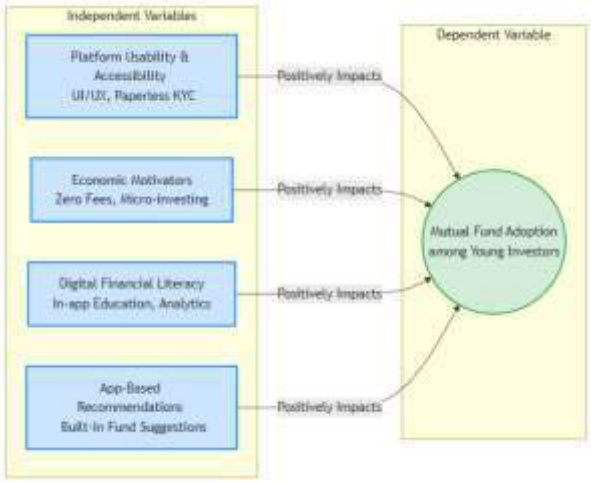
Independent Variables (IVs):

Platform Usability & Accessibility

Economic Motivators

Digital Financial Literacy

App-Based Recommendations



Results

H0 (Null Hypothesis): Digital investment platforms have no significant impact on the adoption and frequency of mutual fund investments among young investors in India.

H1 (Alternative Hypothesis): Digital investment platforms have a significant positive impact on the adoption and frequency of mutual fund investments among young investors in India.

Regression Analysis

Variables Entered/Removeda			
Model	Variables Entered	**Variables Removed**	**Method**
1	I rely on the platform's built-in recommendations over conducting my own independent research., Zero-commission direct mutual funds heavily influenced my decision to use a digital platform., Data tracking tools (e.g., SIP calculators, historical charts) give me the confidence to take higher investment risks., The paperless KYC onboarding process was a primary reason I chose digital investing.b	.	Enter
a. Dependent Variable: The ability to micro-invest (e.g., ₹100–₹500 SIPs) keeps me consistently invested			
b. All requested variables entered.			

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.974a	.948	.947	.241
a. Predictors: (Constant), I rely on the platform's built-in recommendations over conducting my own independent research., Zero-commission direct mutual funds heavily influenced my decision to use a digital platform., Data tracking tools (e.g., SIP calculators, historical charts) give me the confidence to take higher investment risks., The paperless KYC onboarding process was a primary reason I chose digital investing.				

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ANOVAa						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	363.020	4	90.755	1567.284	.000b
	Residual	19.978	345	.058		
	Total	382.997	349			
a. Dependent Variable: The ability to micro-invest (e.g., ₹100–₹500 SIPs) keeps me consistently invested						
b. Predictors: (Constant), I rely on the platform's built-in recommendations over conducting my own independent research., Zero-commission direct mutual funds heavily influenced my decision to use a digital platform., Data tracking tools (e.g., SIP calculators, historical charts) give me the confidence to take higher investment risks., The paperless KYC onboarding process was a primary reason I chose digital investing.						

Coefficientsa						
Model		Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	-.331	.072		-4.590	.000
	The paperless KYC onboarding process was a primary reason I chose digital investing.	.678	.042	.623	16.144	.000
	Zero-commission direct mutual funds heavily influenced my decision to use a digital platform.	.192	.039	.163	4.969	.000
	Data tracking tools (e.g., SIP calculators, historical charts) give me the confidence to take higher investment risks.	.208	.035	.212	5.916	.000
	I rely on the platform's built-in recommendations over conducting my own independent research.	.000	.031	.000	-.007	.994
a. Dependent Variable: The ability to micro-invest (e.g., ₹100–₹500 SIPs) keeps me consistently invested						

Interpretation

The regression analysis indicates that features of digital platforms have a strong predictive power on consistent mutual fund adoption ($R^2 = 0.948$). The overall ANOVA model is highly significant ($F = 1567.284$, $p < 0.001$).

The coefficients analysis shows that a paperless KYC procedure (beta = 0.623, $p < 0.001$), data tracking-tools (beta = 0.212, $p < 0.001$), and zero-commission funds (beta = 0.163, $p < 0.001$) are powerful and positive predictors of micro-investing. There was no significant impact of only built-in recommendations ($p = 0.994$).

The null hypothesis (H0) is rejected and the alternative hypothesis (H1) is accepted since the core platform features have a significant positive impact on the investment behavior.

Correlation

		Platform Usability & Accessibility	Economic Motivators	Digital Financial Literacy	App-Based Recommendations	Mutual Fund Adoption
Platform Usability & Accessibility	Pearson Correlation	1	.917**	.915**	.909**	.966**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	350	350	350	350	350
Economic Motivators	Pearson Correlation	.917**	1	.888**	.882**	.922**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	350	350	350	350	350
Digital Financial Literacy	Pearson Correlation	.915**	.888**	1	.915**	.926**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	350	350	350	350	350

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App-Based Recommendations	Pearson Correlation	.909**	.882**	.915**	1	.903**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	350	350	350	350	350
Mutual Fund Adoption	Pearson Correlation	.966**	.922**	.926**	.903**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	350	350	350	350	350
**. Correlation is significant at the 0.01 level (2-tailed).						

Interpretation

The Pearson correlation table indicates that all the evaluated variables have very strong positive and highly significant relationships ($p<0.001$). The strongest correlation between the ability to consistently micro-invest (the dependent variable) and a paperless KYC onboarding process ($r=0.966$) exists. It also demonstrates very strong correlations with data tracking tools ($r=0.926$) and zero-commission funds ($r=0.922$). Although platform recommendations did not play a significant part in the regression model, they are strongly positively correlated ($r=0.903$) with consistent investing. On the whole, these findings suggest that the better the characteristics of digital platforms are made user-centric, the higher the mutual funds adoption and regular investing habits will be.

Descriptive Statistics

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
age group	350	1	4	1.87	.900
occupation	350	1	4	1.93	.850
annual income	350	1	4	2.02	.982
Investment platform used for investment	350	1	5	2.08	1.205
Tenure of investing in mutual funds through a digital platform	350	1	4	2.32	1.015
typical monthly investment amount (SIP or lump sum) in mutual funds	350	1	4	2.18	.977
primary category of mutual funds most invest in	350	1	4	2.27	1.299
The platform's user-friendly interface (UI) motivated me to start investing.	350	1	5	3.97	1.017
The paperless KYC onboarding process was a primary reason I chose digital investing.	350	1	5	4.03	.963
Zero-commission direct mutual funds heavily influenced my decision to use a digital platform.	350	1	5	4.21	.891
The ability to micro-invest (e.g., ₹100–₹500 SIPs) keeps me consistently invested	350	1	5	4.00	1.048
In-app educational resources and market insights have improved my financial literacy	350	1	5	3.79	1.082
Data tracking tools (e.g., SIP calculators, historical charts) give me the confidence to take higher investment risks.	350	1	5	3.79	1.068
Comfort with platform data has led me to shift towards higher-risk funds (e.g., Small-Cap, Sectoral).	350	1	5	3.66	1.116
I rely on the platform's built-in recommendations over conducting my own independent research.	350	1	5	3.46	1.164
Valid N (listwise)	350				

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Interpretation

The answers of 350 young investors are summarized in the table of descriptive statistics. Among the Likert scale questions (answered between 1 and 5), the best agreement is observed concerning the question of the Zero-commission direct mutual funds, (Mean = 4.21, SD = 0.891) which is that cost-efficiency is the most influential factor that determines the use of digital platforms. This is then closely followed by the ease of Paperless KYC onboarding process (Mean = 4.03, SD = 0.963), and the Ability to micro-invest (Mean = 4.00, SD = 1.048), both of which have a strong positive agreement.

These aspects as in-app education, data tracking tools, etc. are much more likely to be positive (Mean = 3.79 both). Conversely, the lowest degree of agreement is on the use of "Built-in recommendations" (Mean = 3.46) with the largest variance (SD = 1.164) and thus, the split on automated financial advice. The sample means of the demographic data are exactly in line with the desired group of young early-career respondents.

Discussions

The number of respondents surveyed is 350, and a big percentage of 147 respondents are in the age group of 18-24 years.

- The study has depicted that the group of professionals who are salaried personnel is the largest with 168 of them actively using the digital platforms to manage wealth.
- Groww has been made the most popular digital investment application among 142 users and Zerodha Coin with 111 active young investors.
- 35 percent of the youthful group is moderate investors, and 138 of them have a consistent investment amount of 1000-5000 rupees per month with mutual funds.
- Equity mutual funds obviously dominate the investment preferences of the young population, with 159 of those interviewed choosing the type of investment as its main wealth creation tool.
- Descriptive statistics indicate that availability of zero-commission direct mutual funds is the most motivating and has the highest mean of 4.21.
- The convenience of a fully paperless KYC onboarding process is one of the key incentives to the early adoption of the platform with the average rating among the participants of 4.03 being exceptionally high.
- The fact that it is possible to begin with micro-investments starting as low as ₹100-500 is highly valued, with the mean approval rating of the users being 4.00.
- The reliance on built-in platform recommendations had the lowest mean score of 3.46 that indicates that young investors are split into opinion about automated financial advice.
- Correlation matrix indicates that the paperless KYC process has a strong positive relationship with the regular micro-investing among the youth with a correlation of 0.966.
- The ability to have consistent investment portfolios has a very large positive correlation of 0.926 with data tracking tools such as SIP calculators.
- The regression analysis confirms that the model fits very well with the high R-squared of 0.948, which means that digital features are highly determinant in mutual fund adoption.
- According to the regression coefficient, the most robust independent variable that will produce consistent investments with a beta of 0.623 is the paperless KYC onboarding process.
- The second most important predictor of investment consistency is data tracking tools, with a historical chart, and a beta coefficient of 0.212.
- By a stark contrast, inbuilt platform recommendations were not of great significance in the regression model, and that their p-value is 0.994 in terms of consistent investment behavior.

Conclusion

The emergence of the online investment system has transformed the wealth generation of young investors in India radically. The paper conclusively demonstrates that the rise of fintech application is no longer an option but the key driver of mutual fund adoption in millennials and Gen Z. The empirical data indicate that the recent surge in the interest of the young population in the retail market is colossally catalyzed by some platform-specific factors, of which the most noticeable one is the paperless, frictionless KYC onboarding procedure and the affordability of zero-commission direct mutual funds. Additionally, investing with micro-SIPs has been seen to be very effective in the democratization of investing among students and young-professionals, which builds disciplined and regular investment habits.

Interestingly, the study points to the fact that there is a fast emerging financial attitude amongst the young generation. Regression analysis supports their heavy reliance on in-app data tracking tools and past charts to create confidence and more risky equity market, as they do not follow the build-in, automated recommendations but rely on their own judgment. So, having bridged the divide that has been an achille heel between the digital financial literacy and the technological accessibility, such investment platforms have managed to transform the digital-native generation in India into the participants and informed consumers of the capital markets.

Suggestions

- The digital investment platforms are also expected to continue simplifying their processes of onboarding new users without paperwork because it is expected to be fully frictionless between new users who are young.
- Financial technology companies also ought to heavily promote their micro-investing service through social media channels to attract university students. The low entry barrier with very low cost systematic investment plans generates an enormous customer loyalty in the long-term.

- Summary: Zero-commission direct mutual fund system plays a crucial role in retaining millennial and Gen Z cost-conscious investors in the long-run.
- The suite of interactive data tracking tools and historical performance charts should be greatly increased by app developers. It will be viable to provide high degree of analytical capabilities that will allow the independent user decision making and build confidence of the market.
- Since young investors are now very sceptical of automated fund proposals made, websites need to be much more transparent about their algorithms. The lack of trust may be resolved through clarification of the exact steps of why a given mutual fund is displayed.
- The fact that gamified financial literacy elements are directly included in the investment app can be a major contributor to the overall user experience. Education of the users on the basics of the market is a highly commendable method of doing away with panic selling and promoting the most disciplined type of investing.
- Marketing campaigns may also be tailor-made to suit the special tax saving and wealth-creation needs of young working professionals in the early phase of their careers with salaried workers.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Impact of Dr. A. P. J. Abdul Kalam Amrut Aahar Yojana on the Nutritional Status of Mothers and Children in Tribal Areas of Gadchiroli District: A Social Work Perspective

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Abstract

The present research paper studies the impact of the Amrut Aahar Yojana on the nutritional status of mothers and children in the tribal areas of Gadchiroli district. The study is based on data collected from 500 respondents. Simple tables, cross-tabulation, Chi-square test, Cramér's V and Spearman's Rank Correlation were used for data analysis. The findings reveal that the Amrut Aahar Yojana has contributed positively to child health, weight gain, reduction in malnutrition, awareness regarding immunization, family satisfaction and beneficiary participation. ICDS services, Anganwadi centers, quality of food and awareness among beneficiaries were found to be important factors in the effective implementation of the scheme. Thus, the Amrut Aahar Yojana appears to be an important social welfare intervention for improving maternal and child nutrition and health in tribal areas.

Keywords: *Amrut Aahar Yojana, maternal and child nutrition, tribal health, malnutrition, Anganwadi, ICDS, Gadchiroli, social work.*

Introduction

Nutrition is a fundamental component of maternal and child health. In tribal and rural areas, poverty, limited access to health services, lack of awareness and food insecurity often adversely affect the nutritional status of mothers and children. Gadchiroli district is largely tribal and rural in nature; therefore, issues related to maternal health, child nutrition, malnutrition, supplementary nutrition and access to government welfare schemes are highly significant in this region.

Dr. A. P. J. Abdul Kalam Amrut Aahar Yojana is an important welfare scheme implemented to provide nutritious food to pregnant women, lactating mothers and children. The scheme is not limited to food distribution alone; it also works through Anganwadi centers, ICDS staff, health guidance, immunization, nutrition education and beneficiary awareness. In this way, the scheme supports the overall development of maternal and child health. From a social work perspective, the scheme is important because it connects nutrition, health, awareness, family well-being, social participation and access to government services. The present study attempts to examine the impact of this scheme on the nutritional status of beneficiary mothers and children in tribal areas of Gadchiroli district.

Objectives of the Study

The present study is based on the following objectives:

1. To study the impact of Amrut Aahar Yojana on the nutritional status of beneficiary mothers and children in the tribal areas of Gadchiroli district.
2. To examine the role of Anganwadi centers and ICDS services in improving maternal and child nutrition under the Amrut Aahar Yojana.
3. To assess the level of awareness and satisfaction among beneficiary mothers regarding the benefits and implementation of the Amrut Aahar Yojana.

Research Methodology

The present study follows descriptive and analytical research methods.

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Data were collected from 500 respondents from selected tribal and rural areas of Gadchiroli district. The respondents were mainly beneficiary mothers and family members associated with Anganwadi centers.

The collected data were analyzed with the help of simple tables, cross-tabulation and statistical tests. The Chi-square test was used to examine the relationship between two variables, while Cramér's V and Spearman's Rank Correlation were used to measure the strength and direction of association between variables.

Socio-Economic Background of Respondents

Out of the total 500 respondents, 51.08 percent were Marathi-speaking, 29.04 percent were Madia-speaking and 17.02 percent were Gondi-speaking. In terms of religion, 96.06 percent of the respondents belonged to the Hindu religion. This indicates the significant presence of Marathi, Madia and Gondi-speaking tribal and rural communities in the study area.

Regarding family structure, 65 percent of respondents belonged to nuclear families, while around 33 percent belonged to joint families. In terms of occupation, agriculture and wage labor were the dominant sources of livelihood, accounting for 47 percent and 43 percent respectively. This shows that the socio-economic structure of the study area is mainly agricultural, labor-based and economically limited. This socio-economic background is important for studying maternal and child nutrition because government nutrition schemes can play a decisive role in improving the health of families belonging to economically weaker sections.

5.

The study found that the Amrut Aahar Yojana has brought positive changes in the nutritional status of beneficiary mothers and children. Children receiving supplementary nutrition showed improvement in weight gain, health status and physical strength. Most respondents reported positive changes in the physical, mental, intellectual and health-related development of children.

Supplementary nutrition was found to have an important effect on child weight gain. Children who received supplementary nutrition showed higher levels of weight gain, whereas children who did not receive adequate supplementary food showed a comparatively greater tendency toward weight loss. The relationship between supplementary nutrition and change in child weight was found to be statistically significant through Chi-square analysis.

The scheme also showed a positive impact on the reduction of malnutrition. According to the available findings, reduction in malnutrition was observed in 45.06 percent of cases. Regular and balanced food, health guidance and Anganwadi services helped in improving the nutritional status of children.

Impact on Child Health and Immunization

The study indicates that the Amrut Aahar Yojana and Anganwadi services have had a positive impact on child health. Children who received supplementary nutrition, health guidance, immunization and Anganwadi services showed improvement in health and a reduction in the frequency of illness.

In relation to immunization, 95.08 percent of children received immunization services. Among immunized children, improvement in immunity and reduction in illness were observed. The relationship between immunization and health improvement was found to be statistically significant.

Therefore, it can be stated that the coordination of the Amrut Aahar Yojana, Anganwadi services and health department plays an important role in improving child health.

Impact on Family Environment

The benefit of the Amrut Aahar Yojana was not limited only to child nutrition; it also affected the family environment of beneficiaries. About 51.2 percent of respondents reported a happy family environment, while 25.4 percent reported a stressful family environment. Due to the scheme, positive changes such as improved child health, reduced household tension and increased family satisfaction were observed.

The Chi-square test conducted to examine the relationship between family environment and changes in family condition showed a calculated value of $\chi^2 = 59.90$, which was greater than the table value of 16.92. Therefore, a statistically significant relationship was found between family environment and changes in family condition. Cramér's V value was 0.20, indicating a low to moderate but meaningful association.

This indicates that regular and nutritious food for children reduces mental stress in the family and increases family satisfaction.

Role of Anganwadi Centers and ICDS Services

Anganwadi centers and ICDS services play an important role in the effective implementation of the Amrut Aahar Yojana. The study found that beneficiaries received services such as supplementary nutrition, health guidance, immunization and counselling through Anganwadi centers. Among Anganwadi services, 46 percent of respondents reported receiving all services, 24 percent received supplementary nutrition and 18 percent received counselling services.

A significant association was found between ICDS benefits and the outcomes of the Amrut Aahar Yojana. The Chi-square value was $\chi^2 = 170.30$ with df = 16. Spearman's $\rho = 0.414$ indicated a moderate positive correlation between ICDS benefits and scheme outcomes. This means that when ICDS services are regular and effective, the outcomes of the Amrut Aahar Yojana are also better.

Thus, ICDS can be considered a foundational support system for the success of the Amrut Aahar Yojana.

Relationship between Anganwadi Workers and Beneficiaries

The relationship between Anganwadi workers and beneficiaries was generally found to be positive and satisfactory. About 55.2 percent of beneficiaries described their relationship with Anganwadi workers as very good, while 38.6 percent described it as good. This shows that Anganwadi workers play an important role in delivering nutrition and health services to beneficiary families.

However, some disputes between beneficiaries and Anganwadi workers were also reported. The main reasons for disputes were related to not allowing food to be taken

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home, food distribution methods, quality of food and non-availability of certain food items. Cramér's V = 0.334 indicated a moderate association between disputes and satisfaction regarding food, showing that disputes negatively affect beneficiary satisfaction.

Therefore, effective communication, transparency and cooperation between Anganwadi workers and beneficiaries are necessary for strengthening the scheme.

Food Quality and Beneficiary Satisfaction

Food quality emerged as an important factor in the success of the Amrut Aahar Yojana. Among beneficiaries who received excellent quality food, 77.62 percent reported complete satisfaction. However, among those who received medium-quality food, only 31.96 percent reported complete satisfaction.

A moderate positive and statistically significant relationship was found between food quality and beneficiary satisfaction, with Spearman's $\rho = +0.448$ and $p < 0.001$. This indicates that better food quality increases beneficiary satisfaction.

Some beneficiaries reported limitations such as irregular food distribution, variation in food quality and non-availability of certain food items. Therefore, strengthening food quality control and ensuring regular distribution are necessary.

Beneficiary Awareness and Participation

Awareness about the Amrut Aahar Yojana was found to be very high among beneficiaries. About 97.06 percent of respondents were aware of the scheme. Among the sources of awareness, posters displayed in public places accounted for 53.02 percent, home visits by officers or staff accounted for 25.4 percent and public announcements through speakers accounted for 19 percent.

In terms of participation, 71.04 percent of beneficiaries reported regular participation. A positive tendency was observed that higher levels of information were associated with increased participation and cooperation.

However, although awareness was high, behavioral participation was not found to be equal among all beneficiaries. Therefore, awareness campaigns should not remain limited to information dissemination; they should also promote active participation and behavioral change.

Hypotheses and Testing

Three hypotheses were framed in accordance with the objectives of the study. These hypotheses were tested using simple tables, cross-tabulation, Chi-square test, Cramér's V and Spearman's Rank Correlation.

Hypothesis 1

The Amrut Aahar Yojana has brought positive changes in the nutritional status of beneficiary mothers and children in the tribal areas of Gadchiroli district.

Testing:

To test this hypothesis, factors such as child weight gain, health status, reduction in malnutrition, supplementary nutrition and health improvement were studied. Children receiving supplementary nutrition showed greater improvement in weight gain and health status. A positive trend in the reduction of malnutrition was also observed. Therefore, the Amrut Aahar Yojana has contributed to improving the nutritional status of mothers and children.

Decision:

This hypothesis is **accepted**.

Hypothesis 2

Anganwadi centers and ICDS services make the implementation of the Amrut Aahar Yojana more effective.

Testing:

A significant relationship was found between ICDS benefits and the outcomes of the Amrut Aahar Yojana, with $\chi^2 = 170.30$ and Spearman's $\rho = 0.414$. This indicates that when ICDS services are regular and effective, the results of the Amrut Aahar Yojana are better. Through Anganwadi workers, health workers and ICDS staff, beneficiaries receive food, health, immunization and nutrition-related guidance.

Decision:

This hypothesis is **accepted**.

Hypothesis 3

The level of awareness and satisfaction among beneficiary mothers regarding the Amrut Aahar Yojana is positive.

Testing:

The study found that 97.06 percent of respondents were aware of the Amrut Aahar Yojana. Food quality had a positive effect on beneficiary satisfaction. Spearman's $\rho = +0.448$ and $p < 0.001$ indicated a moderate positive relationship between food quality and satisfaction. However, although awareness was high, behavioral participation was not equal among all beneficiaries.

Decision:

This hypothesis is **partially accepted**.

Discussion

The study shows that the Amrut Aahar Yojana is not merely a food distribution scheme; it is a multidimensional intervention affecting nutrition, health, family satisfaction and social participation. Supplementary nutrition, Anganwadi services, health guidance and immunization together contributed to positive changes in child health and nutrition.

The statistical analysis clearly indicates that ICDS services play an important role in the success of the scheme. The moderate positive correlation between ICDS benefits and scheme outcomes shows that administrative efficiency, regular benefit distribution and active functioning of Anganwadi centers are necessary for the effectiveness of the scheme. At the same time, issues such as variation in food quality, irregular distribution, non-availability of some food items and communication gaps between beneficiaries and service providers affect satisfaction. Therefore, quality control, beneficiary feedback and grievance redressal mechanisms need to be strengthened.

Social Work Perspective

From a social work perspective, the Amrut Aahar Yojana is an important intervention for ensuring nutrition security among tribal mothers and children. The scheme is closely linked with issues such as poverty, malnutrition, health inequality, lack of information and social exclusion.

Therefore, the role of social workers becomes important in the areas of awareness generation, counselling, community participation, beneficiary empowerment and monitoring of service delivery.

Social workers can act as a bridge between Anganwadi workers, ICDS staff, health workers and beneficiary mothers. They can also promote behavioral change in the community regarding maternal and child nutrition, breastfeeding, supplementary nutrition, immunization and health check-ups.

Recommendations

1. **Regular monitoring of food quality should be ensured.** Since food quality has a positive relationship with beneficiary satisfaction, quality control should be strengthened.
2. **ICDS and Anganwadi services should be strengthened.** As ICDS benefits are significantly associated with scheme outcomes, improving the efficiency of ICDS services is necessary.
3. **Training should be provided to Anganwadi workers on communication skills and nutrition counselling.** This will help reduce communication gaps between beneficiaries and service providers.
4. **A grievance redressal and beneficiary feedback system should be strengthened.** Complaints related to food distribution, quality and regularity should be addressed in time to improve beneficiary satisfaction.
5. **Awareness campaigns should focus on behavioral participation.** Since awareness does not always result in active participation, awareness activities should encourage behavioral change and community involvement.
6. **Regular counselling should be provided on maternal and child nutrition, breastfeeding, iron tablets, supplementary nutrition and immunization.** Such counselling can strengthen health and nutrition awareness among mothers.
7. **Participation of mothers' groups, self-help groups and village-level committees should be increased.** Community involvement can increase transparency and effectiveness of the scheme.

Conclusion

The present study concludes that the Amrut Aahar Yojana is an effective and useful scheme for improving the nutritional status of mothers and children in the tribal areas of Gadchiroli district. The scheme has contributed to improvement in child health, weight gain, reduction in malnutrition, awareness regarding immunization, family satisfaction and beneficiary participation.

The study also shows that the effectiveness of the scheme depends on several factors, such as food quality, regular distribution, efficiency of ICDS services, performance of Anganwadi workers, administrative coordination and beneficiary participation. Therefore, to make the scheme more effective in the future, special attention should be given to quality control, regular monitoring, grievance redressal, beneficiary feedback and community participation.

Overall, from a social work perspective, the Amrut Aahar Yojana is an important welfare intervention for the nutrition, health and social empowerment of tribal mothers and children.

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I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study entitled **"Impact of Dr. A. P. J. Abdul Kalam Amrut Aahar Yojana on the Nutritional Status of Mothers and Children in Tribal Areas of Gadchiroli District: A Social Work Perspective."**

First and foremost, I express my heartfelt thanks to my supervisor, faculty members, and academic mentors for their invaluable guidance, continuous encouragement, and constructive suggestions throughout the course of this research. Their expertise and support have been instrumental in the successful completion of this study.

I am grateful to my institution for providing the necessary academic resources, facilities, and a supportive environment for conducting this research. I also extend my sincere appreciation to the officials and field functionaries associated with the implementation of Dr. A. P. J. Abdul Kalam Amrut Aahar Yojana for their cooperation and assistance during the data collection process.

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I would also like to acknowledge the contributions of social work professionals, public health experts, nutritionists, researchers, and policymakers whose studies and publications on nutrition, maternal and child health, tribal development, and social welfare served as important references for this work.

I am thankful to my friends and colleagues for their encouragement, support, and constructive discussions throughout the research process.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Central Government Programmes for Women Empowerment

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Abstract

Women empowerment is a fundamental prerequisite for achieving inclusive growth, social justice, and sustainable development. The Government of India has launched several programmes and schemes aimed at improving the social, economic, educational, and health status of women across the country. This study examines the major Central Government programmes designed for women empowerment, including initiatives related to education, skill development, entrepreneurship, financial inclusion, health care, safety, and social welfare. Programmes such as Beti Bachao Beti Padhao, Pradhan Mantri Matru Vandana Yojana, Sukanya Samriddhi Yojana, Stand-Up India, Mission Shakti, and various self-help group initiatives have significantly contributed to enhancing women's participation in society and the economy. The study highlights the objectives, achievements, and challenges associated with the implementation of these programmes. It concludes that while substantial progress has been made, continuous efforts are required to address existing barriers and ensure equitable opportunities for women in all spheres of life. Effective implementation, awareness generation, and community participation remain essential for achieving the broader goals of women empowerment in India.

Keywords: *Women Empowerment, Government Schemes, Gender Equality, Beti Bachao Beti Padhao, Mission Shakti, Financial Inclusion, Women Entrepreneurship, Social Welfare, Skill Development, Sustainable Development.*

Introduction:

The concept of empowerment was introduced at the international women's conference in Nairobi in 1985. As a counter project to the integration concept for advancing women. The empowerment concept makes it clear the political and economic gap between social classes and between men and women. It aims at redistribution of social power and control resources in favour of women based on development stratergy which is no longer oriented on growth the world market and military power.

Definition:

According to **Cambridge English Dictionary** empowerment means 'to authorize'
In other words, the people have to be authorized to have control over their lives that is better socio economic and political conditions.

The world bank defines it has "Improving the productivity of women contributes to growth,efficiency and alleviating poverty"

According to the inter**-American Development Bank**, "Development planning must profit from the decisive role of women in reducing poverty and should enable them to make end even greater social and economic contribution."

It is clear from the definition that women empowerment refers to the process of strengthening the hands of women who have been suffering from various disabilities,inequalities and gender discrimination. Empowerment is a process of providing power to women to become free the control of our patriarchal system and enjoying rights and opportunities granted by the Indian Constitution.

Objectives of the study

1. To analyze the concept of empowerment in present scenario.
2.To explore the policies and programmes of women empowerment.
3.To examine the challenges for women empowerment.

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Dimensions of Empowerment:

Empowerment is a process of awareness and capacity building leading to greater participation, to greater decision-making power and control,and to transformative action Empowerment is the process of challenging existing power relations and gaining greater control over the sources of power. The goals of women empowerment are to challenge patriarchal ideology to transform the structures and institutions that reinforce and perpetuate gender discrimination and social inequality and to enable poor women to gain access to and control over,both material and informational resources.

There are many dimensions to women's empowerment including personal, collective, national and global as well as economic, political and social.

Personal : Developing a sense of self and individual confidence and capacity,and undoing the effects of internalized oppression.

Relational: Developing the ability to negotiate influence the nature of a relationship and decisions made within it.

Collective: where individuals work together to achieve a more extensive impact than each could have had alone. This includes involvement in political structures,but might also cover collective action based on cooperation rather than competition.

Government of India Schemes for Women Empowerment

1. Sharmashakti-the report of the National Commission for Seif-Employed Women and Women in the Informal Sector-(1938)

The Shramashakti Report,for the first time,underlined the critical contribution of the marginalized poor women in both rural and urban areas,to the growth of formal economy. The situation of women in the informal sector,including self-employed and wage labour,paid and unpaid workers,as well as contractual employees was studided by the commission.Based on detailed analyses of such findings,many valuable recommendations were submitted in the report. These included,recognition of women's work as home-makers,as social,economic producers,enlarging the definition of women -workers in all subsequent data collection efforts to embrace all paid and unpaid work performed at the home and outside,setting up of an exclusive credit-body for poor and self-employed women and linking all training programmes to employment with the objective of increasing the remuneration and improving living conditions of poor women.

2. Support to Training and Employment Programme for Women(STEP)

This scheme was launhed in 1987,with the aims to upgrade the skills of poor and assetless women and to provide training and employment on a sustainable basis in the traditional sector so agriculture, fisheries, handlooms, handicrafts, animal husbandry, social forestry, wasteland development etc.

3. Employment-Cum-Income Generation-Cum Production Units

This scheme was launched in 1982-83 with a specific objective of extending training and employment opportunities for women in non-traditional and upcoming trades. Training is imparted to women belonging to weaker sections of the society of the society including school dropouts in non-traditional trades such as electronics,computer programming,printing and binding,weaving and spinning and garment making etc.

4. Condensed Courses of Education and Vocational Training for Adult Women (CCE&VT)

The programme of Condensed Courses of Education and Vocational Training for Adult Women provides new vistas of employment through continuing education and vocational training for women and girls who are school dropouts. Since inception of the programme in 1958 till March,1994,about 7.20 lakh adult women and young girls received continuing and vocational training with a total expenditure of RS.66.72 crores.

5. Socio-Economic Programme(SEP)

One of the major programmes of employment training for women is the Socioeconomic Programme (SEP) implemented by the Central Socio Welfare Board,provides work and wage to needy women such as destitues. Widows,deserted,economically backward and handicapped. Since the inception of this programme in 1958 till today,it had provide work and wage to 1.54 lakh needy women with a total expenditure of Rs.54.18 crores.SEP takes care of both literate,semi-literate and illiterate women trades promoted under this programme includes both traditional and agro based industries besides non-traditional trades.

6. Rashtriya Mahila Kosh (RMK)

Rashtriya Mahila Kosh,set up a Registers Society in March 1993,is intended to meet credit needs of the poor women particulary in the informal sector. It is being managed by a Governing Board and the Minister of Stab for women and Child Development is the Chairperson of the Kosh.

7. Mahila Samriddhi Yogana(MSY)

Mahila Samriddhi Yogana was launched on 2 October,1993.The MSY is a major initiative to empower women by raising their economic status. It aims to promote amongst rural women the habit to save and improve their financial assets, apart from enabling them to exercise greater control over their financial assests,apart from enabling them to exersice greater control over their own household resources. The scheme offers facilities os small deposits,with attractive rates of interest,through the network pf post offices.

8. Indira Mahila Yojana /Swayam Sidha

Swayamsidha is a centraly sponsered scheme launched from 2000-01.It is an integrated project for development and empowerment of rural women and is based on the formation of women's self help groups with emphasis on converging services,developing access to micro credit and promoting micro enterprises. Indira Mahila Yojana started in the state in 10 blocks in the year 1996 has been renamed as Swayam sidha and is now being implemented in 12 districts of the state.

The National Plan of Action foe Women.(NPA)-1976

This plan was adopted in 1976 and became a guiding account for the development of women till 1988. When a National perspective plan for women was formulated.

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The National Policy for Children 1974

This considers children as supreme assets to our country. So it is the duty of the state to accept their nature and should take necessary action for their improvement.

In 1976 a Women cell was formed in the ministry of labour which has been working on the problems of women. For the first time in 1978 a working group was constituted by the planning commission on employment of women.

In 1976 the government promulgated an Equal Remuneration Act.(ERA),according to this act it is the duty of the employer to pay equal remuneration to men and women workers for same work or work of similar nature. This act also provides for no discrimination on the ground of sex at the time of recruitment to central government jobs like post and telegraph,railway administration,banking,company etc.

The National Expert Committee on women prisoners - 1986

This committee was established in 1986 to study the conditions of women prisoners in the criminal correctional system and made recommendations regarding legislative and prison reforms and rehabilitation of women prisoners.

The National Nutritional Policy (NNP) 1998

This policy aims at to improve the nutritional status of women and children and country as a whole. It is the responsibility of the government to implement short term and long term measure to protect women and children from malnutrition in improving their health status.

The National Plan of Action for the Girl child (NPA) 1991-2000

It is an multi sectorat decade plan of Action. This plan of Action ensuring survival protection and development of children with a special gender sensitivity built for girl children and adolescent girls.

National Policy on Education 1986

This policy emphasis on women's participation in vocational technical and profession education at different levels. It encourages women to play a vital role in National education system in the empowerment and that women studies will be promoted as a part of various courses and educational institutions encouraged to take up active programmes to further women's development.

National Health Policy.NHP-1983.

The National Health Policy advocates the welfare of women and children in the country.

The National Commission for women's Act.(NCWA)

1990 advocates for the safe guards of the rights and interest of women.

National Commission for women (NCW)

The NCW, a statutory body set up under the National Commission for Women Act,1990 to safeguard the rights and interests of women. The NCW set up on 31 January 1992 under the Chairperson of Ms. Jayanti Patnaik.

The major objectives of NCW are:

1. To investigate,examine and review all matters relating to the safeguards provided for women under the constitution.
2. Review of the implementation of both women specific and women-related legislation's and and suggest amendments whatever needed.
3. To function as an agency to keep surveillance and facilitate redressal of grievances of women.

The Commission also held public hearings to listen to the grievances of the affected women.

National Policy in Women

This policy emphasis that all institutions of governance, public and private to main stream women's issues their advancement and empowerment.

National perspective plan for women 1988.

The National perspective plan for women adopted to study women issues and to enact policies and programmes. The main objectives of this plan is to initiate women's action in rural development,health,legislation political participation,education employment,support services, communication and voluntary action.

Conclusion

Women who constitute half of the country's total population,are very few in number in the development process. Despite the implementation of many government programs,laws,regulations,modren technology,AI technology,violence against women has not ended even today. As mentioned in the current study ,for all this to be realized, a change in the mindset of women and a broader perspective of women and men,as well as the family and social environment, is essential to accept progressive change.

Acknowledgement

I would like to express my sincere gratitude to all those who have contributed to the successful completion of this study entitled **"Central Government Programmes for Women Empowerment."**

First and foremost, I extend my heartfelt thanks to my supervisor, faculty members, and academic mentors for their invaluable guidance, encouragement, and constructive suggestions throughout the course of this study. Their expertise and support have been instrumental in the successful completion of this work.

I am grateful to my institution for providing the necessary academic resources, facilities, and a conducive environment for conducting this research.

I would also like to acknowledge the contributions of policymakers, government agencies, researchers, and scholars whose reports, publications, and studies on women empowerment, gender equality, and social welfare programmes served as valuable references for this study.

My sincere appreciation is extended to all organizations and individuals working toward the empowerment of women through education, healthcare, financial inclusion, entrepreneurship, and social development initiatives.

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Conflicts of interest
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Original Article

Impact of Non-Performing Assets (NPA) on the Profitability of Public and Private Sector Banks in India: A comparative study

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Abstract:

The banking sector plays a crucial role in the economic development of a country by mobilizing savings and providing credit to productive sectors. However, the growing level of Non-Performing Assets (NPAs) has emerged as one of the most serious challenges affecting the financial health and profitability of banks. NPAs reduce interest income, increase provisioning requirements, and weaken the lending capacity of banks, thereby adversely impacting overall performance and economic growth. In this context, the present study examines the impact of Non-Performing Assets on the profitability of selected public and private sector banks in India.The study is based on secondary data collected from the annual reports of State Bank of India (SBI), Union Bank of India (UBI), ICICI Bank, and HDFC Bank for a period of five years from 2020–21 to 2024–25. Net NPA has been used as a key indicator of asset quality, while Net Profit has been used to measure profitability. In addition, the impact of major financial heads such as total assets, total deposits, and total advances on NPAs has also been analysed. Statistical tools such as correlation analysis and p-value testing have been employed to examine the nature, strength, and significance of the relationship between NPAs and profitability.

The findings of the study reveal a strong and statistically significant negative relationship between NPAs and profitability in public sector banks. A decline in Net NPAs has resulted in a substantial improvement in the net profits of SBI and UBI during the study period. In contrast, private sector banks exhibit better resilience against the adverse effects of NPAs. ICICI Bank shows no statistically significant impact of NPAs on profitability, while HDFC Bank demonstrates consistent profit growth despite variations in NPAs, reflecting superior credit appraisal and risk management practices. The analysis further indicates that total advances play a significant role in influencing NPAs, particularly in public sector banks.

Keywords: *Non-Performing Assets, Bank Profitability, Net NPA, Net Profit, Public Sector Banks, Private Sector Banks*

Introduction:

The banking sector plays a vital role in the economic development of a country by mobilizing savings, facilitating investments, and providing credit to various sectors of the economy. Banks act as financial intermediaries by accepting deposits from surplus units and lending them to deficit units. The efficiency and stability of the banking system largely depend on the quality of its assets, particularly loans and advances. One of the most critical challenges faced by banks in recent decades is the problem of Non-Performing Assets (NPAs).

A Non-Performing Asset refers to a loan or advance for which the principal or interest payment remains overdue for a specified period, generally more than 90 days, as per regulatory norms. When a loan becomes non-performing, it ceases to generate income for the bank. Rising NPAs directly affect the financial health of banks by reducing interest income, increasing provisioning requirements, and weakening liquidity and capital adequacy positions. As a result, NPAs have emerged as a major obstacle to the profitability and sustainability of banks.

Profitability is an essential indicator of a bank's performance and operational efficiency. It reflects the bank's ability to generate income from its assets while managing costs and risks effectively. Indicators such as net profit, return on assets, and net interest margin are commonly used to measure profitability. However, when NPAs increase, banks are compelled to set aside a significant portion of their earnings as provisions to cover potential loan losses. This reduces the available profits and limits the bank's ability to expand lending activities.

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The impact of NPAs on profitability is particularly severe in the case of public sector banks, which often have higher exposure to priority sectors, large infrastructure projects, and stressed industries. Weak credit appraisal systems, delays in recovery, and economic slowdowns have contributed to the accumulation of NPAs in these banks. Although private sector banks have also faced asset quality issues, they generally demonstrate better risk management practices, technological adoption, and recovery mechanisms, enabling them to manage NPAs more efficiently.

In the Indian banking system, the problem of NPAs has gained prominence following periods of economic downturn, corporate distress, and global financial instability. Rising NPAs not only reduce bank profitability but also adversely affect investor confidence, credit growth, and overall economic stability. High NPAs restrict banks' lending capacity, leading to reduced credit flow to productive sectors of the economy, which in turn hampers economic growth.

Given the growing importance of asset quality in determining bank performance, it becomes essential to examine the relationship between NPAs and profitability. Understanding this relationship helps policymakers, bank management, and regulators design effective strategies to control NPAs and improve financial performance. Measures such as improved credit appraisal, early identification of stressed assets, and stronger recovery frameworks are crucial for sustaining profitability.

In this context, the present study aims to analyse the impact of Non-Performing Assets on the profitability of selected public and private sector banks in India. By examining trends in Net NPAs and Net Profits and applying statistical tools such as correlation and significance testing, the study seeks to provide empirical evidence on how NPAs influence bank profitability. The findings of the study are expected to contribute to a better understanding of the NPA–profitability relationship and offer insights for improving banking sector performance.

Need For the Study:

The study is needed to analyse how NPAs affect bank profitability, financial stability, and efficiency. It helps banks and policymakers adopt better credit risk management practices and ensure sustainable growth of the banking system

NPAs block interest income and increase provisioning requirements, which directly reduce bank profits. Studying this impact helps in understanding how asset quality affects financial performance. Profitability is a key indicator of bank stability. Analysing NPAs helps in evaluating the overall financial strength and sustainability of banks. Public and private banks differ in lending practices and risk management. The study helps compare how NPAs affect profitability across different banking sectors. Understanding the NPA–profitability relationship assists banks in improving credit appraisal, monitoring, and recovery strategies. The study adds empirical evidence on the relationship between NPAs and profitability, useful for students, researchers, and academicians. Reducing NPAs improves profitability, liquidity, and capital adequacy, contributing to a stable and resilient banking sector.

Review Of Literature:

The review of literature provides a theoretical and empirical background for the present study. It helps in understanding the nature of Non-Performing Assets (NPAs), their causes, and their impact on the profitability of banks. Several researchers have examined the relationship between NPAs and bank performance using different methodologies, time periods, and banking segments. This chapter reviews important national and international studies related to NPAs and bank profitability Sivakumar and Natarajan (2011):This study examined the impact of NPAs on the profitability of public sector banks in India. The findings revealed that rising NPAs significantly reduce net profits due to increased provisioning and loss of interest income. The study recommended strengthening recovery mechanisms and legal frameworks**.** Kaur and Singh (2012):Kaur and Singh analysed the relationship between NPAs and profitability of Indian commercial banks. The study found that NPAs have a significant negative impact on net profit and return on assets. It also observed that private sector banks manage NPAs more efficiently than public sector banks. Goyal and Joshi (2013):**The** authors studied the performance of public and private sector banks in India. Their findings showed that public sector banks had higher NPAs, which adversely affected profitability, whereas private sector banks maintained better asset quality and profitability levels. Kumar and Mohan (2016)**:**This study examined the causes and impact of NPAs on Indian banks. The results indicated that macroeconomic factors, poor credit appraisal, and delays in recovery contributed to rising NPAs, which in turn reduced bank profitability.Bhatia, Mahajan, and Chander **(2019):**The study analysed the impact of NPAs on profitability of selected Indian banks. Using correlation and regression analysis, the authors found a strong inverse relationship between NPAs and profitability indicators such as ROA and net profit. Sharma and Singh (2021)**:**This study examined post-reform trends in NPAs and bank profitability in India. The findings showed that improved regulatory measures and recovery frameworks helped banks reduce NPAs, leading to improved profitability, especially in private sector banks.

The review of literature clearly indicates that NPAs have a significant negative impact on bank profitability. Prior studies emphasize the importance of effective credit risk management, timely recovery, and regulatory intervention in controlling NPAs. Building on these studies, the present research provides a comparative and updated analysis of the impact of NPAs on profitability in Indian banks

Statement Of the Problem:

The increasing level of Non-Performing Assets (NPAs) has become a major concern for the banking sector in India. NPAs reduce interest income, increase provisioning requirements, and weaken the overall financial position of banks. Despite several reforms and regulatory measures, many banks—especially public sector banks—continue to face serious challenges due to rising NPAs. High NPAs adversely affect bank profitability and restrict their ability to lend further, thereby impacting economic growth. While some banks have successfully reduced NPAs and improved profitability, others continue to struggle.

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Therefore, it is necessary to examine how NPAs influence profitability and whether this impact differs between public and private sector banks.

This study attempts to analyse the impact of NPAs on the profitability of selected banks using empirical data, thereby addressing the problem of declining profitability caused by poor asset quality

Objectives Of the Study: The main objectives of the study are as follows.

- To analyse the trend of Net NPAs and Net Profit of selected banks.
- To examine the relationship between NPAs and profitability of public and private sector banks.
- To study the impact of financial heads (Total Assets, Deposits, Advances) on NPAs.
- To compare the NPA–profitability relationship between public and private sector banks.

Hypotheses Of the Study: with intention to provide more justification to the study following hypotheses are established and tested with suitable statistical tool.

- **H_0:** There is no significant relationship between NPAs and profitability of banks.
- **H_1:** There is no significant impact of financial heads on the NPAs of banks.

Research Methodology: To fulfil above research objectives and test hypothesis following research methodology has been adopted.

Content	Description
Nature of the Study	The present study is analytical and quantitative in nature
Data Source	The study is based on **secondary data** collected from the **annual reports** of selected banks for the period **2020–21 to 2024–25**
Sample Selection	**Public Sector Banks:** 1.State Bank of India (SBI) 2.Union Bank of India (UBI) **Private Sector Banks:** 1.ICICI Bank H 2.DFC Bank
Statistical Tools and Techniques Used	Correlation Analysis P-value testing (to test statistical significance)

Limitations Of the Study:

Despite its contributions, this study is subject to several limitations.

- The study is based only on secondary data.
- The study covers a limited number of banks.
- The period of study is limited to five years.
- Only Net NPA and Net Profit are considered for analysis.

Analysis Of Data: To analyse the data effectively, statistical tools such as correlation analysis and p-value testing have been employed. Correlation analysis helps in identifying the nature and strength of the relationship between NPAs and profitability, while p-value testing is used to examine the statistical significance of the relationship. A significance level of 5 per cent has been adopted for hypothesis testing.

The data analysis has been presented in a systematic manner through tables and interpreted carefully to derive meaningful conclusions. Separate analyses have been carried out for public sector banks and private sector banks to facilitate comparison. In addition, the impact of key financial heads such as total assets, total deposits, and total advances on NPAs has also been examined to understand the factors influencing asset quality.

Analysis of Relation between NPA and Profitability of Public sector banks:

Table : 1_Relation between NPA and Profitability of Public Banks

in Crore

YEAR	SBI		UBI	
	NET NPA	NET Profit	NET NPA	NET Profit
2020-21	51871	20410	27281	2906
2021-22	36810	31676	24303	5232
2022-23	27966	50232	12928	8433
2023-24	21051	61077	8990	13648
2024-25	19667	70901	5969	18027
Correlation	-0.9662		-0.949271638	
P-Value	0.007412487		0.01361061	
Sources: Annual Reports from 2020-21 to 2024-25 of respective Banks				

State Bank of India (SBI): The above table-1 shows that the Net NPAs declined sharply from Rs.51,871 crore to Rs 19,667 crore, Net Profit increased substantially from Rs.20,410 crore to Rs.70,901 crore during the study period, it shows that the SBI's Net NPAs declined consistently, while Net Profit showed a sharp increase. This indicates that improvement in asset quality directly contributed to higher profitability.

The correlation coefficient between Net NPA and Net Profit of SBI is **–0.9662**, which indicates a **very strong negative relationship** between the two variables. This means that as Net NPAs decrease, Net Profit increases significantly. The calculated p-value is **0.0074**, which is less than the 5% level of significance. Hence, the relationship is **statistically significant**, and the null hypothesis is rejected. It

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interprets that reduction in NPAs has a strong and significant positive effect on the profitability of SBI.

Both SBI and UBI show a **strong and statistically significant negative relationship** between NPAs and profitability. This proves that NPAs severely affect profit levels in public sector banks.

Union Bank of India (UBI): The UBI Banks Net NPAs declined sharply from Rs. 27281 crore to Rs. 5969 crore, whereas, Net Profit increased substantially from Rs. 2906 crore to Rs. 18027 crore during the study period. As Net NPAs reduced over the years, UBI's profitability improved steadily. This shows that NPA management played a key role in improving financial performance.

The UBI shows a correlation of **–0.9493**, again indicating a strong inverse relationship between Net NPA and Net Profit. The p-value of 0.0136 is less than 0.05 level of significance. Hence, the relationship is **statistically significant**, and the null hypothesis is rejected It interprets that the NPAs have a significant negative impact on the profitability of Union Bank of India.

Analysis of Relation between NPA and Profitability of Private sector banks:

Table : 2_Relation between NPA and Profitability of Private Bank

in Crore

Year	ICICI Bank		HDFC Bank	
	NET NPA	NET Profit	NET NPA	NET Profit
2020-21	9180	7931	4554	31116
2021-22	6961	16193	4407	38053
2022-23	5155	23339	4368	45997
2023-24	5378	31896	8091	64062
2024-25	5589	47227	11320	70792
Correlation	-0.743839769		0.91889613	
P-Value	0.14950879		0.027386783	
Sources: Annual Reports from 2020-21 to 2024-25 of respective Banks				

ICICI Bank: **The table-2 shows the** ICICI Bank has a negative correlation of **–0.7438** between Net NPA and Net Profit. However, the p-value (0.1495) is greater than 0.05, indicating that the relationship is **not statistically significant**, and the null hypothesis is accepted This indicates that although NPAs have some influence, ICICI Bank's profitability is not heavily affected due to strong risk management practices and it interprets the NPAs do not significantly impact the profitability of ICICI Bank

HDFC Bank : HDFC Bank shows a **positive correlation of 0.9189**, with a statistically significant p-value (0.0273). which is less than 5% level of significance. Hence, the relationship is **statistically significant**, and the null hypothesis is rejected. Despite rising NPAs in recent years, profitability has continued to increase, indicating superior credit appraisal, strong recovery mechanisms, and high operational efficiency. and it interprets the HDFC Bank's profitability is not adversely affected by NPAs, indicating superior asset quality management

Private sector banks show better resilience to NPAs. Their profitability is either less affected or not affected at all due to effective risk control mechanisms.

Analysis of impact of financial heads on NPA of Public Sector Banks

Table:3_Impact of Financial Head on NPA of Public Bank

P-Value of Financial Heads	SBI	UBI
Total Assets	0.015928752	0.086132634
Total Deposits	0.019525382	0.085449549
Total Advances	0.022748834	0.00465748
Overall	0.018892782	0.070478874
Sources: Computed from the data from annual report from 2020-21 to 2024-25 of respective Banks		

The above table-3 shows that the SBIs Total Assets, Deposits, and Advances all show **statistically significant p-values(< 0.05)**, Hence, the acceptance of $\mathbf{H_1}$, it indicats that growth in these financial heads significantly affects NPAs. Whereas, for UBI, Total Advances show a significant impact on NPAs, while Assets and Deposits show marginal significance. This implies that aggressive credit expansion without proper risk assessment leads to higher NPAs in public sector banks. It interprets that the Credit growth (advances) is a major contributor to NPAs in public sector banks.

Analysis of impact of financial heads on NPA of Private Sector Banks

Table:4_Impact of Financial Head on NPA of Private Bank

P-Value of Financial Heads	ICICI Bank	HDFC Bank
Total Assets	0.14446134	0.065193128
Total Deposits	0.112412803	0.036961322
Total Advances	0.140928753	0.038893276
Overall	0.131987493	0.04647426
Sources: Computed from the data from annual report from 2020-21 to 2024-25 of respective Banks		

The above table-4 shows that the ICICI Bank, none of the financial heads show statistical significance, indicating controlled growth and efficient risk management. In HDFC Bank, Total Deposits and Total Advances show statistically significant p-values,

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indicating efficient asset–liability management and disciplined lending. It interprets that the private sector banks effectively manage growth without allowing NPAs to rise disproportionately

Hypothesis Testing Summary

Hypothesis	Result
NPA vs Profitability of SBI Bank	**Rejected H_0**
NPA vs Profitability of UBI Bank	**Rejected H_0**
NPA vs Profitability ICICI Bank	**Accepted H_0**
NPA vs Profitability HDFC Bank	**Rejected H_0**
Financial Heads impact on NPA	**Partially Accepted**

Overall, the analysis clearly establishes that NPAs have a **significant negative impact on profitability**, particularly in public sector banks. Private sector banks demonstrate stronger resistance to NPA-induced profit erosion due to better credit appraisal and monitoring systems.

Findings Of the Study: Based on the analysis and interpretation of data relating to selected public and private sector banks, the following major findings have been derived:

- There is a strong negative relationship between Net NPAs and profitability in public sector banks.
- Reduction in NPAs has led to a significant increase in net profits of SBI and UBI during the study period.
- The relationship between NPAs and profitability is statistically significant in public sector banks.
- Private sector banks show better resilience against NPAs due to efficient credit risk management.
- ICICI Bank's profitability is not significantly affected by NPAs.
- HDFC Bank shows consistent profitability growth despite fluctuations in NPAs.
- Total Advances play a major role in influencing NPAs, especially in public sector banks.
- Public sector banks are more vulnerable to NPA-related profit erosion compared to private sector banks.
- Improved asset quality directly contributes to higher profitability and financial stability.
- Effective monitoring and recovery mechanisms help banks reduce NPAs and improve performance.

Suggestions: Based on the findings of the study, the following suggestions are offered to improve bank profitability through better NPA management:

- Banks should strengthen credit appraisal and loan sanctioning procedures.
- Early identification of stressed assets should be ensured through early warning systems.
- Regular monitoring of loan accounts should be conducted to prevent slippages into NPAs.
- Banks should focus on risk-based lending rather than aggressive credit expansion.
- Recovery mechanisms such as SARFAESI Act and Insolvency and Bankruptcy Code (IBC) should be used effectively.
- Public sector banks should adopt best practices of private sector banks in risk management.
- Use of technology and data analytics should be enhanced for credit risk assessment.
- Training programs should be conducted for bank staff on NPA management and recovery.
- Timely restructuring of viable stressed accounts should be encouraged.
- Regulatory authorities should continue to strengthen prudential norms for asset quality.

Conclusion: The study concludes that Non-Performing Assets have a significant adverse impact on the profitability of banks, particularly public sector banks. High NPAs reduce interest income, increase provisioning requirements, and weaken the financial position of banks. The analysis clearly shows that banks which successfully control NPAs are able to improve their profitability and overall performance.

While public sector banks have shown improvement in recent years through reduction in NPAs, private sector banks continue to outperform due to superior credit appraisal systems, effective monitoring, and strong recovery mechanisms. Therefore, controlling NPAs is essential not only for enhancing bank profitability but also for ensuring financial stability and sustainable economic growth.The study highlights the importance of sound credit risk management practices and provides valuable insights for bank management, policymakers, and researchers.

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I would like to express my sincere gratitude to all those who have contributed to the successful completion of this research study entitled **"Impact of Non-Performing Assets (NPA) on the Profitability of Public and Private Sector Banks in India: A Comparative Study."**

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

AI Ethics for a Global Family: A Vasudhaiva Kutumbakam Framework for Inclusive and Responsible Intelligence

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Abstract:

Artificial Intelligence (AI) is reshaping economies, governance, healthcare, education, and social structures at an unprecedented pace. While its transformative potential is immense, unchecked AI deployment raises serious ethical concerns. From algorithmic bias and surveillance to digital exclusion and autonomous weapons. This paper argues that the ancient Indian philosophy of Vasudhaiva Kutumbakam which means 'The World is One Family' provides a powerful ethical compass for guiding responsible AI integration at local, national, and global levels. Drawing on recent real-world AI ethics cases (2022–2025), the paper proposes a philosophy-driven framework for AI governance. It further introduces the concept of Sanskara Engineering, embedding culturally rooted human values into the design lifecycle of AI systems. The paper concludes with actionable policy recommendations aligned with the United Nations Sustainable Development Goals (SDGs).

Keywords: *AI Ethics, Vasudhaiva Kutumbakam, Responsible AI, Sanskara Engineering, Digital Inclusion, Algorithmic Bias, Sustainable Development*

Introduction

We live in an era where algorithms decide who gets a loan, which patient receives priority care, who is flagged by law enforcement, and what information reaches billions of citizens. The promise of AI is extraordinary; it can accelerate scientific discovery, personalise education, and optimise resource use. Yet, history warns us that powerful technologies, when misaligned with human values, can deepen inequalities, erode rights, and fracture societies.

Global AI governance today is fragmented. The European Union's AI Act (2024), the United States Executive Order on AI (2023), and various national strategies differ substantially in scope and values. What is missing is a universal ethical philosophy, one that transcends national borders and is rooted in the shared recognition of human dignity and interconnectedness.

This paper proposes that Vasudhaiva Kutumbakam, one of the oldest articulations of global kinship, offers precisely this philosophical foundation. Combined with the emerging concept of Sanskara Engineering, it provides a culturally informed, people-centred roadmap for ethical AI design and governance.

Understanding AI Ethics: Core Principles and Emerging Challenges

AI ethics which refers to set of moral principles, values, and guidelines that control and govern the design, deployment, and regulation of AI systems. Several international bodies, including UNESCO, the OECD, and the IEEE, have articulated core AI ethics principles:

- Fairness and Non-discrimination
- Transparency and Explainability
- Accountability and Responsibility
- Privacy and Data Protection
- Inclusivity and Accessibility

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1 Recent Cases Illustrating AI Ethical Failures

The following documented cases from 2022–2025 illustrate the urgency of embedding ethics in AI systems:

Case 1: Racial Bias in Facial Recognition AI — Amazon Rekognition and DataWorks Plus (2019 Onwards)

A 2019 audit by researchers Inioluwa Deborah Raji and Joy Buolamwini at MIT Media Lab found that Amazon Rekognition misidentified darker-skinned women as men at an error rate of 31%, compared to zero errors for lighter-skinned men. The same year, the American Civil Liberties Union (ACLU) tested Amazon Rekognition by comparing photos of every serving U.S. Congress member against a criminal mugshot database. The tool falsely matched 20+ members of Congress with criminal suspects, with false matches thus affecting members of colour, including six members of the Congressional Black Caucus.

Sources: Raji & Buolamwini (2019), MIT Media Lab; ACLU (2018, 2024); Williams v. City of Detroit, ACLU of Michigan.

Case 2: ChatGPT Hallucinations in Legal Practice, Mata v. Avianca, Inc. (S.D.N.Y. 2023)

In May 2023, attorneys Steven A. Schwartz and Peter LoDuca of the New York law firm Levidow, Levidow and Oberman submitted a legal brief in the case Mata v. Avianca, Inc. in the Southern District of New York. The brief, drafted with the assistance of ChatGPT, cited six non-existent court cases, all fabricated by the AI tool. When the defendant's counsel pointed out that the cited cases could not be found, the lawyers initially defended their research, only admitting the role of ChatGPT after the court issued a formal show-cause order.

This case became the most widely cited illustration of AI hallucination risk in high-stakes professional practice. It triggered mandatory AI disclosure rules in courts across multiple U.S. jurisdictions and prompted international calls for minimum verification standards in legal, academic, and policy use of generative AI tools.

Sources: Mata v. Avianca, Inc., 678 F. Supp. 3d 443 (S.D.N.Y. 2023); Seyfarth Shaw LLP Case Update (June 2023); Fortune (June 2023).

Case 3: COMPAS Recidivism Algorithm and Systemic Racial Bias — ProPublica Investigation (2016, Ongoing)

In May 2016, ProPublica published its landmark investigation 'Machine Bias' (Angwin et al.), analysing over 7,000 defendants in Broward County, Florida who had been assessed using COMPAS (Correctional Offender Management Profiling for Alternative Sanctions). The study found that Black defendants who did not go on to reoffend were nearly twice as likely to be falsely classified as high risk compared to their white counterparts (45% versus 23%). Conversely, white defendants who did reoffend were more often labelled low risk by the algorithm.

Sources: Angwin et al. (2016). Machine Bias. ProPublica; ProPublica (2016). How We Analyzed the COMPAS Recidivism Algorithm; UCLA Law Review (2019). Injustice Ex Machina.

Case 4: AI-Generated Deepfakes and Electoral Disinformation in India (2024)

The Indian General Elections (2024), with nearly 970 million eligible voters, were significantly affected by AI-generated disinformation. The parent company of WhatsApp Meta and Facebook, reportedly approved (proved) 14 AI-generated electoral advertisements containing extremist language, including incitement against religious minorities. The Election Commission of India issued an advisory on May 6, 2024, warning and intimating political parties against AI-generated deepfakes and threatening penalties, but enforcement remained largely ineffective given the volume and speed of content circulation across encrypted platforms. This case demonstrates the urgent need for AI governance mechanisms and platform accountability frameworks that protect the integrity of democratic processes.

Sources: GNET Research (September 2024); Reuters Institute for the Study of Journalism (March 2024); Asia Pacific Foundation of Canada (June 2024); World Economic Forum Global Risks Report 2024.

Case 5: EU AI Act: World's First Comprehensive AI Regulation (Regulation EU 2024/1689)

The European Parliament voted to endorse the Artificial Intelligence Act in March 2024 (523 votes in favour, 46 against, 49 abstentions). The Act formally entered into force on 1 August 2024, making it the world's first comprehensive legal framework for AI regulation. It will be fully applicable from 2 August 2026, with a phased implementation timeline. Critically, the Act's prohibition provisions became enforceable from 2 February 2025, meaning banned AI practices were already subject to penalties before the paper's conference date.

The EU Act classifies AI systems into four risk tiers:

1. unacceptable risk (banned outright)
2. high risk (strict requirements)
3. limited risk (transparency obligations)
4. minimal risk (voluntary codes).

While path-breaking in scope, the Act has been criticised as Eurocentric in design, offering limited guidance or applicability for nations in the Global South where AI harms are equally acute but regulatory capacity is weaker. This reinforces the need for a universal ethical philosophy such as Vasudhaiva Kutumbakam to anchor global AI governance.

Sources: European Parliament (March 2024); Regulation EU 2024/1689, Official Journal of the EU (August 2024); EU AI Act Article 5 — Prohibited AI Practices; European Commission Digital Strategy (2024).

Vasudhaiva Kutumbakam: Philosophy of Universal Kinship

"Ayam Nijah Paro Veti Ganana Laghuchetasam, Udaracharitanam Tu Vasudhaiva Kutumbakam"

(Translation: 'This is mine, that is yours; such thinking belongs to the narrow-minded. For those of noble character, the entire world is one family.')

This verse from the Maha Upanishad (circa 800–300 BCE) articulates a radical vision of moral universalism, recognising that all living beings share a common home and deserve equal moral consideration. India's G20 Presidency in 2023 adopted this phrase as its theme, bringing Vasudhaiva Kutumbakam to global policy discourse.

1. Core Tenets of the Philosophy

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- Universal Belonging: No being exists in isolation. Every individual, community, and nation is interdependent.
- Non-Exclusion: The benefits and responsibilities of progress must be shared equitably, and no community should be left behind.
- Ecological Kinship: The philosophy extends care not just to humans but to all of nature, aligning with environmental ethics.
- Peaceful Coexistence: Diversity in culture, language, and worldview is celebrated, not suppressed.
- Collective Responsibility: The wellbeing of one is inseparable from the wellbeing of all.

2. Relevance to AI Governance

Vasudhaiva Kutumbakam challenges the dominant paradigm of AI development, which is largely driven by profit motives in a handful of technology corporations concentrated in the United States and China. Its tenets demand that we ask:

- Who benefits from this AI system, and who is harmed?
- Are the communities affected by this AI system represented in its design?
- Does this system respect the ecological cost of its computational demands?
- Is the data used to train this system sourced ethically and with informed consent?
- Does this AI system promote global peace or enable conflict and surveillance?

These are not abstract questions. They are design imperatives that must shape the entire lifecycle of an AI system, covering collection of data, training the model, monitoring deployment, and decommissioning.

4. Integrating Vasudhaiva Kutumbakam with AI Ethics: A Proposed Framework

The integration of Vasudhaiva Kutumbakam with contemporary AI ethics produces a framework that is both globally relevant and human grounded. The following four pillars form the proposed framework:

Pillar 1: Inclusive Design (Sarve Bhavantu Sukhinah)

AI systems must be designed with diverse and representative datasets. Development teams must include voices from the Global South, marginalized genders, indigenous communities, and persons with disabilities. The goal is to ensure that AI does not merely serve the already powerful.

- Application: India's Aarogya Setu contact-tracing app initially excluded non-smartphone users. A Vasudhaiva-informed approach would require offline or USSD alternatives from the outset.

Pillar 2: Transparent Accountability (Satya and Dharma)

Every consequential AI decision must be explainable in plain language to the person it affects. Accountability must rest with identifiable humans, not diffused across supply chains or corporate hierarchies.

- Application: The EU AI Act's requirement for 'Fundamental Rights Impact Assessments' for high-risk AI systems is a step in this direction.

Pillar 3: Ecological Responsibility (Vasudha as Living Entity)

Training AI LLM (Large Level Models) consumes very high energy. Energy required in training GPT-4 model reportedly emitted as much CO_2 as 300 transatlantic flights. Vasudhaiva Kutumbakam's ecological dimension demands that developers measure, disclose, and offset the carbon footprint used for AI systems.

- Application: Green AI initiatives, such as using renewable energy supplied data centres and efficient model architectures, must become industry standards, especially for AI deployed in climate-sensitive regions.

Pillar 4: Non-Weaponisation (Ahimsa in AI)

The principle of Ahimsa (non-harm) demands a global moratorium on lethal autonomous weapons systems that can decide to kill without human authorisation. AI in surveillance must be subject to democratic oversight and legal safeguards.

- Application: The UN Secretary-General's call for a ban on autonomous lethal weapons (2023) and the Bletchley AI Safety Declaration (2023, signed by 28 nations) reflect growing international consensus aligned with this pillar.

5. Sanskara Engineering: Cultivating Values in AI by Design

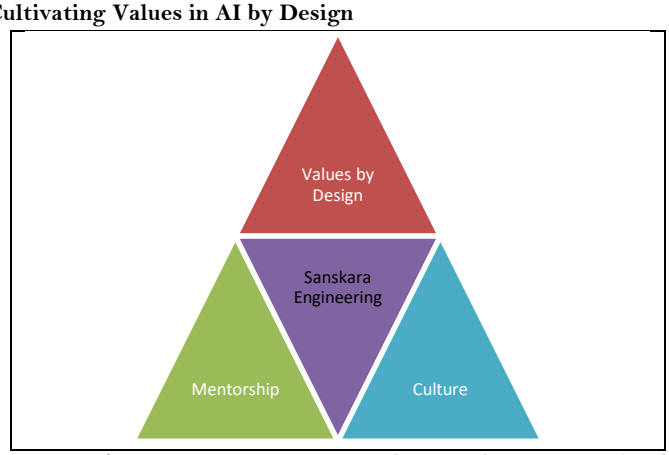

Figure 1Sanskara Engineering

The Sanskrit word Sanskara (संस्कार) denotes the act of refinement, purification, and the instilling of deep-seated values through deliberate practice and mentorship. In the available context of Indian culture, Sansakaras are the formative impressions that shape character across a lifetime.

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Sanskara Engineering is a proposed discipline that applies this concept to technology development, specifically the deliberate and systematic embedding of human values, cultural wisdom, and ethical principles at every stage of the AI design and engineering lifecycle.

1 Core Principles of Sanskara Engineering

- Values by Design: Ethics is not a post-deployment checklist. Ethical considerations must be built into requirements specifications, architecture decisions, data curation, and testing protocols from Day One.
- Culturally Contextual AI: AI systems deployed in specific cultural contexts must reflect local values, languages, norms, and needs, rather than imposing a one-size-fits-all model.
- Mentorship and Moral Imagination: AI developers and data scientists must be trained not in technical skills but in moral philosophy, social impact assessment, and empathetic design thinking.

2. Sanskara Engineering in Practice

The following 02 examples illustrate how Sanskara Engineering can be applied:

- **Healthcare AI in Rural India:** An AI diagnostic tool designed for Tier-3 districts in Odisha embedded local language support, consulted Accredited Social Health Activists (ASHAs) during design, and included a mandatory human-doctor override for all critical diagnoses. This is Sanskara Engineering in action.
- **Indigenous Data Sovereignty:** Several tribal communities in Jharkhand and Chhattisgarh have begun asserting ownership of their agricultural and environmental data, insisting that any AI system using this data must return economic benefit to the community.

Policy Recommendations

As per the *Vasudhaiva Kutumbakam* framework proposed, the following policy recommendations are offered to governments, institutions, and developers:

- Establish a Global AI Ethics Council anchored in the United Nations, with equal representation from the Global South, indigenous communities, civil society, and technical experts, guided by principles including Vasudhaiva Kutumbakam.
- Create a national Sanskara Engineering framework in India, integrating value-based AI design into curricula of IITs, NITs, and State Engineering Colleges.
- Require Algorithmic Transparency Reports from all companies deploying AI in India, akin to financial disclosures under SEBI regulations.
- Develop multilingual, locally adapted AI systems for agriculture, health, justice, and education, particularly in Hindi, Kannada, Marathi, Tamil, Bengali, and other Indian languages.
- Align national AI strategies with SDG 10 (Reduced Inequalities), SDG 16 (Peace, Justice and Strong Institutions), and SDG 17 (Partnerships for the Goals).

Conclusion

The challenges posed by AI to human dignity, democratic governance, ecological sustainability, and social justice are not primarily technological; they are ethical and philosophical. Technical solutions alone cannot resolve questions of fairness, power, and belonging.

Vasudhaiva Kutumbakam, the ancient wisdom that the world is one family, provides a compass for this moment. It reminds us that the real compute of any technology is undoubtedly not its efficiency or profitability, but to serve the wellbeing of every member of the human family, across generations, geographies, and cultures.

Sanskara Engineering operationalises this vision. It calls on technologists, policymakers, educators, and citizens to embed values not as a compliance exercise but as a deep, living commitment, the way a master craftsperson embeds skill, care, and conscience into every work they create.

The world does not need smarter algorithms alone. It needs algorithms with conscience. And conscience begins with recognising, as Vasudhaiva Kutumbakam teaches, that what happens to any one of us ultimately happens to all of us.

Acknowledgment

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We acknowledge the enduring wisdom of the Indian philosophical principle of *Vasudhaiva Kutumbakam*—"the world is one family"—which serves as the guiding inspiration for this framework. Its emphasis on interconnectedness, mutual respect, compassion, and collective well-being offers a meaningful perspective for addressing contemporary ethical challenges in artificial intelligence.

We are also grateful to academic institutions, professional communities, and international organizations that continue to foster dialogue on ethical AI governance, fairness, transparency, accountability, and social responsibility. Their ongoing commitment to ensuring that technological progress benefits all of humanity has significantly influenced the development of this work.

Finally, we extend our appreciation to colleagues, mentors, reviewers, friends, and family members whose encouragement, constructive feedback, and support have contributed to the completion of this manuscript. We hope that this work contributes to the global conversation on building AI systems that uphold human dignity, promote inclusivity, and serve the shared interests of our global family.

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The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Environmental Justice and Sustainable Biomedical Waste Management: A Critical Evaluation of India's Legal Regime

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Abstract

The management of biomedical waste has become one of the most pressing environmental governance problems that India faces due to the development of the healthcare industry, the increasing population, urbanization, and increased consumption of medicine. The COVID-19 pandemic highlighted the weaknesses in the governance of biomedical waste management and its detrimental consequences for the environment due to the poor handling of biomedical waste. Biomedical waste can cause pollution of air, soil, and water resources when poorly managed, harm waste collectors, disadvantaged groups, sanitation workers, and those susceptible to environmental factors. Here, the problem of environmental justice emerges.

The present paper presents a critical assessment of the legal framework in India with respect to biomedical waste management in terms of sustainability and environmental justice. This is done with a focus on constitutional laws, statutory laws, judgments from courts, institutions, and implementation issues arising out of Biomedical Waste Management Rules, 2016. The paper suggests that even though India has created an extensive legal framework, the inability to enforce the laws, the fragmented structure, poor infrastructure, and the non-inclusion of stakeholders have hampered sustainable waste management.

A further analysis is done by examining the instances where the compliance has been lacking, the National Green Tribunal has intervened, and the findings of the Central Pollution Control Board have been made. Legal reforms for sustainable biomedical waste management have also been discussed.

Keywords: *Biomedical Waste, Environmental Justice, Sustainability, Environmental Law, Public Health, Waste Governance*

Introduction

Environmental pollution due to hazardous waste is one of the key legal challenges faced by India. The role of biomedical waste in environment law is very special because it covers public health, occupational safety, environmental sustainability, and human rights. Hospitals, labs, vaccination clinics, diagnostic centers, and many other places produce lots of infectious and hazardous wastes. Disposal of hazardous waste results in a number of problems for the environment, such as groundwater pollution, poisonous discharges, and spread of infectious diseases.

World Health Organization (2022) reported that nearly 15% of the global medical waste produced was hazardous. There has been an increase in biomedical waste in India during the COVID-19 pandemic due to the use of disposable masks, PPE kits, syringes, testing kits, and vaccine waste. The Central Pollution Control Board (CPCB) recorded a sharp increase in biomedical waste production during the COVID-19 pandemic period. This raised issues related to infrastructure inadequacy in biomedical waste treatment plants (Central Pollution Control Board [CPCB], 2023).

Environmental justice has an important role to play in biomedical waste management practices. Poor communities live around biomedical waste plants, whereas sanitation workers and informal recyclers come into contact with biomedical wastes in a manner that does not have sufficient legal backing. Biomedical waste management is, therefore, not only a problem related to technical expertise, but also distributive and procedural justice. This paper analyses the Indian legal framework of biomedical waste management with respect to sustainability and environmental justice.

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Understanding the Concept of Biomedical Waste and Environmental Justice

Biomedical waste means any type of waste that results from medical treatments, diagnoses, immunizations, research work, and biological investigations. According to Rule 3(f) of the Biomedical Waste Management Rules of 2016, biomedical waste includes human anatomical waste, laboratory waste, pharmaceutical waste, contaminated plastic waste, sharp waste, and chemical waste. These types of waste must be processed in a particular manner due to their hazardous nature.

The dumping of biomedical waste in open dumps causes soil and groundwater contamination through toxins leaking from the waste. If biomedical waste is not properly incinerated, then it produces gases like dioxins and furans. The use of re-used syringes and medical plastics may cause infectious diseases like hepatitis and HIV. As per Datta et al. (2018), improper biomedical waste management has significant implications for ecology and public health, especially in developing nations where there are fewer regulations governing this matter. In this regard, the issue of environmental justice gives a moral basis for assessing these kinds of risks. The concept of environmental justice can serve as a normative lens for analyzing such hazards. Environmental justice is concerned with equity in environmental policymaking, whereby there is no disproportionate environmental damage to any particular community. When dealing with biomedical waste, environmental injustices occur when impoverished communities carry the risk of waste management, sanitation workers endure dangerous conditions without safety measures, and disadvantaged groups are left out of decision-making processes.

Constitutional Basis for Biomedical Waste Management Regulations in India

The constitutional basis of environmental regulations in India has undergone considerable development due to judicial interpretation. The Constitution does not include environmental rights among its fundamental rights, but the Indian judiciary has widened the scope of constitutional rights by including environmental issues in its ambit.

Under Article 21 of the Constitution, there is a fundamental right to life and personal liberty. According to the decision of the Supreme Court of India in the case of *Subhash Kumar v. State of Bihar (1991)*, the Court held that environmental pollution affecting water and air quality violates the right to life and the right to life also includes a right to a wholesome environment. This aspect of the right has a bearing on biomedical waste management problems.

As per Article 48A, it is the responsibility of the state to take all necessary steps to preserve and improve the environment, and as per Article 51A (g), it is a fundamental duty of citizens to conserve natural resources.

Moreover, the Supreme Court's judgment in *Vellore Citizens Welfare Forum v. Union of India (1996)* has also recognized environmental principles like sustainable development, precautionary principle, and polluter pays principle.

Evolution of Legal Regime for Biomedical Waste in India

The Indian legal framework that regulates biomedical waste can be seen under the Environment Protection Act of 1986. Under the provisions of this law, the government has the power to frame rules for handling hazardous waste management and environmental protection.

Initially, there were no specific regulations regarding biomedical waste, but these came about via the Bio-Medical Waste Management and Handling Rules of 1998. The rules mandated segregation, collection, transportation, treatment, and safe disposal of biomedical waste. However, these rules suffered due to poor enforcement, ineffective monitoring, and low capacity.

To overcome the limitations of the previous rules, new Biomedical Waste Management Rules were enacted in 2016. These rules widened the ambit of control as they also covered vaccination camps, surgical camps, blood banks, and non-hospital healthcare activities. They simplified the categorization of biomedical waste, used bar-coding, introduced color segregation, and made strict emissions norms for incineration.

The 2016 rules marked a significant step forward in regulation from mere waste disposal to lifecycle management of biomedical waste. Among the many reforms brought about by the Biomedical Waste Management Rules, 2016 include expansion of the scope to cover vaccination camps, blood donation camps, surgical camps, and other activities associated with the production of biomedical waste. The waste segregation process was simplified by reducing the number of categories from ten to only four color-coded categories.

Waste generated from laboratories, micro biological wastes, and blood samples must be pre-treated through either sterilization or disinfection prior to final disposal. Chlorinated plastic bags, gloves, and blood bags should be gradually phased out as they pose great harm to the environment. Introduction of the use of barcode and global positioning system technology has enabled easy identification of biomedical waste during transportation and disposal.

The occupants and operators have various responsibilities under the new rules which include waste collection, storage, transportation, treatment, and disposal. Regular training, annual reports, accident reporting, and stringent authorization processes are some of the obligations imposed by the new amended rules in 2018 and 2019. The principal legislations and regulatory instruments applicable to biomedical waste management are as follows:

Water (Prevention and Control of Pollution) Act, 1974- This law regulates the pollution of water that occurs due to biomedical waste disposed of into water bodies improperly.

Air (Prevention and Control of Pollution) Act, 1981- It controls the emissions caused from the process of incineration of biomedical waste.

Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016- These rules apply to situations where biomedical waste becomes a hazardous material.

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Solid Waste Management Rules, 2016- These regulations cover the segregation of municipal and biomedical waste in healthcare establishments.

Plastic Waste Management Rules, 2016- These laws cover the management of biomedical waste in the form of plastics disposed of by hospitals and diagnostic centers.

E-Waste Management Rules, 2016- These regulations apply to the disposal of electronic biomedical devices.

Factories Act, 1948- Occupational safety rules for hazardous waste workers at some establishments.

Clinical Establishments (Registration and Regulation) Act, 2010- Requires compliance with specified standards, such as those governing biomedical waste management standards.

Bhartiya Nyaya Sanhita, 2023- Sections dealing with public nuisance, negligence, and offenses that cause danger to life can be used in cases of improper biomedical waste disposal.

Bhartiya Nagarik Suraksha Sanhita, 2023- Provides magistrates the power to remove nuisances arising out of improper disposal of biomedical waste.

National Green Tribunal Act, 2010- Establishes a body to decide environmental disputes arising out of biomedical waste management problems.

Public Liability Insurance Act, 1991- Makes provisions for immediate relief in cases of any accident resulting from handling of hazardous substances.

State Municipal Laws on Sanitation/Public Health & Waste Disposal enacts fir the Bio medical Waste management.

Institutional Structure and Regulatory Agencies

Good biomedical waste management needs cooperation between various institutions. The Ministry of Environment, Forest and Climate Change makes policies and regulations regarding the issue. It is the duty of the Central Pollution Control Board to provide guidance on operational matters and to monitor these activities. The State Pollution Control Boards have the task of issuing authorizations and carrying out inspections.

The healthcare institutions are officially classified as "occupiers" by the 2016 Rules and have the primary role of segregating, storing, treating, and disposing of biomedical waste. The Common Biomedical Waste Treatment Facilities also serve as facilitators in collective waste disposal processes. Even though there is such an extensive institutional structure in place, lack of coordination continues to plague this process.

Intervention by Judiciary in Environmental Management

The Indian judiciary has been involved actively in environmental law enforcement through Public Interest Litigation (PIL). Judicial intervention is quite common whenever there is administrative laxity in enforcing environmental laws. The Indian judiciary has contributed immensely to enhancing biomedical waste management by making judgments on the constitutional rights for the environment, statutory duties, and administrative failure in waste disposal systems. Judicial activism in India has been used to develop environmental laws to guarantee that any misuse of biomedical waste does not compromise public health and environmental sustainability. Article 21 of the Indian Constitution has been interpreted several times by the Indian Supreme Court to mean the right to an ecologically balanced environment. Even though most significant environmental case laws do not involve biomedical waste, the principles developed from the *M.C. Mehta vs Union of India* case law are applicable to biomedical waste management.

In *Almitra H. Patel v. Union of India (2000)*, the Supreme Court highlighted scientific approaches for waste disposal and stressed the issue of administrative neglect. While the case dealt mainly with the matter of municipal wastes, it holds good even in the context of biomedical wastes. In *Indian Council for Enviro-Legal Action v. Union of India*, the Supreme Court made polluters responsible for environmental damages and reiterated the principle that those who produce hazardous wastes must be held responsible for their cleanup. The principle has a direct impact on hospitals that produce biomedical wastes. Courts have considered obligations under public health law on the part of the state in the case *of Common Cause v. Union of India*. In addition, various high courts in India have made interventions to stop the illegal disposal of biomedical wastes, open burning of biomedical wastes, as well as the illegal recycling of medical wastes. The Delhi High Court and various other high courts in India have considered applications against illegal dumping of hospital waste in residential areas, illegal incineration of biomedical wastes, and risks associated with the sanitation workers working at such sites. Therefore, it is clear that the courts of India have extended their environmental jurisprudence by connecting the biomedical waste management process with issues related to constitutional rights, environmental laws, as well as public health administration. There have been many cases that have come before the National Green Tribunal regarding biomedical waste dumping and improper disposal.

Role of the National Green Tribunal in Cases Related to Biomedical Waste

The formation of the National Green Tribunal (NGT) through the National Green Tribunal Act of 2010 enhanced environmental dispute resolution in India by setting up a separate body for handling such matters. Biomedical waste disputes gradually started appearing before the National Green Tribunal owing to the non-compliance of regulatory agencies and healthcare organizations with environmental laws. Over time, many interventions by the Tribunal have been seen in cases dealing with the illegal dumping, improper segregation, unauthorized processing centers, and potential public health hazards caused by biomedical waste management. In *Shailesh Singh v. Sheela Hospital & Trauma Centre, Shahjahanpur* (2020), the Tribunal examined widespread violations in biomedical waste disposal and directed stricter implementation of the Biomedical Waste Management Rules, 2016. It ordered state pollution control boards to ensure proper segregation, collection, transportation, and treatment of medical waste.

During the COVID-19 pandemic, courts and tribunals addressed the surge in biomedical waste generation. The National Green Tribunal issued directions regarding disposal of masks, PPE kits, and vaccination waste to prevent environmental contamination. In one of the first interventions by the National Green Tribunal,

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namely, *Court on its own Motion v. All India Institute of Medical Sciences & Others*, the Tribunal analyzed the biomedical waste disposal practices at major hospitals in Delhi. An inspection team was appointed by the Tribunal to inspect some hospitals, which found that many leading government hospitals were failing to segregate and label biomedical waste as per the requirements set out in the Biomedical Waste Rules.

In the case of *Mahesh Chandra Sharma v. Agra Municipal Corporation (2018)*, the NGT was involved with the setting up of a biomedical waste treatment plant in the Taj Trapezium Zone without any environmental clearance and statutory approvals. The Tribunal penalized the Agra Municipal Corporation for violating procedural formalities and reiterated that environmental clearances cannot be ignored in any project involving hazardous waste. In Tamil Nadu, the NGT was confronted with a situation where private hospitals were found to be engaging in the illegal sale of infectious biomedical waste to unauthorized dealers. In 2016, the NGT instructed the State government to investigate the matter regarding a "biomedical waste cartel" in which hospitals were engaged in selling hazardous waste for money rather than sending it to approved disposal units. It was later discovered that criminal acts had been committed, and the NGT ordered punitive measures to be taken against both the hospital administration and private waste management operators.

In more recent times, the NGT's Central Bench in Bhopal (2025) has taken suo motu cognizance of the improper handling of biomedical waste based on the observation that around 1,640 hospitals were found to be functioning without any permission from the Madhya Pradesh Pollution Control Board. The Tribunal has set up a joint committee to conduct a probe into the matter and seek accountability from the concerned State Government. In another case from Sangrur in Punjab (2025), the NGT has dealt with a situation where the allegations are related to the dumping of biomedical waste along with municipal waste. In the petition filed before the Tribunal, there is mention of the use of syringes, bloody substances, and other waste products in the wrong manner.

It is evident from these two cases that while the legislative measures adopted by India seem to be exhaustive, it is only when there is judicial involvement that compliance is sought. The increasing number of cases being heard by the NGT signifies the deficiencies in the functioning of the pollution control boards and healthcare regulatory bodies.

Environmental Justice Issues Associated with Biomedical Waste Treatment

Issues of environmental justice arise from the biomedical waste treatment practices in India. The location of biomedical waste treatment plants is close to poor socio-economic groups who have little political power. These people are faced with environmental degradation, but do not receive any compensatory gain.

Occupational risks are a major issue among sanitation workers and handlers of medical waste due to injuries from needles and toxic exposures to infections. Workers lack protective gear, insurance, and health benefits. Moreover, there are environmental procedural injustices since communities are usually not consulted on biomedical waste facilities.

Sustainability Issues Related to Biomedical Waste Management in India

Despite the availability of alternative methods, including autoclave and microwave treatments, India is excessively dependent on incineration techniques, which are sources of air pollution. In addition, the increasing use of disposable plastics in the health care sector adds to difficulties in sustaining waste management systems.

The outbreak of **coronavirus** disease caused an increase in plastic wastes due to masks, gloves, and protective equipment. Rural health care centers lack access to efficient waste management facilities. There was a significant rise in the production of biomedical waste during the pandemic period due to excessive use of PPE, masks, gloves, vaccination waste, and testing supplies. CPCB came up with interim guidelines on COVID waste. Nevertheless, there were incidents of failures of segregation and improper disposal. The pandemic highlighted a lack of preparedness for emergencies.

Issues Related to Implementation and Regulating Failure

The major problem associated with India's regulation of biomedical waste is one of implementation. Most hospitals do not adhere to the segregation requirements. Inspections are rare due to the unavailability of adequate manpower and budget. Information about the process of managing biomedical waste is not transparent enough, and illegal recycling of contaminated medical plastic goes on in the informal sector. These problems indicate the discrepancies between design and implementation of regulations.

Recommendations

Improving Inspections and Penalties- The laws surrounding biomedical waste management in India have been found to be ineffective due to poor implementation. Despite the regulations outlined in the Biomedical Waste Management Rules, 2016, many hospitals and clinics still contravene the norms on waste segregation, storage, and disposal. Periodic auditing and surprise inspections by the State Pollution Control Boards are essential. Moreover, penalties for non-compliance, including fines, license revocation, and lawsuits, ought to be enforced more effectively to curb the practice.

Electronic Tracking for Compliance- Biomedical waste cannot be monitored effectively through manual methods, leading to illegal dumping and inadequate records. The Central Pollution Control Board has employed barcode systems for the monitoring of biomedical waste. However, such measures are not always implemented in some regions. A national electronic tracking system utilizing GPS technology and an online database would prove effective.

Implementation of Sustainable Technologies- Incineration technology has proven to be useful in the disposal of biomedical waste in India. Incineration technology helps destroy all infectious biomedical waste. However, the use of too much incineration technology causes pollution by releasing harmful substances like dioxin and other toxic gasses. Autoclaving, microwave treatment,

chemical disinfection, and plasma pyrolysis should be encouraged.

Provision of Protection for Waste Handlers- The handling of biomedical waste exposes the personnel to the risk of contracting diseases, toxic reactions, and injury due to needles. Many waste handlers lack proper training, personal protective equipment, and insurance cover. It is the responsibility of the government and health institutions to ensure that waste handlers receive proper training, health insurance, compensation, and protective gear.

Community Involvement- There is generally low community awareness of biomedical waste disposal, especially household biomedical waste disposal. The communities, non-governmental organizations, and educational facilities need to be engaged in creating public awareness on proper disposal methods and report any cases of improper handling of biomedical waste.

Approach to Biomedical Waste Management – Circular Economy- The regulatory framework on biomedical waste management is heavily inclined toward disposing of biomedical waste. There is a need to consider a circular economy approach whereby manufacturers reduce the amount of plastic produced during the production process and adopt environmentally friendly designs when producing medical products.

Conclusion

Waste management in the biomedical sector holds great importance in the context of environmental sustainability, health protection, and justice. In India, the government has made a legal framework for the safety handling and disposal of biomedical waste. The instruments that have been used for the regulation of this sector include Biomedical Waste Management Rules, 2016, interventions of the National Green Tribunal, and constitutional environmental law. However, due to improper implementation, non-compliance, and poor monitoring measures, it remains challenging to implement this legal framework effectively.

This topic not only concerns the methods of waste disposal but also raises issues related to environmental justice. It is evident from the examples given that marginalized groups and sanitation workers suffer the most from such practices. Hence, for the regulation of biomedical waste, a sustainable framework needs to be adopted. For this purpose, it is necessary to ensure better implementation, social protection, clean technology, and community participation. Otherwise, there will be major environmental and health problems in the country due to its increasing healthcare infrastructure.

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Finally, heartfelt thanks are offered to mentors, colleagues, reviewers, friends, and family members for their encouragement, constructive suggestions, and unwavering support throughout the completion of this manuscript.

It is hoped that this study contributes to the ongoing discourse on environmental justice, strengthens awareness of sustainable biomedical waste management practices, and supports the development of a more effective and equitable legal regime for environmental protection and public health in India.

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Original Article

Digital Economy, Innovation, and Economic Transformation: Emerging Trends, Challenges, and Opportunities

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Abstract

The digital economy has emerged as a transformative force reshaping global economic structures, production systems, and social interactions. This paper examines the role of digital technologies and innovation in driving economic transformation, particularly in emerging economies like India. Using a mixed-method approach, the study analyzes secondary data, case studies, and recent trends to evaluate the impact of digitalization on productivity, employment, and inclusive growth. The findings reveal that while digital innovation enhances efficiency and creates new opportunities, it also poses challenges such as digital divide, job displacement, and cyber security risks. The paper concludes with policy suggestions to ensure sustainable and inclusive digital transformation.

Keywords: *Digital Economy, Innovation, Economic Transformation, Digital India, FinTech, Artificial Intelligence, Inclusive Growth*

Introduction

The digital economy has emerged as a powerful engine of economic growth and structural transformation in the 21st century. It refers to an economy that is primarily based on digital technologies, including the internet, information and communication technologies (ICT), artificial intelligence, cloud computing, and big data analytics. These technologies have significantly altered the way businesses operate, governments deliver services, and individuals interact in the marketplace. The integration of digital tools into economic activities has not only improved efficiency and productivity but has also opened up new avenues for innovation and entrepreneurship.

In recent years, the importance of the digital economy has increased rapidly due to globalization and technological advancement. Countries across the world are investing heavily in digital infrastructure to remain competitive in the global market. In India, initiatives such as Digital India, Startup India, and the expansion of digital payment systems like UPI have accelerated the pace of digital transformation. The COVID-19 pandemic further highlighted the critical role of digital technologies, as businesses, education systems, and government services shifted to online platforms to ensure continuity.

Moreover, the digital economy has contributed to inclusive growth by providing access to financial services, education, healthcare, and employment opportunities, especially in remote and underserved regions. However, it also presents challenges such as digital inequality, cybersecurity risks, and job displacement due to automation. Therefore, understanding the dynamics of digital economy and innovation is essential for achieving sustainable and balanced economic development.

Historical Background

The evolution of the digital economy can be traced back to the late 20th century with the development of computers and the internet. During the 1980s and 1990s, advanced economies began integrating information technology into business processes, leading to increased efficiency and productivity. The emergence of the World Wide Web in the 1990s marked a significant turning point, enabling global connectivity and the growth of e-commerce and digital communication.

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In the early 2000s, the rapid expansion of mobile technology and broadband internet further accelerated digital transformation. Companies such as Amazon, Google, and Microsoft revolutionized the global economy by introducing innovative digital platforms and services. These developments laid the foundation for the modern digital economy, characterized by data-driven decision-making and platform-based business models.

In the Indian context, the digital revolution gained momentum after 2010 with the widespread adoption of smartphones and affordable internet services. Government initiatives such as Aadhaar, Digital India (launched in 2015), and BharatNet have played a crucial role in expanding digital access across the country. The introduction of UPI in 2016 transformed the digital payments landscape, making transactions faster, cheaper, and more accessible. Over time, India has emerged as one of the fastest-growing digital economies in the world.

Objectives of the Study

1. The primary objective of this study is to analyze the role of the digital economy and innovation in driving economic transformation. The study seeks to understand how digital technologies contribute to economic growth, productivity, and structural changes in both developed and developing economies. It also aims to examine the relationship between digital innovation and employment generation, particularly in emerging sectors such as fintech, e-commerce, and artificial intelligence.
2. Second important objective is to evaluate the impact of digitalization on inclusive growth. While digital technologies have the potential to bridge economic disparities, unequal access to digital infrastructure and skills can widen the gap between different sections of society. Therefore, the study aims to identify the key challenges associated with digital transformation, including the digital divide, cybersecurity concerns, and regulatory issues.
3. Finally, the study intends to provide policy suggestions and recommendations to ensure that the benefits of the digital economy are distributed equitably. By analyzing current trends and case studies, the research aims to contribute to academic literature and provide insights for policymakers, researchers, and practitioners.

Hypothesis

This study is based on the assumption that digital innovation plays a crucial role in shaping modern economic systems.

1. (H1) states that digital innovation significantly contributes to economic growth and productivity by enhancing efficiency, reducing transaction costs, and enabling new business models.
2. (H2) suggests that while the digital economy creates new employment opportunities in emerging sectors, it also leads to job displacement due to automation and technological advancement.
3. (H3) emphasizes that digital transformation can promote inclusive growth only when supported by appropriate government policies, digital infrastructure, and skill development initiatives. Without these supporting factors, the benefits of digitalization may remain concentrated among certain sections of society, leading to increased inequality. These hypotheses are tested through analysis of secondary data and case studies in the subsequent sections of the paper.

5. Research Methodology

The study adopts a descriptive and analytical research design. Secondary data has been collected from government reports, World Bank data, RBI publications, and academic journals. Case study analysis has been used to understand real-world applications of digital innovation. Basic statistical tools such as percentage analysis and trend comparison are used for data interpretation.

Case Studies

1 Digital Payments in India (UPI)

The introduction of UPI has revolutionized digital payments in India. It enables real-time transactions and has significantly reduced dependency on cash. UPI transactions have grown exponentially, promoting financial inclusion.

2 E-commerce Growth (Amazon and Flipkart)

E-commerce platforms have transformed retail markets by offering convenience, wider choices, and competitive pricing. They have also created employment opportunities in logistics and delivery services.

3 Startup Ecosystem

India has become one of the largest startup hubs globally. Digital innovation has enabled entrepreneurs to develop scalable business models in fintech, edtech, and healthtech sectors.

The number of Internet users in India grew significantly between 2018 and 2023,ore than doubling over the five year period. By the end of 2023, India had approximately 918 million to 930 million internet subscribers, up from roughly 398 million in 2018.

Data Analysis

Table 1: Growth of Digital Transactions in India.

Year-on-Year Growth (2018-2023)

The growth was mainly driven by affordable mobile data and increased penetration in rural areas. According to the Cisco Annual Internet Report and TRAI performance reports, the trend in active users or subscribers was as follows:

Year	Total Internet users/subscribers (approximate)	Internet Pénétration Rate
2018	398.2 millions	29%
2019	574 Millions	41%
2020	622 Millions	43%
2021	692 Millions	48%
2022	759 Millions	525

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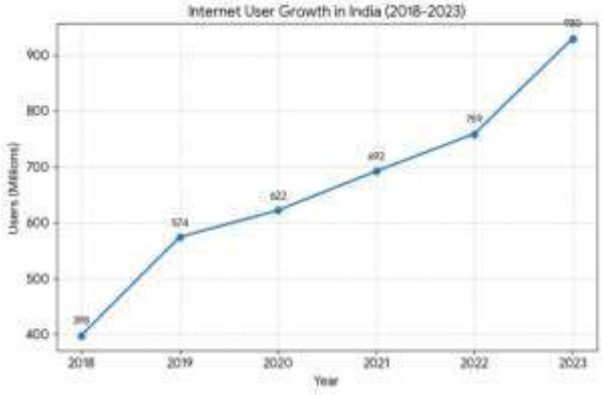
2023	821 Millions-930 Million	55%-64%

Key Growth Drivers

- **Rural Expansion:** By late 2023, rural India accounted for over 50% of the total internet user base, with growth in rural areas nearly four times faster than in urban centers.
- **Data Affordability:** India continues to be one of the most affordable markets for mobile data, with prices dropping from around ₹308 per GB in 2014 to approximately ₹9.34–₹10 per GB by 2022–2023.
- **Mobile Dominance:** The majority of Indians access the internet through mobile devices, with wireless subscribers reaching about 881 million by the end of March 2023.
- **5G Rollout:** The introduction of 5G in October 2022 accelerated high-speed internet adoption, with coverage extending to over 99% of districts by mid-2024.
- **Recent Trend:** By early 2026, this upward trajectory has continued, with India surpassing 1 billion total internet subscribers.



The line chart above visualizes the rapid climb of internet adoption in India.

- **Steepest Climb:** The most significant growth occurred between 2018 and 2019, driven by the widespread adoption of 4G services.
- **Continued Momentum:** Although growth slowed slightly during 2020–2021, it accelerated again by 2023 due to the rollout of 5G and the expansion of rural connectivity.
- **Total Scale:** The internet user base grew from a minority (around 29% in 2018) to a majority, exceeding 60% by the end of 2023.
- **Digital Transactions Growth:** Digital transactions in India witnessed exponential growth from FY 2017–18 to FY 2023–24, increasing from 2,071 crore to 18,737 crore at a compound annual growth rate (CAGR) of 44%. This shift reflects a fundamental transformation in the Indian economy, moving from a cash-dominated system to a digital-first ecosystem, largely driven by the Unified Payments Interface (UPI).

Table 2: Internet Ussern in India.
Growth in Digital Payment Volume (FY 2018-2024)

Financial Year	Total Volume (in Crore)	UPI volume (in Crore)	UPI share of Total (%)
2017-18	2,071	92	4.4%
2018-19	3,134	313	10.0%
2019-20	4,572	1,246	27.3%
2020-21	5,554	2,732	49.2%
2021-22	8,839	4,597	52.0%
2022-23	13,462	8,411	62.5%
2023-24	18,737	13,116	70.00%

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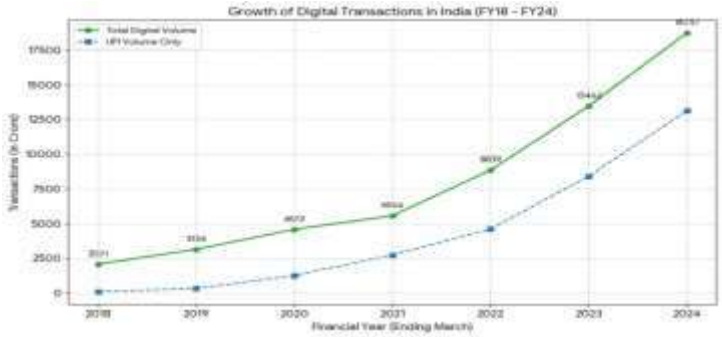

Data Analysis & Key Insights

UPI as the Growth Engine:

UPI transaction volume surged dramatically from 92 crore in FY 2017–18 to 13,116 crore in FY 2023–24, registering an impressive CAGR of about 129%. By 2024, UPI accounted for nearly 70–80% of all digital payments in India.

- **Value vs. Volume Divergence:**
  While transaction volume grew at an annual rate of 44.5%, the total transaction value increased at a comparatively lower rate of 12.1%. This indicates a clear shift toward small-value, everyday transactions (micro-payments) rather than large-value transfers.
- **Global Leadership:**
  India now contributes nearly 49% of global real-time payment transactions. The RBI's Digital Payments Index (RBI-DPI) rose significantly from a base of 100 in March 2018 to 465.33 by late 2024, highlighting substantial improvements in digital payment infrastructure.
- **Rural–Urban Transition:**
  The growth of digital payments is increasingly driven by Tier-2 and Tier-3 cities, as well as rural areas, supported by government initiatives such as BharatNet and enhanced mobile internet penetration.

Findings and Suggestions

Findings

1. The digital economy has significantly contributed to economic growth and GDP expansion.
2. Innovation in digital technologies has improved productivity and efficiency across sectors.
3. Digital platforms such as UPI and e-commerce have enhanced financial inclusion and market access.
4. The growth of startups has created new employment opportunities, especially in technology-driven sectors.
5. There exists a digital divide between urban and rural populations due to unequal access to infrastructure and skills.
6. Increasing reliance on digital systems has led to rising cybersecurity risks and data privacy concerns.
7. Automation and artificial intelligence are contributing to job displacement in traditional sectors.

Suggestions

1. Strengthen digital infrastructure, especially in rural and remote areas.
2. Promote digital literacy and skill development to prepare the workforce for technological changes.
3. Implement strong cybe rsecurity measures and data protection laws.
4. Encourage innovation through government support, startup funding, and research initiatives.
5. Develop inclusive policies to bridge the digital divide and ensure equitable access to digital resources.
6. Support reskilling and upskilling programs to address job displacement caused by automation.

The findings of the study highlight that the digital economy and innovation play a crucial role in driving economic growth, improving productivity, and transforming traditional economic structures. While digital platforms and technologies have created new opportunities for employment, entrepreneurship, and financial inclusion, they have also introduced challenges such as inequality in access, cybersecurity threats, and job displacement due to automation. Therefore, it is essential for policymakers to adopt a balanced approach by investing in digital infrastructure, promoting skill development, ensuring data security, and implementing inclusive policies. Such measures will help maximize the benefits of digital transformation while minimizing its adverse effects, thereby leading to sustainable and inclusive economic development.

Conclusion

The digital economy and innovation are key drivers of economic transformation in the modern era. While they offer immense opportunities for growth and development, addressing challenges such as inequality, security, and job displacement is essential. Policymakers must adopt a balanced approach to ensure sustainable and inclusive digital transformation.

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Special appreciation is extended to academic institutions, research organizations, governmental bodies, and international agencies that continue to promote innovation, digital inclusion, entrepreneurship, and sustainable economic growth. Their efforts in fostering technological advancement and evidence-based policymaking have been

instrumental in shaping the perspectives presented in this work.

The author(s) also acknowledge the numerous books, research articles, reports, policy documents, and statistical resources that have contributed to the analysis of emerging trends, challenges, and opportunities within the digital economy. These sources have enabled a comprehensive examination of the evolving relationship between technology, innovation, and economic transformation.

Heartfelt thanks are further extended to mentors, colleagues, reviewers, friends, and family members for their encouragement, constructive feedback, and unwavering support throughout the preparation of this manuscript. Their guidance and motivation have been invaluable in bringing this work to completion.

Finally, the author(s) hope that this study contributes meaningfully to the ongoing discourse on digital transformation, innovation-driven growth, and inclusive economic development, and serves as a useful resource for researchers, policymakers, practitioners, and students seeking to understand the opportunities and challenges of the rapidly evolving digital era.

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Original Article

Interdisciplinary Horizons: The Role of the Banking Sector in Fostering Innovation, Sustainability, and Global Development in Rural Regions

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Abstract

In the context of rapid globalization and evolving economic dynamics, the role of the banking sector has expanded beyond traditional financial intermediation to becoming a key driver of innovation, sustainability, and inclusive development. Rural areas, particularly in developing economies, continue to face challenges such as financial exclusion, limited access to credit, and low technological integration. This study adopts an interdisciplinary approach to examine how the banking sector contributes to addressing these challenges and fostering holistic rural development. The paper focuses on the role of banking institutions in promoting financial inclusion through digital banking, microfinance, and government-led initiatives. It also explores how sustainable banking practices align economic growth with social equity and environmental responsibility. By analysing recent trends, policies, and institutional frameworks, the study highlights the transformative impact of banking services on rural livelihoods and economic participation. The findings suggest that an integrated approach combining innovation, sustainability, and financial accessibility is essential for achieving long-term global development goals. The study concludes that the banking sector serves as a critical catalyst in enhancing rural resilience and promoting inclusive growth in a globalized world.

KeyWords*: Interdisciplinary Approach, Banking Sector, Rural Development, Financial Inclusion, Sustainability, Innvoation, Global Development*

Introduction

In the era of globalization, innovation, sustainability, and inclusive development have emerged as key drivers of economic and social progress. Rural areas in developing countries continue to face significant challenges such as limited access to financial services, low levels of technological adoption, and inadequate infrastructure. In this context, the banking sector plays a vital role in addressing these issues and promoting balanced regional development.

An interdisciplinary approach, combining insights from economics, finance, technology, and social sciences, helps in understanding the broader impact of banking services on rural transformation. The expansion of digital banking, financial inclusion initiatives, and improved access to credit has enabled rural populations to actively participate in economic activities. Furthermore, sustainable banking practices are increasingly aligning financial growth with social equity and environmental responsibility.

This study examines the role of the banking sector in fostering innovation, ensuring sustainability, and supporting global development in rural areas. By analysing current trends, policies, and institutional frameworks, the paper highlights how banking institutions act as catalysts for inclusive and sustainable rural development in a rapidly changing global environment.

Literature Review

The relationship between the banking sector and rural development has been extensively examined in economic literature. According to Joseph Stiglitz (2013), financial inclusion plays a crucial role in reducing poverty and promoting equitable growth, particularly in developing economies.

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Similarly, Muhammad Yunus (2007) emphasized the importance of microfinance and banking access in empowering rural communities and fostering entrepreneurship.

Studies by Raghuram Rajan (2009) highlight that strengthening financial institutions enhances credit accessibility, which is essential for rural economic development. In the Indian context, research by C. Rangarajan (2008) underlines the significance of financial inclusion policies in expanding banking services to underserved rural areas.

The emergence of digital banking has further accelerated rural transformation. Erik Brynjolfsson and Andrew McAfee (2014) argue that technological advancements, including digital financial services, enhance productivity and economic participation. Moreover, sustainability in banking has gained attention, with John Elkington (1997) introducing the concept of the "triple bottom line," integrating economic, social, and environmental objectives.

Interdisciplinary research suggests that combining financial, technological, and social perspectives provides a comprehensive understanding of rural development. Overall, the literature indicates that the banking sector serves as a key catalyst for innovation, sustainability, and inclusive global development in rural regions.

Conceptual Framework

The conceptual framework of this study is based on the interrelationship between the banking sector, innovation, sustainability, and rural development within a global context. The framework assumes that the banking sector acts as a key independent variable influencing multiple dimensions of rural transformation.

In this study, the **banking sector** (including financial institutions, digital banking services, and credit facilities) is considered the primary driver. It directly affects **financial inclusion**, which enhances access to banking services among rural populations. Improved financial inclusion leads to increased investment, income generation, and economic participation in rural areas.

Furthermore, the banking sector promotes **innovation** through the adoption of digital technologies such as mobile banking and online payment systems. These innovations improve efficiency, reduce transaction costs, and expand outreach. At the same time, sustainability is integrated through responsible lending, green finance, and socially inclusive policies that ensure long-term economic and environmental balance.

These factors collectively contribute to rural development, which is reflected in improved livelihoods, infrastructure, and socio-economic conditions. Ultimately, rural development supports global development goals by fostering inclusive growth and reducing regional disparities.

Research Methodology

This study employs a descriptive and analytical research design to examine the role of the banking sector in fostering innovation, sustainability, and global development in rural areas. An interdisciplinary approach is adopted to integrate perspectives from economics, finance, and development studies.

The research is primarily based on secondary data sources, including reports from the Reserve Bank of India (RBI), Government of India publications, World Bank reports, research journals, and other scholarly articles related to financial inclusion and rural development. These sources provide comprehensive insights into the trends and impact of banking activities in rural regions.

For analytical purposes, the study utilizes descriptive statistics, comparative analysis, and trend analysis to evaluate the role and effectiveness of banking services. Data is systematically organized and interpreted using tables and percentage analysis to ensure clarity and accuracy.

The study identifies the banking sector as the independent variable, while rural development**,** financial inclusion, innovation, and sustainability are treated as dependent variables. The research focuses on rural areas, with contextual relevance to regions such as Sangli district.

However, the study is subject to certain limitations, including reliance on secondary data and constraints related to the availability of recent and region-specific information. Despite these limitations, the methodology provides a reliable framework for analyzing the contribution of the banking sector to rural development.

Discussion

The findings of the study reveal that the banking sector plays a crucial role in promoting rural development. Financial inclusion initiatives have significantly improved access to formal banking services, enabling rural populations to engage in savings, investment, and entrepreneurial activities. The adoption of digital banking and technological advancements has further enhanced the efficiency, transparency, and accessibility of financial transactions in rural areas.

However, several challenges persist. Limited digital literacy, inadequate internet infrastructure, and low levels of financial awareness continue to restrict the full utilization of banking services. Additionally, small and marginal farmers often face difficulties in accessing timely and affordable credit. Although sustainable banking practices are gaining importance, their implementation remains limited in rural contexts.

Policy Implications

Based on the findings, the following policy recommendations are suggested:

1. Expansion of Financial Inclusion**:** Strengthen the outreach of banking services through increased bank branches, banking correspondents, and digital platforms in rural areas.
2. Enhancing Digital Literacy**:** Implement training and awareness programs to improve digital and financial literacy among rural populations.
3. Improving Credit Accessibility**:** Provide easy and affordable credit facilities to farmers, small entrepreneurs, and self-employed individuals.
4. Promotion of Sustainable Banking**:** Encourage green finance and socially responsible investment practices to ensure long-term development.

5. Adoption of Technology**:** Promote the use of mobile banking, digital payment systems, and fintech solutions to improve financial access and efficiency in rural areas.

Conclusion

The study concludes that the banking sector plays a pivotal role in promoting innovation, sustainability, and global development in rural areas. Through financial inclusion initiatives, digital banking services, and improved access to credit, banking institutions have significantly contributed to enhancing the socio-economic conditions of rural populations. These efforts have enabled greater participation in economic activities, leading to increased income opportunities and overall rural development.

The interdisciplinary approach adopted in this study highlights that the integration of financial, technological, and social dimensions is essential for achieving sustainable and inclusive growth. While notable progress has been made, challenges such as limited digital literacy, inadequate infrastructure, and restricted access to credit still persist in rural areas.

To address these issues, there is a need for stronger policy support, increased technological adoption, and a continued focus on sustainable banking practices. Overall, the banking sector serves as a key catalyst in transforming rural economies and contributing to broader global development goals. Future efforts should focus on strengthening institutional frameworks and ensuring that the benefits of banking services reach all sections of rural society in an equitable and sustainable manner.

Future Research Directions

While this study highlights the significant role of the banking sector in promoting rural development, innovation, and sustainability, there are several areas that require further exploration. Future research can focus on conducting primary data-based studies to gain deeper insights into the real impact of banking services on rural households and small enterprises.

Researchers may also examine the role of fintech and emerging technologies such as artificial intelligence and blockchain in enhancing financial inclusion and efficiency in rural areas. A comparative study between different regions or states can provide a better understanding of regional disparities in banking access and development outcomes.

Additionally, future studies can explore the long-term impact of sustainable banking practices, including green finance, on environmental and social development in rural contexts. There is also scope to analyze the effectiveness of government schemes and policy interventions in improving rural financial accessibility.

Finally, interdisciplinary research combining economics, sociology, and technology can offer more comprehensive insights into rural transformation. Such studies will contribute to developing more effective strategies for achieving inclusive and sustainable global development.

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Heartfelt thanks are offered to mentors, colleagues, reviewers, friends, and family members for their encouragement, constructive feedback, and unwavering support throughout the preparation of this manuscript. Their guidance and motivation have been invaluable in bringing this study to completion.

Finally, the author(s) hope that this work contributes to the growing discourse on the transformative role of the banking sector in rural development and highlights the importance of collaborative, interdisciplinary approaches in fostering innovation, environmental sustainability, economic resilience, and global development. It is envisioned that the insights presented herein will support future research, policy formulation, and practical initiatives aimed at empowering rural communities and creating a more inclusive and sustainable future.

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Original Article

Role of Corporate Sector Towards Green Finance & Energy and Sustainable Development –A Case Study of Contribution of Tata Groups

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Abstract

The growing challenges of climate change, environmental degradation, and energy insecurity have increased the importance of corporate participation in sustainable development. In this context, the corporate sector plays a crucial role in mobilizing green finance, promoting renewable energy, and supporting environmentally responsible business practices. This study examines the role of the corporate sector in advancing green finance and sustainable energy initiatives, with a particular focus on the contributions of Tata Group. As one of India's largest and most respected business conglomerates, the Tata Group has demonstrated a strong commitment to sustainability through investments in renewable energy, clean technologies, carbon reduction strategies, green infrastructure, and community-based environmental programs.

The study analyzes the Group's sustainability initiatives, environmental governance practices, and contributions toward achieving national and global sustainable development goals. It further explores how corporate social responsibility, green investments, and innovative business models can facilitate a transition toward a low-carbon economy. The research highlights the economic, social, and environmental impacts of Tata Group's sustainability-driven approach and identifies key challenges and opportunities associated with corporate engagement in green finance and energy development.

The findings suggest that corporate organizations can significantly contribute to environmental sustainability while maintaining long-term business growth and stakeholder value. The study concludes that effective collaboration among corporations, governments, financial institutions, and civil society is essential for accelerating sustainable development and addressing global environmental challenges. The Tata Group case demonstrates how responsible corporate leadership can serve as a model for integrating sustainability into business strategy and promoting inclusive and environmentally conscious economic development.

Key words: Green Finance; Sustainable Development; Green capital market

Introduction

Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need social and economic resources. Sustainability is not just environmentalism. The 17 SDGs and 169 targets are part of a transformative agenda - the 2030 Agenda for Sustainable Development adopted by 193 Member States at the UN General Assembly Summit in September 2015, and which came into effect on 1 January 2016. The Sustainable Development Goals (SDGs) in 2015 as a global initiative aimed at eradicating poverty, safeguarding the environment, and promoting peace and prosperity for all people by 2030.Corporations have the potential to adopt sustainable business practices that not only reduce their environmental footprint but also promote social and economic development1.

Green finance and sustainable investment involve directing capital towards projects that benefit the environment—such as renewable energy, energy efficiency, and pollution control—while aiming for long-term economic returns. Two main goals of green finance are to internalize environmental externalities and to reduce risk perceptions. Promoting green finance on a large and economically viable scale helps ensure that green investments are prioritized over business-

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as-usual investments that perpetuate unsustainable growth patterns. Green finance encourages transparency and long-term thinking of investments flowing into environmental objectives and includes all sustainable development criteria identified by the UN Sustainable Development Goals (SDGs).Green finance covers a wide range of financial products and services, which can be divided into investment, banking and insurance products[2].The predominant financial instruments in green finance are debt and equity. To meet the growing demand, new financial instruments, such as green bonds and carbon market instruments, have been established, along with new financial institutions, such as green banks and green funds. Renewable energy investments, sustainable infrastructure finance and green bonds continue to be areas of most interest within green financing activities. The key concepts of green finance are centred around achieving a sustainable and resilient economy that can address the challenges posed by climate change and promote a transition to a low-carbon economy. Green finance initiatives include[3]:

1. Renewable energy and energy efficiency
2. Pollution prevention and control
3. Biodiversity conservation
4. Circular economy initiatives
5. Sustainable use of natural resources and land

The two main goals of green finance are to "internalise environmental externalities and to reduce risk perceptions." Promoting wide-scale green finance practices ensures that finances are directed towards green investments which are environmentally and socially responsible.

By directing capital towards environmentally friendly projects, green finance helps combat climate change and protects ecosystems[4].

Green Finance Market

According to the Climate Policy Initiative's Global Landscape of Climate Finance 2021, climate finance has steadily increased over the last decade, reaching USD 632 billion in 2019/2020 but flows have slowed in the last few years. This is a concerning trend given that COVID-19's impact on climate finance is yet to be fully observed. The increase in annual climate finance flows between 2017/2018 and 2019/2020 was relatively low, 10% compared to previous periods when it grew by more than 24%.Multilateral development banks: MDBs have deep institutional expertise in providing and catalysing investments in sustainable development and are taking steps to align their activities with the 2030 Agenda, including by scaling up climate finance, designing new SDG-related financial instruments and advancing global public goods in areas such as combating climate change. In 2020, climate financing by the world's largest MDBs accounted for US$ 66 million, with US$ 38 billion or 57.6 per cent of total MDB commitments for low-income and middle-income economies.

Review Of Literature

Megha Chhaochharia (2021)[5] - This paper deals with the developments in green finance in India as well as globally. Variety of data sources have been used to assess both the extent of public awareness and financing options for green projects. The findings conclude that while there have been improvements in the public awareness and financing options in India, a reduction in asymmetric information through better information management systems and increased coordination amongst stakeholders could pave a way towards a greener and sustainable long term economic growth.

Keshav Mishra & Arjun Kannaujia (2023)[6]-Placing the Asian economies onto a sustainable development pathway requires an unprecedented shift in investment away from greenhouse gas, fossil fuel, and natural resource intensive industries towards more resource efficient technologies and business models. The financial sector will have to play a central role in this 'green transformation'. This study discusses the need for greening the financial system and the role of financial governance. It reviews the state of green lending and investment in Asia and provides an overview of green financial governance initiatives across Asia. It also identifies market innovations to increase green finance in Asia, barriers to green investments, and financial policy and highlights priority areas for policy makers. The day when all organizations across the world operated only for financial gain is long past. Natural resource preservation and environmental protection are becoming increasingly important in all spheres of life today. Continuous research has being done worldwide to identify novel approaches for achieving sustainability. In order to safeguard the environment, mitigate the impacts of climate change, invest in renewable energy sources, increase the amount of green space, and support other sustainable development initiatives, financial aid is known as "green finance." This article examines the components of green financing, including green banking, green insurance, and green bonds.

Mingbo Zheng,Limin Wu,Gen-Fu Feng &Chun-Ping Changc (2025)[7]-Environmental, social, and governance (ESG) practice is essential to the achievement of sustainable development goals. Improving macro ESG performance requires lots of financial resource input, while whether green finance exhibits critical effect on national ESG performance has yet to be explored. This study employs a panel fixed effects model and panel data from 103 countries over the period from 2000 to 2020 to explore the role of green finance in national ESG performance. The findings show that green finance is conducive to enhanced national ESG performance. The heterogeneity test reveals those nations with higher levels of financial development, better institutional quality, and faster ICT development experience higher growth of national ESG performance from green finance. The research offers valuable policy reference for governments across different nations seeking to accelerate sustainable development.

Research Methodology

This research paper is based on the secondary data sourced from books, research papers, journals, magazines, articles and published reports. However, activities and initiatives taken by Tata Group of industries are taken from reports published/articles in the website.

Objectives Of the Study:

- To study the role of green finance in maintaining Sustainable development
- To explore the contribution of Tata Industries in Green Finance and sustainable development activities.

Data Analysis and Findings of The Study[8]:

The motto of Tata Group of Industries is **Embracing the Planet, Embracing** the Future in terms of sustainable

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development. The Tata Group is investing heavily in India's green transition, aiming for net-zero emissions through major initiatives in renewable energy, electric vehicles, and green steel. Key projects include Tata Power's >$9.5 billion investment in renewable energy and a ₹6,675 crore solar cell/wafer plant, Tata Motors' EV leadership, and Tata Steel's ₹11,000 crore investment in low-carbon steel production.

Green Investments and Initiatives:

Renewable Energy Generation (Tata Power):

- **Capacity Expansion:** Targeting 70% capacity from green sources by 2030, with a planned capital expenditure (capex) of ~₹21,000 crore for FY25.
- **Solar Manufacturing:** Establishing a 10GW solar ingot and wafer plant in Nellore, Andhra Pradesh, with a ₹6,675 crore investment.
- **Renewable Portfolio:** Operates over 5.75 GW of renewable capacity (solar and wind) and has implemented over 3 GW of rooftop solar across 700+ cities.
- **Investments:** A proposed 7,000 MW renewable energy project in Andhra Pradesh with a ₹49,000 crore investment.

Electric Vehicles and Mobility (Tata Motors):

- **EV Leadership:** Tata Motors dominates India's electric vehicle (EV) market and is accelerating its infrastructure. Dominates India's passenger EV market with models like Nexon EV, Tigor EV, and Tiago EV.
- **EV Business Investment**: Investing between **₹16,000 crore and ₹18,000 crore** through FY30 to develop new products and dedicated EV platforms.
- **New Brand & Models**: Launching the premium **Avinya** brand in late 2026 and reintroducing the **Sierra EV**
- **Charging Network**: Aiming to establish **1 million charging points** by 2030 through collaborations with Tata Power.
- **Green Hydrogen:** Investing in hydrogen-powered trucks for heavy-duty commercial transport.

Green Steel and Manufacturing (Tata Steel):

- **Low-Carbon Technology:** Investing ₹11,000 crore in the Jamshedpur facility to adopt advanced, low-carbon, and green steel technologies, targeting industrial decarbonization.

Sustainability and Clean Tech (Tata Capital & Others)

- **Cleantech Finance:** Financed over 12.16 GW of renewable capacity through ~330 projects.
- **Project Aalingana:** A group-wide initiative focused on sustainability and combating climate change through technological innovations.
- **Water & Green Spaces:** Conserved 60 million gallons of water through a 245-acre wetland at the Tata Motors plant, plus planting over 18 million saplings.

Sustainable Finance & Infrastructure

Tata Group leads green finance in India primarily through **Tata Cleantech Capital Limited (TCCL)**, the country's first private sector green investment institution. It finances renewable energy (over 12.16 GW), solar, e-mobility, and green hydrogen, having averted 25.35 million tonnes of carbon emissions. TCCL collaborates with global partners like the Green Climate Fund (GCF) to support sustainable projects.

- **Tata Capital**: Through its Cleantech Finance arm, it has financed over **12 GW of renewable capacity** across 330+ projects in India.
- **Microgrids**: Deploying solar microgrids in rural India to provide 24/7 reliable power and foster local entrepreneurship.
- **GCF Partnership (BEACON INDIA):** In November 2025, Tata Capital secured a $15.85 million revolving fund and a $3 million grant from the Green Climate Fund (GCF) to support early-stage climate-tech start-ups. This partnership aims to reduce 1.1 million tonnes of emissions.
- **Sustainable Aviation Fuel (SAF) Partnership:** Tata Communications became the first Indian corporate to sign agreements with Lufthansa and Air France-KLM to offset business travel emissions through the purchase of SAF
- **Green SME Financing:** Tata Power supports Small and Medium Enterprises (SMEs) with financial solutions for energy efficiency, utilizing revolving credit to reduce expenditure and re-invest in sustainability projects.
- **Investments in Green NBFCs:** Tata Mutual Fund has invested ₹37 crore in Mufin Green Finance, a small-cap company focused on electric vehicle (EV) financing.
- **Strategic Growth:** TCCL also partners with institutions like the Asian Infrastructure Investment Bank (AIIB) to advance sustainable infrastructure projects.
- Tata Capital acts as a pioneer in climate finance, often serving as a first-mover in bringing new investors to India's green initiatives.

Tata Group's "Sustainable is Attainable" approach aims for 70% green energy capacity by 2030.

Conclusion: As of early 2026, the Tata Group has achieved significant milestones in green finance and sustainable development, driven by its overarching 'Project Aalingana' initiative, which targets net-zero emissions by 2045. Key highlights include pioneering collaborations with global climate funds, major renewable energy capacity additions, and pioneering low-carbon steel production. Tata Capital Limited, a holistic financial services provider, caters to the diverse needs of retail, housing, SME, and corporate customers with a pan-India network of 1500+ branches. Its range of offerings includes Consumer Finance, Housing Finance, Commercial Finance, Cleantech Finance, Microfinance, Debt Syndication, Private Equity, and Credit Cards[9].

Acknowledgment

The author(s) express their sincere gratitude to the scholars, researchers, corporate leaders, environmental experts, financial analysts, and policymakers whose valuable contributions to the fields of green finance, renewable energy, corporate sustainability, and sustainable development have significantly enriched the understanding

and preparation of this study. Their insights and pioneering work have provided a strong foundation for examining the evolving role of the corporate sector in addressing environmental and developmental challenges.

Special appreciation is extended to Tata Group for its longstanding commitment to responsible business practices, environmental stewardship, renewable energy initiatives, sustainable finance, and community development. The Group's efforts in integrating sustainability into corporate strategy have served as an important reference point for this case study.

The author(s) also acknowledge the contributions of academic institutions, governmental agencies, regulatory authorities, international organizations, and industry bodies that continue to promote sustainable finance, clean energy transitions, climate-resilient development, and responsible corporate governance. Their reports, policy frameworks, and research publications have been invaluable in shaping the analysis presented in this work.

Heartfelt thanks are extended to mentors, colleagues, reviewers, friends, and family members for their encouragement, constructive feedback, and unwavering support throughout the completion of this manuscript. Their guidance and motivation have been instrumental in bringing this research to fruition.

Finally, the author(s) hope that this study contributes meaningfully to the growing discourse on the role of corporations in advancing green finance, renewable energy adoption, and sustainable development. It is envisioned that the findings and perspectives presented herein will encourage greater collaboration among businesses, governments, and communities in building a more sustainable, inclusive, and environmentally responsible future.

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Original Article

Bridging Rural Learners to Global Communication: A Functional English Approach

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Abstract

The growing demand for English communication skills in global academic and professional contexts has widened the gap between urban and rural learners. Rural students, particularly in technical institutions, often lack functional English proficiency despite possessing adequate domain knowledge. This study investigates the effectiveness of a Functional English Approach in enhancing communication skills among rural polytechnic students. Using an action research design, the study was conducted on 120 first-year students over a period of 12 weeks. The intervention emphasized task-based learning, real-life communication activities, and collaborative pedagogy. Data were collected through pre- and post-assessments, observation, and student feedback. The findings indicate significant improvement in learners' confidence, fluency, and practical communication abilities. The study proposes a scalable model for integrating functional English into rural technical education.

Keywords: *Functional English- Rural Learners- Communication Skills- Employability- Task-Based Learning- Polytechnic Education.*

Introduction

English language proficiency has become a critical determinant of academic success and employability in the globalized world. In India, the disparity between urban and rural learners in acquiring communicative competence remains a pressing concern. Rural students, particularly those enrolled in polytechnic institutions, face unique challenges due to limited exposure to English-speaking environments and reliance on traditional grammar-based teaching methods.

While conventional pedagogy focuses on linguistic accuracy, it often neglects communicative competence, resulting in students who can write examinations but struggle in real-life interactions. This study advocates a shift toward a **Functional English Approach**, which prioritizes practical usage, contextual learning, and skill integration.

Literature Review

The evolution of English Language Teaching (ELT) has transitioned from structural approaches to communicative and functional paradigms.

- **Communicative Language Teaching (CLT)** emphasizes interaction as the primary goal of learning (Richards, 2006).
- **Task-Based Language Teaching (TBLT)** focuses on meaningful tasks that mirror real-life situations (Nunan, 2004).
- Krashen's Input Hypothesis (1982) highlights the importance of comprehensible input in language acquisition.

Recent studies indicate that rural learners benefit significantly from:

- Contextualized instruction
- Activity-based learning
- Peer interaction

However, there is limited research focusing specifically on:

- Rural polytechnic students
- Functional English implementation models
- Measurable outcomes in skill-based learning

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Research Gap

Despite extensive research in ELT methodologies, there is a lack of:

- Empirical studies addressing rural technical learners
- Structured functional English frameworks for polytechnic education
- Actionable classroom models with measurable outcomes

Objectives of the Study

1. To analyze the challenges faced by rural learners in English communication
2. To implement a Functional English Approach in a rural polytechnic setting
3. To evaluate its impact on students' communication skills
4. To develop a replicable model for rural institutions

Methodology

1 Research Design

This study adopts an **Action Research** approach integrating qualitative and quantitative methods.

2 Sample

- 120 first-year polytechnic students
- Age group: 15–17 years
- Background: Rural, Telugu-medium schooling

3 Instruments

- Pre-test and post-test (speaking & writing)
- Observation schedules
- Student feedback questionnaires
- Performance rubrics

4 Intervention Framework

Duration: 12 weeks

Phase	Duration	Focus
Phase 1	Weeks 1–4	Basic communication & vocabulary
Phase 2	Weeks 5–8	Practice through activities
Phase 3	Weeks 9–12	Real-life application

5 Data Analysis

- Descriptive statistics (percentage improvement)
- Comparative analysis (pre vs post performance)
- Thematic analysis (qualitative feedback)

Results

1 Quantitative Findings

Skill Area	Pre-Test (%)	Post-Test (%)	Improvement
Speaking Confidence	32	74	+42
Vocabulary Usage	38	70	+32
Sentence Formation	41	76	+35
Listening Comprehension	45	79	+34

2 Qualitative Findings

- Students reported reduced fear in speaking English
- Increased participation in classroom activities
- Positive attitude toward learning English

Discussion

The findings demonstrate that the Functional English Approach significantly improves learners' communicative competence. Unlike traditional methods, this approach:

- Encourages active participation
- Reduces psychological barriers
- Promotes experiential learning

The integration of real-life scenarios, peer learning, and continuous practice played a crucial role in enhancing student outcomes.

Real-Time Classroom Practices

1 Situation-Based Role Play

Students enacted scenarios such as:

- Job interviews
- Market conversations
- Telephone dialogues

Impact: Improved fluency and contextual understanding

2 Peer Learning Model

Advanced learners mentored weaker students in small groups.

Impact: Increased confidence and collaborative learning

3 Daily Communication Practice

A structured one-hour session included:

- Vocabulary drills
- Listening exercises
- Speaking tasks

Impact: Consistent skill development

Pedagogical Implications

- Shift from teacher-centered to learner-centered classrooms
- Emphasis on communication rather than grammatical perfection
- Integration of technology and multimedia tools

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Practical Implementation Model
Daily Functional English Schedule

Time	Activity
10 min	Vocabulary Practice
15 min	Listening Activity
20 min	Speaking Practice
15 min	Writing Task

Institutional Action Plan

1. Establish English-speaking environments
2. Conduct weekly communication workshops
3. Train faculty in functional teaching methods
4. Introduce continuous assessment systems

Limitations

- Limited geographical scope
- Short intervention duration
- Dependence on teacher effectiveness

Future Research Directions

- Integration of AI-based language tools
- Longitudinal studies across multiple institutions
- Development of rural-specific ELT curricula

Conclusion

The Functional English Approach provides a viable and effective solution to bridge the communication gap among rural learners. By focusing on practical usage, collaborative learning, and contextual teaching, it empowers students to participate confidently in global communication. The study underscores the need for systemic changes in rural education to ensure equitable opportunities for all learners.

Acknowledgment

The author(s) express their sincere gratitude to the educators, language experts, researchers, and academic scholars whose valuable contributions to the fields of English language teaching, communication skills, and rural education have greatly influenced the development of this study. Their dedication to enhancing language learning and promoting educational inclusion has provided the intellectual foundation for this work.

Special appreciation is extended to teachers, students, educational institutions, and community organizations working in rural areas for their continuous efforts to improve language proficiency and communication competencies among learners. Their experiences, challenges, and achievements have offered important insights into the practical realities of English language education in rural contexts.

The author(s) also acknowledge the contributions of policymakers, curriculum developers, and educational agencies that strive to bridge educational disparities and create opportunities for rural learners to participate effectively in an increasingly interconnected global society. Their initiatives in promoting functional and communicative approaches to language learning have been instrumental in shaping the perspectives presented in this study.

Heartfelt thanks are extended to mentors, colleagues, reviewers, friends, and family members for their encouragement, constructive suggestions, and unwavering support throughout the preparation of this manuscript. Their guidance and motivation have been invaluable in bringing this work to completion.

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Appendix A: Sample Questionnaire

1. Do you feel confident speaking in English?
2. Do classroom activities help you improve communication?
3. Which activity helped you the most?
4. What challenges do you still face?

Appendix B: Assessment Rubric

Criteria	Excellent	Good	Average	Poor
Fluency	Smooth	Minor pauses	Frequent pauses	Hesitant
Vocabulary	Rich	Adequate	Limited	Very limited
Confidence	High	Moderate	Low	Very low

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Original Article

Green Chemistry Approach for Knoevenagel Condensation Using Lemon and Tulsi Leaf Extracts as Natural Catalysts

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Abstract

Green chemistry has become a significant methodology in contemporary organic synthesis owing to the growing demand for environmentally sustainable and safer chemical processes. This study developed an environmentally benign method for synthesizing 4-nitrobenzylidenemalononitrile via Knoevenagel condensation utilizing natural plant-derived catalysts. The reaction occurred between 4-nitrobenzaldehyde and malononitrile in an ethanol medium, utilizing lemon leaf extract and tulsi leaf extract as green catalysts under reflux conditions. We filtered the synthesized products to separate them and then used ethanol to recrystallize them to make them pure. Thin Layer Chromatography (TLC) was used to keep track of how the reaction was going. Comparative studies were conducted based on reaction time, product yield, and reaction efficiency.

The product made with lemon leaf extract had a yield of 90.1%, and the product made with tulsi leaf extract also turned out well when the reaction conditions were mild. The new method doesn't use dangerous synthetic catalysts and is in line with the ideas of green chemistry. This work shows that plant-based catalysts work well for sustainable organic synthesis and offers an environmentally friendly way to make substituted benzylidenemalononitrile derivatives.

Keywords: *Green chemistry, Knoevenagel condensation, natural catalyst, lemon leaf extract, tulsi leaf extract, malononitrile.*

Introduction

Organic synthesis is very important in the fields of pharmaceuticals, agrochemicals, dyes, polymers, and material science. Knoevenagel condensation is one of the most common reactions for making substituted olefinic compounds out of carbon–carbon bonds. In the presence of the right catalysts, the reaction usually involves the condensation of aldehydes or ketones with active methylene compounds like malononitrile. Substituted benzylidene malononitrile derivatives are significant organic intermediates owing to their biological and industrial uses. These compounds are useful in the fields of medicinal chemistry, heterocyclic synthesis, dyes, pigments, and agrochemicals. Acids, bases, metal salts, or other synthetic catalysts are usually used to speed up Knoevenagel condensation reactions. But a lot of regular catalysts are poisonous, costly, hard to separate, and bad for the environment.

In the last few years, green chemistry has been focused on making catalytic systems that are good for the environment and last a long time. Earlier research has documented effective Knoevenagel condensation reactions employing natural catalysts, such as henna leaf extract, for the synthesis of substituted methylene malononitrile derivatives under environmentally friendly conditions. Natural plant extracts have garnered considerable interest due to their biodegradability, cost-effectiveness, renewability, and non-toxicity. Lemon leaf extract has natural organic acids like citric acid and ascorbic acid. Tulsi leaves have phenolics and flavonoids that can help condensation reactions happen at low temperatures.

In this study, 4-nitrobenzaldehyde was reacted with malononitrile utilizing lemon leaf extract and tulsi leaf extract as natural catalysts in an ethanol medium.

A comparative study was performed to evaluate catalytic efficiency based on reaction time and product yield.

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Materials and Methods

Preparation of Plant Extracts

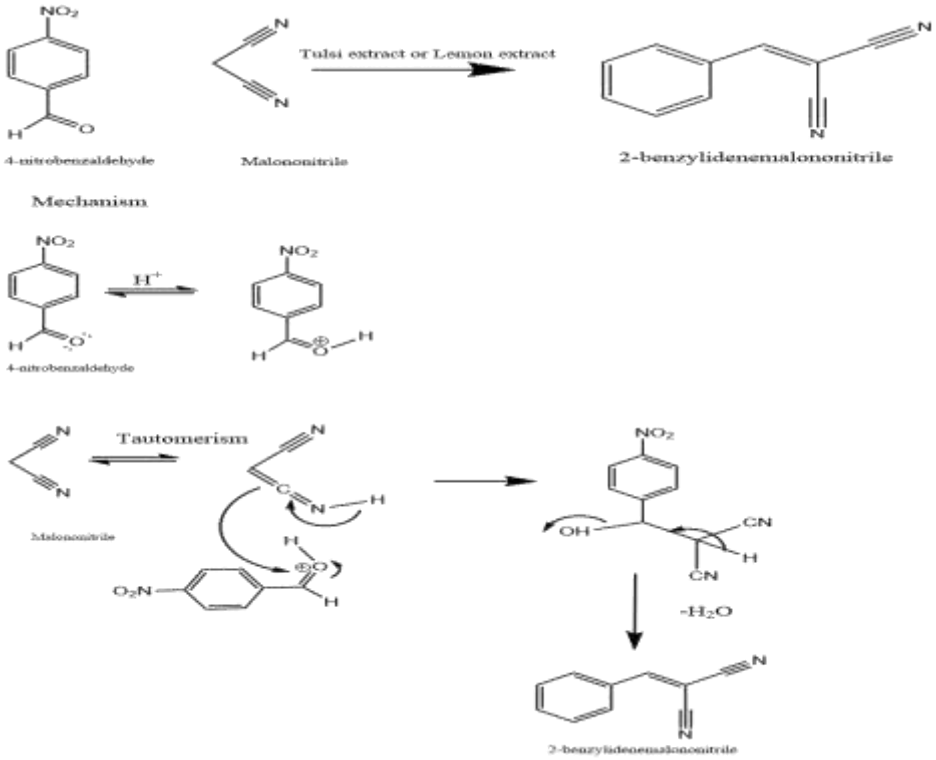
Fresh lemon leaves and tulsi leaves were washed thoroughly with distilled water to remove dust and impurities. The leaves were crushed separately using mortar and pestle, and the extracts obtained were filtered using filter paper. The filtrates were collected and used directly as natural catalysts.

Procedure for Knoevenagel Condensation

Equimolar quantities of malononitrile (0.66 g, 10 mmol) and 4-nitrobenzaldehyde (1.51 g, 10 mmol) were taken in a 100 mL round bottom flask. Ethanol (10–15 mL) was added as solvent followed by addition of 5 mL plant extract as catalyst. The reaction mixture was refluxed with gentle stirring for 20–30 minutes.

The progress of the reaction was monitored by Thin Layer Chromatography using hexane:ethyl acetate solvent system. After completion of the reaction, the mixture was cooled to room temperature. Yellow crystalline solid product separated out and was collected by filtration. The crude product was washed with cold ethanol and distilled water and purified by recrystallization using ethanol.

Reaction Scheme



Results and Discussion

Knoevenagel condensation between 4-nitrobenzaldehyde and malononitrile was efficiently achieved in reflux conditions using natural plant extracts. The reaction was successfully catalyzed by both lemon leaf extract and tulsi leaf extract and gave the desired substituted benzylidenemalononitrile derivative.

The reaction with lemon leaf extract was completed in 20–30 min and afforded excellent yield. The product was a yellow crystalline solid with a melting point of approximately 176 °C. The yield obtained by using the lemon extract was 90.1 %. Similarly, tulsi leaf extract also promoted the reaction efficiently under mild conditions. The product formation was observed in 20-25 min with good yield. Plant extracts were used, which did not require hazardous synthetic catalysts and supported green synthesis The catalytic activity of lemon extract is due to the presence of organic acids such as citric acid and ascorbic acid, whereas tulsi extract contains natural phenolic compounds and flavonoids that aid the process of condensation.

Comparative Result Table:1

Parameter	Lemon Leaf Extract	Tulsi Leaf Extract
Product	4-Nitrobenzylidenemalononitrile	4-Nitrobenzylidenemalononitrile
Reaction Time	20–30 min	20–25 min
Product Appearance	Yellow crystalline solid	Bright yellow crystalline solid
Melting Point	176 °C	174–176 °C
Practical Yield	1.83 g	1.79 g
Percentage Yield	90.1%	88.2%
TLC Solvent System	Hexane: Ethyl acetate (6:4)	Hexane : Ethyl acetate (6:4)
Recrystallization Solvent	Ethanol	Ethanol

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The results indicate that both natural catalysts are effective for the Knoevenagel condensation. Lemon leaf extract had slightly more product yield and tulsi extract also revealed excellent catalytic efficiency. The reaction conditions were mild, economic and environmentally benign.

Spectral Data

FTIR Spectral Analysis

The synthesized 4-nitrobenzylidenemalononitrile was characterized using FTIR spectroscopy. The important absorption bands observed are summarized below:

Table:2

Functional Group	Observed Peak (cm^{-1})	Assignment
C≡N stretching	2220–2230	Nitrile group
C=C stretching	1585–1600	Aromatic alkene
NO_2 asymmetric stretching	1515–1530	Nitro group
NO_2 symmetric stretching	1340–1355	Nitro group
Aromatic C–H stretching	3050–3100	Aromatic ring

The presence of strong nitrile stretching band around 2225 cm^{-1} confirms the formation of benzylidenemalononitrile derivative. Nitro group absorption peaks observed near 1520 cm^{-1} and 1350 cm^{-1} further support successful synthesis of 4-nitro substituted product.

Physical Characterization

The synthesized compound was obtained as a yellow crystalline solid. It exhibited a melting point in the range of 174–176 °C, indicating good purity. The compound was found to be soluble in ethanol as well as in common organic solvents. Thin-layer chromatography (TLC) analysis showed a single spot, confirming the formation of a pure product.

Applications of Synthesized Compound

Pharmaceutical Applications

4-Nitrobenzylidenemalononitrile acts as an important intermediate in medicinal chemistry and pharmaceutical synthesis. Nitro-substituted aromatic compounds are useful in preparation of biologically active molecules.

Heterocyclic Synthesis

The synthesized compound can be used for preparation of heterocyclic compounds such as pyridines and pyrimidines, which are important in pharmaceutical chemistry.

Dye and Pigment Industry

Due to the presence of conjugated double bonds and nitro group, the compound exhibits strong color properties and can be utilized in dye and pigment synthesis.

Agrochemical Applications

The compound can serve as an intermediate in preparation of agrochemicals such as pesticides and insecticides.

Green Chemistry Significance

The use of lemon and tulsi extracts as natural catalysts reduces environmental pollution, minimizes hazardous waste generation, and supports sustainable organic synthesis.

Conclusion

An eco-friendly and efficient method for the synthesis of 4-nitrobenzylidenemalononitrile was developed using lemon leaf extract and tulsi leaf extract as natural catalysts. The reactions were carried out successfully in mild conditions using ethanol as green solvent. The two plant extracts showed excellent catalytic activity and gave good to excellent yields in a short time. The developed methodology avoids the use of toxic synthetic catalysts and promotes green chemistry principles such as sustainability, biodegradability, cost-effectiveness and environmental safety. Of the two catalysts studied, the lemon leaf extract showed slightly higher catalytic efficiency in terms of product yield. The present work demonstrates that plant-derived catalysts can be efficient alternatives to traditional catalysts in organic synthesis.

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Conflict of Interest: The authors' declare that there is no any conflict of interest.

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Original Article

Effect of west water pollution on oxygen consumption rate of Macrones cavasies

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Abstract

Dissolved Oxygen is one of the most important factor for aquatic animals. Wastewater contains organic matter that microorganisms consume, causing a sharp drop in available dissolved oxygen, known as high BOD. Different wastewaters (e.g., dairy, textile, domestic) have varying impacts on oxygen uptake rates (OUR), with higher pollution levels causing more intense oxygen consumption.

In the present study, Macrones cavasies a freshwater common carp has been selected to determine the effect of west water pollution on the oxygen consumption capacity of the fish. Among various forms of pollution in water bodies, west water pollution has an immediate and detrimental effect on the aquatic fauna. The amount of dissolved oxygen consumed by fishes was determined using Winkler's method. This study demonstrates that the dissolved oxygen consumption in Macrones cavasies increases with an increase in the concentration of west water. This is due to the stress caused by the west water on the normal physiological activities of the fish. The study indicates that the draining out of domestic sewage containing detergents in to the water bodies, will adversely affect its aquatic fauna. There is an urgent need to provide environmental education among the common people to avoid water pollution.

Keyword: *West water, eutrophication, dissolved oxygen, freshwater, Macrones cavasies.*

Introduction

Water is one of the most important gifts to mankind and is very essential of life. On a global scale, human activities have created several environmental problems of the hydrosphere. For agricultural purposes human uses chemical fertilizers, pesticides, insecticides which create great problem to the ecology and environment.

Domestic sewage is dumped into nearby water bodies. Detergents are not fully degraded even after sewage treatment and their discharge into the river cause serious problems of pollution. Detergents can also be wetting agents which lower the surface tension of the water and act as clearing agents. It also effects on growth of floating aquatic weeds (eutrophication), temperature of water, PH of water, salinity of water, turbidity of water & dissolved oxygen of water. Macrones cavasies is a common freshwater fish. The food of Macrones cavasies consists of planktonic crustaceans and insects, the tender parts and seeds of water plants, and also fish eggs and larvae. The present study is an evaluation of the effect of west water pollution on dissolved oxygen consumption by Macrones cavasies. Dissolved oxygen consumption increased when it was exposed to the water containing detergents with an increase in the concentration of the detergent, also the breathing rate increased and signs of stress were exhibited by the fish. This study is very important because domestic utilization of detergent pollutes our fresh water fauna.

These detergents were found to interfere with the food utilization, growth and conversion of fishes [3]. Detergents also bring reduction in the biochemical contents in the tissues of aquatic animals. The 24hrs LC_{50} value of detergent to *Macrobranchiumlamarrei* was 0.5%, also investigated the reduction in glycogen, protein and lipid contents of tissues of prawn with increase in concentration and time of exposure [4]. With the various concentrations of detergents fishes shows various types of behavioral changes, like slow swimming movement, bleeding through the gills. They occur loss of nervous control, fishes along lateral side of body. Body was slimy due to mucus secretion from epithelium of gills. Even at the low concentration fishes are died due bleeding through gills with both detergent powders [5].

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The main aim to study and find the effect of pollution on fish due to addition of concentration of detergent in water which reflects information regarding dissolved oxygen consumption by the fish specially Macrones cavasies.

Materials and Methods

1 Materials

For the present study, fish samples were collected from Pimpri dam near tq.udgir in the Latur District and the weight of the fish was recorded (100 to 150 gm). Water sample for the experiment were collected from aquarium tank. Dissolved oxygen content of the sample water was estimated using Winkler's method. After one hour, water sample were collected and the content of dissolved oxygen (DO) is estimated by Winkler's method. The difference between the amounts of DO in the samples with west water and control tank. Similarly, DO consumed by fish in other water samples was calculated. All the experimental work was repeated thrice for accuracy and is reported in the Table 1 & shown in Fig. 1.

2. Method to Estimate Dissolved Oxygen (DO)

Water sample for estimation after the experiment was taken in 250 ml bottles Taking care to reduce the contact of this water to air and not to induce any air bubble in the sample bottle. The bottle was closed with a stopper. 1 ml of manganous sulphate & 1 ml of alkaline Iodine were poured into the bottle using separate pipettes, shake well and allowed to settle down. Shake the bottle again and 2 ml of concentrated sulphuric acid was added to this mixture and shake vigorously to digest the precipitate. 50 ml these solutions were pipetted out in to a conical flask, add 5 drops of starch solution and then titrated against sodium thiosulphate solution. The end point was marked by the first complete disappearance of blue color. Repeat the experiment 2 to 3 times to take mean reading to reduce the errors.

3. Results & Discussion

Dissolved oxygen in the water sample was estimated before adding the west water or introducing the fishes and the values averaged at 9.25 mg/L. This reading was taken as the control. DO concentration near to 10 mg/L indicated that the water sample collected for the experiment is good for the survival of fishes.

Table1. Dissolved oxygen levels under different hours.

Sr. No.	Time period in hours	Dissolved Oxygen (mg/L) (Control)	DO (mg/L) West water & Fish	DO (mg/L) Consumed by Fish
1.	06	9.25	6.23	3.02
2.	12	9.10	5.14	3.96
3.	24	8.60	4.14	4.46
4.	36	7.40	2.70	4.7
5.	48	7.23	1.50	5.73

This decrease in DO content of sample water treated with west water was due to the presence of phosphates in detergents which readily reacts with dissolved oxygen.

Fishes are introduced in to water containing west water they started showing discomfort within 10 minutes and began to move around rapidly. With increased time period the rapid movements reduced respectively. However, in all experiments, the fishes appeared inactive later and rested at the bottom of the aquarium. The experimental fishes continued to breathe rapidly and the mucous on the body surface started to come off. This phenomenon was more observed in the water with 48 hours of exposure. The DO consumed by the fishes showed an increasing trend with the increase in time period. Fishes used in control experiment (No west water added) showed a DO consumption of 3.02 mg/L/hr. Fishes kept at 48 hours of west water showed a mean consumption of 5.73 mg/L/hr.

From this experiment it is observed that the west water had a severe impact on the experimental fish. The fishes DO consumption increased when it was exposed to the water containing west water. With increase in time period, increased breathing and signs of distress were exhibited by the fish.

Conclusion

Soaps and detergents are the main cleaning agents used in households. Most of the ingredients of soap are biodegradable, but that of detergents are not biodegradable. Hence west water causes more water pollution than soap. From this experiment it is clear that the west water had a severe impact on the experimental fish. (Macrones cavasies). This study points out the fact that indiscriminate use of the west water affects an aquatic life. People need to be made aware of the adverse effects of detergents on various forms of aquatic life. Sewage water generated from households should not be allowed to be discharged directly in to the water bodies, better sewage treatment facilities have to be looked in to for the protection of these water bodies.

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Original Article

FOFSANDI Model-Based Preservation of Indian Knowledge Systems and the Role of Artificial Intelligence for Sustainable Development: A Policy-Oriented Study

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Abstract:

Sustainable development is not merely an economic objective but a multidimensional process that integrates social justice, environmental sustainability, and cultural continuity. India's tribal communities possess rich Indian Knowledge Systems (IKS) rooted in ecological balance and sustainable resource management. However, they continue to face structural barriers in accessing modern education, healthcare, digital infrastructure, and effective governance mechanisms.In this context, the present study examines the FOFSANDI Model, developed under the Mission Setubandhan initiative, as a community-based and policy-oriented framework for sustainable tribal development. The model encompasses key components such as forest conservation, organic farming, preservation of folk culture, social awareness, administrative linkage, nutrition and health, participatory development, and inclusive growth.The study further explores the role of advanced technologies, particularly Artificial Intelligence (AI) and Natural Language Processing (NLP), in documenting, preserving, and disseminating Indigenous Knowledge Systems. It also highlights how these technologies can enhance transparency, accountability, and efficiency in governance and service delivery.Additionally, the research analyses the convergence of the FOFSANDI model with important policy frameworks such as the Panchayats (Extension to Scheduled Areas) Act (PESA) and the Forest Rights Act (FRA), emphasizing decentralized governance and community participation. The findings are based on a field study conducted in 15 tribal villages in the Akole block of Ahilyanagar district, Maharashtra, covering 600 respondents.The study concludes that integrating AI within the FOFSANDI framework can significantly strengthen inclusive, transparent, and culturally resilient development, offering a sustainable pathway for tribal empowerment in India.

Keywords: *Sustainable Development, FOFSANDI Model, Indian Knowledge Systems (IKS), Artificial Intelligence (AI), PESA Act, Participatory Governance.*

Introduction

In the era of globalization, 'Sustainable Development' has emerged as the cornerstone of global policy. According to the Brundtland Report, 'Our Common Future,' sustainable development is defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." The United Nations Sustainable Development Goals (SDGs) further prioritize quality education (SDG-4) and environmental protection as essential pillars for holistic growth.Tribal communities in India, particularly those in the Western Ghats like the Mahadeo Koli and Thakar tribes, have lived in harmony with biodiversity for millennia. However, conventional 'Top-down' development policies often overlook localized needs and traditional wisdom, leading to marginalization. The 'FOFSANDI Model' presents a 'Bottom-up' alternative that integrates modern innovation with traditional governance. This research aims to provide a strategic roadmap for preserving IKS through technical precision and administrative empowerment.

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Structural Analysis of the FOFSANDI Model

The FOFSANDI Model is an integrated development framework resting on eight interdependent pillars designed to achieve long-term sustainability:

Pillar	Technical & Strategic Dimension
F - Forest Conservation	Protection of forest resources, biodiversity preservation, and maintaining ecological balance.
O - Organic Farming	Enhancing soil fertility and microbial health through natural farming techniques.
F - Folk Culture	Digital preservation of tribal traditions, oral histories, and cultural heritage.
S - Social Awareness	Large-scale awareness regarding education, health, civil rights, and digital literacy.
A - Administration Linkage	Creating a digital bridge between government schemes and the tribal community.
N - Nutrition & Health	Eradication of *malnutrition via mHealth* and decentralized healthcare delivery.
D - Development through Participation	Empowering the Gram Sabha and ensuring active community involvement in decision-making.
I - Inclusive Growth	Holistic development of women, youth, and marginalized subgroups.

From a technical perspective, each pillar serves as a 'data input' point where advanced analytics can be applied to accelerate developmental outcomes.

Research Methodology

This study utilizes a Mixed-Method Approach to examine the socio-economic and educational conditions of the Western Ghats' tribal communities:

1. **Field Study:** Conducted across 15 tribal villages in the PESA region of Akole, Ahilyanagar district, Maharashtra.
2. **Data Collection:** Information was gathered from approximately 600 respondents (mostly women and youth) through questionnaires, structured interviews, and Participatory Rural Appraisal (PRA).
3. **Secondary Sources:** Analysis of government reports, international research papers, and legal provisions of the PESA and FRA acts.

Field Data Analysis: Akole Block Tribal Villages

The following data represents the demographic and literacy status captured during the field survey:

Sr. No.	Village Name	Total Population	Female Literacy (%)	Sex Ratio
1	Bari	1073	25.60	912
2	Fofsandi	893	56.15	971
3	Kumshet	1254	36.60	993
4	Udadvane	1539	38.90	1052
5	Randha Khurd	239	50.50	811
6	Randha Budruk	1123	44.38	991
7	Koltembe	505	47.39	996
8	Samrad	789	62.10	892
9	Ratanwadi	1118	50.32	955
10	Bhandardara	1765	32.60	999
11	Waki	951	58.81	1028
12	Mutkhel	1417	60.85	929
13	Guhire	932	57.45	904
14	Ghatghar	1176	30.38	929

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15	Shinganwadi	936	48.30	843

Analysis: Remote villages like Bhandardara and Ghatghar show alarmingly low female literacy rates (approx. 30-32%), whereas Samrad and Waki show better outcomes. This disparity highlights the urgent need for technical interventions in 'S-Social Awareness' to bridge the educational gap.

Technical Intervention: Information Technology and IKS

Indigenous knowledge is primarily oral. Advanced technical tools can assist in documenting and validating this wisdom for global scientific recognition.

1 Language and Cultural Heritage Preservation

Many tribal dialects lack a written script, risking extinction. Platforms like 'Adi Vaani' utilize Natural Language Processing (NLP) to perform real-time translation and digitization of languages like Santali, Bhili, and Gondi. By converting oral narratives into text, these technologies ensure that folklore and ecological wisdom are preserved for future generations.

2 Organic Farming and Microbiology

While tribal agriculture is inherently organic, increasing productivity requires modern microbiological insights. Soil microorganisms like bacteria, fungi, and actinomycetes are vital for nutrient cycling. Through predictive modelling, farmers can analyse soil organic carbon (SOC) and nutrient levels to optimize crop cycles.

The mathematical model for SOC tracking is:

$\Delta SOC = SOC_{i+1} - SOC_t = \sum_{i=1}^{n} Ii - \sum_{j=1}^{m} Lj \, \Delta\Delta$

Technical applications assist in predicting 'Inputs' (crop residue) and 'Losses' (erosion) to maintain land fertility.

3 Health and Nutrition: The mHealth Paradigm

In remote areas where Primary Health Centres (PHCs) are distant, mobile health (mHealth) is revolutionary. Devices like 'UdyogYantra' use image recognition to monitor the quality of school nutrition programs and track student BMI. These systems analyse over 2,100 data points per meal to ensure nutrient standards are met, addressing the critical issue of malnutrition.

Strategic Governance and Constitutional Rights

From a policy perspective, the FOFSANDI model provides a framework for the implementation of the PESA Act (1996) and the Forest Rights Act (2006).

1 Strengthening Participatory Democracy

Under PESA, the Gram Sabha is the supreme authority. However, manual record-keeping of meeting minutes is often inconsistent. 'Sabha Saar,' an AI-enabled documentation tool, generates automated and multilingual summaries of Gram Sabha proceedings. Supporting 22 Indian languages, this tool enhances administrative accountability and ensures that community decisions are recorded transparently.

2 Data Sovereignty and IPR

Tribal data is a heritage that must be protected from 'Biopiracy.' Utilizing Blockchain technology to secure traditional medicinal knowledge is a strategic necessity. Blockchain's immutable ledger can validate 'Prior Informed Consent' (PIC) and ensure fair benefit-sharing, granting tribes Intellectual Property Rights (IPR) over their unique knowledge.

Conclusion and Policy Recommendations

Conclusion:

1. Tribal development is most effective when driven by 'Bottom-up' frameworks like the FOFSANDI Model that prioritize community trust.
2. High-level education and technical literacy are key drivers of leadership among tribal women and youth.
3. Modern technology is an equalizer that can improve 'last-mile' service delivery in even the most remote geographical terrains.

Strategic Policy Recommendations:

- **Digital Literacy:** Integrate basic coding and IT education into tribal school curricula through initiatives like 'YUVAI.'
- **Multilingual Platforms:** Ensure all government scheme information is available in local dialects via platforms like 'Bhashini' and 'Adi Vaani.'
- **Digital Land Records:** Use GIS and Remote Sensing to streamline and transparently verify claims under the Forest Rights Act.
- **Organic Certification:** Implement Blockchain-based traceability for tribal organic products to grant them access to global high-value markets.

The FOFSANDI Model serves not just as a development framework, but as a guiding blueprint for the coexistence of nature and technology, leading the way toward a sustainable future.

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Special appreciation is extended to the custodians of traditional knowledge, indigenous communities, cultural institutions, archives, libraries, and educational organizations that continue to safeguard and transmit India's rich intellectual and cultural heritage across generations. Their efforts play a vital role in ensuring the preservation and relevance of traditional wisdom in the contemporary world.

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Particular recognition is given to the emerging role of Artificial Intelligence in facilitating knowledge management, digital archiving, language preservation, data analysis, and intelligent decision-making. The transformative potential of AI in preserving and revitalizing Indian Knowledge Systems has served as a central inspiration for the development of this policy-oriented research.

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Finally, the author(s) hope that this study contributes meaningfully to the ongoing discourse on the preservation of Indian Knowledge Systems, the responsible application of artificial intelligence, and the achievement of sustainable development goals. It is envisioned that the FOFSANDI Model and the insights presented in this research will support future policymaking, interdisciplinary research, and collaborative initiatives aimed at protecting cultural heritage while harnessing technology for the benefit of present and future generations.

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Original Article

Untranslating *Aliya Kattu*: Lexical Gaps and Cultural Erosion in English Translations of Coastal Karnataka Fiction

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Abstract

This paper examines the politics of translating caste-specific kinship and land tenure systems in post-1990 English renderings of Kannada literature from coastal Karnataka. Focusing on Shivaram Karanth's Sarasammana Samadhi and its Sahitya Akademi translation, it analyzes how terms like aliya kattu [matrilineal inheritance law], barsa [annual land division cycle], and guttu [feudal manorial estate] are domesticated for Anglophone readers. Using Tejaswini Niranjana's translation theory and Nicholas Dirks' work on caste representation, the study argues that translation flattens the material basis of dominant-caste power while preserving exotic detail. The guttu mane becomes a generic 'mansion,' aliya kattu is reduced to 'joint family,' and ritual terms like bhuta kola are footnoted as 'spirit worship,' severing their link to landowning authority. This linguistic erasure contributes to the invisibility of regional elites in Indian English literature, even as their economic transition from landlords to entrepreneurs shapes post-liberalization India. By comparing source and target texts, the paper demonstrates how translation participates in constructing a 'readable' modernity that obscures caste. The findings contribute to translation studies and caste studies by centering dominant-caste lexicons, a neglected area compared to Dalit translation. Ultimately, untranslating aliya kattu reveals what English literature cannot say about caste, capital, and regional modernity.

Keywords: *Translation studies, caste, matriliny, coastal Karnataka, Shivaram Karanth, Indian English literature*

Introduction: The Problem of Translating Dominant Caste

"Idu namma aliya kattuda mane. Appa atthu swaathanu illa." In Shivaram Karanth's *Sarasammana Samadhi* (1970), this line establishes the material basis of Bunt power in coastal Karnataka: property inherited through the matrilineal *aliya kattu* system, not from fathers. Yet in Padma Ramachandra Sharma's Sahitya Akademi translation, *Sarasamma's Resolve* (2000), the line becomes: "This is our ancestral home under the matrilineal system. We do not inherit from our fathers." The legal-economic term *kattu*, meaning binding law or line, vanishes into the anthropological descriptor "matrilineal system." This paper asks: what is lost when dominant-caste kinship and land tenure terms are translated for Anglophone readers?

Post-1990 Indian English literature has been celebrated for representing subaltern voices, with extensive translation theory devoted to rendering Dalit experience. However, dominant regional elites remain largely invisible in English, even as their economic transition from feudal landlords to pan-Indian entrepreneurs shapes post-liberalization India. This invisibility is not accidental. This study argues that translation practices participate in producing it. While Dalit caste terms like *holeya* or *madiga* are often politicized through footnotes and glosses, dominant-caste terms central to Bunt identity — *aliya kattu, barsa, guttu mane, bhuta kola* — are domesticated into generic English: "joint family," "year," "mansion," "spirit worship."

Using Karanth's *Sarasammana Samadhi* as a case study, this paper demonstrates how domestication severs the link between language, land, and caste power. The *guttu mane* is not merely an "ancestral mansion" but a feudal tax-collecting estate; *barsa* is not simply "year" but the annual ritual-economic cycle of land division; *bhuta kola* is not "spirit worship" but a judicial assembly legitimizing landlord authority. When these terms lose their institutional specificity, English readers encounter a depoliticized "culture" rather than a historical system of caste capital.

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Ultimately, untranslating *aliya kattu* reveals what English literature cannot say about caste, capital, and regional modernity in globalizing India.

Theoretical Framework: Domestication, Caste, and the Politics of Fluency

Tejaswini Niranjana's *Siting Translation* (1992) established that translation in colonial and postcolonial India is not a neutral linguistic transfer but a site for constructing the 'other' for Western consumption. Building on this, Lawrence Venuti's *The Translator's Invisibility* (1995) distinguishes between domesticating and foreignizing strategies. Domestication renders the source text fluent and intelligible for the target audience by erasing linguistic and cultural difference. Foreignization, conversely, registers difference by retaining strangeness. Venuti contends that Anglo-American publishing overwhelmingly favors domestication, producing an 'invisibility' of the translator and the source culture.

This framework becomes critical when applied to caste. Nicholas Dirks, in *Castes of Mind* (2001), demonstrates how colonial ethnography and postcolonial scholarship narrativized caste as 'tradition' or 'religion,' detaching it from material relations of power. In literary translation, a parallel process occurs: dominant-caste terms are aestheticized or anthropologized, while their legal-economic force is erased. This is a selective domestication. As G. N. Devy notes, Dalit autobiographies in translation often retain caste terms with extensive paratext as a political act of assertion. However, when translating Savarna literature, the same political imperative is absent. Terms marking dominant-caste power are treated as 'cultural color' rather than political infrastructure.

The result is a double erasure. First, the materiality of caste is lost: *aliya kattu* ceases to signify a land tenure system that prevented fragmentation of Bunt estates for centuries and becomes a quaint kinship custom. Second, the agency of dominant castes in post-liberalization capital formation is obscured. English readers meet 'self-made' entrepreneurs in Vivek Shanbhag's *Ghachar Ghochar* without the *guttu* origins that made that entrepreneurship possible. This study therefore proposes a 'caste-aware' translation criticism.

Example 1: Aliya Kattu → "Matrilineal System / Joint Family"

The first and most significant erasure occurs with *aliya kattu*. In Chapter 3 of *Sarasammana Samadhi*, Sarasamma explains inheritance to her sister's son after the *yajaman*'s death.

Table 1: Comparison of Aliya Kattu Translation

Category	Text
Kannada	*Idu namma aliya kattuda mane. Appa atthu swaathanu illa.*
Literal Gloss	This is our *aliya kattu* house. Father's property is not here.
Published English	This is our ancestral home under the matrilineal system. We do not inherit from our fathers.
Erased Meaning	**Legal/economic code binding land to mother's line**

"Matrilineal system" is accurate but anthropological. It removes the legal force of *kattu* = binding law, edict, or line. For Bunts, *aliya kattu* was codified in colonial courts as a legitimate system of property succession that kept estates undivided. By translating it as "matrilineal system," the text presents it as a cultural quirk comparable to Nair or Khasi practices, not as a land management strategy. The reader thinks "women's empowerment" rather than "capital accumulation." This severs the causal link essential to this study: *aliya kattu* prevented fragmentation of *guttu* estates, allowing Bunts to remain landlords across generations. When the system collapses post-1990, that same undivided capital is liquidated into hotels and real estate.

4. Example 2: Barsa → "Year" / "Annual Partition"

The second erasure concerns time. *Barsa* governs the narrative temporality of *Sarasammana Samadhi*.

Table 2: Comparison of Barsa Translation

Category	Text
Kannada	*Ee barsa da kodi mundina barsa ge baradu.*
Literal Gloss	This *barsa*'s harvest won't come next *barsa*.
Published English	This year's harvest won't last till next year.
Erased Meaning	**Institutional cycle of lease, audit, redistribution**

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Barsa is not merely 'year.' It denotes the annual ritual-economic cycle where *guttu* land is leased to tenants, accounts are settled before the *daiva*, and shares are distributed to matrilineal branches. It is a fiscal and judicial unit. The death of the *yajaman* triggers a *barsa* of crisis: the estate must be re-audited, debts called in, and land potentially partitioned. Translating *barsa* as 'year' converts an institutional rupture into a natural seasonal complaint. The English reader hears a farmer worried about crops, not a feudal lord managing the dissolution of a 200-year estate.

This matters because post-liberalization narratives of Bunt entrepreneurs consistently begin 'after the ancestral land was sold.' The end of *barsa* as an institution is the precondition for entrepreneurship. When translation erases *barsa*, it erases the historical hinge between feudalism and capital. The *guttu* dissolves off-stage, and the entrepreneur appears *ex nihilo* as 'self-made.'

5. Example 3: Guttu Mane + Bhuta Kola → "Mansion" + "Spirit Worship"

The third cluster concerns space and ritual authority.

Table 3: Comparison of Guttu Mane and Bhuta Kola Translation

Category	Text
Kannada	*Guttu maneyalli bhutada kola nadeyuttide.*
Literal Gloss	In the *guttu* house, the *bhuta*'s *kola* is happening.
Published English	A spirit-worship ritual is taking place in the ancestral mansion.
Erased Meaning	**Feudal courthouse + legislative assembly**

Guttu is not simply 'ancestral.' A *guttu* was a revenue unit in the pre-colonial *sime* system. Ten to fifteen *guttus* formed one *sime*. The *guttinavaru* or Bunts were tax collectors and magistrates. The *guttu mane* was thus an administrative center. Similarly, *bhuta kola* is not 'spirit worship.' It is the judicial assembly where the *daiva*, embodied by a Dalit or Koraga medium, adjudicates land disputes, theft, and inheritance. Bunts sponsored the *kola* to legitimize their landlord power; the *daiva*'s verdict was law.

By rendering this as 'spirit-worship ritual in the ancestral mansion,' the translation performs two moves. First, it exoticizes: 'spirit worship' signals backward superstition to a secular Anglophone reader. Second, it privatizes: 'ancestral mansion' suggests a domestic, familial space, not a public, political one. The *guttu mane* as courthouse and the *kola* as parliament become invisible. This has direct consequences for representing post-1990 transition. When the *guttu* is sold and the *kola* stops, English narratives record it as 'loss of tradition' or 'modernization.' What is actually lost is a parallel judicial-economic system that rivaled the state.

Conclusion: What English Cannot Say

The domestication of *aliya kattu*, *barsa*, and *guttu* in English translations of Karanth makes dominant-caste power unreadable. This is not a failure of individual translators but a structural feature of Anglophone publishing, which rewards fluency and penalizes the institutional specificity of regional power. Three implications follow.

First, for translation studies, we require a 'caste-aware' practice. Just as Dalit terms are footnoted as political acts, dominant-caste terms must be glossed to retain their legal-economic force. Foreignization is not only for the subaltern. Second, for postcolonial literary studies, the invisibility of Bunts and similar elites in Indian English fiction is partly a translation effect. The 'casteless' modernity of liberalization narratives is constructed through lexical choices. Third, for understanding contemporary India, untranslating *aliya kattu* recovers the grammar of caste and capital. The entrepreneurs of *Ghachar Ghochar* are not self-made; they are the last heirs of the *barsa* system, liquidating *guttu* capital into global forms.

English, in its current domesticating mode, cannot say this. It can say 'joint family,' 'year,' and 'mansion.' It cannot say *aliya kattu*. Untranslating is therefore not about linguistic accuracy. It is about restoring to view the historical process by which regional feudalism became national capital, and by which caste power learned to speak the language of casteless modernity.

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Special appreciation is extended to the writers, storytellers, and literary communities of Coastal Karnataka whose rich linguistic and cultural traditions continue to preserve the unique heritage of the region. Their creative works serve as important repositories of local knowledge, customs, beliefs, and expressions that enrich India's diverse literary landscape.

The author(s) also acknowledge the contributions of translators and language practitioners who strive to bridge cultural and linguistic boundaries through literary translation. Their efforts have highlighted both the possibilities and challenges of conveying culturally embedded meanings across languages, a central concern of this research.

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Original Article

Ideas in Action: Driving Change for a Sustainable World

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Abstract

In a fast-changing and highly connected world, sustainable development has become a major global priority. Rapid industrial growth, technological advancement, urbanization, and globalization have improved human life in many ways, but they have also created serious environmental and social challenges. Climate change, pollution, inequality, unemployment, resource depletion, and social imbalance are now global concerns. In such a situation, sustainable development has emerged as an essential approach for balancing economic progress, environmental protection, and social welfare.

This paper explains how simple but practical ideas, supported by an interdisciplinary approach, can bring real and lasting change. It focuses on the need to move beyond theory and turn ideas into action. By connecting technology, social responsibility, environmental awareness, gender equality, and global cooperation, societies can deal with complex challenges more effectively. The study highlights the importance of innovation, ethical leadership, education, policy-making, and collective participation in creating a sustainable future.

This paper uses a clear and analytical approach to study the link between innovation and sustainability. It highlights the role of individuals, institutions, industries, governments, and international organizations in creating meaningful transformation. It also discusses major challenges such as inequality, lack of awareness, climate crisis, unemployment, limited resources, weak infrastructure, and resistance to change, while pointing out new opportunities in green technology, renewable energy, digital growth, sustainable business models, and inclusive policies.

The paper argues that sustainability is not only an environmental issue but also a social, cultural, economic, and ethical responsibility. It emphasizes that education, awareness, and interdisciplinary cooperation are necessary to create practical solutions for long-term development. The paper further explains that sustainable development is possible only when innovative ideas are implemented effectively at local, national, and global levels.

The study concludes that true development is possible only when ideas are actively implemented. Real progress does not depend only on planning and discussion but on practical action, collective responsibility, and continuous innovation. By combining human values with modern technology and responsible governance, societies can create a more balanced, inclusive, and sustainable world for present and future generations.

Keywords: *Sustainability, Innovation, Global Development, Interdisciplinary Approach, Social Responsibility, Technology, Green Energy, Inclusive Growth, Sustainable Future*

Introduction

The twenty-first century is a period of rapid transformation. Scientific progress, industrial growth, digital communication, and globalization have changed human life significantly. People are now more connected than ever before through technology, transportation, trade, and communication systems. Nations cooperate economically and culturally, and information spreads across the world within seconds. These developments have improved education, healthcare, business, and living standards in many parts of the world.

However, along with progress, modern society also faces serious challenges. Climate change, global warming, environmental pollution, deforestation, unemployment, inequality, shortage of natural resources, food insecurity, and health crises are affecting people worldwide. Rapid industrialization and urbanization have increased pressure on natural ecosystems. Excessive use of fossil fuels, plastic waste, water pollution, and air pollution are damaging the environment and threatening human survival.

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Another major issue is social inequality. While some countries and communities enjoy economic growth and technological advancement, many people still suffer from poverty, unemployment, lack of education, poor healthcare, and social discrimination. Women, children, rural populations, and marginalized groups often face unequal opportunities. Economic development without social justice creates imbalance and weakens sustainable progress.

In this context, sustainable development has become a global necessity. Sustainable development refers to development that meets the needs of the present generation without harming the ability of future generations to meet their own needs. It focuses on balancing three major dimensions: environmental protection, economic growth, and social well-being. Sustainable development encourages responsible use of resources, equality, innovation, and long-term planning.

The idea of "Ideas in Action" is especially important in today's world. Knowledge alone cannot create change unless it is implemented practically. Many countries, organizations, and institutions discuss sustainability, but real transformation happens only when ideas are converted into practical action. Action-oriented approaches are necessary to solve global problems effectively.

Innovation plays an important role in sustainable development. New technologies, scientific research, creative thinking, and modern systems can improve efficiency and reduce environmental damage. Renewable energy, digital governance, smart cities, sustainable agriculture, and eco-friendly industries are examples of innovative solutions that support sustainability.

At the same time, sustainability cannot be achieved through one subject or discipline alone. Environmental science, economics, sociology, technology, education, healthcare, politics, and ethics must work together. Therefore, an interdisciplinary approach is essential for solving complex global problems.

This paper studies the relationship between ideas, innovation, action, and sustainability. It explains how practical implementation, collective responsibility, technological advancement, corporate ethics, education, and international cooperation can help create a sustainable world. The paper also discusses major challenges and opportunities connected with sustainable development and highlights the importance of interdisciplinary thinking in achieving long-term progress.

Literature Review

Recent studies and reports show that sustainable development requires cooperation among governments, industries, educational institutions, communities, and international organizations. Researchers across the world agree that environmental protection and economic development must work together rather than against each other.

The United Nations Sustainable Development Goals Report (2021) explains that the seventeen Sustainable Development Goals (SDGs) provide a global framework for reducing poverty, protecting the environment, improving education, ensuring gender equality, and promoting peace and prosperity. According to the report, global cooperation and practical action are essential for achieving these goals by 2030.

The World Economic Forum Global Risks Report (2022) highlights climate change, cyber threats, economic instability, unemployment, and social inequality as major global risks. The report emphasizes that innovation, digital transformation, and collaborative governance are necessary to reduce these risks and create sustainable societies.

Sachs et al. (2020) argue that sustainable development depends on policy support, public participation, scientific innovation, and responsible leadership. Their research explains that countries investing in education, healthcare, renewable energy, and environmental protection perform better in long-term development indicators.

The World Bank World Development Report (2023) points out that gender equality and social inclusion are directly connected with economic growth. According to the report, empowering women and marginalized communities increases productivity, reduces poverty, and improves social stability.

Research published by the OECD (2021) explains that innovation is a key driver of sustainability. Technological advancement helps improve energy efficiency, reduce pollution, increase agricultural productivity, and strengthen digital governance systems. However, innovation should also consider ethical and environmental impacts.

Harvard Business Review (2021) discusses how sustainable business practices improve corporate reputation, customer trust, and long-term profitability. Companies focusing on environmental responsibility, employee welfare, and ethical governance perform better in competitive markets.

The IPCC Climate Change Report (2022) warns that rising global temperatures, sea-level rise, floods, droughts, and biodiversity loss are serious threats to humanity. The report stresses the urgent need for renewable energy, climate policies, and sustainable consumption practices.

McKinsey & Company (2022) highlights the growing importance of green technology, sustainable finance, and environmentally responsible industries. Businesses and governments are increasingly investing in renewable energy, electric vehicles, and low-carbon technologies.

The IMF Global Economic Outlook (2023) explains that global economic recovery after the pandemic requires inclusive growth, technological innovation, and sustainable investment. Countries that focus on green development and digital transformation are more likely to achieve stable economic growth.

Overall, the literature clearly shows that sustainability depends on interdisciplinary cooperation, innovation, ethical leadership, public participation, and practical implementation. Sustainable development is not limited to environmental protection alone but includes social justice, economic stability, education, healthcare, and technological advancement.

Concept of Sustainability

Sustainability is one of the most important concepts in modern development studies. It focuses on maintaining balance between human needs and environmental protection. Sustainable development aims to improve quality of life while protecting natural resources for future generations.

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Sustainability is generally based on three interconnected pillars: environmental sustainability, social sustainability, and economic sustainability.

Environmental Sustainability

Environmental sustainability focuses on protecting nature and reducing environmental damage. Human activities such as industrialization, mining, deforestation, and excessive consumption have harmed ecosystems and biodiversity. Environmental sustainability encourages responsible use of resources, pollution control, waste management, renewable energy, water conservation, and protection of forests and wildlife.

Climate change is one of the biggest environmental challenges today. Rising temperatures, melting glaciers, floods, droughts, and irregular weather patterns affect agriculture, health, and economies worldwide. Sustainable environmental practices help reduce these risks and promote ecological balance.

Social Sustainability

Social sustainability focuses on equality, justice, education, healthcare, and human rights. A sustainable society ensures that all individuals have access to opportunities and basic needs. Social sustainability promotes gender equality, community participation, cultural diversity, and social inclusion.

Poverty and inequality weaken social development. Lack of education and healthcare creates long-term social problems. Therefore, governments and institutions must invest in human development and public welfare.

Economic Sustainability

Economic sustainability refers to long-term economic growth that does not harm society or the environment. Sustainable economies create employment opportunities, support innovation, and encourage responsible production and consumption.

Economic growth should benefit all sections of society rather than only a few individuals or corporations. Sustainable economic policies focus on balanced development, ethical business practices, fair wages, and responsible investment.

In a globalized world, countries are interconnected economically, socially, and environmentally. Therefore, sustainability is a shared global responsibility. No country can solve global problems alone. International cooperation and collective action are necessary for creating long-term sustainable development.

Innovation and Its Importance

Innovation is one of the strongest forces behind sustainable development. Innovation means introducing new ideas, technologies, systems, or methods that improve efficiency and solve problems effectively. In the modern world, innovation is necessary for economic growth, environmental protection, and social progress.

Technological innovation has transformed many sectors such as healthcare, education, agriculture, communication, and transportation. Renewable energy technologies like solar panels, wind turbines, and hydroelectric systems help reduce pollution and dependence on fossil fuels. Electric vehicles and smart transportation systems reduce carbon emissions and improve energy efficiency.

Digital technology also plays a major role in sustainability. Artificial intelligence, data analysis, cloud computing, and smart systems improve planning, management, and decision-making. Smart cities use digital systems to manage traffic, water supply, waste management, and electricity efficiently.

Innovation in agriculture helps increase food production while protecting the environment. Drip irrigation, organic farming, precision agriculture, and climate-smart farming methods improve productivity and conserve natural resources.

Social innovation is equally important. Community development programs, awareness campaigns, online education, and inclusive policies help improve social welfare. Small community-based initiatives often create significant positive impact.

Innovation also encourages entrepreneurship and employment. Green businesses, eco-friendly industries, and digital startups create new economic opportunities. Sustainable innovation supports long-term growth while reducing environmental harm.

However, innovation should be ethical and responsible. Technology should not increase inequality or environmental damage. Sustainable innovation must focus on human welfare, environmental balance, and inclusive growth.

Interdisciplinary Approach

An interdisciplinary approach means combining knowledge from different subjects and disciplines to solve complex problems. Modern global challenges cannot be solved through one field alone because they involve multiple social, economic, environmental, and technological factors.

For example, climate change is not only an environmental issue. It also affects economics, agriculture, public health, politics, migration, and international relations. Therefore, solving climate-related problems requires cooperation among scientists, economists, policymakers, educators, and communities.

Similarly, public health crises such as pandemics require medical science, technology, communication systems, governance, and social awareness to work together effectively.

Interdisciplinary education encourages creativity, critical thinking, and practical problem-solving. Students and researchers gain broader understanding when they connect knowledge from different subjects.

In sustainable development, interdisciplinary cooperation improves policy-making and innovation. Governments, universities, industries, NGOs, and communities can develop better solutions when they collaborate.

Educational institutions play an important role in promoting interdisciplinary learning. Research programs, seminars, workshops, and collaborative projects help create awareness and practical understanding of sustainability.

An interdisciplinary approach also strengthens global cooperation because countries share knowledge, technology, and experiences to solve common problems.

From Ideas to Action

Ideas alone cannot create change unless they are implemented effectively. Practical action is the most important element of sustainable development. Many plans and policies fail because they remain theoretical and are not applied properly.

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The concept of "Ideas in Action" emphasizes implementation, participation, and responsibility. Real development happens when individuals, communities, institutions, businesses, and governments work together actively.

Individuals can contribute through small but meaningful actions such as reducing waste, conserving water, planting trees, using public transport, and saving electricity. Public awareness and responsible lifestyles create positive environmental impact.

Educational institutions can promote sustainability through research, awareness programs, environmental education, and skill development. Schools and colleges help students understand social responsibility and environmental ethics.

Businesses can adopt sustainable practices by reducing pollution, improving working conditions, using renewable energy, and following ethical management systems. Sustainable business models benefit both society and the economy.

Governments play a major role in creating strong policies and legal frameworks. Effective laws related to environmental protection, renewable energy, waste management, education, healthcare, and social welfare are necessary for sustainable progress.

Non-governmental organizations and community groups also contribute by creating awareness and supporting local development programs.

Collective action is essential because sustainability is a shared responsibility. When all sectors cooperate, even small efforts can create large and lasting change.

Role of Technology

Technology has become an important tool for sustainable development. Modern societies depend heavily on technological systems for communication, transportation, healthcare, education, and economic activities.

Technology improves efficiency and helps reduce waste and environmental damage. Renewable energy systems such as solar and wind power reduce carbon emissions and support clean energy production.

Artificial intelligence and big data systems improve planning and decision-making. Smart technologies help monitor environmental conditions, manage water resources, improve agriculture, and reduce energy consumption.

Digital education platforms increase access to learning opportunities. Online communication systems connect people globally and support knowledge sharing.

Healthcare technology improves disease prevention, diagnosis, and treatment. Telemedicine and digital healthcare systems help provide medical services in remote areas.

Technology also supports disaster management and climate monitoring. Early warning systems help reduce the impact of floods, earthquakes, cyclones, and other natural disasters.

However, technology should be used responsibly. Excessive dependence on technology may create problems such as privacy risks, unemployment, and electronic waste. Ethical use of technology is necessary to ensure balanced and inclusive development.

Corporate Responsibility

Corporate responsibility refers to the ethical and sustainable behavior of businesses and industries. Modern companies are expected not only to earn profit but also to contribute positively to society and the environment.

Corporate social responsibility includes environmental protection, employee welfare, ethical governance, community development, and fair business practices.

Industries can reduce pollution by using clean technologies and renewable energy. Recycling systems, waste management practices, and sustainable production methods help protect the environment.

Businesses should also provide fair wages, safe working conditions, and equal opportunities for employees. Ethical management improves productivity, employee satisfaction, and public trust.

Many companies now invest in sustainability programs, education projects, healthcare initiatives, and community welfare activities. Sustainable branding also improves corporate reputation and customer loyalty.

Consumers are increasingly supporting environmentally responsible products and services. Therefore, sustainability has become both an ethical and economic necessity for businesses.

Gender Empowerment and Inclusion

Gender equality and social inclusion are important parts of sustainable development. Equal opportunities help create balanced social and economic growth.

Women contribute significantly to families, communities, education, healthcare, agriculture, and economic activities. However, many women still face discrimination, unequal wages, lack of education, and limited participation in decision-making.

Empowering women improves social welfare, economic productivity, and national development. Educated women contribute to better healthcare, child education, and family well-being.

Inclusive development also focuses on marginalized groups, rural communities, differently-abled individuals, and economically weaker sections. Equal access to education, healthcare, employment, and technology is necessary for social justice.

Governments and institutions should create policies that support gender equality and inclusion. Awareness programs and legal protection also help reduce discrimination and inequality.

A truly sustainable society is one where every individual has equal rights, dignity, and opportunities.

10. Global Cooperation

Global problems require global solutions. Climate change, pandemics, economic instability, terrorism, and environmental degradation affect all countries directly or indirectly.

International cooperation helps countries share knowledge, technology, resources, and strategies. Organizations such as the United Nations, World Bank, IMF, WHO, and UNESCO play important roles in global development.

Global agreements related to climate action, trade, education, health, and human rights encourage collective responsibility and cooperation.

Developed countries can support developing nations through financial assistance, technology transfer, and capacity-building programs. International partnerships strengthen sustainable development efforts.

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Cultural exchange and international education also improve understanding and cooperation among nations.

Peace, stability, and cooperation are necessary for long-term global sustainability.

Challenges

Although sustainable development offers many benefits, several challenges make implementation difficult.

One major challenge is lack of awareness. Many people do not fully understand environmental problems and sustainable practices. Public education and awareness programs are therefore necessary.

Limited financial resources and weak infrastructure create difficulties, especially in developing countries. Poor healthcare systems, unemployment, and lack of technology slow down progress.

Resistance to change is another challenge. Some industries and individuals oppose sustainable policies because they fear economic loss or inconvenience.

Climate change and environmental degradation continue to increase despite global discussions and agreements. Rapid population growth and urbanization also create pressure on resources.

Political instability, corruption, and weak governance reduce the effectiveness of development programs.

Digital inequality is another important issue. While technology creates opportunities, many communities still lack internet access and digital literacy.

These challenges require strong leadership, policy support, public participation, and long-term commitment.

Opportunities

Despite challenges, sustainable development creates many opportunities for growth and innovation.

Green energy industries create employment and reduce environmental pollution. Solar energy, wind power, electric vehicles, and eco-friendly products are expanding rapidly.

Digital transformation creates opportunities in education, healthcare, communication, and business. Online learning and digital services improve access and efficiency.

Sustainable agriculture improves food security and environmental protection. Organic farming and climate-smart agriculture support long-term productivity.

Research and innovation open new possibilities for solving global problems. Investment in science, technology, and education strengthens national development.

Young people also play an important role in sustainability movements. Youth participation, creativity, and entrepreneurship help drive positive change.

Global awareness about environmental protection is increasing. Consumers are supporting sustainable products and ethical businesses more than before.

Therefore, sustainability is not only a challenge but also an opportunity to create a healthier, fairer, and more innovative world.

Conclusion

Sustainable development is one of the greatest responsibilities of the modern world. Economic growth alone cannot ensure human progress unless it is balanced with environmental protection and social welfare.

The idea of "Ideas in Action" highlights the importance of practical implementation. Real change happens when knowledge, innovation, and responsibility are transformed into meaningful action. Governments, industries, educational institutions, communities, and individuals must work together to achieve sustainability.

Innovation and technology provide powerful tools for solving global challenges. Renewable energy, digital systems, sustainable agriculture, and smart governance improve efficiency and reduce environmental harm. However, technology must be used ethically and responsibly.

An interdisciplinary approach is necessary because modern problems are interconnected. Cooperation among different fields and sectors creates more effective and practical solutions.

Gender equality, social inclusion, corporate responsibility, education, and global cooperation are essential elements of sustainable development. A sustainable society is one that provides equal opportunities, protects human dignity, and respects nature.

Although challenges such as climate change, inequality, lack of awareness, and limited resources continue to exist, there are also many opportunities for innovation and growth. Green industries, digital transformation, sustainable business models, and research initiatives can create a better future.

The future of humanity depends on present actions. Sustainable development requires commitment, creativity, and collective responsibility. By turning ideas into action and combining innovation with ethical values, societies can build a more peaceful, inclusive, and sustainable world for future generations.

Acknowledgment

The author(s) express their sincere gratitude to the scholars, researchers, innovators, educators, policymakers, environmentalists, and development practitioners whose dedication to advancing sustainable solutions has inspired and informed this work. Their contributions across diverse fields have demonstrated the power of ideas, innovation, and collective action in addressing the complex challenges facing our world.

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Original Article

Role of Parliament in National Development

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Abstract

In a democracy, the Parliament is the highest legislative body and is crucial to the growth of the country. The President, the Lok Sabha, and the Rajya Sabha make up India's Parliament, which works together to enact laws, oversee government, and defend democratic principles. Economic growth, social justice, political stability, technological advancement, environmental sustainability, and institutional strengthening are all aspects of the multifaceted concept of national development. By enacting laws, managing finances, formulating policies, establishing accountability systems, and representing the interests of the public, Parliament contributes to these aspects. Through welfare-oriented policies, it guarantees administrative transparency, distributes national resources, and fosters inclusive development. In addition to strengthening national unity, parliament offers a forum for amicable discussion and the settlement of disputes. Although it plays an important role, issues like political divisions, interruptions during sessions, and insufficient examination of legislation hinder its efficiency. This paper explores Parliament's contribution to national development, evaluates its key functions, highlights obstacles, and proposes strategies to enhance parliamentary democracy in India.

Keywords: *Parliament, National Development, Democracy, Governance, Legislation, Accountability, India.*

Introduction

Parliament plays a crucial role in the democratic framework of India, acting as the highest authority for law-making. It embodies the will of the people, providing a channel for public concerns and aspirations to be shaped into meaningful policies and laws. The Indian Parliament is made up of two Houses: the Lok Sabha and the Rajya Sabha, along with the President of India. Its responsibilities encompass legislative, financial, deliberative, and oversight functions that are vital for the nation's operations. When we talk about national development, it goes beyond just economic growth. It also embraces social welfare, political stability, equal opportunities, technological advancements, environmental stewardship, and the enhancement of citizens' quality of life. Through its role in crafting laws, approving budgets, holding the executive accountable, and upholding constitutional principles, Parliament plays an integral part in advancing all these aspects.

Development in contemporary democracies necessitates robust institutions that can strike a balance between the interests of the people and the power of the state. Parliament serves as a conduit between the people and the government and lends legitimacy to its actions. It guarantees that development policies take into account the needs of various segments of society and permits public participation through elected representatives. As a result, Parliament serves as both a legislative body and a catalyst for long-term development and national transformation.

Objectives of the Study

1. To examine the role of Parliament in national development.
2. To analyse the legislative functions of Parliament in promoting economic and social progress.
3. To study the role of Parliament in ensuring accountability and good governance.
4. To identify the challenges affecting the effective functioning of Parliament.
5. To suggest measures for strengthening parliamentary performance in national development.

Role of Parliament in National Development

1. The Development Legislative Framework

The legal framework required for development is established by Parliament. It passes laws pertaining to public health, education, banking, labour welfare, trade, taxes, and industrial regulation. Legal certainty promotes investment, safeguards rights, and creates social order. Development lacks stability and direction in the absence of a robust legal framework.

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2. Direction of Policy and Economic Planning

By discussing and endorsing economic policies and reforms, parliament has an impact on economic growth. Infrastructure, employment creation, agriculture, industrial growth, and digital transformation are all covered. National development goals and economic priorities gain legitimacy when they receive parliamentary support.

3. Allocation of Resources and Financial Management

By approving the Union Budget, Parliament maintains financial control over the government. It guarantees appropriate use of public finances and permits taxation and public spending. The Public Accounts Committee and other parliamentary committees assist in auditing government spending and combating resource abuse.

4. Effective Governance and Institutional Accountability

For a country to develop, good governance is necessary. Through Question Hour, debates, motions, and committee investigations, Parliament guarantees the executive's accountability. These methods improve governance outcomes by encouraging accountability, efficiency, and transparency in administration.

5. Development through Participation and Representation

India's diverse population is represented by Parliament. Parliamentarians call attention to the problems of marginalised communities and bring up local and regional issues. This collaborative strategy encourages inclusive development and lessens regional inequities.

6. Social Change and Fairness

By passing legislation prohibiting social injustice, inequality, and discrimination, Parliament serves as a tool for social transformation. It is in favour of social security, healthcare, education, gender equality, and the protection of marginalised groups. Such actions support development that is equitable.

7. Evolution of Constitutions and Institutions

The Constitution may be changed by Parliament to reflect evolving national needs. By strengthening democratic institutions, local self-government, and administrative systems, constitutional modifications guarantee the continued relevance and efficacy of governance.

8. Political stability and national integration

Peace, harmony, and political stability are necessary for development. A democratic forum for debate and dispute resolution is offered by parliament. Harmony and national integration are strengthened when diverse areas, languages, faiths, and people are represented.

Challenges Affecting the Parliamentary Role

Despite its importance, Parliament faces several challenges that reduce its effectiveness in promoting development:

1. **Regular interruptions and adjournments that impact output:**
   Parliament's time for substantive debates and legislative activity is diminished by frequent disruptions, protests, and adjournments. The institution's effectiveness and credibility are impacted when significant legislation and public concerns go unaddressed.
   Partisan strife and political polarisation:
2. **Reduced quality of talks and debates:**
   Due to a lack of preparation, personal assaults, and a diminished emphasis on policy research, the calibre of legislative discussions has decreased. Discussions may sometimes fall short of offering practical answers to intricate national issues.
3. **Minimal review of legislation prior to passage:**
   Many measures are enacted without sufficient discussion in both Houses or thorough review by parliamentary committees. Inadequate review could result in poorly written legislation and future difficulties with execution.
4. **Making politics and moral issues illegal:**
   Concerns regarding ethics, transparency, and public confidence are raised by the growing number of people with criminal histories entering politics. Effective governance is impacted by corruption and immoral behaviour, which erodes democratic norms.
5. **Insufficient involvement of committee members:**
   Parliamentary committees are crucial for thoroughly analysing laws, budgets, and policies. However, the efficacy of committee suggestions is diminished by members' inconsistent attendance and low involvement.
6. **Insufficient discussion of technical and financial matters**
   Complex topics like artificial intelligence, digital technology, climate change, and economic reforms are all part of modern governance. The quality of legislative discussions on these important issues is occasionally limited by a lack of specialised knowledge and research support.

These difficulties impair parliamentary effectiveness and have an impact on democratic governance.

Findings of the Study

1. By enacting laws, managing finances, and overseeing policies, parliament is essential to the progress of the country.
2. Transparency and administrative effectiveness are enhanced by parliamentary accountability systems.
3. Inclusion and participation in development are encouraged by the representation of many social groups.
4. The parliament has a major role in welfare-oriented government and social justice.
5. Effective parliamentary action is becoming more and more necessary for sustainable growth and technological innovation.
6. Parliamentary performance is adversely affected by political upheavals and a lack of legislative monitoring.
7. Improving the quality of debates and legislative committees can improve developmental results.

Suggestions

1. Parliamentary sessions ought to run more smoothly with fewer interruptions.
2. More time should be set aside for in-depth bill analysis and discussion.
3. Expert help and research support should be provided to enhance parliamentary committees.
4. Members of Parliament should be held to higher ethical standards and be more accountable.
5. MPs should participate in capacity-building programs on environmental, technological, and economic challenges.
6. Transparency and consultations should promote public

involvement in the legislative process.
7. Parliamentary research, debates, and public communication should all make good use of digital technologies.
8. Instead of engaging in combative politics, political parties ought to encourage productive discourse.

Conclusion

The cornerstone of democratic government and a key engine of national progress is the parliament. It carries out budgetary, legislative, deliberative, and supervisory tasks that affect all facets of development in India. Parliament promotes social justice, political stability, economic growth, and sustainable progress through legislation, policy direction, accountability, and representation.

Achieving inclusive and sustainable national development requires a robust and accountable Parliament. However, its efficacy is seriously threatened by escalating political disputes, disturbances, and deteriorating discussion quality. The function of Parliament in nation-building can be strengthened by enhancing ethical standards, guaranteeing meaningful participation, and strengthening parliamentary procedures. Therefore, the development and stability of a democratic country like India continue to depend on an active, open, and responsible Parliament.

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Original Article

Role of Banks in the Development of a small-scale Industry

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Abstract:

The small-scale sector has a high potential for employment, dispersal of industries, promoting entrepreneurship and earning foreign exchange to the country. Small scale industries play an important role in the industrialization of India. They provide immediate large-scale employment and have a comparatively higher labour capital ratio. They also stimulate the growth of industrial entrepreneurship in the country to enable small scale enterprises to succeed and excel, it is necessary to provide them with the basic tools and techniques of modern management with timely credit and other technical services. In the present study an attempt is made to narrate about financial assistance by commercial banks and Government Policies, schemes and subsidies to promote small and medium enterprises in the country.

Keywords: *MSMES, Financial Assistance, Policies, Schemes, Subsidies.*

Introduction:

Small scale sector occupies an important position in the industrial structure of our country. In a country like India, where is on one hand there is the acute problem of unemployment and on the other hand scarcity of capital. It is only the small sector which is best suited under these conditions. Indian economy is characterized by huge size of population, availability of wide variety of abundant natural resources, ever growing size of market and shortage of capital. Development of agricultural sector is important but more emphasis should be placed on the development of industrial sector as it is only this sector which can help in solving numerous problems confronting our economy. Over the year small scale sector has acquired greater importance in Indian economy. In terms of employment generation this sector is next only to agriculture and accounts for about 35 percent of the total exports of the country. In terms of value added it contributes to about 40 percent of the manufacturing sector and 80 percent of Industrial production is from this sector.

The role of small-scale industries is one of the important features of the planned economic development of India. In India this sector has been assigned with the significant role in the industrialization and economic development of the country, as an effective tool in subserving the national objective of growth with Justice. Its crucial role has been increasingly recognized as a solution for the company's problems of scare capital, wide spread of unemployment, regional imbalance of industrial development in equitable distribution of National Income etc. Hence there is a need of Government support measures for the development of a small-scale industry.

Objectives:

The following were the objectives of the study

- To discuss concept of small-scale industry.
- To analyze financial assistance by Banks to small and medium enterprises.
- To examine Government policies and support measures to small enterprises.

Methodology:

The present study is based on secondary data. The data were collected from Books, Journals and Website.

Concept of Small-Scale Industry:

The definition of small enterprises varies from one country to another. In most of the countries of the world, the criterion for defining a small enterprise is related to the size of employment. The small-scale industrial sector (SSI) is a vital constituent of the total industrial sector.

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The small-scale Industrial Sector is playing very important role in Indian economy in terms of employment generation, the strong entrepreneurial talent, its share of production growth.On July 2020, small and medium enterprises are reclassified and defined the meaning of micro small and medium enterprises based on the Investment in plant and machinery & Annual turnover which is shown in the following table 1.1

Table 1.1 meaning of MSMES

Type of enterprise	Investment in plant & Machinery	Annual Turnover
Micro	Not more than Rs. 1 Crore	Not more than Rs. 5 Crore
Small	Not more than Rs 10 Crore	Not more than Rs 50 Crore
Medium	Not more than Rs 50 Crore	Not more than Rs 250 Crore

Financial Assistance to small and medium enterprises.

Finance holds the key to all business activities. It is the life blood of Business in any productive sphare and works as the guide for regulating investment decisions and expenditure. Financial assistance to small and medium enterprises by commercial banks are shown in the following Table 1.2

Table 1.2 Financial Assistance to Small and Medium Enterprises

SL.No.	Year	Credit to Small and Medium Enterprises (Rs. Crores)
1.	2020	142000
2.	2021	150000
3.	2022	160000
4.	2023	167000
5.	2024	174000

The above table 1.2 shows that Financial Credit by Commercial Banks to SMES increased from 142000 crores in 2020 to 174000 crores in 2024. It indicates that commercial Banks are regularly providing financial assistance to SMES.

Loan Distribution to small and medium enterprises. :

Loans are distributed to small and medium enterprises by public sector Banks, Private sector Banks and Foreign Banks. The following Table 1.3 shows that share of public sector Banks, private sector banks and foreign banks in the loan distribution to SMES.

Table 1.3 Loan Distribution to small and medium enterprises.

SL.No.	Type of Bank	Share in small & medium enterprises lending
1.	Public Sector Banks	60%
2.	Private Sector Banks	35%
3.	Foreign Banks	05%

The above table 1.3 shows that Public Sector Banks distribute 60% Private Sector Banks 35% and Foreign Banks 05% Loans to small and medium enterprises. From the above table it is clear that public sector Banks distributed maximum loan to the small and medium Enterprises.

Government Policies and support measures to small and medium enterprises.

To develop MSMES the following policies were implemented: -

- Introduction of the Credit Guarantee scheme in 1999.
- Implementation of the Micro, Small and Medium enterprises Development Act in 2006.
- Launch of schemes like Pradhan Mantri Mudra Yojana and Standup India in 2015.
- Revised micro small and medium enterprises meaning definitions as a part of the Atmanirbhar Bharat Package.

Support Measures:

To support micro, small and medium enterprises the following schemes and subsidies were introduced and implemented.

- Introduction of Credit Guarantee Fund Trust for micro and small enterprises.
- Prime Ministers Employment Generation Programme.
- Introduction of Credit linked Capital subsidy scheme.
- Implementation of micro and small Enterprises cluster Development Programme.
- Introduction of other schemes viz a) Standup India,

b) Trade Receivables to ensure liquidity for MSME
c) Micro units Development and Refinance Agency,
d) Interest Subvention scheme.

Conclusion:

Small scale industries play a very important role in the economic development of our country. The small scale sector covers number of industries classified under medium, small, tiny, ancillary, village and cottage industries etc. The socio-economic development of India depends upon the development of small scale industries. This sector is contributing a lot towards generation of employment, increasing overall production and exports. The private sector Banks contributing 60% Private Sector Banks 35% and Foreign Banks 05% for the development of small and medium enterprises. Government of India introduced and implemented various policies, schemes and subsidies to promote MSME Sector in the country.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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Original Article

Diversity 0f Mammals from Malshiras of Solapur District, M.S., India.

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Abstract:

Forest plays important role in enhancing the surrounding environment quality. A specific checklist is an important resource for biodiversity documentation. This checklist provides an updated list mammalian species from Malshiras of Solapur district. This study was carried out as part of understanding the diversity in Malshiras of Solapur district, Maharashtra, India from 2022 to 2023. As per study, 13 species belong to 7 families and 3 orders were recorded in Malshiras. Out of 13 one species from big cat family and one is scavenger of nature. Selected field area having plain grassland as well as hilly areas. There is wide range of diversity, Blackbuck from open grassland to Chinkara from hilly areas with moderate vegetation.

Key Words: *Malshiras, Solapur, mammals, diversity, checklist, big cat, scavengers, vulnerable, near threatened.*

Introduction:

A checklist of species is an invaluable tool for both researchers and the interested public (Wilson and Reeder, 2005). Forest and animals depend on each other to survive. Living species have their own space and role in maintaining the ecological balance. Nature, being a dynamic entity never remains the same; it keeps changing, adjusting, evolving in a balanced and harmonious manner that means evolution. Nature, in fact, promotes evolution and diversity (Wilson and Reeder, 2005; Subramanyam, 2017). Class mammalia is regarded highest as a group from the evolutionary point of view among the animal kingdom. Mammals encompass not only the largest terrestrial species like the elephant and the largest aquatic species like the Blue Whale, but also the smallest species like shrew, mice, bat etc. Class mammalia includes the most diverse group of wildlife in terms of species, forms, ecologies, physiologies, life histories and behaviours (Jones and Safi, 2011).

The forest department of Solapur district occupy 229.273 square kilometers of reserved and unclaimed forest. And this constitutes only 0.94% of the total area of the district.

Methodology:

Field site-We selected January 2023 to December 2023 for this study. Hilly area from Jalbhavi, Hilly area from Piliv and forest area from Maloli and grassland are selected from Malshiras tehsil for this study. Area of Jalbhavi and Piliv is hilly area having sparse vegetation. We also select the area of active sites of Leopard for this study.

Phaltan range are located at western boundary of Malshiras taluka. Phaltan range rising to over 700 meters. The forest having dense vegetation at some areas and some areas having stunned trees. And some areas have plain grassland.

Methodology: The field work done by direct head count method and indirect evidences like pugmarks, scat, droppings and carcass left from carnivores. For many species, direct counts are impractical, and so researchers must rely on indirect signs such as tracks and scats (Stephens et al. 2006). Walking transects looking for tracks and scat are beneficial because these surveys are simple to implement, time efficient, and sample the entire active period of target species (Edwards et al. 2000). Waterhole method also used for data collection. The field work done in the early morning between 6 AM to 10 AM. Other data collected from forest officials, local farmers, shepherds and goat herders by discussion and questionnaires with them.

Result:

Fourteen species of mammals were recorded under 3 orders and 7 families from the study area (Table no.1). These mammalian orders included carnivores (4 families and 8 species), Cetartiodactyla (2 families and 4 species) and Primates (1 family and 2 species).

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Table No.1 A list of mammals recorded in Malshiras tehsil

Family	Scientific Name	Common Name	IUCN Status
Order: Carnivora			
Canidae	*Vulpes bengalensis*	Indian Fox	LC
	Canis aureus	Golden Jackal	LC
	Canis lupus	Grey Wolf	LC
Felidae	*Felis chaus*	Jungle Cat	LC
	Panthera pardus	Leopard	VU
Viverridae	*Viverricula indica*	Small Indian Civet	LC
	Paradoxurus hermaphrodites	Asian Palm Civet	LC
Hyenidae	*Hyaena hyaena*	Stripped Hyena	NT
Order: Cetartiodactyla			
Bovidae	*Antilope cervicapra*	Blackbuck	LC
	Gazella bennettii	Chinkara	LC
	Bos gaurus	Gaur	VU
Suidae	*Sus scorfa*	Wild Boar	LC
Order: Primates			
Cercopithecidae	*Macaca radiata*	Bonnet Macaque	LC
	Semnopithecus entellus	Hanuman Langur	LC

*LC- least concerned, VU- Vulnerable, NT- Near threatened

Habitats of Mammals across Malshiras tehsil

Mammalian species from selected study area includes terrestrial species. Among the terrestrial species 2 have arboreal species- Bonnet macaque *(Macaca radiata)*, Hanuman langur *(Semnopithecus entellus)*. Carnivores are- Indian Grey Wolf, Jackals, Indian Fox and Stripped Hyena. Felids are Jungle Cat and Leopard from big cat. Leopard attacks on street dogs and on pets also been recorded. Angulates are Blackbuck and Chinkra, Chinkara is sighted at hilly are of Sulewadi, Piliv – Mhaswad road.

Plate 1: Pictures of mammalian species

Hanuman Langur

Bonnet Macaque

Chinkara

Blackbuck

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Stripped Hyena	Indian Grey Wolf	Golden Jackal	Indian Fox

Small Indian Civet	Pugmarks of Leopard	Pugmarks of Jungal Cat

Conclusion:

There is no proper research work on mammals from Malshiras tehsil of Solapur district. In this study 14 species were recorded from selected sites, 3 species from Canidae, 1 from Hyenidae, 2 from Felidae, 2 from Viverridae, 3 from Bovidae, 1 from Suidae and 2 from Cercopithecidae. 2 species are Vulnarable in IUCN status (Leopard and Gaur) and 1 species are Near Threatened in IUCN status (Stripped Hyena). 2 mammals as scavengers in nature were recorded in selected area (Stripped Hyena and Golden Jackal). Gaur is not native but sighted during migration most of the time. Due to plain grassland as well as hilly areas there is vast range of species like Blackbuck from plain grassland and Chinkara from hilly area.

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I would like to express my sincere gratitude to my teacher for giving me the opportunity to complete this project on **"Diversity of Mammals from Malshiras of Solapur District, M.S., India."** Their valuable guidance, constant encouragement, and constructive suggestions were instrumental in the successful completion of this project.

I am also thankful to my school for providing the necessary resources and a supportive learning environment. My heartfelt thanks go to my parents, friends, and classmates for their continuous support, encouragement, and cooperation throughout the preparation of this project.

Finally, I express my gratitude to the authors, researchers, books, journals, and online resources that served as valuable references for this study. Working on this project has enhanced my understanding of mammalian biodiversity, wildlife conservation, and the ecological importance of

protecting the natural habitats of mammals in the Malshiras region of Solapur District, Maharashtra.

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Conflicts of interest
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