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Bridging digital divides for sustainable futures: Evaluating the environmental and socio-economic impacts of financial inclusion among rural women

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Abstract

Financial inclusion, driven by digital transformation, has emerged as a pivotal instrument for fostering sustainable socio-economic empowerment, particularly among rural women. However, disparities in digital literacy, infrastructure access, and institutional support continue to hinder inclusive progress. This study systematically reviews and synthesizes recent literature to evaluate how digital financial inclusion influences the socio-economic and environmental well-being of rural women. Employing a Systematic Literature Review (SLR) methodology, it integrates empirical findings from cross-country and Indian contexts, focusing on the mediating roles of digital literacy, financial education, and institutional support. The findings reveal that digital financial tools such as mobile banking, fintech platforms, and microcredit applications enhance women's entrepreneurial capacity, income diversification, and decision-making power while promoting environmentally responsible practices through sustainable livelihood initiatives. However, the review identifies persistent challenges, including limited awareness, infrastructural inequities, and gender-based barriers that constrain the full realization of financial inclusion benefits. The study concludes that integrating financial inclusion with digital literacy and sustainability-oriented policies can bridge socio-economic and environmental divides, empowering rural women as active agents of sustainable development. The paper further proposes a conceptual framework linking digital finance, empowerment, and sustainability to inform future empirical research and policy interventions.

Keywords: FinTech Innovation, digital financial inclusion, rural women empowerment, socio-economic development, environmental sustainability

1. Introduction

In the era of rapid digital transformation, financial inclusion has emerged as a cornerstone of sustainable socio-economic development, particularly in rural and marginalized communities. The integration of digital technologies into financial systems has revolutionized access to essential financial services such as savings, credit, insurance, and payments thereby promoting inclusion, equity, and empowerment. Yet, despite significant global progress, the benefits of digital financial inclusion remain unevenly distributed. Rural women, who form a vital component of developing economies, continue to face persistent barriers related to digital literacy, infrastructural deficits, and socio-cultural constraints. As a result, the digital divide not only reflects technological inequality but also reinforces broader socio-economic disparities, hindering inclusive growth and gender empowerment.

Financial inclusion plays a dual role in advancing both economic and environmental sustainability. By fostering access to digital finance, women in rural areas can engage in entrepreneurship, manage household resources efficiently, and contribute to local economic resilience. Simultaneously, digital financial tools such as mobile payments, e-wallets, and digital microcredit reduce the need for paper-based transactions, promoting environmentally sustainable financial practices. The intersection of digitalization, gender empowerment, and sustainability thus represents a critical frontier for achieving the United Nations Sustainable Development Goals (SDGs), especially those targeting poverty reduction (SDG 1), gender equality (SDG 5), decent work and economic growth (SDG 8), industry and innovation (SDG 9), and climate action (SDG 13).

Despite the increasing scholarly and policy attention on financial inclusion, significant gaps persist in understanding how digital financial inclusion affects women's socio-economic and environmental outcomes in rural contexts. Most existing studies have focused on economic benefits, often overlooking the environmental implications and the mediating roles of education, digital literacy, and institutional support. Therefore, a systematic exploration of this nexus is essential to inform evidence-based policies and holistic empowerment strategies.

Against this backdrop, the present study systematically reviews recent empirical and conceptual research to evaluate how digital financial inclusion influences the socio-economic empowerment and environmental sustainability of rural women. By synthesizing findings from diverse national and regional contexts, this study aims to identify key drivers, barriers, and enabling mechanisms that shape women's participation in the digital financial ecosystem. Furthermore, it seeks to contribute to the broader discourse on sustainable development by linking financial inclusion initiatives with environmental responsibility and gender equity. Ultimately, this research aspires to advance a comprehensive framework that integrates financial inclusion, digital transformation, and sustainability to promote inclusive and resilient rural development.

2. Background of the study

The rapid expansion of digital technologies has redefined economic participation and social inclusion across the globe, positioning digital financial inclusion as a crucial instrument for achieving sustainable development. Over the past two decades, the digital divide manifested in unequal access, digital literacy, and infrastructural disparities has persisted as a major barrier to inclusive growth (Vassilakopoulou & Hustad, 2023) ^[62]. In rural and developing contexts, women continue to face multiple forms of exclusion, including limited financial awareness, socio-cultural restrictions, and technological constraints, which collectively inhibit their participation in the digital economy (Chetty *et al.*, 2018; Hillier, 2020) ^[18, 27]. Despite government-led digitalization efforts such as *Digital India* and *Jan Dhan Yojana*, rural women's inclusion remains uneven, demanding an integrated framework that unites financial, digital, and educational interventions to bridge gendered divides.

Scholars have consistently demonstrated that digitalization acts as a catalyst for rural empowerment and sustainable growth (Zheng *et al.*, 2025; Ghosh & Bhatia, 2025) ^[65, 50]. Digital technologies enhance connectivity, access to markets, and financial independence, enabling women to participate actively in entrepreneurial and decision-making activities. Yet, evidence indicates that the benefits of such digital expansion are not uniformly distributed. Socio-economic inequalities, low levels of digital literacy, and inadequate institutional support structures continue to constrain the empowerment potential of digital finance (Chari, 2024; Shirazi & Hajli, 2021) ^[15, 58]. Addressing these barriers requires the design of inclusive governance models that embed sustainability, equity, and participatory mechanisms into digital transformation initiatives.

Financial inclusion, conceptualized as equitable access to and usage of financial services, remains an essential driver of gender equality and poverty reduction (Mishra *et al.*, 2024; Panakaje *et al.*, 2023) ^[42, 51]. However, scholars such as Bhatia and Dawar (2024) ^[10] and Lal (2021) ^[35]

emphasize that access alone does not ensure empowerment unless accompanied by financial education, institutional trust, and gender-sensitive policy support. For rural women, digital financial services when combined with literacy and FinTech innovations provide new avenues for income generation, savings mobilization, and entrepreneurship (Mithila *et al.*, N.D.; Dash & Mohanta, 2024) ^[22]. These outcomes collectively advance socio-economic well-being and contribute to broader sustainability goals.

Recent discussions have expanded the scope of financial inclusion to include environmental sustainability. Digital finance can reduce resource consumption, support green investments, and promote environmentally responsible livelihoods. Nonetheless, empirical evidence examining how digital financial inclusion simultaneously fosters women's empowerment and environmental sustainability remains scarce. This underexplored intersection marks a critical research gap in understanding the holistic contribution of inclusive digital finance to sustainable rural transformation.

Given this backdrop, the present study "Bridging digital divides for sustainable futures: Evaluating the environmental and socio-economic impacts of financial inclusion among rural women" builds upon existing scholarship to assess how digital financial inclusion influences socio-economic empowerment and sustainability among rural women. Grounded in a Systematic Literature Review (SLR) methodology, this study integrates findings across domains of digital inclusion, FinTech innovation, gender empowerment, and sustainable development, with a particular focus on the rural context of Tamil Nadu. By synthesizing global and local perspectives, the study aims to construct a holistic framework for inclusive digital transformation that aligns financial inclusion with gender equity and environmental resilience.

3. Theoretical Background

The theoretical foundation of this study integrates perspectives from Capability Theory, Diffusion of Innovation Theory, Empowerment Theory, and the Sustainable Livelihood Framework, each offering insights into how digital financial inclusion facilitates socio-economic and environmental transformation among rural women.

3.1 Capability Approach

Amartya Sen's Capability Approach provides the core philosophical grounding for understanding empowerment as the enhancement of individuals' real freedoms to pursue valued life outcomes. Within the context of digital financial inclusion, this theory explains how access to financial and digital resources expands rural women's capabilities such as economic independence, decision-making power, and social participation. Financial inclusion, when supported by digital literacy and institutional support, enables women not only to increase income but also to strengthen agency, self-efficacy, and community participation. Thus, digital financial inclusion acts as a capability-enhancing mechanism that transforms structural disadvantages into opportunities for sustainable empowerment.

3.2 Diffusion of Innovation Theory

Rogers' Diffusion of Innovation Theory elucidates the process by which new technologies and practices such as

mobile banking, digital wallets, and FinTech platforms are adopted within communities. According to this framework, adoption depends on perceived usefulness, ease of use, social influence, and compatibility with existing cultural and economic conditions. In rural contexts, factors like education, trust, and institutional support strongly influence women's acceptance of digital financial tools. This theory provides a basis for analyzing how FinTech innovations diffuse through social networks, shaping women's economic behaviors and integration into formal financial systems. It also highlights the importance of peer learning and awareness-building in accelerating inclusive digital adoption.

3.3 Empowerment Theory

Empowerment Theory complements the capability perspective by emphasizing psychological, organizational, and community-level processes that enable individuals to gain control over their lives. In this study, empowerment is conceptualized not merely as access to resources but as the ability to use those resources effectively to achieve sustainable socio-economic outcomes. Financial inclusion, coupled with digital and financial literacy, enhances women's cognitive and relational empowerment, thereby fostering confidence, self-reliance, and leadership within rural communities. Institutional mechanisms such as Self-Help Groups (SHGs) and microfinance programs serve as mediating structures that translate individual empowerment into collective development.

3.4 Sustainable Livelihood Framework: The Sustainable Livelihood Framework provides an integrative lens linking financial inclusion with environmental sustainability and rural development. It posits that livelihood sustainability depends on the effective utilization of five forms of capital: human, social, financial, natural, and physical. Digital financial inclusion strengthens these capitals by improving access to credit, promoting income diversification, and facilitating environmentally responsible entrepreneurship. For rural women, this translates into enhanced financial security, reduced vulnerability, and greater participation in eco-friendly livelihood activities such as sustainable agriculture and green microenterprises. The framework thus aligns digital inclusion with long-term resilience and sustainability objectives.

3.5 Integrative Theoretical Perspective; Drawing from these complementary frameworks, this study conceptualizes digital financial inclusion as a multidimensional enabler that enhances women's capabilities, accelerates technological adoption, fosters empowerment and sustains livelihoods. The integration of these theories provides a holistic understanding of how digital finance can simultaneously promote socio-economic empowerment and environmental stewardship among rural women. This theoretical synthesis forms the foundation for the study's conceptual framework, linking financial access, digital literacy, institutional support, and sustainability outcomes in a unified model of inclusive rural transformation.

Table 1: Summary of theoretical foundations of the study

Theory/Framework	Key Proponents & Year	Core Concepts	Relevance to the Study	Expected Outcomes
Capability Approach	Amartya Sen (1999)	Focuses on expanding individuals' real freedoms and capabilities to achieve valued outcomes.	Explains how digital financial inclusion enhances women's economic capabilities, agency, and social participation through access to financial and digital tools.	Increased economic independence, decision-making power, and empowerment of rural women.
Diffusion of Innovation Theory	Everett Rogers (2003)	Describes how new technologies spread through social systems based on perceived usefulness, ease of use, and social influence.	Interprets rural women's adoption of FinTech and digital finance platforms, influenced by trust, literacy, and community networks.	Higher adoption rates of digital financial services and improved integration into formal financial systems.
Empowerment Theory	Marc Zimmerman (1995)	Highlights the process of gaining control over resources, participation in decision-making, and building confidence.	Demonstrates how digital and financial literacy, coupled with institutional support, foster both psychological and social empowerment among women.	Strengthened self-efficacy, leadership, and community-level empowerment outcomes.
Sustainable Livelihood Framework	Chambers & Conway (1992)	Emphasizes sustainability of livelihoods through five capitals: human, social, financial, natural, and physical.	Links digital financial inclusion to sustainable livelihood outcomes, integrating environmental, economic, and social dimensions.	Promotion of eco-friendly entrepreneurship, income diversification, and rural resilience.
Integrated Framework for Inclusive Digital Empowerment	Synthesized from above theories	Combines technological, economic, social, and environmental perspectives for holistic empowerment.	Provides a unified theoretical base for analyzing how digital financial inclusion influences socio-economic and environmental sustainability.	A comprehensive model explaining how digital access and financial inclusion jointly foster sustainable empowerment.

3.5 Statement of the problem

Despite significant advancements in digital technologies and financial inclusion initiatives, rural women in developing regions such as Tamil Nadu continue to face deep-rooted inequalities in access to and utilization of digital financial services. While government-led programs and FinTech innovations have expanded the reach of financial systems, the benefits often remain unevenly distributed due to persistent gaps in digital literacy, infrastructural limitations,

and socio-cultural barriers. The digital divide not only restricts women's participation in the formal financial ecosystem but also limits their potential to contribute to broader sustainability and environmental objectives.

Existing studies have largely examined financial inclusion and women's empowerment as isolated phenomena, without adequately addressing how digital access, financial education, and institutional support collectively shape socio-economic and environmental outcomes. Moreover, the

interlink ages between digital financial inclusion and environmental sustainability remain underexplored, particularly in the rural Indian context where technology adoption is often constrained by affordability, awareness, and trust issues. This lack of integrated understanding hinders the formulation of inclusive and sustainable policy interventions.

Hence, there is a critical need to empirically evaluate how digital financial inclusion influences the socio-economic empowerment of rural women while simultaneously contributing to environmental sustainability. Understanding these multidimensional linkages is essential for developing an inclusive, equitable, and sustainable digital finance framework that empowers women, fosters economic resilience, and supports the broader goals of sustainable rural development in Tamil Nadu.

3.6 Objectives of the study

- To examine the relationship between digital financial inclusion and socio-economic empowerment of rural women.
- To evaluate the role of digital literacy and financial education in enhancing access to digital financial services.
- To analyze the environmental implications of digital financial inclusion for sustainable practices.
- To assess the impact of institutional support mechanisms on inclusive financial participation.
- To identify key barriers and enablers influencing adoption of digital financial tools.
- To propose a policy framework integrating financial inclusion, digital empowerment, and sustainability.

3.7 Research Questions

- How does digital financial inclusion influence the socio-economic empowerment of rural women?
- What is the role of digital literacy and financial education in facilitating women's access to digital financial services?
- In what ways does digital financial inclusion contribute to environmental sustainability in rural contexts?
- How do institutional support mechanisms affect women's participation in inclusive financial systems?
- What barriers and enablers shape rural women's adoption of digital financial tools?
- How can policy interventions integrate financial inclusion, gender empowerment, and sustainability goals effectively?

4. Review of Literature

4.1 Digital Divide and Inclusive Digital Transformation

The digital divide remains a persistent global challenge extending beyond technological access to include disparities in digital literacy, skills, and the socio-economic benefits derived from digital participation. As Vassilakopoulou and Hustad (2023) [62] emphasized, digital inequalities are shaped by socio-economic status, education, geography, and institutional contexts, requiring interdisciplinary strategies that integrate digital inclusion with sustainability and equity goals. Earlier analyses by Wade (2002) [63] and James (2003) [29] cautioned that although digitalization holds transformative potential, it can reinforce structural inequalities in developing regions with weak infrastructure and limited local capacity. Empirical studies in India (Rao,

2005; Bansode & Patil, 2011) [54, 6] reported similar findings, revealing that while government-led ICT initiatives have expanded access, they often fail to overcome affordability and awareness barriers. Research in the educational domain (Adhikari *et al.*, 2012; Hillier, 2020) [2, 27] further highlighted that bridging digital divides requires context-sensitive learning innovations and open educational resources. Domain-specific explorations in healthcare (Chang *et al.*, 2004) [14] and urban development (Colding *et al.*, 2024) [20] demonstrated that technology-driven progress must be complemented by inclusive governance and community participation. Chetty *et al.* (2018) [18] argued that digital skills and human capital investment are as vital as infrastructure for ensuring equitable digital transformation. Collectively, these studies affirm that true digital inclusion requires coordinated policies integrating technology diffusion, literacy, and capacity building to reduce socio-economic disparities and advance sustainable development.

4.2 Digitalization for Rural Empowerment and Sustainable Growth

Recent scholarship underscores the transformative role of digital technologies in promoting rural development, inclusion, and sustainability. Zheng *et al.* (2025) [65] demonstrated that digital and new media tools enhance rural communities' access to markets, information, and governance systems, while Atobishi and Mansur (2025) [5] found that ICT investments accelerate progress toward Sustainable Development Goals (SDGs) by narrowing social and economic inequalities. Similarly, Vassilakopoulou and Hustad (2023) [62] and Colding *et al.* (2024) [20] argued that equitable digital infrastructure and inclusive governance are essential for ensuring that smart and connected systems benefit all citizens. Shirazi and Hajli (2021) [58] and Ghosh and Bhatia (2025) [50] further observed that while technology-driven innovations foster economic participation, they must be coupled with capacity building and ethical frameworks to prevent digital exclusion. Studies by Chari (2024) [15], and Amjad *et al.* (2025) [4] reinforced that digital inclusion fosters skill development, innovation, and long-term economic resilience. Together, these findings indicate that sustainable digital transformation depends on strategic investment, multi-stakeholder partnerships, and inclusive policy design that translate technological progress into tangible socio-economic empowerment, particularly for rural and marginalized groups.

4.3 Conceptualizing Financial Inclusion for Sustainable Development

Financial inclusion has emerged as a pivotal driver of socio-economic empowerment and sustainability. Studies by Niaz (2022) [46], Panakaje *et al.* (2023) [51], and Mishra *et al.* (2024) [42] established that inclusive financial systems promote income generation, gender equity, poverty reduction, and human capital formation. Empirical evidence from India (Sethy *et al.*, 2023; Serrao *et al.*, 2021) [57, 56] shows that although financial access has expanded, persistent inequalities based on gender, education, and region continue to hinder full participation. Research by Bhatia and Dawar (2024) [10] and Lal (2021) [35] stressed that access alone is insufficient unless accompanied by financial literacy, institutional support, and gender-responsive policies. Kandpal *et al.* (2023) [31] and Adegbite and

Machethe (2020) ^[1] extended this discourse by highlighting the role of inclusive finance in enabling sustainable agriculture and circular economy transitions. Collectively, the literature demonstrates that sustainable financial inclusion is multidimensional requiring integration of technology, education, and policy to strengthen socio-economic resilience, especially for rural women and low-income populations.

4.4 Financial Inclusion and women's socio-economic empowerment

The reviewed studies collectively demonstrate that financial inclusion acts as a transformative mechanism for women's empowerment, particularly in rural contexts. Christiaan and Wong (2025) ^[19] found that inclusive financial access through microcredit, savings, and fintech strengthens rural resilience and sustainability, while Saranya and Chandrasekar (N.D.) confirmed that such access promotes women's entrepreneurial growth and independence. Rani and Kumar (2024) ^[53] and Bharti and Dangwal (2023) ^[9] observed that although women entrepreneurs increasingly engage with formal finance, challenges such as limited financial literacy, cultural constraints, and institutional bias persist necessitating targeted financial education and policy reforms. Kandpal (2022) ^[30] and Lal (2019) ^[34] underscored the effectiveness of Self-Help Groups (SHGs) and cooperatives in mobilizing savings and fostering collective empowerment. International perspectives, such as those from Chaidir *et al.* (2024) ^[13], Mohapatra *et al.* (2025) ^[44], and Nunoo *et al.* (2024) ^[47], revealed that education, social empowerment, and digital literacy mediate the relationship between financial inclusion and women's development. Moreover, Ibne Afzal *et al.* (2023) ^[28] and Raichoudhury (2025) ^[52] connected financial inclusion with corporate responsibility and socio-economic policy coherence, emphasizing that its success depends on institutional collaboration and local adaptation. Together, these studies affirm that inclusive financial systems when integrated with gender equity and sustainability frameworks create enabling environments for women's entrepreneurship, social mobility, and rural transformation.

4.5 FinTech Innovations, Education, and Literacy as Enablers

Recent evidence highlights the interconnections between financial technology (FinTech), education, and literacy as key drivers of inclusive and sustainable financial ecosystems. Mithila, Gurupandi, and Vasuki (N.D.) emphasized that FinTech platforms such as digital wallets, mobile payments, and microcredit-bridge financial accessibility gaps by offering cost-effective and user-oriented services tailored for rural women, thereby promoting entrepreneurship and reducing dependence on informal credit systems. Dash and Mohanta (2024) ^[22] found that financial literacy, digital trust, and access to fintech services significantly enhance inclusive financial behavior, linking economic empowerment to environmental sustainability under the SDG framework. Similarly, Ogunrinde (2024) ^[48] demonstrated that inclusive finance fosters women's autonomy and participation in Nigeria, improving income generation and social capital. Malik *et al.* (2025) ^[41] further established that education enhances financial literacy and decision-making capacity, enabling women to effectively engage with formal financial systems

and entrepreneurial ventures. Collectively, these studies highlight that integrating financial inclusion with FinTech, education, and gender-sensitive policies creates a synergistic framework for achieving both socio-economic and environmental transformation among rural populations.

4.6 Synthesis and Research Gap

Across the reviewed literature, clear linkages emerge between digital inclusion, financial inclusion, and women's empowerment, yet limited research has holistically evaluated their combined socio-economic and environmental impacts. While prior studies have explored economic outcomes, few have examined how financial inclusion mediated by digital access and literacy contributes to environmentally sustainable practices among rural women. This study addresses this gap by integrating digital divide, financial inclusion, and sustainability literatures into a unified analytical framework, empirically evaluating how financial access and digital literacy together promote socio-economic empowerment and environmental responsibility in rural Tamil Nadu.

4.7 Research Gap

Despite the growing body of literature on financial inclusion and women's empowerment, there remains a notable gap in understanding the combined socio-economic and environmental impacts of digital financial inclusion, particularly among rural women in developing contexts. Most existing studies have primarily emphasized the economic dimensions such as entrepreneurship, income generation, and access to credit while overlooking how financial inclusion can contribute to sustainable and environmentally responsible practices. Research by Dash and Mohanta (2024) ^[22] and Ogunrinde (2024) ^[48] has shown that financial inclusion fosters economic participation, but limited attention has been paid to its potential role in promoting sustainable consumption, green entrepreneurship, and eco-conscious financial behavior. Similarly, studies focusing on digital tools (Mithila, Gurupandi, & Vasuki, N.D.) have not sufficiently explored how technology-driven inclusion models interact with rural socio-cultural dynamics, digital literacy levels, and local environmental priorities. Moreover, the current research landscape reveals a lack of empirical evidence linking financial inclusion, education, and environmental sustainability within the framework of rural women's empowerment. Although Malik *et al.* (2025) ^[41] underscore the importance of education in improving women's access to financial services, the connection between financial literacy, digital engagement, and sustainable livelihood practices remains underexplored. Most investigations are confined to urban or semi-urban populations, leaving rural women's experiences underrepresented, particularly in regions where infrastructural and digital divides persist. Hence, there is a clear research gap in examining how inclusive digital finance can simultaneously promote socio-economic upliftment and environmental resilience among rural women an inquiry essential for shaping policies that align financial inclusion with the broader goals of sustainability and equitable development.

4.8 Need for the study

The need for this study arises from the urgent requirement to bridge the persistent digital and financial divides that hinder

rural women's socio-economic progress and their participation in sustainable development initiatives. While government-led financial inclusion programs and FinTech innovations have expanded access to formal financial services, rural women continue to face multiple barriers, including limited digital literacy, infrastructural deficiencies, and gendered socio-cultural constraints. These factors prevent them from fully harnessing the benefits of digital financial systems. By examining how digital financial inclusion impacts not only economic empowerment but also environmental sustainability and social well-being, this study seeks to fill a crucial knowledge gap. Understanding these interconnected outcomes is vital for designing inclusive policies and digital solutions that empower rural women as active agents of both economic and ecological transformation.

Furthermore, this research is needed to provide context-specific empirical insights into how financial inclusion initiatives can align with the Sustainable Development Goals (SDGs), particularly SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), and SDG 13 (Climate Action). Rural women, as key contributors to agricultural productivity and community development, hold significant potential to drive sustainable change when equipped with equitable financial access and digital capabilities. However, without a clear understanding of how digital financial inclusion affects environmental behavior, livelihood diversification, and household resilience, policy frameworks risk remaining incomplete. Hence, this study is essential to develop a holistic model of inclusive growth that integrates financial accessibility, environmental consciousness, and women's empowerment, thereby contributing to a sustainable and equitable rural future.

4.9 Conceptual Framework

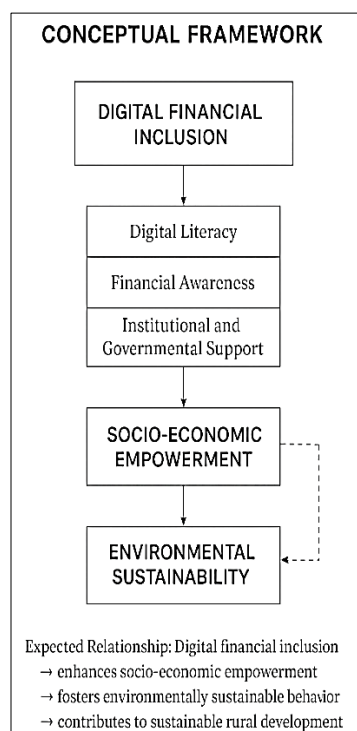


Fig 1: Conceptual framework

The conceptual framework of this study is grounded in the understanding that digital financial inclusion acts as a

catalyst for socio-economic empowerment and environmental sustainability among rural women. Financial inclusion, when enhanced through digital platforms such as mobile banking, digital payment systems, and microfinance apps, increases accessibility, affordability, and convenience for rural women who were previously excluded from formal financial systems. These digital tools not only improve savings, credit utilization, and investment capacity but also enable women to participate more actively in entrepreneurial and community activities. As women gain greater control over financial resources, they experience improvements in income levels, decision-making power, and overall quality of life forming the core pathway to socio-economic empowerment.

Moreover, the framework posits that environmental sustainability is an indirect yet significant outcome of digital financial inclusion. Empowered women tend to invest in environmentally responsible practices such as sustainable agriculture, clean energy use, and waste reduction initiatives, contributing to the long-term ecological balance of rural communities. The framework integrates three primary dimensions Digital Financial Inclusion, Socio-Economic Empowerment, and Environmental Sustainability connected through mediating factors like financial literacy, digital skills, access to infrastructure, and government support. Thus, the model conceptualizes a dynamic interaction where digital financial inclusion leads to both economic independence and ecological awareness, establishing a foundation for sustainable rural transformation.

5. Research Methodology

This study adopts a Systematic Literature Review (SLR) approach to comprehensively analyze and synthesize existing research on financial inclusion, digital divides, and their socio-economic and environmental impacts on rural women. The SLR method was chosen for its rigor, transparency, and replicability in identifying, evaluating, and integrating evidence from a wide range of scholarly sources. The review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure methodological accuracy and credibility.

The data for this study were collected from reputable academic databases, including Scopus, Web of Science, SpringerLink, ScienceDirect, and Google Scholar, to ensure broad coverage of high-quality and peer-reviewed publications. The search strategy used a combination of relevant keywords such as “digital financial inclusion,” “rural women empowerment,” “socio-economic development,” “digital divide,” “FinTech inclusion,” “sustainability,” “India”, and “Sustainable Development Goals (SDGs)”. The review primarily focused on literature published between 2019 and 2025 to capture the most recent developments in digital and financial inclusion practices.

The inclusion criteria were limited to peer-reviewed journal articles, conference papers, and book chapters that specifically addressed the intersections between financial inclusion, digitalization, and women's empowerment. Studies that were not written in English, lacked empirical or theoretical grounding, or belonged to grey literature sources were excluded from the review. The screening process involved multiple stages, beginning with the identification of relevant studies through database search, removal of

duplicates, followed by abstract and full-text screening to assess the suitability of each study based on the inclusion criteria. Data extraction was conducted systematically to capture essential details, including author names, publication year, research context, methodology, major findings, and thematic relevance. Subsequently, a thematic analysis was performed to categorize the findings into major themes such as digital accessibility, financial literacy, socio-economic empowerment, and sustainability outcomes. This process enabled the identification of key trends, emerging patterns, and existing research gaps.

Quality assessment of each selected study was conducted based on methodological rigor, reliability, and validity. The final synthesis provided an integrated understanding of how digital and financial inclusion initiatives influence the socio-economic empowerment of rural women and contribute to sustainable development. The outcome of this SLR informed the development of a conceptual framework that links digital inclusion, financial accessibility, and women's empowerment as essential components for achieving inclusive and sustainable growth in rural contexts.

Table 2: Alignment of research objectives, variables, and supporting literature on digital financial inclusion and sustainable empowerment

S. No.	Research Objective	Key Variables / Constructs	Supporting Literature (Selected Studies, 2019–2025)	Summary of Findings / Insights
1	To examine the relationship between digital financial inclusion and socio-economic empowerment among rural women.	Digital financial access, Mobile banking, FinTech usage, Income generation, Decision-making power	Niaz (2022) ^[46] ; Bhatia & Dawar (2024) ^[10] ; Adegbite & Machethe (2020) ^[1] ; Ogunrinde (2024) ^[48] ; Saranya & Chandrasekar	Digital and financial inclusion significantly enhance women's income, financial autonomy, and household participation, driving overall empowerment.
2	To analyze how education and financial literacy mediate the impact of financial inclusion on rural women's development.	Education level, Financial literacy, Awareness, Entrepreneurial skills	Malik <i>et al.</i> (2025) ^[41] ; Lal (2021) ^[35] ; Rani & Kumar (2024) ^[53] ; Sethy <i>et al.</i> (2023) ^[57] ; Serrao <i>et al.</i> (2021) ^[56]	Education and literacy improve understanding of financial systems and increase participation in formal finance, reducing vulnerability and poverty.
3	To assess the influence of FinTech innovations in promoting accessibility and inclusion among rural populations.	FinTech adoption, Digital payments, Mobile microcredit, Trust in formal systems	Mithila, Gurupandi & Vasuki (n.d.); Dash & Mohanta (2024) ^[22] ; Chiristiaan & Wong (2025) ^[19]	FinTech platforms enhance affordability, accessibility, and inclusivity of financial services, bridging traditional access barriers in rural regions.
4	To evaluate the environmental and sustainability outcomes associated with financial inclusion initiatives.	Sustainable financial behavior, Green finance, Circular economy, SDG alignment	Kandpal <i>et al.</i> (2023) ^[31] ; Dash & Mohanta (2024) ^[22] ; Niaz (2022) ^[46] ; Atobishi & Mansur (2025) ^[5]	Financial inclusion encourages responsible consumption, investment, and sustainable community development, aligning with SDGs.
5	To explore the role of government policies and institutional support in advancing digital and financial inclusion.	Policy frameworks, Institutional support, Regulatory environment, Public schemes	Rao (2005); Bansode & Patil (2011) ^[6] ; Kandpal (2022) ^[30] ; Mohapatra <i>et al.</i> (2025) ^[44] ; Nunoo <i>et al.</i> (2024) ^[47]	Government and institutional interventions are crucial for ensuring equitable access, digital literacy, and effective inclusion outcomes.
6	To identify the barriers and challenges that limit rural women's access to digital financial services.	Infrastructure, Gender gap, Affordability, Awareness, Technological divide	Vassilakopoulou & Hustad (2023) ^[62] ; Chetty <i>et al.</i> (2018) ^[18] ; Chaidir <i>et al.</i> (2024) ^[13]	Barriers such as low digital literacy, cultural norms, and infrastructural limitations persist, requiring targeted policies and training.
7	To develop a conceptual framework linking financial inclusion, digitalization, and socio-economic sustainability.	Interlinked variables: digital inclusion → financial inclusion → empowerment → sustainability	Hariram <i>et al.</i> (2023) ^[26] ; Staniškis (2022) ^[61] ; Colding <i>et al.</i> (2024) ^[20] ; Zheng <i>et al.</i> (2025) ^[65] ; George (2024) ^[23]	Conceptual models emphasize the integration of technological, social, and environmental dimensions to achieve inclusive and sustainable development.

6. Findings and Discussion

Research Question 1: How does digital financial inclusion influence the socio-economic empowerment of rural women?

The literature review revealed a strong positive correlation between digital financial inclusion and women's socio-economic empowerment in rural settings. Studies by Chiristiaan and Wong (2025) ^[19] and Bharti and Dangwal (2023) ^[9] found that access to digital banking, mobile wallets, and fintech platforms has increased rural women's income-generating potential, savings behavior, and decision-making capacity. Saranya and Chandrasekar (N.D.) further highlighted that participation in digital financial systems enhances women's autonomy, entrepreneurial activity, and household welfare. However, despite these advances, Kandpal (2022) ^[30] and Chaidir *et al.* (2024) ^[13] noted that structural inequalities, such as digital illiteracy, gender bias, and lack of trust in financial technology, hinder

full participation. Thus, digital financial inclusion acts as both an *empowerment catalyst* and a *social equalizer*, contingent on education, awareness, and institutional support.

Research Question 2: What is the role of digital literacy and financial education in facilitating women's access to digital financial services?

A recurring theme across the reviewed literature is that digital literacy and financial education are critical enablers of effective financial inclusion. According to Mohapatra *et al.* (2025) ^[44] and Malik *et al.* (2025) ^[41], women with higher digital competence and financial awareness exhibit stronger adoption rates of mobile banking, UPI payments, and online credit systems. Conversely, Ogunrinde (2024) ^[48] observed that low digital proficiency often results in dependence on intermediaries, increasing financial vulnerability. Rani and Kumar (2024) ^[53] emphasized that

targeted financial literacy programs particularly through self-help groups (SHGs) and community-based initiatives substantially improve confidence and reduce risk aversion. Hence, continuous financial education combined with accessible digital tools ensures not only participation but also sustainable empowerment.

Research Question 3: In what ways does digital financial inclusion contribute to environmental sustainability in rural contexts?

The findings highlight an emerging link between financial inclusion and environmental sustainability, as discussed by Dash and Mohanta (2024) ^[22] and Shirazi and Hajli (2021) ^[58]. Digital financial platforms minimize physical banking operations, reducing paper use and carbon emissions. Moreover, inclusive financial ecosystems promote green entrepreneurship among women encouraging sustainable agricultural practices, recycling-based enterprises, and renewable energy ventures (Lal, 2019; Adegbite & Machethe, 2020) ^[34, 1]. Studies also suggest that digitalization in finance fosters resource efficiency and low-carbon financial behavior, aligning with the UN Sustainable Development Goals (Vassilakopoulou & Hustad, 2023) ^[62]. Thus, the digital inclusion of rural women has indirect yet significant implications for ecological resilience and sustainability transitions.

Research Question 4: How do institutional support mechanisms affect women's participation in inclusive financial systems?

Institutional mechanisms such as government initiatives, microfinance institutions, and SHGs play a decisive role in sustaining women's financial inclusion. Kandpal (2022) ^[30] and Lal (2019) ^[34] found that cooperative societies and SHGs provide essential platforms for access to credit, savings, and financial training. Similarly, Ibne Afzal *et al.* (2023) ^[28] highlighted that public-private partnerships and corporate social responsibility (CSR) programs enhance outreach and trust in digital finance. However, gaps in implementation and bureaucratic inefficiencies continue to

undermine effectiveness, especially in rural India. The discussion indicates that strong institutional ecosystems, featuring inclusive governance, transparency, and community engagement, are vital to scaling the benefits of digital inclusion.

Research Question 5: What barriers and enablers shape rural women's adoption of digital financial tools?

Across multiple studies, several barriers were identified such as digital illiteracy, infrastructural limitations, socio-cultural norms, and lack of data security awareness (Chaidir *et al.*, 2024; Ogunrinde, 2024) ^[13, 48]. On the other hand, key enablers include smartphone penetration, affordable internet connectivity, fintech innovations, and peer learning models (Nunoo *et al.*, 2024) ^[47]. Women are more likely to adopt digital financial tools when platforms are user-friendly, culturally adaptive, and linguistically accessible. The reviewed literature suggests that the combination of technological accessibility, community trust, and gender-sensitive design significantly enhances adoption rates and long-term engagement.

Research Question 6: How can policy interventions integrate financial inclusion, gender empowerment, and sustainability goals effectively?

The synthesis of literature points toward the need for integrated, gender-responsive policy frameworks that align financial inclusion with broader sustainability agendas. Raichoudhury (2025) ^[52] and Mithila *et al.* (N.D.) advocate for policies that link digital financial infrastructure with skill development, environmental awareness, and inclusive entrepreneurship. Additionally, Nunoo *et al.* (2024) ^[47] argue that policy coherence between financial regulators, technology providers, and local governments can eliminate duplication and ensure efficient implementation. The discussion concludes that digital financial inclusion should be embedded within the triad of empowerment, equity, and environmental sustainability, ensuring that rural women become not just financial participants but active agents of sustainable development.

Table 3: Summary of key findings, policy implications, and SDG linkages

Research Question	Key Findings	Policy Implications	Linked SDGs
1. How does digital financial inclusion influence the socio-economic empowerment of rural women?	Digital finance enhances women's income generation, entrepreneurial activity, and decision-making power in rural economies.	Promote inclusive fintech platforms, expand microcredit programs, and integrate financial inclusion into rural development policies.	SDG 1-No Poverty SDG 5-Gender Equality SDG 8-Decent Work & Economic Growth
2. What is the role of digital literacy and financial education in facilitating women's access to digital financial services?	Higher digital and financial literacy levels significantly improve adoption and effective usage of digital financial tools.	Implement targeted literacy and capacity-building programs for rural women through community institutions and NGOs.	SDG 4-Quality EducationSDG 5-Gender EqualitySDG 10-Reduced Inequalities
3. In what ways does digital financial inclusion contribute to environmental sustainability in rural contexts?	Digital financial platforms promote paperless transactions and enable eco-friendly entrepreneurship through microfinancing green projects.	Integrate sustainability criteria into financial inclusion policies and encourage green microfinance models.	SDG 12-Responsible Consumption & Production SDG 13-Climate Action
4. How do institutional support mechanisms affect women's participation in inclusive financial systems?	Institutional backing through SHGs, cooperatives, and microfinance institutions builds trust and facilitates greater participation.	Strengthen institutional frameworks and provide gender-responsive financial infrastructure in rural areas.	SDG 5-Gender Equality SDG 9-Industry, Innovation & Infrastructure SDG 16-Peace, Justice & Strong Institutions
5. What barriers and enablers shape rural women's adoption of digital financial tools?	Barriers include low literacy, limited internet access, cultural constraints, and financial risk perception; enablers include trust networks and mobile access.	Develop localized digital infrastructure, awareness campaigns, and inclusive regulatory mechanisms to reduce adoption barriers.	SDG 9-Industry, Innovation & Infrastructure SDG 10-Reduced Inequalities
6. How can policy interventions integrate financial inclusion, gender empowerment, and sustainability goals effectively?	Integrated frameworks linking digital finance, women's empowerment, and sustainability yield the most impactful outcomes.	Design cross-sectoral policies connecting financial inclusion with green and gender-sensitive initiatives for holistic rural development.	SDG 1-No Poverty SDG 5-Gender Equality SDG 8-Decent Work SDG 13 Climate Action SDG 17 Partnerships for the Goals

7. Implications of the study

7.1 Theoretical Implications

This study contributes to the theoretical understanding of the nexus between digital financial inclusion, gender empowerment, and sustainable development. The review extends existing frameworks such as the Capability Approach and Technology Acceptance Model (TAM) by demonstrating how digital access transforms women's capabilities and economic agency within rural ecosystems. It also reinforces institutional and social capital theories, emphasizing that financial inclusion outcomes depend not only on access but also on the socio-institutional context that enables trust, participation, and empowerment. Moreover, the study integrates the Sustainability Transition Theory, proposing that digital inclusion functions as a catalyst for achieving social equity and environmental responsibility simultaneously. The synthesis of multiple models highlights that digital financial inclusion is multidimensional spanning economic, social, and ecological domains and thus requires interdisciplinary theoretical frameworks that account for human, institutional, and technological interactions in shaping sustainable empowerment.

7.2 Practical Implications

From a practical perspective, the findings offer actionable insights for development practitioners, financial institutions, and technology providers working to enhance women's socio-economic participation. The evidence suggests that FinTech innovations such as mobile banking, digital payment platforms, and microcredit applications can bridge long-standing barriers to financial access in rural regions. However, these tools must be designed with a user-centered approach, ensuring affordability, simplicity, and local-language support to meet the specific needs of rural women. Training programs focused on digital literacy and financial education can strengthen women's ability to engage effectively with digital finance and make informed financial decisions. Additionally, community-based institutions like Self-Help Groups (SHGs) and cooperatives should be digitally integrated to facilitate collective participation and peer learning. Practitioners should also prioritize data security, transparency, and trust-building measures to encourage sustainable digital adoption. By combining technology with grassroots capacity-building, stakeholders can ensure that financial inclusion initiatives lead to real, measurable empowerment rather than surface-level participation.

7.3 Policy Implications

The findings reveal several key policy implications essential for bridging digital divides and advancing sustainable socio-economic empowerment among rural women. Firstly, governments and financial institutions should prioritize inclusive fintech policies that expand access to mobile banking, savings tools, and microcredit platforms tailored for women in rural contexts. These policies must embed gender-sensitive frameworks that promote both economic and social inclusion. Secondly, policymakers should integrate digital literacy and financial education into rural development programs, delivered through local institutions, NGOs, and educational networks. Such interventions will

enhance women's digital confidence, reduce dependency on informal credit systems, and promote entrepreneurship.

Thirdly, environmental sustainability should be mainstreamed within financial inclusion initiatives. Promoting paperless transactions, supporting green microenterprises, and linking financial incentives to eco-friendly practices can align financial inclusion with environmental stewardship. Fourthly, institutional support mechanisms including SHGs, cooperatives, and microfinance institutions must be strengthened to serve as intermediaries that connect rural women to formal financial systems, ensuring trust, accessibility, and long-term engagement. Fifthly, targeted interventions addressing barriers to adoption, such as limited internet connectivity, affordability, and socio-cultural restrictions, should be prioritized. Tailored digital infrastructure investments and women-led fintech innovations can serve as effective enablers.

Finally, the review underscores the need for integrated policy frameworks that align financial inclusion with national gender equity and sustainability goals. Cross-sectoral coordination between ministries of finance, women and child development, and rural affairs is essential to harmonize programs under the Sustainable Development Goals (SDGs), particularly SDGs 1 (No Poverty), 5 (Gender Equality), 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), and 13 (Climate Action). By embedding inclusive digital finance into sustainable development policies, nations can ensure equitable economic growth, environmental responsibility, and holistic empowerment of rural women.

8. Conclusions

This study provides a comprehensive synthesis of contemporary research on the intersection of digital financial inclusion, socio-economic empowerment, and environmental sustainability among rural women. Through a systematic literature review, the study establishes that digital financial inclusion serves as a critical enabler of inclusive growth, transforming access to finance into tangible improvements in income generation, entrepreneurship, and social participation. Evidence across diverse contexts particularly from India, Nigeria, and other developing regions demonstrates that when digital tools such as mobile banking, microcredit, and e-payment systems are combined with literacy and institutional support, they significantly enhance women's financial autonomy and household decision-making power. However, the review also reveals that persistent barriers including gender bias, limited digital literacy, infrastructural deficiencies, and affordability issues continue to constrain the full realization of inclusive development outcomes.

The findings reaffirm that digital financial inclusion must be viewed not merely as a technological innovation but as a socio-economic transformation process grounded in equity, participation, and sustainability. Financial technologies (FinTech) can be transformative only when supported by education, capacity building, and institutional trust mechanisms that empower women to navigate digital ecosystems confidently. Moreover, integrating environmental sustainability within financial inclusion initiatives through paperless transactions, green financing, and eco-enterprise development can simultaneously advance the Sustainable Development Goals (SDGs), particularly

SDGs 1, 5, 8, 9, and 13. Thus, the synergy between financial inclusion, gender empowerment, and sustainability creates a holistic pathway toward resilient rural development.

In conclusion, bridging digital divides requires a multidimensional approach that combines technology diffusion with social inclusion, education, and policy alignment. Governments, financial institutions, and community organizations must collaboratively develop frameworks that ensure digital access translates into socio-economic empowerment and ecological responsibility. Future efforts should focus on developing gender-sensitive digital policies, expanding rural digital infrastructure, and integrating sustainability metrics into financial inclusion programs. By adopting such inclusive and systemic strategies, policymakers and practitioners can ensure that digital financial inclusion becomes a powerful instrument for advancing equitable, sustainable, and digitally empowered futures for rural women worldwide.

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10. Author Contributions

Dr. S. Saranya, Conceptualization, Methodology, Literature Review, Data Curation, Analysis, Visualization, Writing Original Draft Preparation, Writing Reviewing and Editing, Validation. Dr. K Chandrasekar: Supervision.

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12. Ethical Approval

This research is a systematic review based solely on existing, publicly available literature and did not involve human or animal subjects, primary data collection, or experimental intervention. Hence, ethical approval was not required.

13. Competing Interest

The authors declare no competing financial, institutional, or personal interests that could have influenced the content or conclusions of this paper.

14. Data Availability

The study is based entirely on secondary data obtained from peer-reviewed academic sources. No new primary data were generated or analyzed. Supplementary references and materials can be made available by the corresponding author upon reasonable request.

15. AI Usage Disclosure

The authors confirm that no generative AI tools (e.g., ChatGPT, Gemini, Claude) were used to draft or write the substantive content of this manuscript. Only standard spelling, grammar, and formatting tools in Microsoft Word were used. All analytical, theoretical, and critical writing is original and authored by the researchers.

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