

Green FinTech and Climate Finance: An Economic Perspective on Digital Financial Innovation for Sustainable Development

Dr. R. Uma¹, FNU Aishwariya Kannan², Dr. Nandini Jagannarayan³

Assistant Professor¹, Co-founder², Assistant Professor³

Department of Economics¹, Co-founder², Department of Hindi³

Nirmala College for Women, Coimbatore¹

Amohas LLC, Oakley, California²

Hindi Vidya Prachar Samiti's Ramniranjan Jhunjhunwala College of Arts, Science and Commerce

(Empowered Autonomous), Ghatkopar, Mumbai³

umabchander@gmail.com, aishwariyak100@gmail.com, n.jagannarayan@somaiya.edu

¹ ORCID: 0009-0009-6911-005X, ² ORCID: 0009-0004-3795-4120

³ ORCID: 0009-0003-5909-0274

Abstract: *Fintech services that affect financial services, banking, lending, insurance, payments, investment management and financial inclusion. AI, blockchain, machine learning, cloud computing, IoT, big data analytics, digital wallets, peer-to-peer lending, robo-advisory platforms, decentralized finance (DeFi), and digital currencies have revolutionized the financial systems to improve efficiency, access, and transparency.*

The financial innovations, combined with environmental sustainability, have created Green FinTech, more recently. Green FinTech relates to the application of digital financial technologies in the fields of environmentally responsible investments, climate risk management, disclosure and transparency on environmental matters and sustainable economic growth. Traditional financial technologies focus on improving the efficiency of financial operations and enhancing the convenience of financial services. In contrast, Green FinTech is a concept that places equal importance on the environment, aiming to integrate financial technology into the environment by promoting renewable energy projects, carbon markets, green bonds, sustainable banking and climate-related investments.

Climate action is achieved in a number of ways from an economic point of view. Digital payment systems reduce reliance on paper payment systems and increase financial inclusion. Financial institutions can leverage AI to more effectively understand and evaluate environmental risks and offer credit to sustainable businesses. The blockchain has enhanced the transparency and traceability of carbon trading, renewable energy certificates and green supply chains. Big data analytics is used to support climate risk modelling, and crowdfunding platforms are helping to make green investments more accessible to everyone and make it possible to finance renewable energy and environmental conservation programs.

The low- and middle-income countries (LMIC), such as the emerging economies, are beginning to emerge as laboratories for innovation of Green FinTech. In India, for example, the government's efforts, such as the Digital India initiative, Aadhaar, Unified Payments Interface (UPI), Account Aggregator Framework, Open Credit Enablement Network (OCEN) and Digital Rupee, have resulted in one of the world's most advanced digital financial ecosystems. They can provide a platform for opportunities to weave climate considerations into financial services and for inclusive economic growth.

In spite of the increase of research activity in this field in recent years, the FinTech field is still rich in publications on financial inclusion, banking efficiency, payment technologies and technological adoption. The research on the use of digital financial innovation for the promotion of climate finance and environmental sustainability, carbon markets and

green economic development is still relatively small. Furthermore, the interdisciplinary research between disciplines, which integrates economics, sustainability and digital innovation is not yet developed in the respective disciplines.

This review aims to fill these gaps by examining the latest literature around Green FinTech from an economic perspective. It covers theoretical analysis related to the concept of Green FinTech, presents an overview of important theoretical frameworks, reviews the empirical literature available and examines key technological innovations in climate finance, identifies policy issues and recommends future research directions. The paper's economic, financial, environmental, and digital innovation lenses provide a broader perspective on the role of Green FinTech in the sustainable development of the economy and climate.

Keywords: Green FinTech and Climate Finance: An Economic Perspective on Digital Financial Innovation for Sustainable Development

I. INTRODUCTION

Financial technology has significantly changed over the last few decades. FinTech is defined by various technologies, initially mainly related to banking automation and electronic payment systems, which has evolved into a wide digital financial ecosystem that includes mobile banking, digital payments, peer-to-peer lending, blockchain, artificial intelligence, machine learning, robo-advisory, digital wallets, decentralized finance, big data analytics, and digital currencies. This has had a profound impact on the structure and operations of financial markets: it has lowered transaction costs, boosted operational efficiency, brought more people into the financial system, and made financial transactions quicker and easier.

As climate change accelerates, innovation in the financial sector has added a new dimension to it. Financial systems are increasingly responsible for environmental sustainability, climate adaptation, low carbon development and responsible investment, not just profitability and financial efficiency and liquidity. The confluence of these has led to the development of Green FinTech, a combination of digital financial technologies and environmental and sustainability goals.

Green FinTech can be defined as the use of digital financial innovation in the context of responsible investment, climate risk management, sustainable lending, ESG investing, carbon markets, financing of renewable energies, green bonds, and environmental disclosure. Unlike traditional FinTech, it is not just about enhancing financial efficiency, it's also about integrating environmental and social factors into the financial decision-making process.

Green FinTech has the potential to affect sustainable development from an economic point of view in a number of ways. Digital payment systems can help to decrease the use of paper financial instruments and physical financial infrastructure, and increase financial inclusion. AI and machine learning can help financial institutions evaluate environmental risks and prioritize lending for sustainable businesses. The blockchain technology holds promise for enhancing transparency and traceability in carbon markets, renewable-energy certificates, and sustainable supply chains. Big data analytics can help model the effects of climate change more accurately and digital crowdfunding can help make environmental and renewable energy projects more accessible to financing.

Green FinTech is a topic of special interest in emerging economies. In countries like India, the Digital India, Aadhaar, Unified Payments Interface (UPI), Account Aggregator Framework, Open Credit Enablement Network and Digital Rupee are just some of the digital financial infrastructure initiatives that have been developed. These developments create the opportunity to embed considerations of climate change within digital financial services and to promote financial inclusion and economic growth.

Although the study of FinTech has grown in volume and sophistication in recent years, there is still a lack of scholarly attention to issues of financial inclusion, banking efficiency, digital payments, and technological adoption. Less focus has been placed on the importance of digital financial innovation for climate finance, carbon markets, environmental sustainability and green economic development. Furthermore, the research on the economics, sustainability, finance and digital innovation are disconnected.

This is the motivation for the present review. The study analyzes the economic development of Green FinTech from an economic perspective, summarises the theoretical and empirical dimensions, and assesses the role played by key digital technologies in climate finance, highlighting economic and policy challenges and suggesting directions for future research.

The paper offers three general contributions. On the one hand, it synthesizes several theoretical viewpoints to understand Green FinTech adoption and implications for sustainable economic transformation. On the other hand, it provides a synthesis of the diverse theoretical views to explain Green FinTech adoption and implications for sustainable economic transformation. Second, it combines the nascent empirical research on key technology and financial issues. Third, it elaborates an integrated economic analysis of how Green FinTech can impact market efficiency, financial inclusion, sustainable capital allocation and climate resilience.

II. LITERATURE REVIEW

Over the past few years, the literature on financial technology has gone beyond banking automation and electronic payment systems and expanded to include new concepts within the digital financial space such as artificial intelligence (AI), blockchain, big-data analytics, mobile payments, digital lending, robo-advisory, crowdfunding and digital currencies. The times of climate change and sustainable development are becoming more urgent, and this has given rise to a new research field, which is commonly called Green FinTech. Green FinTech is the field of digital financial innovation and environmental sustainability, including sustainable lending, green investment, climate-risk management, ESG investing, carbon markets, finance of renewables and environment disclosure. In contrast to traditional FinTech, which focuses on financial efficiency and accessibility, Green FinTech aims to incorporate environmental factors into financial planning and investment, thereby aiming for a more sustainable economy (Geetha & Biju, 2024; Puschmann & Khmarskyi, 2024). ([PubMed][1])

A recent systematic review suggests that Green FinTech is a relatively young and still developing field of research that lacks a unified theme. Geetha and Biju (2024) have prepared a systematic review of the link between FinTech and green finance and found that Green FinTech has significant potential to enable climate finance, enhance financial inclusion, promote transparency and trust, minimize information asymmetry and overcome certain challenges of traditional green finance. They said that the literature on Green FinTech is still disjointed though, and further research is needed to make the practical implementation of Green FinTech in climate finance systems more effective. ([PubMed][1]) Another systematic analysis of 74 academic papers by Puschmann and Khmarskyi (2024) found that Green FinTech research is still in its infancy. Their analysis revealed that strategy, organisation, technology and potential are key dimensions in research, though the research is heavily skewed toward blockchain and comparatively under-researched for other financial technologies, such as AI. ([Wiley Online Library][2])

It is supported by the wider literature on FinTech and sustainable development. Offiong, Szopik-Depczyńska and Ioppolo (2025) examined the connection between FinTech innovations and sustainable development and concluded that blockchain, AI and big-data analytics hold great promise in providing sustainable resource efficiency, cut carbon footprints, and offer access to sustainable products and services. Meanwhile, the authors outline key research gaps that need to be addressed through further empirical research, including the role of inclusive innovation, stakeholder engagement, gender gaps in accessing FinTech, digital social entrepreneurship, and the potential of FinTech in different regions for sustainable development. ([Wiley Online Library][3]) A similar bibliometric analysis of 218 publications from the past 6 years (2017-2023) identified green finance, green innovation and Green FinTech as the key areas of research, and several other emerging topics that warrant further research, such as green employment and the connection between FinTech and sustainable labour markets. ([ScienceDirect][4])

Digital finance is an important building block of Green FinTech. Mobile banking, digital wallets, electronic payments and digital public infrastructure can help to lower transaction costs, reach every corner and make formal financial services more accessible. In emerging economies, the developments are especially relevant for financial inclusion, as well as providing avenues for the distribution of sustainable financial products, through digital financial infrastructure.

The digital financial ecosystem in India has been built with initiatives like Account Aggregator infrastructure, Unified Payments Interface (UPI), Digital Rupee and Open Credit Enablement Network (OCEN) that enable new forms of intermediation. The current document also acknowledges that digital infrastructure in India is a crucial platform to incorporate climate considerations into financial services and facilitate inclusive economic growth.

There is also an important rationale for sustainable financial behaviour, with the rise of digital finance. Jagannarayan's study on the digital financial system in India underscores the significance of technological advancement, digital infrastructure, government policies, and evolving consumer behavior in the uptake of digital financial services. This line of research is relevant to the topic of Green FinTech due to the fact that a vast number of digital payments and financial platforms are being introduced and adopted across the globe, which provides the infrastructure and foundations required for the next phase of green investment products, sustainable lending, carbon-related financial services and climate-risk information. Therefore, digital financial inclusion may be considered as a means to (not only an end to) inclusive climate finance.

A growing empirical literature focuses on the link between digital finance and environmental performance. Lu, Li and Zhang (2023) examined the development of digital finance and carbon-emission intensity, and found that the development of digital finance has a positive effect on the environment. Ding, Li and Wang (2023) also explored the impact of digital finance, as well as government policies and carbon-emission efficiency, the significance of institutional arrangements in shaping the environmental implications of financial digitalisation. Similarly, Razzaq and Yang (2023) highlighted the relevance of inclusive digital finance for green growth, and Wang et al. (2023) looked at green innovation and carbon emissions of SMEs in the region and digital inclusive finance. Taken together, these studies suggest that digital financial development can have an effect on environmental performance in two ways: technological innovation and better allocation of resources and access to financial resources.

This relationship has been reinforced by recent evidence. According to empirical studies in 2024, digital finance has a negative impact on the intensity of carbon emissions, both by technological innovation and green technological innovation, with varying size differences among regions. Other enterprise-level evidence also points to the potential to reduce carbon emissions, indicating that the impact of digital inclusive finance is not just at the macroeconomic level, but can also be through enterprise and production systems. These findings strengthen the economic case for digital financial technologies to combat information asymmetry, to better allocate capital and to promote investments in environmentally friendly technologies.

There is, however, not always a direct line between digital finance and environmental performance. For instance, Jiang and Wang (2024) differentiate between the mechanism of digital finance and traditional green finance on carbon emissions. From this, their results indicate that digital finance works mainly in the field of technological innovation, while green finance is more related to restructuring the industrial sector and environmental regulation. These conclusions suggest that the concept of Green FinTech cannot be equated with green finance.

Digital finance, on the contrary, is an enabling tool to enhance effectiveness, accessibility and transparency of green financial instruments.

Among the most mentioned technologies found in the Green FinTech literature, Blockchain is one of the most discussed ones. Distributed ledger technology can help boost the transparency and traceability of carbon credits, renewable energy certificates and sustainable supply chains. Smart contracts can ensure automated verification and compliance, and blockchain-based technologies can help to mitigate information asymmetry and build trust in environmental claims. The existing literature thus pinpoints that blockchain could be a promising instrument for enhancing the integrity of carbon markets and lower the transaction and monitoring costs. The present manuscript also makes reference to blockchain as an important tool to enhance transparency, traceability, and accountability in carbon markets and renewable-energy financing.

However, the focus on blockchain has led to an unbalanced literature as well. According to Puschmann and Khmarskyi (2024), only a few Green FinTech studies delve into the use of AI, whereas blockchain is more widely studied. This is a significant research opportunity as AI and Big-Data analysis has a broad applicability in Climate-risk assessment,

Environmental credit scoring, ESG analysis, sustainable investment and insurance. AI can help financial institutions manage vast amounts of environmental and financial data, and to estimate the risk of borrowers and investment portfolios to climate change. The present manuscript recognizes these applications as a crucial channel for digital financial innovation to enhance environmental credit assessment and climate-risk management.

As AI becomes more prevalent, it also poses new governance challenges. Algorithmic decision-making can be a way to achieve more accurate predictions, but can also raise questions of bias, transparency, explainability, privacy, and unequal access to digital financial services. Therefore, further research on Green FinTech shouldn't merely focus on the question of whether AI can enhance financial efficiency but also on whether AI supported sustainable finance is fair, explainable and environmentally responsible. This is especially crucial in developing economies where disparities in digital literacy, connectivity and access to fintech can affect the distribution of the benefits of technological innovation.

The other literature that needs to be considered is on the link between Green FinTech and sustainable investment. The FinTech platforms can offer investors real-time ESG data, sustainability ratings, carbon-footprint indicators and assessments of climate-risk. This information can help to diminish uncertainty and enhance investor capacity to differentiate between the environmentally responsible firms and environmentally risky firms. Digital investment platforms are thus potentially able to shift money from fossil fuel investment back to renewable energy, sustainable infrastructure and low carbon enterprises. The literature indicates that greater environmental information can help limit information asymmetry and enhance transparency in the sustainable investment marketplace.

Green crowdfunding is another new model that can help through digital finance to support climate finance. Crowd funding platforms have the ability to link individual investors from directly with renewable energy projects, sustainable agriculture, waste management and other eco-friendly businesses. These platforms can help to make it easier for small green projects to raise funds, as they may not have collateral, or access to conventional bank finance. Economic value of green crowdfunding thus goes beyond funding itself; it can be used to stimulate entrepreneurship, innovation, employment and community contribution to environmental initiatives.

In addition, the financial institutions' role in Green FinTech falls under increasing attention in literature. Digital innovation is mediated by banks and other financial institutions, whose role is to allocate capital in line with sustainability. The concept of green banking can include environmental criteria in loan decisions, offer green products (loans and mortgages), fund renewable-energy projects and incorporate environmental, social and governance (ESG) into investment portfolios. Jagannarayan and co-authors' recent research on Green Banking offers a new understanding of Indian institutions influencing sustainable finance. Their work focuses on how institutional features, financial rules and institutions and organisational commitment influence the financing of green activities. This research builds on the existing Green FinTech literature by showcasing how technological capability is not enough, with the inclusion of institutional structures and strategic commitment to make digital innovation a sustainable financial outcome.

Green FinTech has been less explored so far from the behavioural perspective. The existing literature is commonly related to the financial behavior of banks, companies, investors, carbon emissions, and macroeconomic variables; and the financial behavior of households, sustainable consumption, environmental awareness, financial literacy, and financial trust are less studied. Recent studies by Jagannarayan et al. regarding digital marketing and sustainable consumer behaviour in India demonstrate that digital platforms can both shape consumer decision-making processes, and present opportunities and challenges for sustainability. Although digitalisation can lower search and transaction costs, and enable people to access information on sustainability, it can also lead to overconsumption and new types of digital inequality.

In the same way, recent studies by Jagannarayan and Uma on the consumption behaviour of households in Maharashtra highlights an important behavioural dimension of sustainability. They found that the relationship between household expenditure and sustainability varies for each type of expenditure and that incomes do not lead to sustainable consumption patterns immediately. These observations are relevant to the issue of Green FinTech because the use of digital financial systems is increasing in its effect on households' payments, access to credit, saving, and investment and consumption. The household is thus an underdeveloped level of analysis in the Green FinTech literature.

The behavioural perspective also links the concepts of Green FinTech to technology-adoption theories. Both the Technology Acceptance Model indicates that perceived usefulness and perceived ease of use play a role in the adoption of technology (Davis, 1989) and the Diffusion of Innovation theory highlights the influences of relative advantage, compatibility, social influence, and institutional conditions in the diffusion of innovations (Rogers, 2003). The current theoretical approaches are applicable to sustainable digital finance as the environmental advantages of Green FinTech are not possible to achieve without the willingness and capacity of the consumers, investors, firms and financial institutions to use the technologies. Now, the study of continued use of Green FinTech also shows that performance expectancy, effort expectancy, social influence and facilitating conditions have impact on the continuance intention, which indicates the need for more focus on the behavioural adoption of Green FinTech in future research.

Another major issue that is coming to the fore is the fact that digitalisation can create environmental costs of its own. Digital infrastructure must have electricity, data centres and computational power; some blockchain applications and AI can consume significant energy resources. Despite this, recent empirical evidence shows that Green FinTech can bring positive benefits to environmental sustainability through various pathways such as green innovation and AI, and it is possible to reduce environmental benefits at the margins, as well as a digital carbon footprint, as Qiao, Cai and Chen (2025) indicate. This opens the door to a new qualification in the mostly positive perspective of Green FinTech.

The question that should be asked, then, is whether there is a net positive environmental impact from digital financial innovation once the environmental costs of the digital infrastructure are taken into account.

The literature thus shows several important gaps in the research. There is a conceptual gap between the two, first. Digital finance, green finance, climate finance, and sustainable development and FinTech are largely developed as separate research streams. While systematic reviews have started incorporating these areas, Green FinTech is still a relatively young area. In particular, fragmentation is highlighted as a key feature of the current literature by Geetha and Biju (2024) and Puschmann and Khmarskyi (2024) show that research on Green FinTech is not distributed evenly across technologies and applications.

Secondly, there is a geographical gap. Much of the empirical literature on the environmental impacts of digital finance is from China. While these studies offer useful insight into carbon emissions, green innovation and digital financial inclusion, the results need not be extrapolated to India, given that there are significant differences in institutional structures, financial systems and regulatory frameworks and digital infrastructures. Thus, further studies of Green FinTech in the fast-growing digital financial landscape in India are warranted.

Thirdly, there is a technology gap. While blockchain has garnered significant attention in the existing research, AI, big data analytics, IoT, digital payments, digital currencies, and crowdfunding and other technologies have been comparatively less integrated. Underrepresentation of AI and other technologies is an important research opportunity, explicitly identified by Puschmann and Khmarskyi (2024).

Fourth, there is an institutional and regulatory gap. Green FinTech is situated in a complex institutional landscape of governments, central banks, financial regulators, banks, FinTech companies and investors. The effectiveness of Green FinTech can be impacted by regulatory fragmentation, ESG reporting differences, data governance, cybersecurity requirements and carbon-accounting standards. The current manuscript also highlights the issue of regulatory fragmentation, cybersecurity, data privacy, algorithmic bias and digital inequality as challenges.

Fifth, a behavioural gap and inclusion gap. There are limited studies that have investigated the various factors, including financial literacy, environmental awareness, trust in financial education and technology acceptance, gender, income and access to digital financial services, that impact financial participation in sustainable digital finance. However, the research work on digital payments, sustainable consumption and Green Banking is emerging in India, and has so far studied some of these aspects in isolation, without combining them into a holistic Green FinTech-climate finance framework.

Sixth, there is a gap in the longitudinal dimension and in the macroeconomic dimension. The empirical literature has a distinctly cross-sectional or short time perspective nature. Therefore, there is relatively little research on the impact of Green FinTech on productivity, employment, financial stability, sustainable investment and carbon reduction in the

long-term. The current manuscript also suggests the need for longitudinal studies to measure the dynamic impacts of Green FinTech over time.

Lastly, there is a net sustainability deficit. While digitalisation is often assumed to have positive environmental effects, the environmental impacts of digital infrastructure, data processing, AI and blockchain are not always taken into account. Future studies should thus examine the sustainability aspects and environmental externalities of digital financial innovation.

The literature seems to indicate that Green FinTech cannot be considered only as the application of technology to green finance. It is an economy-wide shift in which digital technologies impact information flows, transaction costs, financial inclusion, investment choices, risk management, governance and institutional design, and environmental effects. Recent studies have given rise to significant linkages between digital finance, green innovation and carbon reduction in the context of sustainable development, and emerging studies by Jagannarayan and collaborators have shown evidence of the digital, institutional, and behavioural aspects of sustainability in India. These strands are not yet well connected, though.

The present study thus seeks to fill this identified gap in the literature through the synthesis of the literature based on an integrated economic perspective. It links digital financial innovation to climate finance via transaction cost reduction, information asymmetry reduction, financial inclusion, sustainable capital allocation, financial technological innovation, and managing climate risk. It also integrates the institutional and behavioural aspects of Green FinTech, in order to have a better understanding of the contribution that digital finance can bring to the sustainable economic development and climate resilience. This positioning is inline with the main goal of the manuscript: integrating the economic, financial, environmental and digital-innovation viewpoints, while not considering the phenomenon Green FinTech as a technological-only one.

III. RESEARCH METHODOLOGY

In this study, a systematic narrative review method is employed to combine the most up-to-date economic research on Green FinTech. Unlike empirical articles which are based on primary data, review articles aim at conveying an impression of synthesizing knowledge, identifying new directions of research, evaluating the theoretical development, and proposing new avenues of research. The methodology adopted is a mixture of systematic literature identification and qualitative thematic analysis, as it is important to understand the role of digital financial innovation in addressing climate change and sustainable economic development in a holistic way.

This review primarily focuses on peer-reviewed research in journals from 2020 to 2026, reflecting the heightened interest and accelerated growth of digital finance since the COVID-19 pandemic, and of environmental, social and governance (ESG) investing globally. Other sources include reports of the World Bank and the International Monetary Fund (IMF), the Bank for International Settlements (BIS), the United Nations Environment Programme (UNEP), the Organisation for Economic Co-operation and Development (OECD), the International Energy Agency (IEA), the Intergovernmental Panel on Climate Change (IPCC) and the Reserve Bank of India (RBI).

The following combinations of the keywords were used to conduct systematic searches in electronic databases on Sustainable Finance, Climate Finance, Smart Systems, Digital payments, Artificial Intelligence, Blockchain, ESG investing, Carbon markets, Digital banking, Climate risk, Green bonds, and Financial inclusion. The search approach ensured a comprehensive coverage of multidisciplinary literature both from the economics and finance and environmental sciences/public policies.

In English there was only literature directly related to FinTech and climate sustainability taken into account. The methodological rigor and reliability was obtained by excluding conference abstracts, opinion pieces, newspaper articles, duplicate records, and publications that were not peer-reviewed.

Following the identification of literature themed coding was performed to categorize the studies under the major conceptual themes. Topics discussed included digital financial inclusion, the use of AI in sustainable finance, blockchain for climate governance, digital payments and environmental sustainability, ESG investing, carbon markets,

green crowdfunding, climate risk analytics, regulatory frameworks and new policy challenges. The synthesized evidence was then analyzed economically from the perspectives of enhancing market efficiency, capital allocation, environmental externalities, financial inclusion and sustainable economic growth.

The review does not use a quantitative meta-analysis as the approach, instead it has a thematic synthesis approach and can better understand the development of research directions while integrating the theoretical and empirical ideas provided by different research fields.

IV. DATA ANALYSIS AND INTERPRETATION

Thematic literature analysis of the literature analyzed reveals that Green FinTech is one of the most influential factors to accelerate sustainable finance on a worldwide level. The literature shows that there are six dominant themes, which explain how digital financial innovation can contribute to climate action and sustainable economic development.

V. AI AND SUSTAINABLE FINANCE

Artificial Intelligence (AI) is one of the most significant technologies in today's financial environment. Machine learning algorithms are increasingly being used by financial institutions to analyse vast amounts of environmental, financial and behavioural data in order to enhance investment decisions and climate risk management.

By integrating environmental factors like carbon emissions, energy efficiency, ESG performance, and climate vulnerability into lending decisions, AI plays a crucial role in boosting the efficiency of environmental credit assessment. AI credit evaluation models are more accurate than traditional models, and they can predict environmental risks to address information asymmetry between financial institutions and borrowers.

AI-driven investment platforms have been making waves by integrating sustainability measures into portfolio optimization, with several studies suggesting this is becoming more common. Several studies indicate that AI-driven investment platforms have been making a significant presence and are increasingly incorporating sustainability metrics into their investment portfolios. Today, robo-advisors can propose ESG investments to clients according to their preferences, climate goal and the ESG performance. These technological innovations promote the efficiency of the markets and promote the participation in sustainable investments.

On the economic side, AI can be used to optimize resource utilization, such as directing investments towards sectors that have environmental benefits and avoiding high carbon industries.

Use of blockchain for carbon markets. Carbon Market Transparency (CMT) through blockchain.

Another major innovation is blockchain technology which provides support to Green FinTech. Distributed ledger systems provide secure, transparent and decentralized financial transaction, fraud prevention and accountability tools.

Blockchain can help facilitate the verification and monitoring of environmental compliance certificates, carbon credits, and renewable energy certificates in the climate finance space. There could be problems with double counting, with not enough information and verification costs in conventional carbon markets. The immutability of blockchain can significantly reduce these inefficiencies and foster investors' trust.

Various platforms are also being used to facilitate P2P energy trading on the blockchain, in a few renewable energy projects, that would allow solar power generation households to sell their surplus electricity directly to the end user or the end consumer. In such decentralised markets, energy efficiency improvement and development of renewable energy can take place.

In an economic context, blockchain reduces the cost of transactions, enhances market transparency and contributes to environmental governance, increases the attractiveness of climate-related investments.

VI. DIGITALIZATION OF PAYMENT SYSTEMS AND THE GREEN ECONOMIC GROWTH.

Digital payment systems have become a part and parcel of modern-day FinTech ecosystem. In today's times, the financial transactions have transformed for better with the help of Mobile Banking, QR code payments, Digital Wallets, Unified Payments Interface (UPI), and Central Bank Digital Currencies (CBDCs).

There are a few environmental benefits associated with digital payment systems, as per literature. Electronic transactions reduce paper usage, alleviate physical banking transportation requirements and improve the effectiveness of financial institutions. Digital payments can also be leveraged to promote financial inclusion and extend banking services to the excluded, in addition to inclusive economic development.

UPI is one of the most successful instances of digital financial transformation in India. Nowadays, digital payments are enabling millions of small businesses and households to gain access to formal financial services and the cost of transactions has declined substantially.

The environmental effects of digital payments, although potentially low at the moment, are consistent with wider sustainability goals, such as supporting resource efficiency, financial inclusion and the reduction of physical infrastructure.

The innovative financing solution that has emerged is the so called 'green crowdfunding' whereby citizens can be a part of environmental projects directly. Renewable energy, sustainable agriculture, afforestation, waste management, water conservation, and social enterprises are examples of investments that can be made on digital crowdfunding platforms.

The necessity of providing collateral in traditional financing systems and the high transactions cost often leaves out small-scale environmental projects. Crowd Funding is about making funding available in a democratic manner, directly connecting investors with environmentally responsible entrepreneurs.

The literature has demonstrated that the impact of crowdfunding on boosting financial inclusion and the community's awareness and involvement in climate action is significant. Small investors, who have not had sustainable investment opportunities before, are now able to directly invest in green projects via digital platforms.

Economically, crowd funding can raise the amount of capital, encourage entrepreneurship, generate jobs and promote innovation in green economy.

VII. ENVIRONMENTAL, SOCIAL AND GOVERNANCE (ESG) INVESTING.

The global financial markets have seen one of the fastest growing investments – ESG investing. Investors also consider environmental, social and governance (ESG) aspects when evaluating companies in addition to the financial aspects.

The information and tools provided by FinTech platforms can greatly enhance ESG investing by offering real-time sustainability analytics, climate risk assessments, corporate ESG ratings, and carbon footprint data. AI can analyze comprehensive information on how companies are being sustainable, assisting investors in making informed decisions.

There are now a number of digital investment websites which automatically assemble portfolios of environmentally-friendly companies, and remove companies from industries that are high in carbon emissions.

It is always noticed in the literature that with greater transparency in ESGs, investment uncertainty is reduced, the markets are made more efficient and long-term sustainable economic growth is promoted.

VIII. CLIMATE RISK & FINANCIAL STABILITY

Financial institutions are increasingly at risk of climate-related financial risks. For banks, insurance companies, and investors, financial losses from extreme weather events and environmental degradation and new climate rules will be one of the consequences.

It is technologies like big data analytics, satellite data, remote sensing, and IoT that enable the opportunities to assess climate risks. Predictive analytics is becoming a key tool that financial institutions use to assess the risks of flooding, agricultural production, the vulnerability of infrastructure, and risk exposure.

Advanced climate risk models can be used by insurers to enhance premium pricing and help governments to design better disaster risk financing strategies.

Climate risk assessment, in the economic sense, has the potential to enhance financial stability, reduce uncertainty and encourage sustainable long-term investment.

IX. INTEGRATED ECONOMIC PERSPECTIVE

The literature reviewed showed that Green FinTech has a number of interconnected pathways that are contributing to sustainable economic development.

First, digital technologies help to increase the market efficiency, due to lower transaction costs and information asymmetry. Second, the better the financial inclusion is, the more people can access sustainable investment by FinTech. Thirdly, AI and big data help to optimize resource use, directing investments to environmentally conscious enterprises. Fourth, blockchain can increase transparency of institutions that will support the trust of investors in climate finance. Finally, digital financial innovation serves as an enabler for green economic growth in investments in sustainable entrepreneurship, carbon markets and renewable energy resources.

Overall, these mechanisms demonstrate the fact that Green FinTech is not only about technological modernization but is also a new economic paradigm that will become a reality through financial innovation and climate resilience and sustainable development.

X. DISCUSSION

The journey of Green FinTech from technology innovation in the financial sector to a valuable tool for sustainable economic development and climate resilience is demonstrated throughout the review. Digital finance, artificial intelligence, blockchain technology, big data analytics and environmental sustainability have all come together to shift the way capital is mobilised, allocated and tracked in order to support climate action. In contrast to conventional financial systems that are mainly based on financial efficiency and profitability, Green FinTech brings the element of environmental and social goals in the financial decision-making process, promoting the transition to a low-carbon economy.

As discussed in the literature reviewed, it is clear that FinTech has significant positive effects on the market from an economic perspective, including the decrease in information asymmetry, decrease in transaction costs, financial inclusion and market efficiency. In the area of climate finance, which often features significant uncertainties, long time horizons for investments, high costs of monitoring, and high investment volumes, these features are especially significant. Digital financial technologies can allow investors to access live environmental data, to be more accurate in determining climate risk and track the performance of green investments. This has led to greater investor confidence and a significant increase in investment in renewable energy, sustainable infrastructure and eco friendly enterprises.

Moreover, the research offers insights into how AI is increasingly influencing financial decision-making. The integration of environmental indicators like carbon emissions, energy efficiency, ESG scores, and climate vulnerability metrics into credit assessment processes is a growing trend with AI systems. Environmental criteria like energy efficiency, carbon emissions, ESG scores, and climate vulnerability are increasingly being incorporated into AI-powered credit assessment systems when deciding on lending. This helps financial institutions to manage their resources more efficiently, and helps firms to practice sustainable production. Likewise, machine learning models can enhance the prediction of climate risks, enabling financial institutions to better foresee environmental events and create investment strategies resilient to climate change.

The other key enabler for sustainable finance is blockchain technology. Blockchain helps to increase the integrity of carbon markets, renewable energy certificates and sustainable supply chains by offering secure, transparent and decentralised transaction records. The literature points to the potential of blockchain in the field of climate finance to substantially lower fraud, enhance traceability and boost governance. These improvements not only reduce the transaction costs but will also increase the trust in green financial instruments, which will in turn increase the number of institutional and retail investors.

The review also reveals that digital payment ecosystems act as an indirect enabler to climate mitigation by decreasing reliance on paper financial transactions, enhancing operational efficiencies and growing financial inclusion. Digital public infrastructure can simultaneously serve the interests of economic efficiency and environmental sustainability by optimising resources, as seen in India's Unified Payments Interface (UPI), digital wallets, and mobile banking systems.

Another important trend in the literature that emerged was that of ESG investing. More and more, FinTech platforms offer investors real-time sustainability analytics, carbon footprint analysis, and ESG performance indicators. The technologies enable sound investment decisions and promote better environmental performance by the corporations. Digital financial platforms are likely to be increasingly relevant in guiding the global flow of investment towards sustainable economic activities, particularly climate-resilient ones, as sustainable investment becomes the norm.

While these are tremendous opportunities, there are still a number of challenges. Regulatory fragmentation remains a challenge for global development of Green FinTech. The lack of harmonisation between the ESG reporting frameworks, carbon accounting frameworks and digital financial regulations from different authorities also means investors and financial institutions have uncertainty. Moreover, there are policy issues to consider, such as the threat of cybersecurity and data privacy, algorithmic bias, digital inequality, and the energy use of some blockchain technologies. Solving these problems will be crucial for the impact of Green FinTech on sustainable development in the long run.

The overall findings from the literature indicate that Green FinTech holds significant promise for transforming financial systems, blending economic efficiency with environmental stewardship. For more than twenty years, the World has experienced a structural shift from conventional finance to sustainable digital finance.

There are repetitions of statements especially in the implications of the central banks, financial institutions, academic institutions, theoretical implications, and the conclusions. These have been combined, with no new themes introduced, and the key points are preserved from the original.

XI. PRACTICAL IMPLICATIONS

The results of the review have implications for the governments, financial regulators, financial institutions, FinTech companies, businesses, investors and academic institutions.

Governments need to acknowledge the need of Green FinTech as a key tool to reach climate goals and Sustainable Development Goals. Policy frameworks should foster sustainable finance, green bonds, carbon markets, ESG reporting and green crowdfunding, and bolster digital public infrastructure. Digital green investment can be further promoted by fiscal incentive, subsidy, and the appropriate regulatory measure, which can help achieve sustainable economic development.

Central banks and financial regulators have a crucial role to play in embedding climate-related financial risks within monetary and financial stability frameworks. The harmonised ESG disclosure framework, digital-risk management guidance and climate stress-testing tools can enhance the strength of sustainable financial systems. CBDCs can also enable efficient, transparent and traceable sustainable financial transactions.

AI, blockchain and big-data analytics should be part of the financial institutions' sustainability approaches. Environmental and ESG indicators can be used in credit assessments and investment decisions, and financial institutions can develop new products, including sustainable loans, finance for renewable energy, green mortgages, climate insurance, and investment portfolios focused on environmental, social and governance (ESG) issues.

Digital solutions to address climate finance and environmental sustainability, such as carbon-footprint tracking, blockchain-based carbon markets, and AI-powered ESG analytics and digital green-investment platforms, are crucial for FinTech companies to prioritize. Meanwhile, cybersecurity, data protection and ethical AI governance should be enhanced to ensure responsible digital innovation.

Green FinTech can help companies enhance environmental reporting, sustainable supply-chain management, carbon monitoring, and environmental, social and governance performance measurement. Enhanced transparency of the environment will increase access to sustainable finance and draw in socially responsible investors.

Investors can use Green FinTech platforms to access sustainability data, ESG metrics, carbon-footprint data, and climate-risk analysis, which can help them make better investment decisions. More widespread use of such technologies can help to reinforce sustainable capital markets and help channel capital into environmentally friendly activities.

Academic education should integrate Green FinTech into both economics and finance, and business management and environmental fields, as well as information-technology education. Interdisciplinary education can cultivate skills for the operation of digital financial systems and for sustainable economic transformation. Overall, these implications highlight the need for a combination of technological innovation and the right institutional and regulatory and behavioral environment to be effective in the implementation of Green FinTech.

XII. THEORETICAL IMPLICATIONS

The review brings together a range of theoretical perspectives to provide an understanding of the link between digital financial innovation, sustainable finance and climate resilience. Schumpeter's Theory of Innovation is proposed as the theoretical background to Green FinTech, which is regarded as a technological and financial innovation that can create new business models, productivity enhancement and structural economic change.

Perceived usefulness and perceived ease of use are the two constructs that attempt to explain adoption in the context of the Technology Acceptance Model (TAM). Consumers, investors and financial institutions are more willing to use digital financial technologies in the Green FinTech context when they believe that they are efficient, accessible, transparent and useful for sustainable financial decision-making.

The Diffusion of Innovation Theory provides an explanation for the process of the technological advancement, communication, institutionalization and user preference that drive the diffusion of Green FinTech. The speed of mobile banking, digital payments, blockchain and AI shows their importance for the digital financial transformation.

Regulatory quality, governance and policy support are crucial in the context of Institutional Theory. Sustainable digital-finance ecosystems require suitable regulations, digital infrastructure and institutional capacity. Stakeholder Theory adds to this by balancing the needs of the various stakeholders, including investors, the government, the business community, the consumer, communities and others, with economic, environmental and social interests.

These theories, when put together, provide a comprehensive understanding of Green FinTech that suggests that digital financial innovations are enabling and mediating factors between technological innovation and financial inclusion, sustainable investment and climate resilience. Green FinTech should thus be seen not only as financial modernization but as a tool for more comprehensive sustainable economic transformation.

XIII. CONCLUSION

Climate change has changed the economic and financial landscape significantly, and the need for sustainable finance and investment has grown as well. The review illustrates the significance of Green FinTech, highlighting how digital financial innovations and environmental sustainability intersect. AI, blockchain, big-data analytics, digital payments, cloud computing and ESG platforms, among other technologies, can help to boost capital allocation, cut transaction costs, increase environmental transparency, widen financial access and bolster climate-risk management.

The literature suggests that Green FinTech can help to unlock access to climate finance, enhance transparency in the carbon market, drive sustainable investment and help finance climate adaptation, renewable energy and sustainable infrastructure. But, achieving these benefits depends on proper regulatory and institutional arrangements. In addition to environmental governance, regulatory fragmentation, cybersecurity, digital inequality, data privacy, algorithmic bias and ethical issues surrounding AI must be addressed.

The long-term success of Green FinTech will, thus, rely on the ability of policy makers, financial institutions, technological providers and other stakeholders to connect technological innovations with environmental and social goals. For digital financial transformation to meaningfully drive sustainable economic development, standardized reporting of ESG-related data, interoperability of digital infrastructure, transparency of carbon accounting and responsible digital governance will all be vital to this.

XIV. FUTURE RESEARCH DIRECTIONS

While the research activities in the field of Green FinTech have increased significantly, a number of aspects still need to be explored. Comparative studies between developed, emerging and low-income economies could lead to increased understanding of the role of institutional, regulatory and technological conditions on Green FinTech adoption and impact.

Much of the current evidence is cross-sectional and further long-term research is especially needed to understand the long-term impacts of Green FinTech on economic growth, employment, productivity, financial stability and carbon emissions. Future endeavors should also focus on how emerging technology, like AI, IoT, quantum computing, digital twins, blockchain and satellite technology, individually and collectively, can be used to assess climate risks, monitor the environment and to invest in sustainability.

The potential of CBDCs for green monetary policy, sustainable payment system and financial regulation in relation to climate change should also be explored in more detail. In the same way, future studies could investigate the role of digital financial platforms in promoting the circular economy in recycling, sustainable production, waste management, resource efficiency and restoration.

Special focus is also needed on the behavioural aspects of sustainable digital finance, such as consumer trust, awareness of the environment, intentions to invest in sustainable finance, financial literacy and the acceptance of digital technology among various demographic groups. This study provides a possible understanding of the gap between access to Green FinTech and sustainable financial behaviour.

Third, more future research is needed with truly multi-disciplinary methods that integrate economic, financial, environmental science, computer science, and public policy and behavioural psychology. This incorporation would offer a deeper insight into the role digital financial innovation can play in climate resilience and sustainable investment and inclusive economic development.

REFERENCES

1. Bank for International Settlements. (2021). *Project Genesis 1.0: Prototype digital platforms for green bond tokenisation*. BIS Innovation Hub.
2. Bank for International Settlements. (2022). *Project Genesis 2.0: Smart contract-based carbon credits attached to green bonds*. BIS Innovation Hub.
3. Bank for International Settlements. (2023). *BIS, COP28 and Central Bank of United Arab Emirates launch TechSprint to develop technological solutions for sustainable finance and combating climate change*. BIS.
4. Chouchene, M. R., Ben-Ammar, H., & Ben Jabeur, S. (2026). FinTech and the Sustainable Development Goals: Global evidence from economic, environmental, and social dimensions. *Journal of Environmental Management*, 400, 128725. <https://doi.org/10.1016/j.jenvman.2026.128725>
5. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
6. Ding, K., Li, J., & Wang, Q. (2023). Digital finance, government intervention, and carbon emission efficiency in China. *Environmental Science and Pollution Research*, 30, 119356–119371. <https://doi.org/10.1007/s11356-023-30730-2>
7. Financial Stability Board. (2017). *Recommendations of the Task Force on Climate-related Financial Disclosures*. FSB.
8. Freeman, R. E. (1984). *Strategic management: A stakeholder approach*. Pitman.
9. Geetha, S., & Biju, A. V. N. (2024). Is green FinTech reshaping the finance sphere? Unravelling through a systematic literature review. *Environmental Science and Pollution Research*, 31(2), 1790–1810. <https://doi.org/10.1007/s11356-023-31382-y>

10. Hasan, M., Hoque, A., Abedin, M. Z., & Gasbarro, D. (2024). FinTech and sustainable development: A systematic thematic analysis using human- and machine-generated processing. *International Review of Financial Analysis*, 95, 103473. <https://doi.org/10.1016/j.irfa.2024.103473>
11. Hossain, M. R., Rao, A., Sharma, G. D., Dev, D., & Kharbada, A. (2024). Empowering energy transition: Green innovation, digital finance, and the path to sustainable prosperity through green finance initiatives. *Energy Economics*, 136, 107736. <https://doi.org/10.1016/j.eneco.2024.107736>
12. International Energy Agency. (2023). *World energy investment 2023*. IEA.
13. International Monetary Fund. (2024). *FinTech applications for boosting climate finance*. *FinTech Notes*, 2024(008).
14. Jagannarayan, N., Gopani, M., & Uma, R. (2026). *Digital marketing and sustainable consumer behavior in India*. *Asian Basic and Applied Research Journal*.
15. Jagannarayan, N., Gopani, M., Uma, R., & Pandey, P. D. (2026). *Green banking as a strategic sustainability initiative: An empirical analysis*.
16. Jagannarayan, N., & Uma, R. (2026). *Green economics and household consumption in Maharashtra, India*. *Asian Research Journal of Current Science*.
17. Lu, F., Li, Z., & Zhang, S. (2023). Does digital finance development affect carbon emission intensity: Evidence from China. *International Review of Economics & Finance*, 88, 1272–1286. <https://doi.org/10.1016/j.iref.2023.07.036>
18. National Payments Corporation of India. (2024). *UPI product statistics*. NPCI.
19. Network for Greening the Financial System. (2019). *A call for action: Climate change as a source of financial risk*. NGFS.
20. Offiong, U. P., & Szopik-Depczyńska, K. (2025). FinTech innovations for sustainable development: A comprehensive literature review and future directions. *Sustainable Development*. <https://doi.org/10.1002/sd.70068>
21. Pazarbasioglu, C., Garcia Mora, A., Uttamchandani, M., Natarajan, H., Feyen, E., & Saal, M. (2020). *How countries can expand access to digital financial services*. World Bank.
22. Puschmann, T., & Khmarskyi, V. (2024). Green fintech: Developing a research agenda. *Corporate Social Responsibility and Environmental Management*, 31(4), 2823–2837. <https://doi.org/10.1002/csr.2675>
23. Qiao, C., Cai, W., & Chen, S. (2025). Green fintech contributes to environmental sustainability—Based on empirical evidence from China. *Humanities and Social Sciences Communications*, 12, 1895. <https://doi.org/10.1057/s41599-025-06159-y>
24. Razzaq, A., & Yang, X. (2023). Digital finance and green growth in China: Appraising inclusive digital finance using web crawler technology and big data. *Technological Forecasting and Social Change*, 188, 122262. <https://doi.org/10.1016/j.techfore.2022.122262>
25. Reserve Bank of India. (2023). *Framework for acceptance of green deposits*. Reserve Bank of India.
26. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
27. Sayari, S., Mgadmi, N., Ben Dhaou, I., Almedhar, M., Chishty, S. K., & Rabeh, A. (2025). Advancing sustainable development through digital transformation and FinTech innovation. *Sustainability*, 17(11), 4924. <https://doi.org/10.3390/su17114924>
28. Schulz, K., & Feist, M. (2021). Leveraging blockchain technology for innovative climate finance under the Green Climate Fund. *Earth System Governance*, 7, 100084. <https://doi.org/10.1016/j.esg.2020.100084>
29. Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Harvard University Press.
30. Wang, Y., Zhao, Z., Zhang, S., & Su, Y. (2023). Research on the impact of digital inclusive finance on regional carbon emissions: Based on the sustainable green innovation of small and medium-sized enterprises. *Journal of Cleaner Production*, 428, 139513. <https://doi.org/10.1016/j.jclepro.2023.139513>

31. World Bank. (2022a). *World Development Report 2022: Finance for an equitable recovery*. World Bank.
32. World Bank. (2022b). *World Bank Group global market survey: Digital technology and the future of finance*. World Bank.
33. Xiao, Y., Lin, M., & Wang, L. (2024). Impact of green digital finance on sustainable development: Evidence from China's pilot zones. *Financial Innovation*, 10, 10. <https://doi.org/10.1186/s40854-023-00552-9>
34. Zaid, M. A. K., Khan, M. F., Al-Mekhlafi, A.-W. A.-G. S., Al Koliby, I. S., Saoula, O., Saeed, H. A. E. M., & Mohammad, R. A. (2025). The future of green finance: How digital transformation and FinTech drive sustainability. *Discover Sustainability*, 6, 480. <https://doi.org/10.1007/s43621-025-01356-w>
35. Zhou, Y., Zhang, C., & Li, Z. (2023). The impact of digital financial inclusion on household carbon emissions: Evidence from China. *Journal of Economic Structures*, 12, 2. <https://doi.org/10.1186/s40008-023-00296-w>