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EXPLORING GREEN RESEARCH OPPORTUNITIES WITHIN THE FINTECH LANDSCAPE FOR SUSTAINABLE GROWTH

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ABSTRACT

Objective: This research aims to identify green research opportunities in fintech and develop a conceptual framework to support sustainable growth in the financial sector.

Research Design & Methods: This research uses a Systematic Literature Review (SLR) approach to collect, analyze, and evaluate relevant literature related to fintech, green finance, and sustainability from various reputable sources within the span of 2015-2024, with strict selection criteria to identify research gaps and develop an in-depth conceptual framework.

Findings: The study highlights the important role of FinTech in improving transparency, efficiency, and accountability in green finance, such as through green bonds and sustainable investment platforms. Fintech also expands financial inclusion, empowering diverse stakeholders to participate in the green economy. However, challenges such as data privacy, cybersecurity, regulatory gaps, and limited accessibility for smaller companies hinder its full potential. Overcoming these barriers requires multi-stakeholder collaboration, standardized data practices, and the development of green competencies.

Implications & Recommendations: These findings underscore the need for strong policy and industry collaboration to optimize the role of FinTech in sustainable finance. Investments in green competencies and innovative regulatory frameworks are recommended to enable the seamless integration of FinTech into green initiatives. Future research should explore the interactions between green job creation and FinTech advancements to advance sustainable development goals.

Contribution & Value Added: This research contributes to the understanding of the transformative potential of FinTech in achieving sustainable economic growth.

Keywords: FinTech, Sustainable Growth, Green Finance, Financial Inclusion.

JEL codes: G18, O16, Q56

Article type: research paper

INTRODUCTION

The topic of financial technology, commonly known as FinTech, has attracted significant interest from a diverse range of professionals in different sectors, as well as from researchers and market regulators. FinTech covers a broad spectrum of technological innovations applied in the financial domain (Alt et al., 2018; Jalal et al., 2024; Leong, 2018). Solutions within the FinTech sector address many areas, including payment systems, retail and mobile banking, consumer finance, crowdfunding, digital currency, treasury management, financial instrument trading, and financial or investment advisory services, among others (Zheng et al., 2023). By integrating digital technology into the financial system, fintech not only facilitates access to financial services but also promotes financial inclusion, which has a positive impact on social and environmental sustainability (Vergara & Agudo, 2021).

A broad definition of the FinTech sector can hinder a thorough analysis, prompting studies and discussions to adopt a more focused approach. These narrower perspectives often examine the FinTech sector from the perspective of an entity, deliberately excluding traditional financial service providers (Harasim & Mitreġa-Nieštrój, 2018). Among the various definitions, an object-oriented approach is also apparent; for example, the Basel Committee on Banking Supervision has suggested categorizing the FinTech sector into three product segments related to core banking services, alongside market support services related to innovation and new technologies, which are not directly related to banking services (Bank for International Settlements (BIS), 2018).

FinTech solutions are poised to play an important role in advancing established sustainable economic development priorities. Fintech enables the reduction of transaction costs and increased efficiency in fund management, ultimately contributing significantly to achieving the Sustainable Development Goals (SDGs) (Arner et al., 2019). Primarily, this technology helps reduce information asymmetry among investors interested in green financial products (Pawłowska et al., 2022). Fintech is important in facilitating green financing through transparent and efficient digital platforms, allowing investors to screen investment opportunities based on sustainability criteria such as ESG (Environmental, Social, Governance) (Elias et al., 2024). Furthermore, the FinTech sector improves access to capital for various pro-environmental initiatives by providing critical infrastructure. Therefore, it is important to recognize that the FinTech sector can facilitate the implementation of renewable energy projects, help establish climate funds or socially responsible investment portfolios, and promote the adoption of green bonds (Gilchrist et al., 2021; Kozar & Paduszyńska, 2024; Taghizadeh-Hesary et al., 2021).

However, while fintech's contribution to sustainability has been recognized, there is a lack of systematic exploration of the green research opportunities that can be further explored. Existing literature suggests that data privacy, regulatory risks, and technical uncertainties are still major obstacles in optimizing fintech's potential for green finance (Addy et al., 2024). In addition, previous research has often been fragmentary, focusing differently on technical or regulatory aspects without establishing a holistic relationship between fintech and green finance (Dar et al., 2024).

This article aims to identify sustainability-focused research areas discussed in academic papers related to FinTech. This is crucial as a better understanding of the relationship between fintech and green finance can help address sustainability challenges while paving the way for more environmentally friendly financial innovations (Nassiry, 2018). Therefore, this research aims to identify green research opportunities in fintech based on a review of previous literature. By analyzing findings from previous research, this study also aims to develop a relevant conceptual framework to support sustainable growth and green innovation in the financial sector (Rehman & Hossain, 2024). Through this approach, this research provides not only theoretical insights but also practical recommendations for policymakers, researchers, and industry players. This research will contribute to global efforts to create a more inclusive, transparent, and sustainable financial system.

LITERATURE REVIEW

Fintech Definition

Fintech is derived from the term financial technology. According to The National Digital Research Centre (NDRC) in Dublin, Ireland, fintech is defined as “innovation in financial services,” representing advancements in the financial sector incorporating modern technology. Fintech can be understood as applying digital technology to solve financial problems. Fintech encompasses an industry of companies that utilize technology to create more efficient financial systems and service delivery (Santi et al., 2017).

In terms of functional criteria, the fintech industry generally includes several key functions, such as online financial transactions, electronic money, virtual accounts, aggregators, lending institutions, crowdfunding, and personal financial planning. Fintech activities are closely related to financial services such as payments, transfers, clearing, and settlement (Gusriyani et al., 2024).

These activities are significantly related to mobile payments (both facilitated by banks and non-bank financial institutions), digital wallets, and similar services. The models developed in this sector aim to increase financial inclusion, ensure greater consumer access to payment services, and maintain the effective functioning of payment systems (Wibowo, 2016). Fintech or financial technology is defined as innovation in financial services powered by digital technologies, such as blockchain, artificial intelligence (AI), and the Internet of Things (IoT). Fintech has revolutionized how financial transactions are conducted, created efficiencies, and expanded access to financial services for previously marginalized communities (Vergara & Agudo, 2021).

Definition of green finance

Green finance refers to efforts to raise funds for projects that support environmental sustainability and a low-carbon economy. Examples include green bond issuance, renewable energy project financing, and carbon trading (Misra et al., 2024). Sustainability, in this context, encompasses economic, social, and environmental dimensions, aiming to meet the needs of the present without compromising the ability of future generations to meet their own needs (Elias et al., 2024). Green finance is a financial concept that emphasizes environmental sustainability in the investment decision-making process. It encompasses various financial instruments, such as green bonds, green loans, and equity investments, aimed at supporting environmentally friendly projects. Such projects include renewable energy, energy efficiency, waste management, and natural resource conservation. Green finance theory is rooted in the principle that integrating environmental considerations into financial decisions can encourage innovation, reduce environmental risks, and ultimately lead to sustainable economic growth. This concept is closely linked to the growing awareness of climate change and its adverse environmental impacts. The Intergovernmental Panel on Climate Change (IPCC) report highlights the urgency of reducing greenhouse gas emissions to prevent global temperatures from rising more than 1.5°C above pre-industrial levels. Green finance plays an important role in financing the transition to a low-carbon economy by directing capital to projects that support climate change mitigation and adaptation. Financial instruments such as green bonds have experienced significant growth in recent years, reflecting investors' commitment to sustainable initiatives. From a theoretical perspective, green finance can be linked to the triple bottom line (TBL) theory, which measures corporate success based on three key elements: profit, people, and the planet. According to Elkington, J. (1997), TBL emphasizes that companies have a responsibility to not only generate financial benefits but also create a positive impact on society and the environment (Rangkuti, 2024).

Sustainable Economic Development

Sustainability refers to efforts that aim to improve the social and environmental performance of present generations without compromising the ability of future generations to meet their own social and environmental needs (Hart & Milstein, 2003). Another interpretation of sustainable economic development is an activity that seeks to meet the needs of the present without jeopardizing the needs of future generations, emphasizing environmental capacity, the achievement of social justice, and the sustainability of economic and environmental systems (Solechah & Sugito, 2023). Economic development is characterized as a process of economic growth in developing countries, which involves an increase in total output and per capita income alongside fundamental changes in the structure of their economies. These changes typically include a shift in focus from agricultural activities to the industrial sector, migration of labor from rural areas to urban centers and industrial areas, reduced dependence on imports for more advanced producers, and support from other countries that provide investment funds and encourage economic development to improve living standards and overall well-being (Hartika, 2020). Based on the literature review that has been formulated above, conclusions can be drawn including how the role of fintech in encouraging the application of green finance and economic sustainability, especially in the context of green investment, and how synergies between regulation, financial technology innovation, and financial inclusion can accelerate the adoption of sustainable investment in the economic sector.

METHODS

This research employed the Systematic Literature Review (SLR) method, chosen to systematically and comprehensively analyze existing literature on the intersection of fintech, green finance, and sustainability. The literature was sourced from reputable databases, including Scopus, Web of Science, ScienceDirect, and Google Scholar, as well as industry reports from financial institutions and policy papers from international organizations. The search process incorporated a combination of keywords such as “fintech and green finance,” “sustainable financial innovation,” and “financial inclusion and ESG.” To ensure the relevance and quality of the selected studies, predefined inclusion and exclusion criteria were applied. The inclusion criteria encompassed research published between 2015 and 2024 in high-impact journals, peer-reviewed conference proceedings, and authoritative reports addressing green financial innovation, financial inclusion, or the sustainability impact of fintech. Conversely, studies with limited empirical evidence, non-peer-reviewed sources, or lacking direct relevance to fintech’s role in sustainability were excluded.

Following the selection process, 11 highly relevant studies were identified and categorized into three primary themes: green financial innovation, financial inclusion and ESG adoption, and regulatory and policy frameworks. The first category examined the role of fintech solutions, such as blockchain and digital lending, in promoting sustainable investments. The second explored how fintech contributes to expanding financial accessibility while aligning with environmental, social, and governance (ESG) criteria. Lastly, the third category analyzed the impact of regulations on the development and adoption of sustainable fintech models. Data analysis was conducted to map these themes to the research problem, synthesize key insights, and identify knowledge gaps in the existing literature. This structured methodological approach not only provides a comprehensive understanding of fintech’s contribution to sustainable economic development but also establishes a foundation for future research in the field.

Table 1. Summary of Research on Fintech and Green Finance: Methods and Key Findings

No	Author	Research Methods	Research Results
1.	(Vergara & Agudo, 2021)	Literature and case studies	Fintech supports sustainability through platforms that promote transparency, accountability, and resource optimization, as well as mitigate greenwashing.
2.	(Elias et al., 2024)	Literature analysis and case studies	Technologies such as AI, IoT, and blockchain enhance ESG assessment, sustainable investment, and green lending practices.
3.	(Dar et al., 2024)	Bibliometric and network analysis	Green finance accelerates the transition to a low-carbon economy by amplifying the positive impact of fintech on environmental conservation and economic efficiency.
4.	(Misra et al., 2024)	Literature review based on inclusion and exclusion criteria	Fintech is accelerating fundraising for sustainable energy projects through technologies such as blockchain and IoT.
5.	(Addy et al., 2024)	Data-driven approach (big data analytics, machine learning)	Fintech is facilitating data-driven green investment decisions, although challenges such as data privacy and regulatory standards remain.
6.	(Nassiry, 2018)	Literature study	Blockchain and fintech support green finance through carbon trading, renewable energy, and decentralized market implementation.
7.	(Macchiavello & Siri, 2020)	Policy analysis and literature review	Fintech can address gaps in the sustainable finance framework, such as access to retail financing and ESG verification.
8.	(Wang et al., 2024)	Survey data and econometric approach	Fintech reduces corporate carbon emissions through improved energy efficiency and green innovation.

No	Author	Research Methods	Research Results
9.	(Anwar et al., 2024)	Regression and mediation analysis	Fintech supports sustainability by reducing carbon emissions through the integration of financial technology innovation and regulation.
10.	(Rehman & Hossain, 2024)	SEM-ANN (Structural Equation Modeling-Intelligent Neural Network)	Green finance and digital transformation play an important role as mediators in the relationship between fintech adoption and sustainability in the banking sector.
11.	(Muganyi et al., 2021)	Panel data analysis and Semi-parametric Difference-in-Differences method	China's green finance policy significantly reduced industrial gas emissions with fintech support in environmental investment management.

RESULT

Research on the relationship between fintech, green finance, and sustainable development further confirms that fintech plays a strategic role in driving the transformation of the global economy towards sustainability. Vergara & Agudo (2021), through a literature review and case study approach, highlighted that fintech-based platforms improve transparency, accountability, and efficiency in green finance. For example, blockchain is used to permanently record carbon credit transactions, ensuring data is immutable and easily verifiable. This is important to prevent greenwashing practices, where companies claim sustainability without any real evidence. For example, carbon trading projects in the European Union have integrated blockchain technology to track carbon footprints, reducing the risk of data manipulation.

Technologies such as AI, IoT, and blockchain play a significant role in supporting ESG assessments, driving sustainable investments, and facilitating green financing (Elias et al., 2024). For example, fintech companies like Clim8 Invest use AI to screen green projects based on ESG data, helping investors choose initiatives that truly contribute to sustainability. IoT also enables real-time monitoring of energy efficiency, such as in large-scale solar panel installations in India that use this technology to measure energy production and detect breakdowns, thereby improving operational efficiency. In addition, green finance accelerates the transition to a low-carbon economy by harnessing the potential of fintech to improve economic efficiency and environmental sustainability (Dar et al., 2024). In China, apps like Alipay's Ant Forest encourage individuals to reduce carbon emissions through digital incentives that are converted into tree planting, combining technology with sustainability initiatives (Dar et al., 2024). Technologies like blockchain also accelerate fundraising for sustainable energy projects (Misra et al., 2024). For example, the CrowdfundRES project in Europe allows small investors to contribute to the construction of wind farms through blockchain-based crowdfunding, providing greater transparency in the allocation of funds and increasing investor confidence. Fintechs are also utilizing big data analytics and machine learning to support data-driven green investment decisions, as done by MSCI, to evaluate environmental risks in investment portfolios (Addy et al., 2024). However, challenges such as data privacy and inconsistent regulatory standards are still obstacles that need to be overcome.

In the context of carbon trading and renewable energy markets, blockchain provides better efficiency through platforms like Power Ledger (Nassiry, 2018). The platform allows users to trade solar energy directly, encouraging household investment in renewable energy, and has been adopted in Australia and other countries. In addition, fintech is able to address gaps in sustainable financing, as seen with the Kiva platform that uses peer-to-peer lending to provide access to microfinance for smallholder farmers in developing countries, helping them adopt sustainable agricultural practices (Macchiavello & Siri, 2020). Fintech plays an important role in supporting sustainability by reducing carbon emissions through technological innovations such as the Internet of Things (IoT). These technologies allow companies to monitor energy usage in real time, identify waste, and optimize operations. In the heavy industry sector in Europe, the adoption of IoT has helped companies such as steel producers improve energy efficiency, replace inefficient equipment,

and significantly reduce their carbon footprint (Wang et al., 2024). These innovations not only provide environmental benefits but also greater economic efficiency. In addition, the synergy between financial technology and regulation is a key factor in accelerating the adoption of green solutions. In the Netherlands, digital banks that adopt Environmental, Social, and Governance (ESG) standards prioritize financing for green projects, such as renewable energy and energy efficiency. This policy not only reduces carbon emissions but also improves the bank's reputation in the eyes of consumers who care about sustainability issues. With strong regulatory support, banks can ensure that the investments they make actually support green projects that have a positive impact on the environment (Anwar et al., 2024).

Digital transformation through platforms like bKash in Bangladesh also proves the effectiveness of fintech in supporting sustainability. The platform enables the distribution of funds for renewable energy projects, such as solar and wind power plants, in a more efficient manner. In addition, bKash expands financial access for communities previously excluded from the formal financial system, supporting the transition to a more inclusive green economy. With this approach, green projects become easier to fund, operational efficiency increases and sustainability becomes easier to achieve, especially in developing countries (Rehman & Hossain, 2024). In China, green finance policies supported by fintech applications have had a real impact on reducing greenhouse gas emissions. Green finance programs in heavy industry sectors, such as steel, use technology to track and control the environmental impact of production processes. By using fintech applications to calculate carbon footprints, companies can ensure that their operations meet stringent environmental standards. Incentives provided to companies that successfully reduce emissions have accelerated the adoption of more sustainable business practices, supporting national goals for emissions reduction and providing concrete examples of the success of this policy (Muganyi et al., 2021).

Overall, this study shows that fintech, supported by innovative technologies and appropriate policies, can provide real solutions to reduce carbon footprints and promote sustainable development. With technologies such as IoT, blockchain, and digital platforms supporting green finance, the industry and financial sector can move towards sustainability in a more efficient and transparent manner. Furthermore, the collaboration between fintech and regulatory policies that support green projects provides strong incentives and frameworks to accelerate the transition to a more inclusive and sustainable low-carbon economy. With this evidence, it is clear that fintech has a strategic role to play in supporting global sustainability. However, optimizing this role requires close collaboration between governments, the private sector, and society. The implementation of technology needs to be supported by a robust regulatory framework, as well as innovations that can address challenges such as financial inclusion, data privacy, and uniform sustainability standards.

Conceptual model underlines the strategic role of fintech as a bridge between green finance and sustainable development. With a three-layer approach, namely Input Layer, Process Layer, and Output Layer, this framework offers a holistic view to understand how financial technology can be integrated with sustainability initiatives to achieve significant economic, social, and environmental impacts. At the Input Layer, three key elements underpin the operation of this model: digital technology, regulation, and digital financial infrastructure. Digital technologies such as blockchain, artificial intelligence (AI), and the Internet of Things (IoT) are not just innovative tools but are transformative pillars for increasing transparency, efficiency, and accountability in green finance. For example, blockchain enables a more secure verification process in carbon trading, ensuring accurate data and preventing fraud. IoT, on the other hand, provides smart solutions for managing energy efficiently in green projects such as renewable energy. Beyond the technological aspect, regulation plays a critical role by creating a supportive ecosystem through environmental, social, and governance (ESG) standards, as well as fiscal incentives, such as tax breaks for investments in renewable energy. Digital financial infrastructure complements this layer by providing more inclusive financial access through e-payment platforms, crowdfunding, and micro-lending, which help marginalized communities engage in green economic activities.

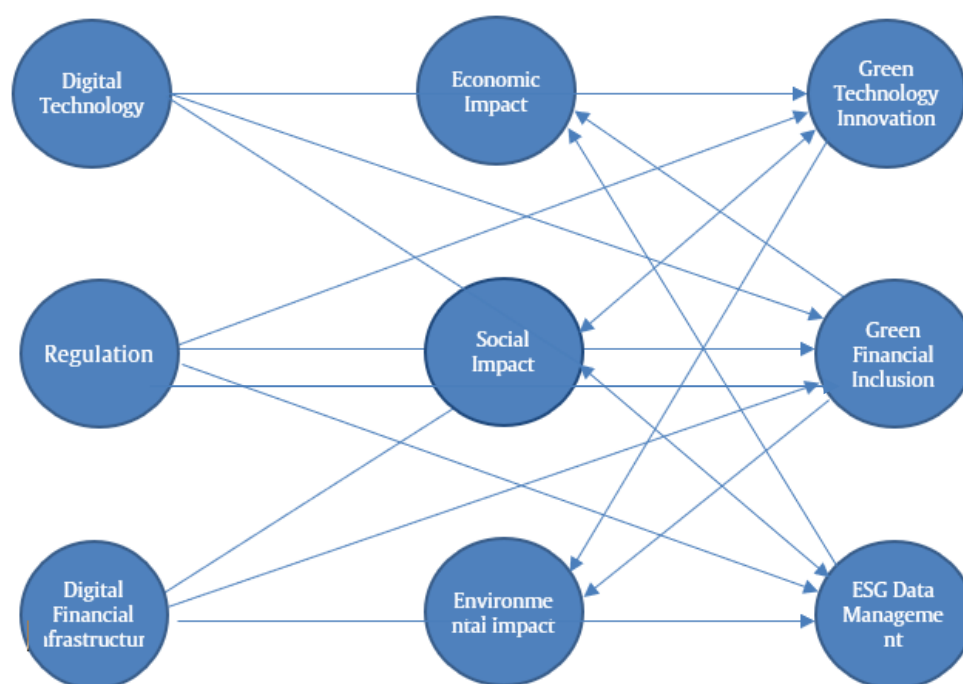


Figure 1. Conceptual model of the relationship between fintech and sustainable development through a green perspective.

In the Process Layer, core mechanisms function to translate inputs into concrete actions. Green Technology Innovation emphasizes the application of advanced technologies such as IoT and blockchain to create solutions that enhance energy efficiency, facilitate more transparent carbon trading, and support the development of sustainable green projects. Green Financial Inclusion expands financial access through digital technology, enabling communities in remote areas to participate in green investments while strengthening economic and social inclusion. Meanwhile, ESG Data Management leverages AI and data analytics to monitor environmental risks, measure social impact, and ensure accountability in green projects, thereby assisting policymakers and industry players in making more informed, data-driven decisions.

In the Output Layer, the results of this process are reflected in real impacts on the three main dimensions of sustainable development: economic, social, and environmental. Economically, fintech is able to reduce carbon trading transaction costs by up to 20%, increase the efficiency of financial resource allocation, and encourage more targeted green investments. From a social perspective, this model expands financial inclusion and strengthens social justice by opening access to financial services to previously unserved communities while reducing economic disparities. From an environmental perspective, positive impacts are seen in significant reductions in carbon emissions through the adoption of green energy projects, more efficient supply chain management, and reduction of unsustainable exploitation of natural resources.

This model not only provides a conceptual view of the role of fintech in supporting green finance but also offers a practical approach to maximize the potential of financial technology as a catalyst for global sustainability. By providing technology- and data-driven solutions to sustainability challenges, this model enables the development of more measurable and impactful strategies. On a larger scale, this model can be used as a primary reference by policymakers, industry players, and academics in integrating fintech with sustainable development initiatives, creating synergies between technological innovation, financial inclusion, and environmental protection. Thus, this framework is a concrete step towards achieving a global vision for holistic and inclusive sustainable development.

DISCUSSION

The Role of FinTech and Green Competence in Sustainable Economic Transformation

Greening the financial sector, which plays a crucial role in capital allocation within the real economy, is a significant step toward achieving a more sustainable economy (Gilchrist et al., 2021; Ioan et al., 2020). As a result, there has been a noticeable increase in the emergence of green-labeled financial instruments. This includes a wide range of green loans and green bonds that have grown rapidly in recent years. In addition, discussions around FinTech are increasingly associated with the transformation of the green economy, highlighting its potential to improve the sustainability of financial practices. Some studies have even introduced the concept of green FinTech, which combines financial technology with sustainable economic practices that aim to address environmental challenges on a global and regional scale.

Effective implementation of FinTech in this green context requires employees within financial institutions to have specific competencies, often referred to as green competencies (Kozar & Paduszyńska, 2024; Subramanian et al., 2016). Therefore, individuals who possess these competencies and are assigned to manage green financial instruments or green FinTech can be classified as green job holders. The topic of green jobs is a significant area of research, which is explored by many scholars across different sectors of the economy (Sulich & Kozar, 2023). However, the authors of this article recognize that the exploration of green jobs within financial institutions is limited, posing a challenge for future research efforts. It is important to distinguish within the broader category of green jobs those jobs that can be classified as green-gold jobs, which are key positions responsible for the effective operation of green FinTech or the management of green financial instruments. It will be possible to gain insights into how FinTech, particularly green FinTech, can impact the development of green labor markets, with green jobs being a particularly important component.

The bibliometric analysis conducted in this article can be integrated into a broader set of studies examining FinTech-related topics. However, the analysis presented here is distinguished from previous studies by its research objectives, which focus on identifying green research domains and establishing bibliometric investigations. It is important to note that the chosen analytical framework, the content of the bibliometric investigation, and the research methodology used are limitations of this study and are factors that influence the results obtained. Therefore, choosing alternative databases, modifying the structure of the bibliometric investigation, or changing the research methodology may result in different analytical results.

Innovations in Financial Technology for Sustainable Investment

In recent years, the financial sector has undergone an important transformation towards sustainable investment practices, largely influenced by the increasing recognition of environmental, social, and governance (ESG) factors among investors. Innovations in financial technology have been instrumental in supporting this shift by utilizing advanced technologies to evaluate sustainability risks and opportunities, create sustainable investment platforms, and screen investments according to ESG standards. This article discusses various fintech innovations that enable investors to make informed decisions and direct capital to environmentally and socially responsible projects.

Big data involves large amounts of structured and unstructured data generated at an incredible speed from various sources, such as social media, sensors, and financial transactions. In the realm of sustainable finance, the application of big data analytics enables investors to gain deeper insights into sustainability-related risks and opportunities by examining data related to environmental, social, and governance factors. Fintech companies use big data analytics to evaluate environmental risks, including climate change, pollution, and resource scarcity. By examining data related to carbon emissions, water consumption, and waste production, investors can determine which companies and sectors are vulnerable to environmental threats and integrate these findings into their investment strategies (Addy et al., 2024; Gupta & Rani, 2019; Ikegwu et al., 2022).

In addition, big data analysis is essential for assessing social impacts, such as labor practices, human rights violations, and community relations. Fintech platforms leverage social media insights, employee feedback, and news reports to assess an organization's social performance and exclude those with an unsavory social history. Additionally, fintech innovations empower investors to analyze corporate governance practices by reviewing data on board diversity, executive pay, and shareholder rights. By evaluating governance elements, investors can identify companies with strong corporate governance frameworks, thereby reducing the risk of governance-related disputes (Aizenberg & van den Hoven, 2020).

Fintech companies have created online investment platforms that give investors access to a wide array of sustainable investment options, such as green bonds, environmentally, socially, and governance-focused exchange-traded funds (ETFs), and impact investment portfolios. These platforms facilitate easy access to a wide range of sustainable investment opportunities and allow investors to customize their portfolios according to their individual preferences and risk appetite. Robo-advisors, which are automated investment platforms that use algorithms, offer personalized investment guidance and portfolio management services. Fintech companies have incorporated ESG criteria into the algorithms of robo-advisors, enabling investors to build sustainable investment portfolios that reflect their values and financial goals. In addition, robo-advisors provide real-time monitoring and reporting of ESG performance, allowing investors to assess the impact of their investments over time. Innovations in fintech have also resulted in a mobile app that allows investors to make sustainable investment choices on the move (Arner et al., 2020; Hoang et al., 2022; Vergara & Agudo, 2021). These apps offer access to ESG ratings, impact assessments, and sustainability news, thus ensuring that investors stay informed about the latest trends in sustainable finance and can make informed investment decisions.

Fintech companies are increasingly incorporating Environmental, Social, and Governance (ESG) criteria into their investment evaluation process to determine organizations that demonstrate strong performance in these areas. By integrating ESG considerations into their investment strategies, investors can reduce potential risks, improve long-term financial returns, and drive beneficial social and environmental impacts. Innovations in fintech facilitate investment screening across a range of ESG factors, such as carbon emissions, diversity and inclusion, and ethical supply chain management. Sophisticated data-driven screening tools utilize advanced analytics and machine learning techniques to process vast data sets and identify companies that fit specific sustainability benchmarks. In addition, the fintech platform increases transparency and provides detailed reporting on ESG performance, enabling investors to evaluate the sustainability profile of their portfolio (Du et al., 2022; Liu et al., 2021; Macchiavello & Siri, 2020). Offering access to ESG ratings, impact assessments, and sustainability indicators, fintech companies empower investors to make informed decisions about their investments.

Challenges and Factors to Consider

While the financial sector is increasingly adopting data-driven approaches to drive sustainability and scale up green finance initiatives, challenges and considerations arise that require thorough examination. This article discusses the complex issues relating to data privacy and security, regulatory compliance, and the critical need for collaboration and standardization in the realm of fintech innovation supporting green finance. Data privacy relates to the protection of individuals' personal information, while data security focuses on protecting data from unauthorized access, disclosure, and misuse. In the data-driven sustainability space, it is critical to adequately protect sensitive environmental information, including carbon emissions, biodiversity data, and renewable energy yields, to mitigate the risk of privacy breaches and cyber threats (Ali et al., 2020; Bibri, 2021; Remolina, 2020).

Fintech companies face various obstacles in managing sensitive environmental data, such as data collection, storage, processing, and sharing. The decentralized nature of environmental data sources, as well as the huge volume and variety of data, make it difficult to maintain data privacy and security throughout its lifecycle. The rise of data breaches and cyberattacks presents a major

risk to the privacy and security of environmental data. Cybercriminals can exploit vulnerabilities in fintech platforms and systems to access sensitive environmental information or disrupt critical infrastructure, leading to financial losses, reputational damage, and legal repercussions for companies and their clients. Regulatory requirements on data privacy, cybersecurity, ESG reporting, and sustainable finance differ significantly across jurisdictions, creating compliance difficulties for fintech companies. Complying with these regulatory standards incurs substantial costs and resource constraints, especially for startups and small and medium-sized enterprises (SMEs). These compliance costs include costs associated with regulatory research, legal advice, compliance training, and necessary technology upgrades, which can strain already limited budgets and stifle innovation in green finance.

In addition, regulatory uncertainty and ambiguity further complicate compliance for fintech companies as regulations around data-driven sustainability and green finance continue to evolve and differ across jurisdictions (Kozar & Paduszyńska, 2024). Lack of clarity in the regulatory framework can result in confusion, misinterpretation, and regulatory arbitrage, which can undermine investor confidence and hinder market growth. It is critical for stakeholders, including fintech companies, financial institutions, regulators, policymakers, industry associations, and environmental organizations, to collaborate in order to address common challenges and drive sustainable finance. By joining forces, these stakeholders can exchange knowledge, best practices, and resources to create comprehensive solutions that align environmental, social, and economic goals. Standardizing data and reporting frameworks is essential to increase transparency, comparability, and reliability in data-driven sustainability and green finance. Implementing standardized data formats, metrics, and methodologies will promote interoperability, facilitate data exchange, and enable benchmarking across fintech platforms and financial institutions, empowering investors to make informed decisions and achieve positive environmental outcomes. Collaborative initiatives and partnerships are critical to promoting data-driven sustainability and green finance. Initiatives such as the Task Force on Climate-related Financial Disclosures (TCFD) exemplify this collaborative approach.

CONCLUSION

FinTech and green competencies have a strategic role to play in the transformation of a sustainable economy by catalyzing the integration of technology and sustainability practices. Innovations such as blockchain, AI, IoT, big data analytics, ESG-based robo-advisors, and sustainable investment platforms have increased transparency, efficiency, and accountability in green finance. In addition, FinTech is expanding financial inclusion by enabling people from all walks of life to participate in the green economy. However, challenges such as data privacy, cybersecurity, cross-jurisdictional regulations, and limited access for small companies remain barriers that need to be addressed through multi-stakeholder collaboration, data standardization, and strengthened regulatory frameworks. Optimal adoption of green FinTech can accelerate the achievement of sustainable development goals, strengthen financial inclusion, and create significant green economic impact globally. It also requires investment in green competency development as well as close collaboration between industry players, policymakers, and technology developers to produce innovative, scalable, and impactful solutions across economic, social, and environmental dimensions.

Future research should explore empirical studies on FinTech's role in carbon reduction, particularly its impact on carbon credit markets, emissions tracking, and sustainable investment behavior. Comparative studies across different regulatory environments can provide insights into best practices for balancing innovation and risk mitigation. Moreover, investigating the socio-economic effects of green FinTech adoption, including its influence on marginalized communities and small businesses, can offer valuable perspectives on achieving inclusive and scalable sustainability solutions. Optimal adoption of green FinTech requires investment in green competency development and close collaboration between industry players, policymakers, and

technology developers to generate innovative, impactful solutions across economic, social, and environmental dimensions.

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