



FINTECH, SUSTAINABLE FINANCE, AND FINANCIAL INCLUSION: A SYSTEMATIC LITERATURE REVIEW

Reni Nur Arifah¹⁾, Danis Prihanti²⁾, Putri Aryo JFK³⁾, Rizqa Mayla Azzahra⁴⁾

^{1,2,)} Management, Agung Putra University, Semarang, Indonesia

¹⁾ reniarifah@apu.ac.id (*), ²⁾ putriaryo@apu.ac.id, ³⁾ danisprihanti97@gmail.com, ⁴⁾ missrizz05@gmail.com

ARTICLE HISTORY

February 28, 2026

Revised

August 22, 2026

Accepted:

August 26, 2026

Online available:

September 01, 2026

Keywords:

FinTech, Sustainable Finance, Financial Inclusion

*Correspondence:

Name: Reni Nur Arifah

E-mail: reniarifah@apu.ac.id

Editorial Office

Ambon State Polytechnic
Center for Research and
Community Service
Ir. M. Putuhena Street, Wailela-
Rumahtiga, Ambon
Maluku, Indonesia
Postal Code: 97234

ABSTRACT

Introduction: This study aims to analyze the relationship between Financial Technology (FinTech), sustainable finance, and financial inclusion through a systematic literature review of relevant national and international studies.

Methods: The research applies a qualitative approach using a systematic literature review method of 86 Scopus-indexed scientific articles discussing FinTech innovation, the implementation of Environmental, Social, and Governance principles, and digital transformation in supporting green finance and sustainable development.

Results: The findings indicate that FinTech plays a significant role in expanding access to financial services for unbanked and underbanked populations, improving transaction efficiency, and strengthening sustainable finance practices through data transparency, green financing mechanisms, and carbon emission tracking based on digital technologies such as blockchain and artificial intelligence. Furthermore, FinTech contributes to accelerating the achievement of Sustainable Development Goals by facilitating environmentally friendly investments and microfinancing for green projects. However, several challenges remain, including regulatory fragmentation across countries, cybersecurity risks, and the lack of standardized global Environmental, Social, and Governance metrics. This study concludes that collaboration among governments, financial institutions, regulators, and technology industry actors is essential to optimize the potential of FinTech in building an inclusive, innovative, and sustainable financial system.

INTRODUCTION

Two major forces, the digital revolution and environmental awareness, are transforming the global financial system. Conversely, by offering unprecedented speed, efficiency, and convenience, FinTech has transformed conventional finance (Arifah et al., 2025). Transactions has become cheaper, access has become faster, and geographical barriers have been reduced for previously underserved groups. However, empirical evidence shows that FinTech's impact on financial inclusion is positive but inconsistent across countries and groups; while access has improved, many differences and limitations remain (Cevik, 2025). Conversely, global issues such as the economic crisis, social inequality, and climate change have prompted the international community to adopt sustainable finance principles as a new way to invest and channel capital (WRI Indonesia).

Published by P3M Ambon State Polytechnic

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Financial inclusion continues to be a prominent issue in Indonesia. Data released by the Financial Services Authority (OJK) indicates that the national financial inclusion index reached 85.10% in 2022, before standing at 75.02% in 2024. Despite this progress, significant challenges persist in expanding access to financial services, particularly for unbanked and underbanked populations in underdeveloped, frontier, and outermost (3T) regions (OJK, 2024). At the same time, as an archipelagic country that is highly susceptible to climate change impacts, Indonesia's commitment to achieving the Sustainable Development Goals (SDGs) and Net Zero Emissions by 2060 requires a substantial reallocation of capital from extractive economic sectors toward more sustainable and inclusive activities (Yunita et al., 2023; Luthfyana, 2025).

Fintech offers a potential solution to various financial challenges by lowering transaction costs, increasing access to remote areas, and providing real-time data (Hasan et al., 2024). Fintech not only simplifies transactions but also plays a role in supporting sustainability, such as connecting MSMEs with funding sources through peer-to-peer (P2P) platforms (Suryani et al., 2025). Furthermore, investment applications facilitate the channeling of funds to ESG-based instruments and support the financing of renewable energy projects (Butu et al., 2021). Innovations such as digital green bonds demonstrate the potential integration between fintech and sustainable finance (J. Huang et al., 2024).

At the same time, the sustainable finance agenda encompassing green financing, environmentally focused financial instruments, and the incorporation of ESG criteria has attracted increasing global attention as a means of advancing the Sustainable Development Goals (SDGs). Financial technology offers significant opportunities to enhance sustainable finance practices by improving data transparency, enabling emissions monitoring, supporting green microfinance initiatives, and providing digital capital market products that link retail investors with sustainable projects (Hasan et al., 2024).

FinTech's development and contribution to financial inclusion and sustainable finance are inseparable from the role of key technologies such as artificial intelligence and blockchain. Artificial intelligence enables large-scale financial data processing to support risk analysis, more inclusive financing feasibility assessments, and real-time, data-driven decision-making. Meanwhile, blockchain technology plays a role in increasing transparency, accountability, and reliability of financial data through a secure and tamper-proof recording system, including tracking green financing and ESG-labeled financial instruments. The integration of these two technologies strengthens FinTech's role as an enabler of a digital financial system that is not only efficient but also inclusive and sustainable.

However, the extent to which the synergistic relationship between Fintech, sustainable finance, and financial inclusion is understood remains unclear. Numerous studies have been conducted, but their findings are scattered and need to be synthesized to provide a comprehensive picture. Some studies may focus on Fintech's role in inclusion, while others examine its impact on environmental aspects. Therefore, a comprehensive literature review is needed to summarize, analyze, and conclude the empirical and conceptual findings from various previous studies.

Based on the above description, this literature review, titled "Fintech, Sustainable Finance, and Inclusion: A Literature Review," is highly relevant. This research aims to provide a solid theoretical foundation, identify research gaps, and provide recommendations for policymakers, industry players, and future researchers on how to harness the potential of Fintech to create a financial system that is not only inclusive but also sustainable for all.

LITERATURE REVIEW

Fintech

Financial technology, commonly referred to as FinTech, represents innovation within the financial services sector. According to the National Digital Research Centre (NDRC) in Dublin, Ireland, FinTech is defined as a form of financial service innovation characterized by continuous developments in the financial industry driven by advancements in modern technology (Zuliansyah et al., 2022). Broadly, FinTech encompasses a wide range of technology-based financial innovations that give rise to new business models, applications, processes, or products with substantial effects on financial markets and institutions. This perspective is consistent with the view that FinTech functions as a transformative tool or approach that enhances the speed, efficiency, affordability, and accessibility of financial services (Gomber et al., 2017).

Various literature studies indicate that fintech not only presents a new way of providing financial services but also causes significant disruption to the banking system and the traditional financial industry. Through digital technology, fintech is able to provide a variety of services such as electronic payments, investments, online loans, fund transfers, digital financial planning, and even comparisons of various financial products, making it easier for consumers to access and manage their finances more efficiently (Aryo et al., 2025) .

Financial technology (FinTech) has evolved through a lengthy process that integrates technological advancements with contemporary financial systems. Its progression can be categorized into three distinct stages. The initial stage, referred to as FinTech 1.0 (1866–1967), signified the early phase of financial digitalization, characterized by the introduction of telegraph-based communication, interbank transfer mechanisms, and automated teller machines (ATMs). The subsequent stage, FinTech 2.0 (1967–2008), was defined by the rise of computerized systems and internet-enabled banking services that facilitated rapid and efficient international transactions. The most recent stage, FinTech 3.0 (2008–present), accelerated following the global financial crisis and is distinguished by the growth of non-bank startups delivering digitally driven financial services, including mobile payment platforms, peer-to-peer (P2P) lending, crowdfunding, and blockchain-based financial solutions (D.W. Arner et al., 2015).

In general, Fintech has brought significant disruption to the traditional financial system by providing efficiency, transparency, and easy financial access for the public. The main forms of Fintech include digital payments and remittances (such as digital wallets and cross-border payment systems), online financing and lending (including P2P lending and crowdfunding), digital wealth and asset management (such as robo-advisory), digital fundraising (through equity crowdfunding or initial coin offerings), and financial market innovations including Insurtech, Regtech, and financial data analytics. This diversity of forms demonstrates that Fintech not only facilitates transactions but also expands financial inclusion, improves market efficiency, and supports the growth of a more open digital economy.

Classification and Forms of Fintech

1. Fintech has a very broad scope, which can be classified based on its service segments. According to Arner, Barberis, & Buckley (2015), In their publication in the University of Hong Kong Faculty of Law Research Paper No. 2015/036, they comprehensively identified several main categories of Fintech, including: Payments and Fund Transfers: This includes digital wallet applications (e-wallets) such as GoPay, OVO, and Dana. This payment technology has revolutionized the retail payment system by reducing reliance on cash and increasing economic efficiency (Ozili, 2018) .
2. Lending & Funding: This category is dominated by peer-to-peer (P2P) lending platforms such as Akseleran and Amarta. Research by Maskara et al. (2021) shows that P2P lending platforms can address market failures by providing credit access to those underserved by traditional banking while also offering investment alternatives for lenders.
3. Digital Banking : The presence of digital banks such as Jago, Blu, and Seabank represents the digitalization of core banking services.
4. Insurance Technology (Insurtech): Insurtech leverages technologies such as the Internet of Things (IoT) and big data to transform traditional insurance business models.
5. Investment Management and Robo-Advisors: These services use algorithms to provide investment advice and manage portfolios automatically at affordable costs. According to Bonelli & Dongul (2023) in their journal, robo-advisors have opened up access to more inclusive and efficient investment services, making investing more democratic and accessible to all levels of society through FinTech innovation.
6. These enabling technologies include fundamental technologies such as blockchain and distributed ledger technology (DLT), which underpin many fintech innovations. Kou & Lu (2025) stated in their research that While blockchain/DLT holds significant potential to ensure transaction security, transparency, and efficiency, challenges such as scalability and regulation remain. It's important to emphasize that supporting technology is an integral part of fintech innovation.

The Role of Artificial Intelligence and Blockchain in Digital Financial Management

The development of digital financial management is increasingly supported by Artificial Intelligence (AI) and blockchain technologies, which not only improve the efficiency and reliability of financial processes but also

create mechanisms that can strengthen financial inclusion and sustainable finance. Artificial Intelligence enables automated transaction recording, financial data classification, cash flow analysis, risk assessment, and the preparation of data-driven financial reports. These capabilities allow businesses, particularly MSMEs, to obtain more accurate and timely information for financial decision-making, improve financial planning, and support more efficient resource allocation. By improving data analysis, credit assessment, and the accessibility of financial services, AI can also help underserved businesses and individuals overcome barriers to formal financial services and contribute to financial inclusion and sustainable development (Makore, 2024)

Meanwhile, blockchain and Distributed Ledger Technology (DLT) strengthen the transparency, security, traceability, and reliability of financial transaction data through decentralized and tamper-resistant recording systems. These features are particularly relevant to sustainable finance because transparent and traceable financial information can support the monitoring and verification of funds allocated to environmentally and socially responsible activities. Blockchain can therefore contribute to greater accountability in green financing and ESG-oriented financial transactions by reducing information asymmetry and improving the traceability of financial flows (Ren et al., 2023). In the context of financial inclusion, blockchain-based financial services can also improve the authenticity of credit information and expand access to financing for underserved borrowers, although the effectiveness of such systems depends on appropriate institutional and technological conditions (Galanti & Özsoy, 2023).

The integration of AI and blockchain further strengthens these mechanisms. AI can analyze large volumes of financial data to identify risks, assess financing needs, and support more inclusive decision-making, while blockchain provides a secure and transparent infrastructure for recording and verifying financial transactions. Their complementary capabilities can improve the efficiency, transparency, and accountability of digital financial systems while simultaneously supporting broader access to financial services and the development of sustainable financing mechanisms. Recent systematic evidence indicates that digital innovations, including AI and blockchain, can facilitate the nexus between financial inclusion and sustainable finance, although their benefits depend on appropriate governance, risk management, and institutional safeguards (Mamun & László, 2025). Thus, the integration of AI and blockchain positions digital financial management not merely as an operational tool for improving financial efficiency, but also as an enabling mechanism for advancing financial inclusion and sustainable finance.

Sustainable Finance

A sustainable financial system is defined not solely by its pursuit of economic returns but also by its consideration of the social and environmental consequences associated with financial activities. This framework is built upon three core dimensions—environmental, social, and governance—commonly referred to as ESG principles (Zairis et al., 2024). These principles provide a critical foundation for the development of a responsible and sustainable financial system, requiring financial institutions to incorporate social and environmental factors into their investment and financing decisions (Nusantara & Rahadi, 2024).

From an environmental perspective, sustainable finance encourages financing for environmentally friendly projects such as renewable energy (e.g., solar and wind power), increasing energy efficiency, and avoiding funding for potentially environmentally damaging industries like coal mining (Sabrina et al., 2025). The social perspective emphasizes the importance of fair and responsible business practices, such as not employing children, ensuring decent working conditions, and providing access to financial services to underprivileged communities. Meanwhile, the governance aspect requires companies or financial institutions to have transparent, accountable, and responsible management systems towards stakeholders (Gillan et al., 2021).

Sustainable finance is not just an investment strategy, but rather a fundamental goal and principle in channeling funds to support inclusive and environmentally sound economic development, while building a better future for future generations (Mamun & László, 2025). In this context, financial inclusion is an important part, namely efforts to ensure that all levels of society, especially groups that have not had access to financial institutions (*unbanked*) or have very limited access (*underbanked*), can enjoy formal financial services fairly, easily, and affordably.

In recent years, financial technology (FinTech) innovation has emerged as a crucial driver in accelerating the realization of sustainable finance and financial inclusion objectives. By leveraging digital technologies and advanced network infrastructures, FinTech not only broadens access to financial services but also enhances corporate

efficiency and financial performance through innovative financing models. A growing body of literature indicates that FinTech acts as a catalyst in the shift toward a low-carbon economy by promoting financial inclusion, expanding green financing channels, and reinforcing market connectivity as well as financial product innovation. Moreover, the development of FinTech has been found to support an increasing share of renewable energy within the energy mix by enabling novel financing mechanisms, reducing transaction costs, and improving risk management practices, thereby making a substantial contribution to the progress of green finance and sustainable economic growth (CQ Ma et al., 2025).

Inclusion

Financial inclusion represents one of the most significant advantages, particularly for developing economies. This is because access to financial services is essential not only for individuals but also for many small and medium-sized enterprises (SMEs) that play a vital role in productive activities yet often face capital constraints. Within this framework, Financial Technology (FinTech) has a pivotal role in broadening financial service accessibility through digital innovations such as mobile banking, digital wallets, peer-to-peer lending, and crowdfunding, which help lower transaction costs and mitigate geographical limitations. Beyond enhancing the efficiency of the financial system, FinTech also functions as a key driver in promoting broader social and economic inclusion.

Ha et al. (2025) emphasized that FinTech contributes significantly to increasing global *financial inclusion* through easily accessible financial services that adapt to community needs and support the achievement of *the Sustainable Development Goals (SDGs)*. Therefore, for green finance to align with the core principles of allocating funds that support sustainable development, broad participation from various economic actors, including the public and SMEs, is required in an inclusive, transparent, and sustainability-oriented financial system (Bayram et al., 2022).

Furthermore, the link between financial inclusion and green finance is becoming increasingly close with the development of the sustainability-oriented FinTech ecosystem. Through digital platforms, the public not only gains access to basic financial services but can also participate in investment and financing of environmentally friendly projects such as renewable energy, sustainable agriculture, and green micro-enterprises. Mamun & László (2025) emphasized that the synergy between *financial inclusion* and *sustainable finance* facilitated by FinTech can expand socio-economic impacts while simultaneously encouraging the transition to a low-carbon economy. With the support of technologies such as *blockchain*, *artificial intelligence (AI)*, and *big data analytics*, FinTech provides greater transparency, accountability, and efficiency in the distribution of green funds to the public and small businesses. Thus, financial inclusion not only serves as a means of equalizing economic access but also serves as an important entry point for accelerating the implementation of sustainable finance at the national and global levels.

RESEARCH METHODS

This study employs a Systematic Literature Review (SLR) approach to systematically identify, evaluate, and synthesize previous studies concerning the relationship and integration of FinTech, financial inclusion, and sustainable finance. The SLR approach provides a structured procedure for identifying relevant evidence, minimizing potential selection bias, synthesizing previous findings, and identifying research gaps (David Tranfield, 2003). The review process follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) reporting guideline to strengthen transparency, systematicity, and reproducibility (Page et al., 2021). The literature search was conducted using the Scopus database, focusing on peer-reviewed journal publications from 2017 to 2025. The search strategy used the following Boolean search string: TITLE-ABS-KEY (("FinTech" OR "financial technology" OR "financial technologies") AND ("financial inclusion" OR "inclusive finance") AND ("sustainable finance" OR "sustainable financial")). The search was applied to titles, abstracts, and keywords. Studies were considered relevant when they examined FinTech in relation to financial inclusion, sustainable finance, or the integration of the three concepts. This search strategy, together with the database, publication period, and selection criteria, was established to facilitate replication of the review process.

The selection of studies was conducted through four stages: identification, screening, eligibility assessment, and final inclusion. At the identification stage, the Scopus search produced 1,522 records. After 112 duplicate records

were removed, 1,410 records remained for screening. Title and abstract screening excluded 1,180 records, leaving 230 articles for full-text eligibility assessment. A further 144 articles were excluded because they did not meet the predetermined eligibility criteria, resulting in 86 articles included in the final review. The inclusion criteria required studies to be peer-reviewed journal articles indexed in Scopus, published in English between 2017 and 2025, and substantively related to FinTech, financial inclusion, sustainable finance, or the integration of these concepts. Studies were excluded if they were duplicates, conference proceedings, books, book chapters, editorials, notes, non-English publications, or did not address the research focus. The complete selection process, including identification, screening, eligibility, inclusion, and reasons for exclusion, is presented in the PRISMA flow diagram. Before synthesis, the methodological quality and relevance of the selected studies were assessed based on the clarity of research objectives, appropriateness of methodology, adequacy of data sources and analysis procedures, consistency between research questions and findings, and relevance to the objectives of this review.

Data were extracted systematically using a structured extraction framework covering authors and publication year, research context or country, research objectives, FinTech application, financial inclusion dimension, sustainable finance dimension, research methodology, major findings, challenges, and implications. The extracted data were analyzed through descriptive and thematic synthesis. Descriptive synthesis was used to identify publication trends, research contexts, FinTech applications, and methodological characteristics, while thematic synthesis was used to identify recurring themes, patterns, benefits, challenges, and research gaps concerning the relationship and integration of FinTech, financial inclusion, and sustainable finance. The review specifically examines the integration of FinTech, financial inclusion, and sustainable finance, while also considering studies that address the relationship between FinTech and either financial inclusion or sustainable finance when they contribute to understanding the broader integration. The synthesis particularly considers how FinTech supports inclusive access to financial services, sustainable financial practices, transparency, efficiency, innovation, and broader financial sustainability. This systematic procedure was applied to minimize selection bias and ensure that the conclusions were derived from evidence reported in the selected studies, thereby providing a transparent and reproducible basis for synthesizing the existing literature.

RESULT AND ANALYSIS

The synthesis of the 86 reviewed articles reveals several common patterns regarding the relationship between FinTech, financial inclusion, and sustainable finance. Overall, the literature indicates that FinTech can improve access to financial services, reduce transaction costs, enhance financial efficiency, and facilitate the development of technology-enabled financial products that support sustainability objectives. These findings suggest that FinTech functions not only as a technological innovation but also as an enabling mechanism for broader financial inclusion and sustainable finance outcomes.

A consistent pattern across the literature is the positive contribution of FinTech to financial inclusion. Digital payments, mobile banking, digital lending, and other technology-enabled financial services can reduce geographical, cost, and accessibility barriers, particularly for underserved populations and small businesses. However, the findings are not uniform across all contexts. The extent to which FinTech promotes financial inclusion is influenced by factors such as digital infrastructure, financial literacy, affordability, cybersecurity, regulatory quality, and institutional capacity.

The reviewed literature also demonstrates an important relationship between FinTech and sustainable finance. FinTech can support sustainable finance by improving transparency, data accessibility, transaction efficiency, and the availability of digital financial products that incorporate environmental, social, and governance (ESG) considerations. More importantly, financial inclusion can serve as a potential connecting mechanism between FinTech and sustainable finance. FinTech can expand access to financial services, while greater financial inclusion can increase participation in the formal financial system and create broader opportunities for individuals and businesses to engage in sustainable economic activities. In this regard, FinTech, financial inclusion, and sustainable finance are interconnected rather than independent concepts.

Despite these common findings, differences and contradictions are also evident across the reviewed studies. While many studies report positive effects of FinTech on financial inclusion and sustainability, others highlight potential challenges, including digital exclusion, cybersecurity risks, data privacy concerns, and unequal access to

digital infrastructure. Similarly, the availability of FinTech does not necessarily guarantee sustainable financial outcomes, as its effects depend on the regulatory, institutional, and socioeconomic context in which the technology is implemented. These findings indicate that the relationship among FinTech, financial inclusion, and sustainable finance is context-dependent rather than universally linear.

The synthesis further identifies several research gaps. First, existing studies frequently examine FinTech, financial inclusion, and sustainable finance as separate dimensions, while relatively limited attention has been given to their interrelationship within an integrated framework. Second, the literature remains fragmented across different FinTech technologies, geographical contexts, and methodological approaches, limiting a comprehensive understanding of how FinTech can simultaneously contribute to financial inclusion and sustainable finance. Third, further research is needed to examine the contextual factors that determine whether FinTech can generate inclusive and sustainable outcomes, particularly the roles of digital infrastructure, financial literacy, regulation, and institutional capacity.

Based on these gaps, this review contributes conceptually by positioning financial inclusion as a potential connecting mechanism between FinTech and sustainable finance. The synthesis suggests an integrated perspective in which FinTech provides the technological infrastructure, financial inclusion represents a pathway through which access and participation in financial services can be expanded, and sustainable finance provides a broader orientation toward long-term economic, social, and environmental objectives. This perspective provides a basis for future research to examine not only whether FinTech contributes to financial inclusion and sustainable finance, but also the conditions under which these outcomes can be achieved simultaneously. The characteristics, methodological approaches, samples, and main findings of the 86 reviewed studies are summarized in Table 4.1. The table provides an overview of the existing literature and serves as the basis for the cross-study synthesis presented in the following section.

Table 4.1. Literature Review

No.	Researcher Name / Source	Article Title	Sample / Data	Research methods	Key Findings
1	Quenum (2024)	<i>Fintech and Sustainability: A Literature Review</i>	Global academic literature 2015–2024	Systematic literature review	Discovering the integration of fintech and sustainability as a new paradigm in digital financial services.
2	(Roy & Vasa, 2025)	<i>Financial Technology and ESG in Sustainable Finance</i>	Scopus journal articles 2010–2025	Bibliometric & thematic content analysis	ESG is a key pillar in sustainable fintech development, but global standards are still not uniform.
3	Baker, H.K., Filbeck, G., & Black (2024)	<i>The Emerald Handbook of Fintech: Reshaping Finance</i>	Cross-industry financial study	Conceptual & comparative studies	Fintech plays a vital role in the global financial transformation towards sustainable business models.
4	Li et al. 2025)	<i>Blockchain Applications in Green Finance</i>	Sustainable investment case study	Empirical – Blockchain impact analysis	Blockchain increases transparency & accountability in green investments.
5	Alhalwachi et al., (2025)	<i>AI and Blockchain in Enhancing ESG Reporting</i>	ESG company secondary data	Big data model analysis	AI & blockchain integration increases ESG report accuracy by up to 98.8%.
6	Evangeline (2025)	<i>Regulatory Frameworks for Inclusive FinTech Ecosystems</i>	Fintech regulations in several countries	Policy analysis	Adaptive regulation is needed to balance innovation & data security.

7	Ranchordas & Meoli (2025)	<i>Regulatory Sandboxes for Sustainable Finance</i>	Europe & Middle East sandbox cases	Comparative legal studies	Sandboxes effectively encourage continuous innovation with targeted oversight.
8	(Xue & Xi, 2025)	<i>Impact of FinTech on Regional Financial Development</i>	30 developing & developed countries	Spatial econometrics (Tobit-SDM)	Fintech has a greater impact in developing countries; adoption is influenced by the quality of regulation.
9	Ding et al. (2024)	<i>How Fintech Prompts Corporations Toward ESG Development</i>	Companies in China	Panel regression analysis	Fintech improves corporate ESG performance and financial efficiency.
10	Sundharesalingam et al. (2025)	<i>AI Enhanced FinTech Strategies for ESG Investments</i>	Sustainable investment data	Predictive AI model analysis	AI-based strategies strengthen compliance and governance of green investments.
11	Drago et al. (2025)	<i>Bridging Sustainability and Inclusion in the ESG Landscape</i>	Developing countries (Asia, Africa)	Empirical – Machine learning typology	Fintech expands financial inclusion and supports the SDGs through ESG.
13	Akram et al., (2025)	<i>AI Adoption and Green Investment</i>	300 global companies	Multivariate regression	AI adoption is driving a significant increase in green investments.
14	Colossus (2025)	<i>Regulatory Sandboxes in FinTech Innovation: UK, Singapore, Hungary</i>	3 developed countries	Comparative study of policies	Sandbox supports ethical & sustainable fintech innovation through adaptive regulation.
15	C. Huang & Yao, (2025)	<i>Synergies Among Responsible AI, ESG, and SDGs</i>	Cross-sector theoretical study	Conceptual framework	Responsible integration of AI with ESG & SDGs is needed for the future of fintech.
16	Kozar & Padaszyńska, (2024)	<i>FinTech and Sustainable Development: Study Focused on Identifying Green Research Areas</i>	Scientific articles on green fintech	Bibliometric mapping	Identifying green fintech research areas and cross-disciplinary research opportunities.
17	Chien et al. (2025)	<i>Smart ESG Framework for Corporate Responsibility in DeFi</i>	DeFi Platform & CSR reports	ESG framework model analysis	DeFi can implement ESG with blockchain-based automated regulatory tools.
18	H. Ma et al. (2025)	<i>Spatial Spillover of Fintech Innovation on Green Economic Growth in China</i>	30 provinces in China	Spatial econometric model	Fintech drives green economic growth and innovation across regions.

19	(Z. Wang et al., 2024)	<i>Spillover Effect of Fintech on Regional Innovation</i>	China's provincial innovation data	Econometric panel analysis	Fintech is driving regional innovation, especially in areas with strong digital infrastructure.
20	Kiselakova & Kosikova (2025)	<i>Challenges of Financial Technologies and Global FinTech Indexes</i>	Global FinTech Index	Comparative descriptive analysis	Countries with strong regulations have better sustainable fintech performance.
21	Drangolli, V.B., & Rayfield (2025)	<i>Exploring Fintech Ventures in Central and Eastern Europe</i>	Eastern European fintech companies	Comparative study	Different regulations affect the level of innovation and sustainability between countries.
22	Ladha & Ladha, (2025)	<i>Fintech as a Catalyst for ESG Excellence Across Industries</i>	Global industry studies	Cross-sectoral study	Fintech accelerates the achievement of ESG targets through business digitalization.
23	Soomro et al., (2025)	<i>Integrating Emerging Technologies with ESG</i>	Green technology company	Case study approach	The integration of IoT, AI, and blockchain strengthens ESG transparency.
24	Alqudah et al., (2025)	<i>The Moderating Role of ESG Scores on FinTech Adoption and Performance</i>	Middle East Bank	Moderated regression	Fintech improves financial performance when the company's ESG score is high.
25	Oanh et al. (2025)	<i>Banks' Financial Performance and ESG Dimensions</i>	Banks in Southeast Asia	Panel regression analysis	ESG has a positive impact on the performance of banks that adopt fintech.
26	Duran & Tierney, (2023)	<i>Fintech Data Infrastructure for ESG Disclosure Compliance</i>	ESG fintech platform	Policy & system analysis	A shared data infrastructure is needed for global ESG compliance.
27	Donkor et al., (2025)	<i>Corporate Governance and ESG Disclosure in Fintech Firms</i>	Cross-border fintech company	Cross-country comparative study	National culture influences the effectiveness of ESG governance in the fintech sector.
28	Shala & Berisha, (2024)	<i>The Impact of Fintech on Achievement of ESG Goals</i>	European ESG Data	Panel regression	Fintech plays an important role in accelerating the achievement of SDGs targets.
29	Paridhi et al., (2024)	<i>Corporate Barriers to ESG Reporting Adoption</i>	150 global companies	Hierarchical model	The main barriers to ESG: lack of standards, data quality, and managerial awareness.

30	Shrinag et al., (2024)	<i>Blockchain and ICT for Strategic Integration of ESG Compliance</i>	Indian banking sector	Qualitative case study	Blockchain strengthens ESG transparency and e-governance in banks.
31	Wang et al., (2025)	<i>Eco-Friendly Algorithms: AI and Green Finance in Europe</i>	European Union countries	AI & ESG data analysis	AI improves the efficiency of green investments and environmental risk management.
32	Akram et al., (2025)	<i>Artificial Intelligence (AI) Adoption and Green Investment</i>	300 multinational companies	Multivariate regression	Young & highly educated CEOs are quicker to adopt AI for green investing.
33	Yu & Zhao, (2025)	<i>Revealing the Impact of Fintech on Energy Saving and Carbon Reduction</i>	China's energy industry data	Dynamic panel analysis (Akram et al., 2025)	Fintech reduces carbon emissions through technological innovation and energy efficiency.
34	Zhao et al. (2024)	<i>Green Finance, Green Tech Innovation and Industrial Upgrading in China</i>	China industrial data	Simultaneous analysis of panel data	The combination of green finance & technological innovation accelerates industrial transformation.
35	Kakar et al. (2024)	<i>Role of Green FinTech in Carbon Emission Reduction in Asia</i>	12 Asian countries	ARDL quantile panel	Green fintech effectively reduces carbon emissions in developing countries.
36	Batchu & Settibathini (2024)	<i>Sustainable Finance Beyond Banking: Shaping the Future of FinTech</i>	Cross-industry financial study	Interdisciplinary conceptual studies	Fintech extends sustainability beyond banking through cross-sector innovation.
37	Geddarn et al., (2025)	<i>Fintech for a Sustainable Future: Mapping Financial Innovation to the SDGs</i>	Global SDGs investment data	SDGs mapping analysis	Fintech contributes directly to SDG 8 (economic growth) and SDG 13 (climate).
38	Bu, Y. et al. (2025)	<i>From Digital Finance to Green Growth: The Role of FinTech in Sustainable Manufacturing</i>	China's manufacturing industry	Econometric analysis	Fintech drives green innovation in the manufacturing and energy efficiency sectors.
		<i>Spatial Effects of Financial</i>			

39	Hao et al. (2025)	<i>Agglomeration and Green Tech Innovation on Carbon Emissions</i>	City data in China	Spatial econometric model	Fintech-based green technology innovation reduces urban carbon emissions.
40	Gecheng et al., (2021)	<i>Financial Innovation and Green Innovation in OECD Industries</i>	OECD Industry	Industry panel analysis	Fintech is boosting green innovation in high-energy-intensive industries.
41	Nayak et al. (2025)	<i>Sustainable Finance and Green Investments: Role of Blockchain</i>	Global ESG company	Literature & case studies	Blockchain plays a vital role in circular finance and green investment.
42	Nefla & Jellouli, (2025)	<i>Circular Economy Emerging Technologies in Finance: Challenges for Sustainable Finance</i>	Financial technology literature	Qualitative study	Key challenges: data security and algorithmic bias in AI for green finance.
43	Sneha et al. (2024)	<i>Can AI Propel Sustainable Finance Toward SDGs?</i>	Study of Indian financial institutions	Policy & social analysis	AI accelerates the achievement of the SDGs, but requires ethical governance.
44	Alsmadi et al., (2024)	<i>Sustainable Decision-Making in Fintech: Impact on SD Development</i>	Decision-making data in fintech	Survey & decision models	ESG data-driven decisions improve social and economic efficiency.
45	(Zetzsche et al., 2017)	<i>FinTech for Financial Inclusion: Driving Sustainable Growth</i>	Developing countries of Asia and Africa	Policy & legal studies	Fintech expands financial inclusion and reduces social disparities.
46	D. Arner et al., (2020)	<i>Sustainability, FinTech and Financial Inclusion</i>	European & Asian Regulations	Comparative legal analysis	Fintech drives sustainable finance through inclusive regulation.
47	Chen & Taeihagh, (2025)	<i>Designing Regulatory Sandboxes: Framework Alignment</i>	Countries with active sandbox	Policy design framework	Sandboxes are effective when they align with the goals of innovation and consumer protection.

48	Mohamed (2023)	<i>The Sandbox in Saudi Arabia: Regulatory Approach and Applications</i>	Saudi Arabian Fintech	National case study	Sandbox enhances regulator–startup collaboration, encouraging green innovation.
49	Vikram et al., (2025)	<i>Developing a Regulatory Sandbox Model for FinTech Products</i>	Conceptual model of India	System design analysis	The adaptive sandbox model supports sustainable fintech innovation.
50	Buckley (2019)	<i>TechRisk: Regulating Financial Technologies</i>	Global regulations	Legal studies	The main risks of fintech: cybersecurity and user data privacy.
51	Yakubu et al., (2025)	<i>Cybersecurity and Data Protection in FinTech</i>	Africa's digital platform	Study & legal studies	Cybersecurity is a key prerequisite for digital financial inclusion.
52	Peng & Li (2025)	<i>Concerns About the Rapid Growth of FinTech: Data Privacy and Regulation</i>	Asian regulatory studies	Legal analysis & reform	Regulation needs to balance innovation with consumer protection.
53	Shafik (2025)	<i>Security, Privacy, and Trust in FinTech</i>	Global digital platform	Conceptual analysis	Public trust is key to sustainable fintech adoption.
54	Filliung, L. (2025)	<i>Harmonizing Innovation and Regulation: Sandboxes and Data Trusts in EU, UK, Singapore</i>	Regulation of 3 countries	Comparative policy analysis	Collaboration and data trust are essential for ethical fintech governance.
55	Lukács & Molnár, (2025)	<i>Companies' ESG Performance Under Different Regulatory Environments</i>	European companies	ESG data panel	Tough regulation results in better ESG performance than soft regulation.
56	Giupponi et al., (2025)	<i>What ESG Has Not (Yet) Delivered: Framework to Overcome Its Hurdles</i>	Cross-industry ESG study	Conceptual analysis	ESG is still not fully integrated; a new framework is needed to address the implementation gap.
57	Y. Huang (2025)	<i>Fintech as a Catalyst for Sustainable Development: A Bibliographic Review</i>	300 fintech publications	Bibliographic analysis	Fintech is a catalyst for financial inclusion and the global green economy.

58	Moro-Visconti et al. (2020)	<i>Sustainability in FinTechs: Business Model Scalability and Market Valuation</i>	European fintech startups	Business model analysis	The scale of a digital business determines the market value and sustainability of a fintech startup.
59	Saxena et al., (2023)	<i>Technologies Empowered ESG: Industry 4.0 Landscape</i>	Global industrial company	Technology literature study	IoT, AI, and cloud are strengthening real-time ESG reporting and industrial sustainability.
60	Zhang (2025)	<i>The Role and Discourse of FinTech Companies in ESG Issues</i>	100 fintech companies	Content analysis	Fintech companies are increasingly actively publicizing ESG initiatives as a reputation strategy.
61	Fernandez et al. (2025)	<i>Corporate Governance and ESG Strategies: Internal Audit Quality Impact Does Corporate Governance Affect ESG Disclosure?</i>	Indonesian Company	Moderated regression	Internal audits enhance the influence of governance on fintech ESG performance.
62	Mkadmi & Daafous (2025)	<i>Impact of Corporate Governance on Sustainability Disclosures</i>	50 developing countries	Cross-country analysis	Corporate governance has a significant impact on the quality of ESG reporting.
63	Erben Yavuz et al. (2024)	<i>Becoming Sustainable Together: ESG Data Commons for Fintech Startups</i>	200 financial & non-financial companies	Panel analysis	Foreign ownership structures enhance ESG transparency.
64	Wang et al., (2022)	<i>Harnessing Technologies and Data to Accelerate ESG Initiatives Tech-Driven</i>	European & US fintech startups	Case study	Shared data collaboration improves the efficiency of ESG reporting between startups.
65	Perdana & Tan, (2024)	<i>Revolutionizing Green Banking Advances in Emerging Financial Technology and Digital Money</i>	Accounting & audit industry	Digital transformation study	Technology is accelerating the integration of ESG into financial reporting.
66	Taneja et al., (2023)		Banks in India & South Asia	Qualitative study	Fintech is driving green banking services and environmentally friendly digitalization.
67	Maleh et al. (2024)		Global digital financial platform	Technology studies	Digital money supports efficiency and reduces the financial carbon footprint.

68	Gadicha, AB, Gadicha, VB, Burange, MS, & Khan (2025)	<i>Leveraging Blockchain and AI for Sustainable Development Impact of Fintech and Economic Development on Carbon Emissions Information Moderation Principle on Regulatory Sandbox</i>	Global interdisciplinary studies	Conceptual analysis	The synergy of AI and blockchain strengthens the governance and transparency of green finance.
69	Thangaiyarkarasi & Vanitha (2025)	<i>FinTechs Playing in the Sandbox — Effect of Interacting Signals on Funding How Social Interactions Influence Regulators and Innovators in Sandboxes</i>	Countries with mobile money	Econometric analysis	Fintech reduces carbon emissions through digital transaction efficiency.
70	X. Chen (2022)	<i>FinTechs Playing in the Sandbox — Effect of Interacting Signals on Funding How Social Interactions Influence Regulators and Innovators in Sandboxes</i>	China's fintech regulations	Legal & policy analysis	Information moderation is important to keep the sandbox innovative and safe.
71	Kraljev, M. et al. (2021)	<i>FinTechs Playing in the Sandbox — Effect of Interacting Signals on Funding How Social Interactions Influence Regulators and Innovators in Sandboxes</i>	Startups in Europe	Empirical studies	Participation in the sandbox increases a startup's chances of funding.
72	Alaassar et al., (2020)	<i>FinTechs Playing in the Sandbox — Effect of Interacting Signals on Funding How Social Interactions Influence Regulators and Innovators in Sandboxes</i>	European Sandbox	Qualitative study	Social collaboration between stakeholders strengthens the legitimacy of sandbox policies.
73	Minhat & Dzolkarnaini, (2025)	<i>Financing SDGs Through Responsible FinTech</i>	Global SDGs study	Conceptual analysis of policy	Ethical fintech is becoming a key financing instrument for sustainable development goals.
74	Vimal & Kumar (2024)	<i>Digital Transformation and Sustainable Development in Cities and Organizations</i>	Smart cities in Asia	Cross-case study	Financial digitalization strengthens the economic resilience of sustainable cities.
75	Baker, H.K., Filbeck, G., & Black (2024)	<i>The Emerald Handbook of Fintech: Reshaping Finance</i>	Academic reference books	Multidisciplinary synthesis	Fintech is the foundation of a sustainable and inclusive future financial system.
76	(Takeda & Ito, 2021)	<i>A Review of FinTech Research</i>	88 academic articles on FinTech (2015– 2018)	Systematic Literature Review	FinTech is divided into two types of value: creating new value and efficiency; dominant in startups and Asia/Europe; general method of case studies.

77	(Rahman et al., 2024)	<i>FinTech in Sustainable Banking: An Integrated Systematic Literature Review with TCCM Framework</i>	44 articles (2002–2023)	Systematic Literature Review + Bibliometrics (TCCM)	FinTech supports green banking, SDGs, efficiency; dominant theories of TAM & ARDL; research needs to broaden context and methods.
78	(Shaharuddin et al., 2025)	<i>FinTech and Green Finance in ASEAN Countries</i>	68 articles from 5,508 publications	Systematic Reviews (PRISMA) + Bibliometrics	FinTech strengthens green finance through efficiency, innovation, and regulation; moderating factors: digital policies and infrastructure.
79	(Zairis et al., 2024)	<i>Sustainable Finance and ESG Importance: A Systematic Literature Review and Research Agenda</i>	80 articles (2011–2021)	Systematic Literature Review	Four key themes: new economic value, green bonds, ESG performance, and financial risk; the need for global ESG standardization.
80	(Ha et al., 2025)	<i>Financial Inclusion and FinTech: A State-of-the-Art Systematic Literature Review</i>	96 articles from 2,951 publications (WoS, Scopus, EBSCO)	Systematic Review + Bibliometrics + Content Analysis	FinTech expands global financial access; three research clusters: new services, market transformation, and stakeholder roles.
81	(Liu et al., 2024)	<i>Inclusive FinTech, Open Banking, and Bank Performance: Evidence from China</i>	Panel data of Chinese commercial banks (2011–2020)	Quantitative (panel data regression)	Inclusive FinTech improves bank profitability & efficiency; greater impact on national and rural banks.
82	(Ather Alam Khan & Yasmeen Wahab, 2024)	<i>Sustainable Finance and Green FinTech (Dialogue Social Science Review)</i>	Global conceptual literature	Qualitative Conceptual / Literature Analysis	FinTech strengthens sustainable finance through green bonds, ESG investing, and carbon tracking; challenges: regulation & data security.

83	(Mamun & László, 2025)	<i>Advancing Sustainability through Financial Inclusion and Sustainable Finance</i>	54 Scopus indexed publications	Systematic Literature Review (PRISMA)	FinTech & blockchain strengthen financial inclusion and green finance; new risks: cybercrime and fragmented regulation.
84	(Moro-Visconti et al., 2020)	<i>Sustainability in FinTechs: An Explanation through Business Model Scalability and Market Valuation</i>	Global FinTech company data (theoretical and stock market analysis)	Empirical & Theoretical Analysis	FinTech resembles a digital startup with a scalable business model; supporting financial inclusion and the SDGs through digital innovation.
85	(Zaid et al., 2025)	<i>The Future of Green Finance: How Digital Transformation and FinTech Drive Sustainability</i>	Survey of 152 bank employees in Saudi Arabia	Quantitative (Hierarchical Regression – PROCESS Macro)	Green finance positively impacts sustainable performance; FinTech and digital transformation strengthen this relationship.
86	(Ather Alam Khan & Yasmeen Wahab, 2024)	<i>Sustainable Finance and Green FinTech</i>	Academic literature and policy reports	Conceptual Literature Analysis	FinTech facilitates green and ESG capital flows; barriers: lack of standardization, cybersecurity, and non-adaptive policies.

CONCLUSION

Drawing on the synthesis of 86 Scopus-indexed articles published between 2017 and 2025, this study concludes that FinTech contributes to financial inclusion and sustainable finance primarily by reducing barriers to financial access, improving transaction efficiency, and enabling greater transparency and accessibility of technology-based financial services. Across the reviewed literature, digital payments, mobile banking, digital lending, and other technology-enabled financial services consistently emerge as mechanisms for reducing geographical, cost, and accessibility barriers, particularly for underserved populations and small businesses. The literature also indicates that technologies such as artificial intelligence and blockchain can strengthen these outcomes by supporting data-driven risk assessment, improving the transparency and traceability of financial transactions, and facilitating sustainable and ESG-oriented financing mechanisms.

However, the synthesis shows that the contribution of FinTech is not uniform or automatically translated into inclusive and sustainable financial outcomes. The reviewed studies identify digital infrastructure, financial literacy, affordability, cybersecurity, regulatory quality, and institutional capacity as important contextual factors that influence the effectiveness of FinTech adoption. In addition, differences across the reviewed studies indicate that FinTech may simultaneously create opportunities for greater financial access and introduce risks of digital exclusion, data privacy concerns, cybersecurity vulnerabilities, and unequal access to digital infrastructure. These findings demonstrate that the relationship among FinTech, financial inclusion, and sustainable finance is context-dependent rather than universally linear.

The review further identifies three major gaps in the existing literature. First, FinTech, financial inclusion, and sustainable finance are still frequently examined as separate dimensions, with relatively limited research addressing their interrelationship within an integrated framework. Second, the literature remains fragmented across different FinTech technologies, geographical contexts, and methodological approaches, which limits a comprehensive understanding of their combined effects. Third, further evidence is needed on the contextual conditions that determine

whether FinTech can simultaneously generate inclusive and sustainable outcomes, particularly regarding digital infrastructure, financial literacy, regulation, and institutional capacity.

Based on these findings, this study positions financial inclusion as a potential connecting mechanism between FinTech and sustainable finance: FinTech provides the technological infrastructure, financial inclusion expands access and participation, while sustainable finance provides an orientation toward longer-term economic, social, and environmental objectives. Thus, the evidence from the 86 reviewed articles suggests that the strategic value of FinTech lies not simply in technological innovation, but in the conditions under which such innovation can be translated into broader and more sustainable financial participation. Future research should therefore examine the integrated relationship among these three dimensions using more context-sensitive approaches and should pay greater attention to the institutional, technological, and socioeconomic factors that shape their outcomes.

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