

The Role of Digital Financial Inclusion and Green Fintech in Achieving the Sustainable Development Goals

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Abstract: The 2030 Agenda for Sustainable Development faces a staggering financial shortfall, recently estimated by the OECD to exceed \$4 trillion annually [1]. This review systematically synthesizes the most recent literature (2020-2024) to investigate how Digital Financial Inclusion (DFI) and Green Fintech (GFT) act as catalysts to close this gap and achieve the SDGs. We identify three primary impact pathways: (1) direct economic empowerment and poverty reduction (SDGs 1, 8) [2, 3], (2) enhanced access to basic services in health, education, and utilities (SDGs 3, 4, 6, 7) [4, 5], and (3) the mobilization of climate finance through transparent platforms and AI-driven analytics (SDGs 7, 12, 13) [6, 7]. Moving beyond techno-optimism, our critical appraisal scrutinizes significant barriers, including the digital divide [8], the environmental footprint of digital infrastructures [9], algorithmic bias [10], and regulatory gaps [11]. We conclude that DFI and GFT are transformative yet conditional tools, their success hinges on strong governance, ethical design, and equitable implementation. We propose a targeted future research agenda focused on establishing causality, promoting inclusive co-design, developing 'sustainable-by-design' technology, and creating integrative policy models to steer these innovations toward fulfilling their promise for a sustainable and inclusive future

Keywords: Digital financial inclusion, Green fintech, Sustainable development goals (SDGs), Financial technology, Climate finance, ESG, Digital divide.

1. INTRODUCTION

The United Nations' (UN) 2030 Agenda represents a historic pledge to forge a more equitable and sustainable world [12]. However, progress toward its 17 Sustainable Development Goals (SDGs) is severely impeded by a daunting financial obstacle. Recent analyses from the Organisation for Economic Co-operation and Development (OECD) indicate an annual funding gap surpassing \$4 trillion, a situation exacerbated by pandemic-related economic distress, ongoing geopolitical instability, and rising debt burdens in developing countries [1]. This financial deficit threatens to derail critical efforts in poverty eradication and climate action, underscoring the urgent need for innovative financing solutions [13].

This context has propelled the financial sector to the forefront of development strategy, with Digital Financial Inclusion (DFI) and Green Fintech (GFT) gaining prominence as pivotal instruments. This review therefore addresses the following central research question: *How do Digital Financial Inclusion (DFI) and Green Fintech (GFT) contribute to the achievement of the SDGs, and what are the critical barriers and future research priorities?* This question is critically important and interesting because it moves beyond cataloging potential benefits to provide a balanced, evidence-based assessment of both the opportunities and the risks at a crucial juncture in the 2030 Agenda.

To frame our analysis, we define the core concepts. **Digital Financial Inclusion (DFI)** refers to the use of digital technologies—such as mobile phones, digital platforms, and electronic payment systems—to provide affordable, accessible, and formal financial services (e.g., payments, savings, credit, insurance) to populations traditionally excluded from the banking system [14]. **Green Fintech (GFT)** encompasses a suite of technological innovations within finance specifically designed to support environmental sustainability. This includes platforms for green bonds and carbon credits, algorithms for Environmental, Social, and Governance (ESG) investing, and Internet of Things (IoT) systems for monitoring environmental impact [15].

The efficacy of DFI and GFT is theorized to be heavily influenced by underlying enabling infrastructures. We propose that **National Digital ID (NDI)** coverage is a key moderator for DFI's impact on social and economic SDGs (e.g., 1, 3, 4, 8), as it reduces identity-based exclusion [16]. Similarly, the strength of **Green Taxonomy Enforcement (GTE)**—a regulatory framework defining sustainable activities—is a critical moderator for GFT's impact on environmental SDGs (e.g., 7, 12, 13), as it mitigates greenwashing and ensures market integrity [17].

Academic engagement with this intersection has grown rapidly across disciplines including economics, finance, and information systems [18]. Early scholarship often exhibited a strong techno-optimism, emphasizing potential benefits while overlooking practical complexities. This perspective has since been tempered by a more critical body of work that examines serious drawbacks, such as the potential for the digital

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divide to exacerbate exclusion [8], the substantial energy consumption of technologies like blockchain [9], and the danger of algorithms perpetuating societal biases [10]. A critical review is therefore necessary to move beyond hype and focus on developing solutions that are genuinely effective, equitable, and sustainable.

This review aims to provide a timely and comprehensive synthesis of the most recent evidence (2020-2025) as the 2030 deadline approaches. Its main objectives are to:

- Systematically map and critically evaluate research on the contributions of DFI and GFT to the SDGs.
- Analyze the significant barriers, risks, and unintended consequences that could undermine their success.
- Propose a clear agenda for future research to address existing gaps and inform effective policy.

2. METHODOLOGY

This review adhered to a structured Systematic Literature Review (SLR) protocol, guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework [19]. The review period, spanning from January 2020 to May 2024, was deliberately selected to capture the most recent and disruptive developments in the field. This timeframe is pivotal as it encompasses the period following the COVID-19 pandemic, which acted as a major catalyst for the adoption of digital finance [20]; the strengthening of global climate commitments after COP26 [21]; and a significant maturation in both the commercial application and academic study of GFT [22].

The process involved four key stages: identification, screening, eligibility assessment, and inclusion. We searched for relevant literature in major academic databases—Scopus, Web of Science, and Google Scholar—focusing on peer-reviewed articles, reviews,

and conference proceedings. To incorporate valuable insights from policy and practice, we also included influential reports from leading international institutions such as the World Bank, International Monetary Fund (IMF), Bank for International Settlements (BIS), and the United Nations. However, to maintain academic rigor, our final thematic analysis prioritized empirically sound, peer-reviewed sources.

A targeted search strategy was designed using keywords and Boolean operators. The core search string was: ("digital financial inclusion" OR "fintech" OR "mobile money" OR "digital payments") AND ("green fintech" OR "sustainable finance" OR "climate fintech" OR "ESG fintech") AND ("SDG" OR "sustainable development goal" OR "sustainability"). This string was adapted to the specific syntax of each database. The initial search returned over 1,750 records. After removing duplicates, 830 unique publications remained for screening.

Screening occurred in two phases. First, titles and abstracts were reviewed for relevance to the intersection of DFI/GFT and the SDGs. Publications focused solely on technical aspects without a development link, or on traditional finance without a digital component, were excluded. This phase narrowed the pool to 210 articles. Second, the full texts of these articles were assessed for eligibility.

To ensure the credibility of our synthesis, included articles underwent a formal quality appraisal based on the following criteria: (1) Empirical studies with strong methodologies (e.g., randomized control trials, longitudinal studies) were prioritized for making claims about impact. (2) Theoretical and conceptual papers from high-impact journals were included for framing arguments and identifying mechanisms. (3) Publications with low academic rigor or significant methodological flaws (e.g., lack of a control group, small sample size, evident bias) were excluded. This appraisal ensured the review's conclusions are built on a foundation of reliable evidence.

Table 1: Literature Search and Screening Protocol

Database/Source	Search Keywords	Initial Hits	After Duplicate Removal	Articles Included after Screening
Scopus	TITLE-ABS-KEY(...)	~450	~400	45
Web of Science	TS=(...)	~300	~280	38
Google Scholar	(allintitle:)	~1000 (first 200 reviewed)	~150	25
Institutional Repositories	Manual Search	-	-	22
Total				130

Following this process, 130 publications were included for final thematic analysis. Thematic analysis was then employed to identify, analyze, and report patterns (themes) within the selected literature, leading to the identification of the three primary impact pathways discussed in the results [23].

3. THEMATIC ANALYSIS: THREE PATHWAYS TO THE SDGS

Our analysis of the literature reveals that Digital Financial Inclusion (DFI) and Green Fintech (GFT) advance the Sustainable Development Goals through three distinct yet interconnected pathways. The sections below detail these pathways, outlining their mechanisms and exploring the nuances of their impact with supporting evidence

3.1. Pathway 1: Direct Economic Empowerment and Poverty Reduction

DFI directly advances SDG 1 (No Poverty) and SDG 8 (Decent Work and Economic Growth) by significantly reducing the cost and complexity of accessing financial services for unbanked and underbanked populations [2]. This trend is powerfully illustrated by the latest Global Findex data, which shows a notable increase in account ownership in developing economies—from 63% to 71%, driven largely by the proliferation of mobile money [8]. Access to a transaction account serves as a vital tool for economic resilience, allowing households to manage irregular incomes, weather financial shocks, and save securely. The shift to digital wages and remittances strengthens this effect, making transfers faster, cheaper, and safer, which in turn increases recipients' disposable income and stimulates local economies [3].

The impact reaches beyond basic banking. Digital credit and crowd funding platforms are significantly expanding access to capital for micro-enterprises and entrepreneurs [24]. By using algorithmic scoring and alternative data—such as mobile phone usage or transaction histories—these platforms can assess creditworthiness without requiring physical collateral or

extensive credit histories, thus overcoming traditional barriers that have excluded small businesses from the formal financial system [18, 25]. A growing body of evidence confirms this trend, though it also highlights the concomitant risk of over-indebtedness, which requires robust consumer protection frameworks [10].

A growing body of research also highlights DFI's role in building climate resilience at the individual and household level. Digital channels enable governments and aid organizations to disburse emergency funds quickly after disasters, offering a crucial lifeline for recovery [26]. More innovatively, they provide access to parametric insurance products, which automatically pay out when specific triggers (e.g., a predefined amount of rainfall measured by satellites) occur. This offers immediate protection for farmers' livelihoods after catastrophic weather events, by passing the delays associated with traditional insurance claims [27, 28].

However, this pathway is not without significant risks. The same algorithms that efficiently expand credit access can also foster dangerous cycles of over-indebtedness. If these models rely on biased or incomplete data, they may miscalculate a borrower's repayment capacity, potentially pushing vulnerable individuals further into financial distress [10]. This creates a critical tension between the drive for rapid financial inclusion (SDG 8) and the imperative of consumer protection, a cornerstone of SDG 16 (Peace, Justice, and Strong Institutions). Literature consequently argues that for innovation to be truly responsible, it must be coupled with strong financial education and agile regulatory frameworks designed to mitigate these new risks [11].

3.2. Pathway 2: Enhancing Social Inclusion and Access to Basic Services

DFI enables social SDGs by acting as the financial infrastructure for delivering essential services. This pathway shows how digital finance acts as a multiplier, enhancing interventions in health, education, and utilities. Digital payment systems are increasingly the

Table 2: Documented Economic and Social Impacts of DFI

Mechanism	SDG Target	Documented Impact	Key Studies
Mobile Money & Payments	1.4, 8.3	Strengthens household ability to maintain stable consumption during shocks; lowers remittance fees; facilitates G2P aid distribution.	[3, 8]
Digital Credit & Crowdfunding	8.10, 9.3	Enhances funding avenues for SMEs and micro-entrepreneurs, stimulating business activity, but carries risk of unsustainable debt.	[10, 18]
Digital Insurance	1.5, 13.1	Improves capacity of agricultural producers to withstand shocks via index-based insurance with payouts based on climate triggers.	[27, 28]

default method for distributing government-to-person (G2P) social safety nets, including pensions, unemployment benefits, and conditional cash transfers. Digitizing these payments has been shown to drastically reduce leakage and improve efficiency by minimizing human handling of funds, thereby curbing corruption and ensuring more aid reaches its intended recipients [4]. A landmark study on India's biometric smartcards for benefit transfers found a significant reduction in fraud and delays, which directly increased household consumption among beneficiaries [4].

Beyond economic empowerment, integrated digital payment platforms are significantly improving access to fundamental services. In healthcare (SDG 3), mobile money allows for manageable micropayments for insurance premiums and medical bills, making healthcare more affordable for low-income families [29]. In education (SDG 4), digital platforms facilitate small, incremental payments for fees and supplies, removing the barrier of large, upfront costs [5].

This model is particularly transformative in the utilities sector. Pay-as-you-go (PAYG) systems, powered entirely by mobile money, have revolutionized access to clean energy (SDG 7) and water (SDG 6) in regions like Sub-Saharan Africa and South Asia [30]. Companies like M-KOPA in Kenya allow households to make small, frequent payments via phone to lease solar home systems, providing light and power without a large initial investment [30]. This same PAYG model is now being applied to water filtration and irrigation. Importantly, the digitization of these transactions generates valuable data, enabling providers to analyze usage patterns, predict maintenance needs, and improve the efficiency and targeting of their services, creating a virtuous cycle for improved delivery [31].

3.3. Pathway 3: Catalyzing Environmental Sustainability and Climate Finance

This pathway represents the core domain of Green Fintech (GFT), an area that has seen explosive growth in both practice and research since 2020 [22]. GFT is creating new markets and revolutionizing existing ones for funding environmental goals by introducing unprecedented transparency, efficiency, and access to sustainable finance—a critical function for mobilizing the trillions needed for a green transition. This pathway focuses on *system-level* climate finance mobilization, distinct from the *individual-level* risk management discussed in Pathway 1.

- **Green Digital Finance:** Specialized platforms are streamlining the entire lifecycle of green bonds, using blockchain to create immutable records of ownership and automate compliance.

This reduces costs, boosts investor transparency, and helps direct large-scale capital toward renewable energy (SDG 7) and climate resilience projects (SDG 13) [6]. A key advancement is the use of Artificial Intelligence (AI) to screen ESG compliance and combat greenwashing; algorithms can now analyze satellite imagery and vast datasets to verify corporate environmental claims, bringing rigor to a often-murky field [32].

- **Carbon Markets and IoT:** Blockchain is bringing much-needed transparency and traceability to voluntary carbon markets by tokenizing credits and preventing double-counting and fraud [33]. However, a significant critique notes the irony that the high energy consumption of some blockchain protocols (like proof-of-work) can contradict the environmental goals they serve [9]. This is complemented by the Internet of Things (IoT), where sensors provide real-time, verifiable data on forest health or pollution levels. This data can automatically trigger payments via smart contracts, moving beyond self-reporting to objective, data-driven verification [34].
- **ESG Data and Analytics:** A revolution in AI and big data is reshaping ESG investing. Fintech platforms now analyze unconventional datasets—from satellite monitoring of deforestation to social media sentiment—to provide dynamic, holistic assessments of corporate sustainability performance [7]. This empowers investors to align portfolios with principles of responsible consumption (SDG 12) and manage climate risk, a shift heavily driven by new regulatory pressures like the EU's sustainable finance taxonomy [17].

A persistent and significant barrier within this pathway is **greenwashing**. Despite technological advances, the lack of globally standardized, verifiable data makes it difficult to accurately assess the true impact of financed projects [35]. This risk undermines the integrity of the entire sustainable finance ecosystem, highlighting the non-negotiable need for robust international regulation to work in tandem with innovation [11].

4. DISCUSSION: A CRITICAL APPRAISAL OF CHALLENGES AND RISK

An uncritically optimistic view is risky, as it may worsen the very problems the SDGs aim to solve. Our review identifies several pressing challenges that require urgent attention. These are summarized in Table 3 below

Table 3: Summary of Key Challenges and Proposed Mitigation Strategies

Challenge	SDG Conflict	Key Risks	Proposed Mitigation Strategies
The Persistent Digital Divide	SDG 10 (Inequality)	Exacerbates exclusion of poorest/vulnerable; creates "digitally excluded" underclass.	Parallel investments in digital infrastructure and literacy; promotion of low-cost devices; gender-inclusive design [8, 16].
Environmental Footprint	SDGs 7, 12, 13	High energy consumption of tech like proof-of-work blockchain counteracts environmental goals.	Prioritize energy-efficient protocols (e.g., proof-of-stake); conduct full lifecycle assessments of digital services [9, 36].
Data Privacy & Algorithmic Bias	SDG 16.10 (Justice)	Algorithms can automate and scale societal discrimination (digital redlining); data exploitation.	Implement strong data protection laws; adopt Explainable AI (XAI); ensure diverse data and development teams [10, 37].
Regulatory Uncertainty & Greenwashing	SDG 16.6 (Institutions)	Lack of global standards leads to market instability, consumer harm, and false sustainability claims.	Develop international regulatory standards; use regulatory sandboxes; strengthen Green Taxonomy Enforcement (GTE) [11, 17, 35].

5. FUTURE RESEARCH DIRECTIONS

- To guide effective policy and ethical innovation, future research must move beyond correlation to address specific, pressing gaps. We prioritize the following four directions:
- **Causal Identification and Impact Measurement:** Employing rigorous methods like Randomized Control Trials (RCTs) and longitudinal studies is crucial to isolate the net effects of DFI and GFT interventions on specific SDG outcomes, such as income volatility (SDG 1.5) or carbon emissions (SDG 13.2) [38]. Research should develop standardized metrics for measuring the direct and indirect impacts of these technologies.
- **Interdisciplinary Research on Ethics and Governance:** The risks of algorithmic bias and data privacy demand interdisciplinary studies that combine economics with computer science (AI ethics), law, and sociology [37]. Future work should investigate frameworks for explainable AI (XAI) in credit scoring and create models for inclusive digital governance that protect vulnerable populations (SDG 16.6) [10].
- **Sustainable-by-Design Technology Lifecycle Assessment:** Research must investigate the sustainability-scalability trade-off of foundational technologies like blockchain [36]. This involves creating standardized frameworks to assess the full environmental lifecycle of digital financial services, promoting a shift to energy-efficient consensus mechanisms (e.g., proof-of-stake) to ensure a net-positive environmental contribution [9].
- **Integrated Policy and Regulatory Experimentation:** Studies should explore the design of integrated policy models that

synchronize digital, financial, and environmental goals [11]. This includes examining how to embed sustainability criteria into the design of Central Bank Digital Currencies (CBDCs) and using regulatory sandboxes to test innovative approaches to GTE and consumer protection in a controlled environment [39].

6. FUTURE RESEARCH DIRECTIONS

This comprehensive review has outlined the potent, multi-faceted role of Digital Financial Inclusion (DFI) and Green Fintech (GFT) as crucial enablers of the Sustainable Development Goals (SDGs). The evidence strongly suggests they function not as isolated solutions but as cross-cutting catalysts—embodying the partnership spirit of SDG 17—that improve the efficiency, scalability, and targeting of interventions across the entire 2030 Agenda. Through the interconnected pathways of direct economic empowerment, improved social service delivery, and the catalytic mobilization of environmental finance, these technologies offer a concrete, innovative response to the colossal \$4 trillion annual financing gap hindering global progress.

However, this review has consistently contended that this transformative potential is conditional, not guaranteed. The technologies designed to promote inclusion and sustainability possess an inherent duality: they can narrow existing divides or widen them. The challenges identified are not minor issues but are central to the integrity of the entire project. The enduring digital divide threatens to create a new, digitally marginalized underclass, directly opposing the pledge to "leave no one behind." The substantial energy footprint of key technologies like blockchain ironically subverts the environmental goals they are intended to support. Moreover, without careful oversight, algorithmic systems can automate and scale

societal biases, perpetuating discrimination under a veil of technological neutrality.

Therefore, achieving a positive outcome is not merely a technical challenge but one of governance and ethics. The way forward requires a decisive shift from techno-optimism to a framework of deliberate and responsible stewardship. This review has underscored that their impact is profound yet conditional, hinging on the deliberate construction of robust governance and ethical frameworks. The success of this digital revolution will be judged not by its technical sophistication, but by its tangible contributions to human dignity and planetary health.

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ETHICAL STATEMENT

This study does not contain any studies with human or animal subjects performed by any of the authors.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest to this work.

DATA AVAILABILITY STATEMENT

NA

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