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Digital Finance and Green Investment: A Descriptive Synthesis of Adoption Trends, Classification Infrastructure, and Green-Instrument Verification

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Abstract

This study descriptively examines developments in digital finance adoption, global green investment activity, sustainable finance classification infrastructure, and green-instrument standards alignment. It uses qualitative document analysis of four independent secondary sources: the World Bank Global Findex Database 2025 (reporting 2024 survey indicators), the Indonesia Taxonomy for Sustainable Finance Version 2 (2025), LSEG's Investing in the Green Economy 2024, and Climate Bonds Initiative cumulative bond-alignment statistics reported through end-2025. The sources have different units of analysis, geographies, and observation dates; accordingly, no correlations, causal pathways, or firm-level sustainability outcomes are estimated. Global Findex indicators show wider account ownership and digital-payment and mobile-money use over time, while LSEG reports substantial growth in segments of the green investment market over broadly comparable periods. Indonesia's taxonomy establishes rules for categorizing financial activities, but does not measure actual adoption of sustainable business practices. A Climate Bonds Initiative end-2025 cumulative snapshot classifies approximately 83% of reported GSS+ issuance as aligned with science-based criteria and approximately 17% as not aligned; it cannot establish whether the alignment share has increased or decreased. The synthesis highlights the distinction between finance adoption, market expansion, regulatory classification, and verifiable instrument alignment and proposes conceptual relationships for future testing rather than claiming empirical confirmation.

Keywords: digital finance; FinTech; green bonds; green investment; sustainable finance taxonomy

1. Introduction

Digital payment services, mobile money, and other financial technologies have expanded access to financial services, while green investment instruments and sustainable-finance classification systems have gained policy and market attention. Existing empirical studies suggest that digital finance can affect green innovation, financing constraints, energy intensity, or ESG performance under particular institutional conditions (Zhuang et al., 2022; Chen et al., 2024; Lin & Xie, 2025; Liu et al., 2025). Yet these studies use specific samples and outcome measures; their findings cannot be assumed to apply to independently reported global aggregates.

This paper does not attempt to estimate an association between digital adoption and green investment because the four documents reviewed cannot be linked at a shared country-year, firm-year, or instrument-year level. Its contribution is a transparent comparison of reported developments and of the different meanings and limitations of the measures used. In particular, a national regulatory taxonomy is a classification infrastructure, not evidence that businesses have adopted sustainable practices; and alignment with science-based bond criteria is narrower than overall market credibility or transparency.

Four research questions guide the analysis: (RQ1) How have reported trends in digital finance adoption and

global green investment evolved over broadly comparable periods? (RQ2) How do Indonesia's sustainable-finance classification rules differ in purpose, scope, and measurement from market-level green-instrument alignment assessments? (RQ3) What does the available cumulative snapshot show about aligned and non-aligned GSS+ bond issuance, and what remains unknown about change over time? (RQ4) What conceptual connections, evidence boundaries, and future data requirements emerge when these independent sources are considered together?

Section 2 reviews the literature; Section 3 explains document selection, construct definitions, and synthesis; Section 4 reports descriptive findings; and Section 5 discusses implications, limitations, and future research.

2. Literature Review

2.1. Digital Finance Adoption and Environmental Outcomes

Digital finance may lower transaction costs and information frictions and support financing access, but an increase in account access or payments is not equivalent to measured environmental impact. Reviews describe a rapidly developing yet fragmented research field (Ellili, 2023; Kwong et al., 2023; Rahman et al., 2024; Ha et al., 2025). Empirical work finds context-dependent links between digital finance and energy intensity, green innovation, or ESG indicators (Zhuang et al., 2022; Gu et al., 2023; Chen et al., 2024; Fu & Xu, 2024; Lin & Xie, 2025; Tan & Tao, 2026). These studies provide a rationale for conceptual inquiry, not identification of relationships in the current unmatched documents.

2.2. Green Investment and Credibility-related Assessments

Green bonds, green equities, and other sustainable-finance products differ in definition, financial mechanism, and environmental objectives. Independent bond-screening frameworks assess whether labeled issuance meets specified eligibility criteria; they do not automatically measure issuer-wide transparency, market trust, or achieved environmental outcomes. Literature on bond disclosure and assurance emphasizes the importance of verifiable information, reporting quality, and standards (Jankovic et al., 2022; Broby & Yang, 2025; Gaur et al., 2026). Other research highlights disagreement across ESG ratings and variation in green financial performance (Anselmi & Petrella, 2025; Jindal, 2025; Khan & Vismara, 2025).

2.3. Sustainable-finance Taxonomies versus Business Practices

Taxonomies define eligibility, transition categories, and screening conditions for activities or financing. They can improve classification consistency, yet the existence of rules cannot itself show how often firms apply them or whether emissions, resource use, or governance practices improve. Studies of green credit and firm-level ESG outcomes report differing effects across samples (Dai et al., 2025; Liao & Zhou, 2024). The Indonesian setting offers an informative policy example, including green sukuk and green banking discussions (Endri et al., 2022; Setyorini & Hakam, 2025).

Table 1. Primary data sources

Source	Coverage and Purpose	Reference Date
World Bank, Global Findex Database 2025	Account ownership, digital payments, and mobile-money adoption among adults; population-based survey	2024 survey, with earlier comparison waves
OJK, Indonesia Taxonomy for Sustainable Finance v2	National eligibility tiers, screening criteria, and assessment routes	February 2025
LSEG, Investing in the Green Economy 2024	Global green-economy equity-market indicators and reported bond-market figures	Q1 2024, and selected 2023 indicators
Climate Bonds Initiative market alignment data	Cumulative alignment status of labeled GSS+ bond issuance	End 2025

2.4. Research Positioning

The reviewed studies motivate investigation of links among financial inclusion, sustainable investment, measurement, and governance. This article contributes a source-bounded descriptive synthesis rather than novel statistical evidence. It separates (i) use of digital financial services, (ii) reported green-market size and performance, (iii) legal or regulatory classification arrangements, and (iv) instrument-level alignment screening. The distinctions are necessary to prevent treating conceptual relevance as measured correspondence.

3. Methodology

3.1. Design and Sources

We conducted a qualitative document review and thematic synthesis using four sources selected for institutional authority, relevance to the research questions, and reported coverage (see Table 1). The documents constitute separate evidence streams and were not pooled into a joint dataset. Indicators are reported with their stated reference dates and denominators; comparisons are narrative, not statistical. The analysis does not perform correlations, significance tests, causal estimation, or a longitudinal examination of the aligned share of labeled bonds.

3.2. Construct Boundaries and Operationalization

Terminology is deliberately narrower than in the initial submission. "Green investment decisions" is replaced by "green investment market activity," because the LSEG aggregate measures do not observe decision-making. "Sustainable business practices" is replaced by "sustainable finance classification infrastructure." "Market credibility/transparency" is replaced by "green instrument standards alignment." Broad outcomes such as realized emissions reductions, firm-level taxonomy uptake, disclosure integrity, and investor confidence remain outside the measured constructs. See Table 2 for the summary.

Table 2. Analytical dimensions, evidence sources, and interpretive boundaries

Analytical dimension	Evidence used	Permissible interpretation/ exclusion
Digital finance/ FinTech adoption	Account ownership, digital-payment usage, mobile money (Global Findex)	Adoption indicators; not a firm digital-finance infrastructure measure
Green investment market activity	Green economy market capitalization, returns, reported green-bond indicators (LSEG)	Market-scale and performance indicators; not individual investment decisions
Sustainable finance classification infrastructure	Green/ transition/ unqualified tiers, TSC, SDT, consumptive-finance linkage (OJK)	Regulatory rules only; not observed sustainable business behavior or outcomes
Green instrument standards alignment	Aligned/non-aligned share of cumulative GSS+ issuance (climate bonds initiative)	Proxy for one verification dimension; not a comprehensive measure of transparency, credibility, or realized impact

3.3. Synthesis Protocol and Evidence Rules

The sources were read for their definitions, metrics, geography, reference period, and inferential limits. Extracted observations were assigned to one of the four analytical dimensions. Results are first presented within each source; cross-source commentary is explicitly identified as contextual comparison. A shared temporal window is used only in a broad narrative sense and never implies equivalent measurement periods. The following descriptive expectations structure interpretation, but are not hypotheses tested here: D1, selected indicators of digital financial inclusion and green-market activity both show growth within their respective datasets; D2, a national taxonomy and an independent bond-alignment screen use criteria to distinguish qualified activities or instruments but are not interchangeable; D3, the cumulative bond-alignment distribution includes both aligned and non-aligned issuance, without allowing a conclusion about their relative growth rates. No proposition is advanced linking technology-sector renewable-energy purchases to FinTech-enabled verification.

3.4. Conceptual Diagram and Scope

Figure 1 presents proposed conceptual relationships derived from literature and descriptive document synthesis. These relationships are not empirically tested pathways. Digital-finance adoption, green-investment market activity, classification infrastructure, and standards alignment are shown as distinct analytical dimensions;

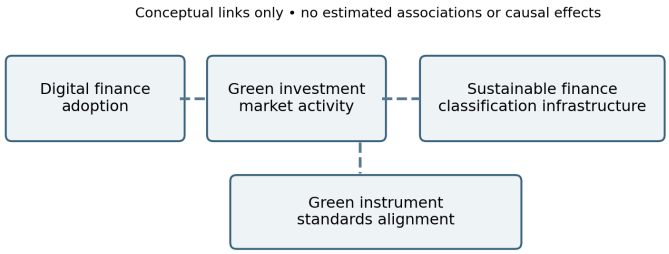


Figure 1. Proposed conceptual relationships
Note: Dashed connectors do not indicate tested associations or causal effects

Table 3. Descriptive indicators of digital finance adoption and green market activity

Measure	Reported value/period	Interpretive scope
Global account ownership	51% (2011); 79% (2024)	Adults; Findex
Digital payment use in LMICs	34% (2014); 62% (2024)	Adults in low- and middle-income economies; Findex
Mobile-money ownership in LMICs	2% (2014); 18% (2024)	Adults in low- and middle-income economies; Findex
Green economy market capitalization	More than US$7 trillion (Q1 2024)	LSEG market indicator
Green economy ten-year CAGR	13.8% versus 8.3% broad market (reported in 2024)	LSEG market indicator
Green bond issuance	Approximately US$540 billion (2023)	LSEG reported issuance

connections are represented as dashed conceptual links rather than directed causal arrows.

4. Results

4.1. Adoption and Market Indicators: Distinct Reported Trends (RQ1)

The Global Findex series reports that global adult account ownership increased from 51% in 2011 to 79% in 2024 (see Table 3). For low- and middle-income economies, digital-payment use increased from 34% in 2014 to 62% in 2024, and mobile-money account ownership from 2% to 18% during the same dates. These are measures of financial access and usage, not direct measures of investment allocation.

Separately, LSEG's 2024 report describes green-economy market capitalization exceeding US$7 trillion in Q1 2024 and a reported ten-year green-economy compound annual growth rate of 13.8%, compared with 8.3% for the broader equity market. Its reported 2023 FTSE Environmental Opportunities Index return is +32% against +22% for a stated benchmark, and green bond issuance was approximately US$540 billion in 2023 (about +7% year over

Table 4. Cumulative GSS+ bond issuance and standards alignment as of end-2025

Climate Bonds cumulative end-2025 indicator	Approximate result
Labeled GSS+ issuance	US$8.1 trillion
Aligned under the reported screening criteria	US$6.8 trillion (83%)
Not aligned under the reported screening criteria	US$1.3 trillion (17%)

year). These indicators differ in units and coverage from Global Findex. Their reported upward patterns may be juxtaposed descriptively, but cannot establish a correlation, common growth rate, statistical association, or direction of influence.

4.2. Classification Rules and Market Alignment (RQ2)

Indonesia's OJK Taxonomy for Sustainable Finance Version 2 classifies specified economic activities as Green, Transition, or Unqualified subject to applicable environmental objectives and essential criteria. Its Technical Screening Criteria (TSC) route applies to the relevant corporate activities; a Simplified Decision Tree (SDT) provides an assessment route for micro, small, and medium enterprises. The taxonomy also discusses a consumptive-finance linkage. These are policy and classification arrangements. The documents analyzed do not establish the number of companies that use the classifications, how frequently financiers apply them, or realized reductions in environmental harm.

Climate Bonds Initiative's instrument-screening framework operates on a different population and scope, using criteria to characterize GSS+ issuance as aligned or not aligned with its standards. The shared feature is the use of explicit assessment criteria. However, there is no one-to-one mapping between Indonesian activity classifications and global bond issuance, and equivalence of rules, market outcomes, or verification rates cannot be inferred.

4.3. Cumulative Aligned and Non-aligned Labeled Issuance (RQ3)

The Climate Bonds Initiative figures reported in the manuscript indicate approximately US$8.1 trillion in cumulative labeled GSS+ bond issuance by end-2025, of which approximately US$6.8 trillion (83%) met its science-based alignment criteria and approximately US$1.3 trillion (17%) did not (see Table 4). These percentages describe a cumulative distribution at one observation date. They do not show an annual alignment trend, a growing gap, or a faster increase in self-labeled issuance than in aligned issuance. A time series using consistent definitions and denominators would be needed to evaluate those claims. "Not aligned under the selected screening framework" also must not be equated automatically with fraud, greenwashing, or failure to produce environmental benefits.

4.4. Illustrative Technology-sector Context, Not a FinTech Test (RQ4)

LSEG also describes the technology sector as a major purchaser of renewable power and reports growth in the market capitalization of green information technology and efficiency activities. Such information illustrates that digital-intensive industries can participate in green markets. It does not measure adoption of digital financial services, data-enabled verification of bond claims, or a closer correspondence between labeled investments and measured outcomes. Consequently, the technology-sector examples are contextual only and are not presented as evidence supporting a fourth proposition.

5. Discussion

5.1. Interpretation of the Descriptive Synthesis

This source-bounded comparison suggests three distinctions. First, increasing financial-service adoption and green-market expansion can be documented separately, but their relationship is not estimable from these sources. Second, a regulatory taxonomy may specify what qualifies for sustainable-finance classification without showing whether firms adopt relevant behaviors. Third, the share of instrument issuance meeting an independent science-based standard is informative about a particular screening criterion, not a complete measure of market credibility, transparency, investor confidence, or environmental effectiveness.

The literature provides plausible mechanisms through which digital finance might lower financial frictions or improve traceability (Chen et al., 2024; Lin & Xie, 2025; Li et al., 2025), and through which more reliable disclosure could affect green-bond markets (Jankovic et al., 2022; Gaur et al., 2026). These are externally reported scholarly findings and theoretical possibilities, not relationships verified by the present document comparison. Figure 1 therefore remains a future-testing framework, not a confirmed causal cycle.

5.2. Theoretical and Practical Implications

The central theoretical contribution is greater construct precision when synthesizing diverse sustainable-finance reports. Policy discussions should distinguish outreach and adoption metrics, green-market activity, sustainable-finance classification systems, and instrument verification from actual environmental outcomes. For regulators and standard setters, taxonomy publication alone should not be treated as proof of corporate sustainability improvements; additional records on classification uptake, disclosures, assurance, and measured environmental performance would be required.

5.3. Limitations

The review uses four independent documents rather than a matched primary or secondary microdataset. The indicators differ in population, geography, definition, financial instruments, observation dates, and units. The Indonesian taxonomy is a country-specific legal framework, whereas Findex, LSEG, and Climate Bonds present broader populations. No statistical correlation or causal effects can be calculated. There is no time series of the aligned proportion of GSS+ issuance, no firm-level sustainable-practice measurements, and no direct indicator relating FinTech infrastructure to bond verification. Additional limitations include potential source-specific definitions and selection effects; the original documents

should be consulted before precise comparisons across datasets.

5.4. Future Research

A linked country-year or firm-year panel combining digital-finance use, identifiable green capital allocation, and environmental outcomes could test statistical relationships with appropriate controls. A separate instrument-year dataset reporting labeled and aligned issuance under consistent criteria would allow analysis of how alignment changes through time. Firm surveys or administrative taxonomy records could measure actual classification uptake and sustainable practices. Studies seeking to assess market credibility more comprehensively should incorporate disclosure completeness, external assurance, information access, investor perceptions, and realized use-of-proceeds or environmental impact. These steps would turn the paper's conceptual questions into measurable empirical hypotheses.

6. Conclusion

Across the documents considered, both digital financial inclusion indicators and selected green-market indicators increased in their respective reporting periods. Indonesia's sustainable-finance taxonomy illustrates a formal classification infrastructure, while cumulative Climate Bonds statistics identify a non-aligned portion of labeled GSS+ issuance under specific standards. None of these findings establishes a correlation or causal link among digital adoption, green-market growth, verification, and sustainable business behavior. The proposed connections warrant testing with aligned observations and direct sustainability-outcome measures.

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