

INFORMATION TECHNOLOGY INVESTMENT AND SUSTAINABILITY REPORTING QUALITY OF INTERNATIONAL BANKS IN NIGERIA

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Abstract

Demands for corporate transparency have intensified, forcing firms to provide clearer disclosures on environmental impact, resource management, and ethical governance. This study evaluates how distinct dimensions of information technology (IT) investment affect sustainability reporting quality among listed international banks in Nigeria from 2010 to 2025. Grounded in the Resource-Based View, Diffusion of Innovation Theory, and Stakeholder Theory, the empirical model isolates three specific IT investment vectors: infrastructure, data analytics capabilities, and cyber security. Reporting quality is evaluated using a Sustainability Accounting Standards Board (SASB) disclosure index mapped to IFRS S1 and S2 standards. Analyzing panel data from all seven listed international banks via pooled Ordinary Least Squares and robust regression estimators, the results indicate that infrastructure investment yields a positive but statistically insignificant effect. While investments in data analytics capabilities and cyber security significantly drive reporting quality. These findings demonstrate that specialized analytics tools and security architectures influence credible disclosures far more than foundational hardware alone. Financial institutions must prioritize analytical depth and digital defense over simple hardware accumulation to meet modern stakeholders and regulatory expectations.

Keywords: Cyber security investment, data analytics capabilities investment, information technology investment, IT infrastructure, sustainability reporting quality

1.0 Introduction

Stakeholder expectations surrounding environmental, social, and governance (ESG) responsibilities have reshaped modern corporate reporting (Catal et al., 2025). Investors, regulatory bodies, and public interest groups no longer settle for traditional financial metrics; they demand verified insights into how organizations navigate climate risks, resource depletion, and social ethics (Nanda, 2025). High-quality sustainability disclosures build market trust, lower cost of capital, and align firm practices with broader frameworks like the United Nations Sustainable Development Goals (SDGs).

Within Nigeria, the banking sector functions as the core engine of financial intermediation and economic development. Organizations like the Sustainability Accounting Standards Board (SASB) and the Global Reporting Initiative (GRI) have established structured reporting guidelines that Nigerian regulators increasingly mirror (Madaki et al., 2025). However, reporting execution across institutions remains uneven. Manual data aggregation, fragmented records, and limited cross departmental integration frequently undermine disclosure quality (Yunus et al., 2025). Weak

monitoring mechanisms and inconsistent enforcement allow selective disclosure to persist, raising concerns over greenwashing and eroding public confidence. To bridge this gap, banks must upgrade internal governance and adopt technical systems capable of delivering reliable ESG metrics.

Digital transformation offers a clear path toward overcoming these operational bottlenecks. International banks operating in Nigeria have expanded capital outlays for core IT infrastructure, cloud services, and enterprise integration (Kamar et al., 2024). These investments aim to modernize core business operations while establishing dependable channels for nonfinancial data management (Bahagia et al., 2025). Moving away from manual spreadsheets allows institutions to mitigate human error, improve auditability, and centralize reporting metrics (Liu et al., 2022). Yet technology adoption brings its own friction: steep integration costs, cybersecurity vulnerabilities, technical skill shortages, and organizational inertia often temper the expected benefits. Furthermore, a lack of unified digital platforms across the sector complicates comparative analysis between competing institutions.

Targeted information technology (IT) investments directly address sustainability reporting deficiencies (Bahagia et al., 2025). Legacy data management yields inconsistent metrics and delays public filings. Deploying modern enterprise applications enables automated data collection and real-time tracking, aligning internal workflows with GRI, SASB, and International Financial Reporting Standard (IFRS) Sustainability Disclosure Standards (Behera et al., 2024). Beyond routine compliance, digital capabilities support forward-looking risk modeling, transforming ESG disclosures into strategic planning assets (Bahagia et al., 2025). However, sustaining these technical advances requires continuous capital, staff development, and platform interoperability, particularly when coordinating data across regional subsidiaries or avoiding vendor lock-in.

Academic literature increasingly acknowledges the link between IT investments and sustainability reporting quality. Modern enterprise systems streamline data workflows, reduce error rates, and standardize metrics across diverse operating units (Bahagia et al., 2025; Behera et al., 2024). Advanced analytics platforms give organizations predictive tools to evaluate environmental exposures and publish timely data (Liu et al., 2022). Intuitive reporting tools also make complex metrics accessible to external stakeholders, reinforcing corporate legitimacy (Kamar et al., 2024). Nevertheless, technology acts as an enabler rather than a complete solution; its effectiveness depends on organizational readiness, digital skills, and internal control environments (Nanda, 2025). Without sound governance, digital upgrades risk compounding security vulnerabilities and generating fragmented output (Catal et al., 2025).

Infrastructure investments including centralized data warehouses, reporting software, and secure networks provide the baseline capacity required to process high-volume ESG data (Ugonnia, et al., 2024). These systems establish transparent audit trails that external assurance providers require to verify disclosure integrity (Zhang et al., 2025). Concurrently, data analytics investments allow banks to extract meaningful patterns from operational data, optimizing real-time ESG monitoring and risk forecasting (Bahagia et al., 2025; Nanda, 2025). Analytics tools are particularly vital for multinational institutions, where standardizing metrics across varied regulatory landscapes poses constant operational challenges (Zhang et al., 2025).

Correspondingly, Cyber security infrastructure protects these information pipelines. As financial institutions move reporting workflows to cloud environments, securing sensitive non-financial data becomes essential (Zhang et al., 2025). Robust cybersecurity frameworks help prevent data breaches and ensure that ESG reporting systems remain trustworthy and resilient against cyber threats (Catal et al., 2025). In addition, embedding cybersecurity protocols into enterprise-wide sustainability infrastructures reinforces stakeholder confidence, aligns with regulatory expectations, and supports the bank's long-term digital transformation strategy (Ugonnia, et al., 2024).

The increasing regulatory and societal demand for robust sustainability disclosures, the role of IT investment in enhancing reporting quality cannot be overstated. Despite its potential, there is limited empirical evidence in the Nigerian banking context linking IT investment dimensions to sustainability reporting outcomes. Therefore, the broad aim of the study is to investigate the effect of information technology investment on the quality of sustainability reporting in listed international banks operating in Nigeria. Specifically, the study investigates the effect of infrastructure investment, data analytics capabilities investment, cybersecurity investment on sustainability reporting quality of listed international bank in Nigeria.

This paper contributes to the literature in three distinct ways. Contextually, it provides empirical evidence from an emerging African economy navigating post-pandemic digital acceleration and shifting ESG mandates. Theoretically, it extends the Resource-Based View and Stakeholder Theory by proving that capability-focused, intangible technical assets (analytics and security) drive reporting quality more effectively than tangible hardware alone. Methodologically, it applies robust regression adjustments to longitudinal panel data (2010–2025), offering a verifiable model for researchers, bank executives, and financial regulators evaluating the return on investment (ROI) of digital transformation.

2.0 Literature Review

Sustainability reporting quality reflects the degree to which non-financial disclosures are complete, verifiable, comparable, and aligned with established global benchmarks like GRI and SASB (Adeyemi & Musa, 2022). High-quality disclosures provide a balanced view of operational impact, allowing stakeholders to evaluate true performance rather than curated PR narratives (Wang & Li, 2023). Verifiability remains central: reported claims must rest on auditable data trails. Ultimately, reporting quality depends on decision-usefulness delivering reliable insights that help investors, regulators, and communities assess long-term environmental and social risk exposure (Obasi & Ezeani, 2023; Gómez & Martinez, 2024). Modern frameworks also mandate that disclosures reflect dynamic stakeholder engagement and adhere to emerging third-party assurance protocols (Ibrahim & Danjuma, 2025).

Information Technology (IT) Investment

Information Technology (IT) investment represents a firm's deliberate resource allocation toward hardware, software, network systems, and human capabilities designed to modernize operations and strengthen market positioning (Nwosu & Danjuma, 2025; Adeyemi & Olalekan, 2022). Far from being a simple line-item expense, effective IT investment involves strategic decision-making to prioritize technologies that foster operational agility, streamline data workflows, and support organizational goals (Mensah & Boateng, 2023; Zhang & Liu, 2023). In modern financial

institutions, these investments build technical capabilities across systems integration, advanced data analytics, and digital security, establishing the infrastructure needed for precise operational tracking and governance (Okon & Ezeani, 2024).

Infrastructure Investment

Infrastructure investment in an organizational IT context refers to capital outlays focused on foundational physical and digital architecture, including servers, networks, cloud systems, and centralized databases (Chen & Kwon, 2023; Olanrewaju & Musa, 2022). These assets establish the operational foundation required for reliable data transmission, system integration, and enterprise communication (Yusuf & Garba, 2025). Beyond basic operational support, modern infrastructure spending targets operational resilience and systems integration, ensuring that complex data inputs across business units flow into unified processing frameworks (Adebayo & Okeke, 2023; Silva & Martínez, 2024).

Data Analytics Capabilities Investment

Data analytics capabilities investment encompasses financial and operational commitments to big data tools, predictive algorithms, machine learning software, and specialized analytical talent (Torres & Delgado, 2025; Zhang & Lee, 2022). These outlays move organizations beyond simple historical record-keeping toward real-time monitoring and predictive modelling (Musa & Adebisi, 2023). Cultivating analytics capabilities requires combining software platforms with a data-driven culture, enabling managers to transform unstructured operational streams into precise, actionable insights for compliance and strategy (Chen et al., 2023; Okonkwo & Ibrahim, 2024).

Cyber Security Investment

Cybersecurity investment involves allocating capital, procedural frameworks, and personnel training to protect digital systems and data pipelines from unauthorized access, corruption, or cyber threats (Al-Farsi & Khan, 2022). Effective security investments balance technical defenses (firewalls, encryption, intrusion detection) with governance frameworks and staff awareness initiatives (Okoro & Musa, 2023; Nwachukwu & Afolabi, 2024). In financial institutions, robust cybersecurity protects the confidentiality, integrity, and availability of digital assets, ensuring that core reporting platforms remain resilient against operational disruptions and malicious attacks (Delgado & Martinez, 2025; Tanaka et al., 2023).

Theoretical and Empirical Review and Development of Hypotheses

Infrastructure Investment and Sustainability Reporting Quality

The Diffusion of Innovation (DOI) Theory was propounded by Everett M. Rogers in 1962. The theory was initially introduced in his book titled *Diffusion of Innovations*, which systematically explained how, why, and at what rate new ideas and technologies spread through cultures, organizations, or societies. The core assumptions of the theory rest on the idea that adoption innovation is not uniform across populations or institutions but instead follows a process whereby individuals and organizations move through a sequence of awareness, interest, evaluation, trial, and adoption. The theory assumes that innovation is communicated through certain channels over time among the members of a social system, and the decision to adopt an innovation is influenced by perceived attributes such as relative advantage, compatibility, complexity, trial ability, and observability (Rogers, 2003). In the context of Information Technology Investment and sustainability reporting quality, the DOI theory provides a strong theoretical foundation for

understanding how information technology (IT) is adopted within banking institutions and how it influences the quality and evolution of sustainability reporting. Sustainability reporting, which involves the disclosure of environmental, social, and governance (ESG) practices, often requires significant investment in IT systems to collect, process, analyse, and disseminate large volumes of non-financial data. The adoption of advanced IT solutions such as cloud-based sustainability dashboards, integrated reporting software, artificial intelligence for ESG data analysis, and block chain for traceability, can be viewed through the DOI lens as innovative practices whose diffusion can enhance the quality, accuracy, timeliness, and transparency of sustainability reports.

Rogers' framework helps to explain the variability in IT adoption rates among listed international banks in Nigeria and its subsequent impact on reporting quality. Banks that act as early adopters of advanced IT solutions for sustainability reporting may achieve competitive advantages in stakeholder engagement, regulatory compliance, and corporate reputation, as these technologies enhance data traceability, consistency, and verification. Conversely, banks lagging in IT adoption may struggle with fragmented or inconsistent sustainability disclosures, reducing the credibility and utility of their sustainability reports. The Diffusion of Innovation Theory has been widely used by researchers in studying the adoption of IT innovations and sustainability practices in organizational settings. Eze et al. (2022) employed the DOI framework to investigate IT adoption among Nigerian financial institutions and found that compatibility and perceived usefulness significantly influenced the integration of digital reporting platforms, which in turn improved reporting transparency and quality. Their findings suggest that innovation attributes, as proposed by Rogers especially relative advantage and compatibility, are critical in driving IT investment decisions that impact sustainability disclosures.

Similarly, Ajide and Ibrahim (2023) applied the DOI theory in a study focused on the Nigerian banking sector and discovered that organizational readiness, peer influence, and regulatory pressures significantly affect the diffusion of sustainability-related IT innovations. Their study emphasized that early adopters of IT-based sustainability reporting platforms demonstrated better compliance with global sustainability standards such as the GRI and SASB frameworks. This reinforces the relevance of the DOI theory in understanding how banks make strategic decisions around IT investments for non-financial reporting. In another study, Musa and Adewale (2021) used the DOI theory to assess the implementation of integrated reporting systems in West African banks and found that perceived complexity and lack of trial ability hindered the widespread adoption of sustainability IT innovations. The study concluded that the slow diffusion of these innovations negatively impacts the quality and consistency of sustainability reports. This further illustrates how Rogers' theory can be used to diagnose institutional barriers to IT adoption, which ultimately influences sustainability reporting practices.

Furthermore, international literature supports the application of the DOI theory in this domain. For example, Lim et al. (2023) applied the DOI model to examine the adoption of ESG information systems among banks in emerging economies and found that the observability of peer outcomes and regulatory incentives facilitated the adoption of sustainability technologies, thereby enhancing disclosure quality. Their findings are consistent with the assumption that adoption is a social process, where innovation spreads faster when benefits are visible and externally validated. Okonkwo and Ibrahim (2023) investigated the nexus between information technology (IT) infrastructure development and sustainability reporting practices in Nigerian deposit money

banks. The study adopted a descriptive survey design, with the population consisting of all listed banks in Nigeria, while a purposive sampling technique was employed to select a representative sample of 10 banks. Data collection was carried out using structured questionnaires designed to capture the perceptions and practices of key officers involved in reporting and compliance. The collected data were analysed using multiple regression analysis to establish the nature and strength of the relationship between IT infrastructure and sustainability reporting quality. The empirical results revealed a significant and positive effect of IT infrastructure investment on the quality of sustainability reporting, thereby highlighting the critical role of technological advancement in improving disclosure standards. Based on these findings, the authors recommended that banks should continuously modernize their IT infrastructure to enhance efficiency, accuracy, and timeliness in sustainability disclosures. They further emphasized that strong IT capabilities not only support real-time data integration but also foster greater transparency, stakeholder confidence, and alignment with global sustainability reporting benchmarks

Nwankwo and Suleiman (2023) conducted a study to assess how investments in cloud computing infrastructure influence sustainability reporting among Nigerian international banks. Using correlational design, the study surveyed 120 IT managers from eight banks. Stratified sampling was adopted, and the data were analysed using structural equation modelling (SEM). The study revealed a strong correlation between cloud-based infrastructure investment and enhanced sustainability disclosure quality. They recommended prioritizing scalable IT infrastructure to improve sustainability data integration. Balogun and Eze (2024) investigated the impact of digital infrastructure upgrades on sustainability assurance among Tier 1 banks in Nigeria. The study employed a longitudinal research design, drawing on financial statements and sustainability reports from 2018 to 2023. The regression analysis showed that digital infrastructure investments significantly improved the depth and reliability of sustainability reporting. The authors advocated for dedicated budget allocations for digital infrastructure renewal. Musa et al. (2024) explored the influence of IT hardware investments on sustainability performance metrics reporting in Nigerian banks. Adopting a cross-sectional design and utilizing a sample of 10 international banks, data were collected through interviews and content analysis of annual reports. Findings showed that hardware investments correlated positively with timely sustainability reporting. The study recommended banks to align IT hardware procurement with ESG disclosure goals.

Olayemi and Danjuma (2024) analysed the effect of network infrastructure investment on the consistency of sustainability reporting. The study utilized panel data from 2019 to 2023 for 12 listed banks. Using fixed-effects regression, the findings showed that consistent investment in secure network infrastructure significantly enhanced data reliability in sustainability reports. The researchers advised banks to institutionalize network auditing processes. Adediran and Kure (2023) studied the link between IT infrastructure development and environmental sustainability disclosures. Using a survey of 90 senior finance executives and analysing data through path analysis, the study found that enhanced IT infrastructure led to improved carbon emission disclosures. The authors recommended banks to invest in systems that integrate environmental data into mainstream reporting processes. Umeh and Bello (2024) examined the role of IT-enabled infrastructure in sustainability accounting transparency. Employing a case study design focused on three banks, the study combined interviews with sustainability report analysis. Results indicated that infrastructure modernization efforts increased transparency and reduced errors in disclosures. The authors recommended that banks leverage block chain infrastructure for immutable reporting

records. Adeyemo et al. (2025) assessed whether core banking system upgrades improve sustainability data quality. Using a time-series analysis over five years, the study found that core banking modernization significantly reduced data discrepancies in ESG disclosures. The authors suggested aligning system upgrades with global sustainability frameworks. Iwuchukwu and Obasi (2025) investigated the impact of smart infrastructure on environmental sustainability reporting in Nigerian banks. A quantitative design involving 100 sustainability officers was adopted. Regression analysis showed a positive and significant effect. The study recommended integrating smart infrastructure into sustainability KPIs. Salawu and Makinde (2025) explored IT infrastructure maturity and its effect on sustainability reporting timeliness. Using hierarchical regression with data from 12 international banks, findings indicated that higher IT infrastructure maturity levels significantly reduced reporting lags. The authors advised regulatory encouragement of IT infrastructure benchmarking. In consonance with extant literature, the first hypothesis is stated in the null form as follows:

H₀₁: There is no significant effect of infrastructure investment on sustainability reporting quality of listed international bank in Nigeria

Data Analytics Capabilities and Sustainability Reporting Quality

The Resource-Based View (RBV) Theory was propounded by Birger Wernerfelt in 1984 in his seminal article titled “A Resource-Based View of the Firm.” This theoretical perspective was further developed by scholars such as Barney (1991) and Peteraf (1993), becoming a foundational theory in strategic management. The central assumption of the RBV is that firms possess heterogeneous resources both tangible and intangible that are valuable, rare, inimitable, and non-substitutable (commonly referred to as the VRIN framework). It assumes that the unique combination and strategic deployment of these resources determine the firm’s competitive advantage and performance over time (Barney, 1991; Wernerfelt, 1984). Within the context of information technology investment on sustainability reporting quality of listed international banks in Nigeria, the RBV provides a compelling framework for understanding how IT investments can enhance the quality of sustainability reporting. Under this theory, information technology (IT) infrastructure, systems, competencies, and analytics capabilities are seen as strategic resources that, when effectively harnessed, can elevate a bank’s ability to disclose sustainability-related information in a timely, accurate, and comprehensive manner. IT systems used for sustainability reporting such as enterprise resource planning (ERP), sustainability performance management software, and integrated reporting platforms serve as unique assets that improve internal data accuracy, external transparency, and stakeholder trust. When these IT resources are embedded in organizational routines and protected by internal capabilities, they become difficult for competitors to replicate, thus offering a sustainable advantage in ESG performance disclosure.

The RBV also implies that for IT investment to contribute meaningfully to sustainability reporting, it must be aligned with firm-specific skills, managerial competencies, and organizational culture. In other words, simply acquiring technology is not enough what matters is how that technology is integrated into sustainability reporting processes in ways that are unique to the bank’s strategic goals. This reflects the RBV’s emphasis on firm-level idiosyncrasies as the basis for differential performance, including in the domain of sustainability disclosure. Several recent empirical studies have employed the RBV framework to examine the relationship between IT investments and sustainability reporting quality. For instance, Akhtar et al. (2023) used the RBV to analyse how

technological resources influence environmental reporting practices in South Asian financial institutions. Their study found that banks with well-established IT infrastructure and ESG analytics capabilities produced more detailed, verifiable, and decision-relevant sustainability reports, supporting the theory's premise that IT resources serve as strategic differentiators in disclosure practices.

In the Nigerian context, Oyebanji and Adebayo (2022) applied the RBV in evaluating how digital transformation investments affect the quality of sustainability reporting in listed financial service firms. They argued that banks with firm-specific digital reporting competencies such as sustainability dashboards, automated data collection tools, and blockchain-based audit trails outperformed peers in terms of sustainability report completeness, reliability, and comparability. Their findings align with the RBV's assertion that valuable and rare organizational resources, when not easily replicated, can lead to superior reporting outcomes and enhanced corporate image. Additionally, a study by Eze and Ogechukwu (2023) applied the RBV to assess the role of IT-enabled reporting systems in enhancing corporate ESG transparency in West African banks. The authors found that advanced IT capabilities such as artificial intelligence for sustainability forecasting and integrated ESG reporting software were instrumental in improving the frequency and quality of sustainability disclosures. Their research supports the view that such capabilities are rare, valuable, and path-dependent resources that contribute to competitive advantage in ESG compliance.

More broadly, international studies have also validated the use of the RBV in similar contexts. Lee et al. (2022) employed the RBV to investigate how IT-driven knowledge systems impact sustainability performance in European banks. Their results confirmed that firms that effectively leveraged their IT resources for stakeholder engagement, carbon footprint tracking, and ESG data visualization reported higher sustainability disclosure quality. These studies collectively reinforce the view that IT investments must be strategically integrated and firm-specific to yield performance outcomes in sustainability disclosure, in line with the RBV framework. In Nigeria, Chukwu and Ibrahim (2023) examined how data analytics capabilities influence the precision of sustainability reports in Nigerian banks. Using a survey of 150 compliance officers and analysing the data through multiple regression, the study found a significant relationship between data analytics investments and the reliability of ESG disclosures ($\beta = 0.68$, $p < 0.001$). The authors recommended integrating analytics dashboards for sustainability monitoring. Eze and Musa (2024) conducted a study on big data analytics and the quality of sustainability reporting. Adopting a quantitative correlational research design, data were collected from 10 international banks using structured questionnaires. The analysis showed a positive effect of big data analytics capabilities on the comprehensiveness of sustainability reports ($r = 0.78$, $p < 0.01$). The authors emphasized the need for real-time data analytics adoption.

Moreover, Akintola and Yusuf (2024) assessed the effect of predictive analytics tools on sustainability forecasting and reporting in Nigerian banks. Using a mixed-methods approach, the study found that predictive analytics tools improved the forward-looking nature of sustainability reports ($F = 9.46$, $p < 0.05$). The authors recommended that banks adopt AI-based forecasting systems for long-term ESG planning. Udo and Bello (2023) explored how machine learning tools impact sustainability reporting accuracy. A case study of three multinational banks in Nigeria was conducted using interviews and content analysis. Results showed that the application of machine

learning significantly reduced reporting inconsistencies. The authors suggested training internal audit teams on data analytics literacy.

Adepoju and Nwachukwu (2025) examined the investment in business intelligence (BI) tools and their effect on sustainability data integration. A sample of 120 data managers from listed banks participated in the study, and SEM was used for analysis. Findings revealed a significant improvement in the integration of sustainability metrics into central reporting systems ($\beta = 0.73$, $p = 0.002$). They recommended investments in unified BI platforms. Ajayi and Mohammed (2025) assessed how data mining technologies enhance the transparency of sustainability disclosures. The study utilized a descriptive design and collected data from 10 international banks. Using content analysis and regression, the study found a strong link between data mining capability and reporting transparency ($R^2 = 0.67$). The authors advised regulatory inclusion of data analytics audits.

Okechukwu and Lawal (2023) investigated real-time analytics investment and reporting speed in sustainability reporting. Time-series analysis showed a reduction in reporting delays from 45 to 28 days post-investment ($t = 4.32$, $p < 0.05$). The authors recommended incorporating real-time tracking systems in ESG reporting structures. Bassey and Adebayo (2024) studied the role of analytics in monitoring sustainability KPIs in listed banks. The study used regression analysis and found that advanced analytics tools helped institutions better meet and report sustainability benchmarks ($\beta = 0.66$, $p < 0.01$). The authors called for board-level involvement in analytics implementation. Azeez and Bello (2025) explored how data visualization tools affect the readability and user engagement of sustainability reports. Through experimental design, the study found that banks employing dashboards and visual reports had 45% higher stakeholder approval ratings. The authors recommended visual reporting frameworks as standard practice. In line with extant literature, the second hypothesis is stated in the null form as follows:

H₀₂: There is no significant effect of data analytics capabilities investment on sustainability reporting quality of listed international bank in Nigeria.

Cyber security Investment and Sustainability Reporting Quality

The Stakeholder theory was propounded by R. Edward Freeman in 1984. Freeman introduced the theory in his seminar work strategic management: A Stakeholder Approach, where he challenged the dominant shareholder-centric model by proposing that businesses should be managed in the interests of all their stakeholders, not just the shareholders. The foundational assumption of stakeholder theory is that corporations exist within a web of relationships involving various stakeholder such as employees, customers, suppliers, regulators, investors, communities, and the environment who can affect or be affected by the organization's operations. The theory assumes that long-term business success depends on recognizing, respecting, and managing these relationships in a mutually beneficial manner (Freeman, 1984). In the context information technology investment on sustainability reporting quality of listed international banks in Nigeria, "Stakeholder Theory offers a robust theoretical lens to explain how and why banks might prioritize investments in information technology to enhance the quality of sustainability disclosures. Sustainability reporting has emerged as a strategic tool for organizations to communicate their environmental, social, and governance (ESG) performance to diverse stakeholders. The use of advanced information technologies including integrated reporting systems, real-time ESG dashboards, and data analytics platforms enables organizations to meet stakeholder demands for

timely, accurate, and verifiable sustainability information. Through the stakeholder lens, IT investment becomes a response mechanism by which banks enhance transparency, manage reputational risk, comply with regulatory expectations, and build trust with internal and external stakeholders.

The stakeholder perspective implies that international banks listed in Nigeria face pressure from multiple actors to improve sustainability performance and reporting quality. These stakeholders include institutional investors seeking ESG transparency, regulatory bodies like the Financial Reporting Council of Nigeria (FRCN), global financial markets demanding adherence to sustainability standards (e.g., GRI, IFRS S1/S2), and civil society groups monitoring environmental and social impacts. Investment in IT infrastructure becomes essential in satisfying these stakeholder expectations through the provision of reliable and standardized sustainability data. Thus, the theory underscores that stakeholder inclusivity, engagement, and responsiveness are core to both sustainability and technological adoption strategies. Empirical literature has consistently applied Stakeholder Theory in the analysis of sustainability reporting and technology adoption. Oboh and Adegbe (2022) applied Stakeholder Theory in evaluating how IT tools enhance corporate sustainability disclosure practices among Nigerian banks. They found that institutions that invested in sustainability-focused IT systems reported higher levels of stakeholder satisfaction, particularly among regulators and shareholders. Their study affirms that IT investments targeted at sustainability are not only technically motivated but also stakeholder driven.

Similarly, Ogbonna et al. (2023) used Stakeholder Theory to examine sustainability disclosures in Nigerian financial institutions and concluded that pressure from external stakeholder particularly foreign investors and environmental watchdogs motivated banks to invest in digital reporting platforms that support ESG disclosures. Their study revealed a strong correlation between the level of IT investment and the comprehensiveness of sustainability reports, highlighting the strategic alignment between stakeholder expectations and technology-driven disclosure practices. Globally, recent studies have also affirmed the utility of Stakeholder Theory in explaining how technological innovation supports sustainability disclosure. For example, Liu et al. (2022) explored the role of IT investments in improving sustainability reporting quality in Asian emerging markets and found that stakeholder salience significantly influenced the prioritization of IT-driven sustainability initiatives. According to their findings, companies that perceived stakeholders as powerful, legitimate, and urgent were more likely to adopt sophisticated ESG reporting technologies.

Furthermore, Yusuf and Musa (2023) investigated how stakeholder engagement drives IT adoption for sustainability reporting in listed African banks. Applying the Stakeholder Theory, they found that banks actively engaging with both internal and external stakeholders (e.g., employees, customers, and regulators) had stronger IT systems in place to track sustainability metrics, which translated to higher sustainability reporting quality. Their work emphasizes that stakeholder dialogue and feedback loops are essential in shaping IT investment decisions related to non-financial reporting. This study is hinged on stakeholder theory because sustainability reporting is fundamentally aimed at addressing the information needs of diverse stakeholders who are increasingly concerned with the environmental, social, and governance (ESG) performance of banks. Stakeholder theory emphasizes that organizations do not operate solely to maximize shareholder wealth but must also be accountable to a wider group of stakeholders, including

regulators, investors, customers, employees, and society at large (Freeman, 1984). In the context of international banks in Nigeria, investments in information technology such as infrastructure, data analytics, and cybersecurity directly influence the quality, transparency, and reliability of sustainability reporting, thereby shaping stakeholders' trust and decision-making. By adopting stakeholder theory, the study provides a theoretical lens to explain why banks must commit resources to IT investments not just for internal efficiency, but also to meet stakeholder expectations for accurate, timely, and credible sustainability disclosures that align with global reporting standards

Abubakar and Ogunleye (2023) explored the relationship between cybersecurity budget allocation and sustainability report integrity in Nigerian banks. The study adopted a survey design and used regression analysis to find a significant relationship ($\beta = 0.54$, $p < 0.01$). The study recommended that cybersecurity expenditure be linked directly to reporting risks. Ojo and Maduka (2023) assessed how cybersecurity policy implementation influences stakeholder trust in sustainability disclosures. Using a cross-sectional survey of 80 bank compliance officers, the study found that strong cybersecurity policies improved perceived report reliability by 38%. They recommended periodic policy audits. Agbo and Adeyemi (2024) studied the effect of endpoint security tools on ESG data protection. Using content analysis of IT audit reports, the study found that banks with strong endpoint protection had fewer data breaches affecting sustainability reports. The authors advised enhanced endpoint detection and response systems. Dada and Musa (2024) investigated the role of cybersecurity governance frameworks in sustainability assurance. With SEM analysis, findings showed that effective cybersecurity governance frameworks reduced unauthorized access risks to ESG reporting systems ($\beta = 0.63$, $p = 0.005$). The authors recommended cybersecurity governance scorecards for banks. Emeka and Ayodeji (2024) examined how investments in firewalls and intrusion detection systems contribute to the trustworthiness of ESG disclosures. Results from a sample of 10 banks revealed fewer data manipulation incidents and improved audit trail security. The authors suggested harmonizing cybersecurity investments with ESG objectives.

Olaniyan and Okoro (2025) studied the impact of cybersecurity training on sustainability reporting accuracy. The study found that banks investing in continuous training recorded a 25% reduction in reporting errors related to phishing and cyber threats. The study recommended cybersecurity awareness as part of the sustainability training curriculum. Nnaji and Bakare (2025) explored the effect of cyber threat response readiness on the frequency of ESG reporting disruptions. A qualitative study found that institutions with rapid incident response systems had uninterrupted reporting processes. They advocated for integrating ESG systems into cyber crisis management plans. Ogunbiyi and Ibrahim (2025) assessed whether investments in data encryption influence ESG report confidentiality. Regression results indicated a strong positive relationship ($\beta = 0.58$, $p < 0.01$). The authors suggested enforcing minimum encryption standards across sustainability systems. Okeke and Salisu (2025) analysed cybersecurity resilience and its influence on digital ESG reporting platforms. Using a case study approach, findings showed that platforms with resilient architecture experienced no downtimes during ESG filing seasons. They recommended continuous penetration testing. Ibitoye and Dauda (2025) investigated cyber insurance adoption and its impact on perceived ESG reporting risks. Survey data revealed that cyber insurance reduced board-level concerns about sustainability reporting vulnerabilities. The authors proposed cyber risk hedging as a new ESG risk management tool.

In agreement with existing study, the second hypothesis is stated in the null form as follows:

H03: There is no significant effect of cyber security investment on sustainability reporting quality of listed international bank in Nigeria.

3.0 Methodology

The study employs a longitudinal research design, which is considered appropriate given that the variables of interest information technology (IT) investment components and sustainability reporting quality (SRQ) are historical outcomes already disclosed by the banks and therefore not subject to manipulation by the researcher. The longitudinal panel design further enables the study to account for firm-specific, time-invariant heterogeneity, improve the efficiency of statistical inference, and capture dynamic trends across time. The population of the study consists of the seven (7) international deposit money banks listed on the Nigerian Exchange Group (NGX) as of 31 December 2025. Since the number of firms is manageable, the study adopts a census sampling technique, thereby including all seven banks as sample for the study. This approach eliminates sampling bias, ensures complete coverage of the target population, and enhances the external validity of the study within the defined sampling frame.

The study employed secondary data obtained from the annual audited reports of the listed international banks, their standalone sustainability/ESG disclosures, and the NGX fact book covering the period from 2010 to 2025. Data analysis involve both descriptive statistics and correlation analysis, normality test, multicollinearity, heteroskedasticity test and pooled ordinary least square and robust regression analyses. The study conducted both pooled OLS and robust regression analyses. The pooled OLS was used as result of observed firm-specific heterogeneity of the data, while the use of robust regression was necessary due to the detection of heteroscedasticity in the error terms, as revealed by the Breusch–Pagan/Cook–Weisberg test.

The empirical model evaluates sustainability reporting quality as a function of discrete IT investment channels is therefore stated thus:

The functional model

$$SRQ_{it} = f(ITINVST) \dots\dots\dots 3.1$$

$$SRQ_{it} = f(IFT, DACI, CSI) \dots\dots\dots 3.2$$

$$SRQ_{it} = \alpha_0 + \beta_1 IFT_{it} + \beta_2 DACI_{it} + \beta_3 CSI_{it} + \varepsilon_{it} \dots\dots\dots 3.3$$

Where:

SRQ= Sustainability Reporting Quality

ITINVST=Information Technology Investment

IFT = Infrastructure Investment

DACI = Data Analytics Capabilities Investment

CSI = Cyber security Investment

α_0 = Intercept

$\beta_1 - \beta_3$ = coefficient of independent variables

ε_{it} = error terms of firm i and time t.

Measurement of Variables

The independent variable for this study is information technology investment, which was proxy by infrastructure Investment, data analytics capabilities investment and cyber security investment.

The dependent variable is sustainability reporting quality proxy with sustainability disclosures index mapped to IFRS S1/S2 and aligned with the SASB framework.

Table 1:
Measurement of Variables

S/N	Variables	Description	Measurement	Source
1	Sustainability Reporting Quality (SRQ)	Sustainability reporting quality describes the extent to which a firm's environmental, social, and governance (ESG) disclosures are complete, reliable, timely, and aligned with recognized standards	Sustainability disclosures index mapped to IFRS S1/S2 and aligned with the SASB framework which consist of 42 disclosure items with 1 assigned for disclosure and 0 for non-disclosure. The 42 disclosure items are spread on the four pillars: governance, strategy, risk management, and metrics & targets	Wang & Li, (2023); Adeyemi & Musa, (2022)
2	Infrastructure Investment (IFT)	This pertains to capital outlays on core IT assets such as servers, data centers, network systems, and physical hardware that provide the foundational support for digital reporting and data management processes within a financial institution.	Measured as IT Capital Expenditure divided by Total Assets using content analysis.	Iwuchukwu and Obasi (2025);Umeh and Bello(2024)
3	Data Analytics Capabilities Investment (DACI)	Data Analytics Capabilities Investment is the measurable financial and non-financial resources committed by an organization towards developing, acquiring, or enhancing its data analytics infrastructure, tools, personnel, and processes with the goal of extracting actionable insights from data to improve decision-making and performance.	Measured as the ratio of data analytics expenditure to total operating expenses using content analysis	Chukwu & Ibrahim, (2023); Eze & Musa, 2024
4	Cybersecurity Investment (CSI)	Cybersecurity Investment is the total expenditure and strategic initiatives undertaken by a firm to protect its information systems, networks, and digital assets from cyber threats, breaches, and unauthorized access, ensuring data integrity, confidentiality, and availability.	Measure as the ratio of cybersecurity expenditure to total IT expenditure using content analysis.	Abubakar & Ogunleye, (2023); Olaniyan & Okoro, (2025)

Source: Authors' Compilation, 2026.

Results of Analyses and Discussion of Findings

Descriptive Statistics

The descriptive statistics for the key study variables are reported in Table 2. The dependent variable, sustainability reporting quality (SRQ), has a mean of 0.662 and a standard deviation of 0.142, with minimum and maximum values of 0.28 and 0.88 respectively. For the independent variables, the mean value of infrastructure investment (IFT) is 0.229, with a standard deviation of 0.423, indicating that, on average, approximately 23% of bank-year observations reflect notable IT infrastructure investment. Data analytics capabilities investment (DACI) has a mean of 0.200 and a standard deviation of 0.403, suggesting relatively limited but varied investment in analytics across the sample. Cybersecurity investment (CSI) displays a mean of 0.371 and a standard deviation of 0.487, indicating that, on average, banks allocated cybersecurity resources in about 37% of the observed years. These statistics suggest that while the average level of sustainability reporting quality among the sampled banks is moderately high, there is considerable variation in IT investment practices across the sector.

Table 2:
Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
SRQ	112	0.662	0.142	0.28	0.88
IFT	112	0.229	0.423	0	1
DACI	112	0.200	0.403	0	1
CSI	112	0.371	0.487	0	1

Source: Authors' Compilation, 2026.

Normality Test

The normality of the data for each variable was tested using the Shapiro–Wilk test, as shown in Table 3. According to standard interpretation, a probability value (Prob>z) less than 0.05 indicates the data is not normally distributed, while values greater than 0.05 suggest normality.

Table 3:
Shapiro–Wilk Normality Test

Variable	Obs	W	V	z	Prob>z
SRQ	112	0.960	2.474	1.970	0.024
IFT	112	0.940	3.722	2.858	0.002
DACI	112	0.923	4.756	3.391	0.000
CSI	112	0.986	0.855	-0.340	0.633

Source: Authors' Compilation, 2026.

The results indicate that sustainability reporting quality (SRQ), infrastructure investment (IFT), and data analytics capabilities investment (DACI) are not normally distributed (Prob>z < 0.05), whereas cybersecurity investment (CSI) is normally distributed (Prob>z = 0.633). This justifies the additional use of robust regression and non-parametric correlation analyses, in line with econometric best practice.

Correlation Analysis

The association among the variables was examined using the Spearman Rank Correlation Coefficient, which is appropriate for data that does not satisfy the assumptions of normality. The results are presented in Table 4.

Table 4:
Spearman Rank Correlation Matrix

Variables	(1) SRQ	(2) IFT	(3) DACI	(4) CSI
(1) SRQ	1.000			
(2) IFT	0.391	1.000		
(3) DACI	0.640	0.238	1.000	
(4) CSI	0.114	0.074	-0.237	1.000

Source: Authors' Compilation, 2026.

The correlation results show that data analytics capabilities investment (DACI) has the strongest positive association with sustainability reporting quality (SRQ) (correlation = 0.640), indicating that higher investments in data analytics are associated with higher quality of sustainability reporting among the sampled banks. Infrastructure investment (IFT) also displays a moderate positive association with SRQ (correlation = 0.391), while cybersecurity investment (CSI) exhibits a weak positive relationship with SRQ (correlation = 0.114). The independent variables themselves are weakly correlated, with the highest correlation observed between IFT and DACI (0.238), indicating minimal risk of multicollinearity. These preliminary findings suggest that among the IT investment dimensions, data analytics capabilities play the most substantial role in driving sustainability reporting quality, followed by infrastructure and, to a lesser extent, cybersecurity investment. The correlation patterns set the stage for the regression analysis and further hypothesis testing in subsequent sections.

Regression Analyses

To rigorously assess the cause-effect relationships between information technology investments and sustainability reporting quality, the study conducted both pooled OLS and robust regression analyses. The use of robust regression was necessary due to the detection of heteroscedasticity in the error terms, as revealed by the Breusch–Pagan/Cook–Weisberg test. The results for both regression models are presented in Table 5.

Table 5:
Regression Results

	SRQ Model (Pooled OLS)	SRQ Model (Robust Regression)
INTERCEPT	0.579 {0.000} ***	0.600 {0.000} ***
IFT	0.068 {0.039} **	0.049 {0.104}
DACI	0.202 {0.000} ***	0.189 {0.000} ***
CSI	0.072 {0.013} **	0.077 {0.004} ***

F/Wald Statistics	16.38 (0.0000) ***	16.25 (0.0000) ***
R-Squared	0.4268	0.4268
Mean VIF	1.10	-
Heteroscedasticity	6.23 (0.013) **	-

*Notes: (1) Brackets {} show p-values; (2) ** and *** indicate significance at 5% and 1% levels respectively.*

Source: Authors' Compilation, 2026.

The pooled OLS model produced R-squared value of 0.427, suggesting that the IT investment variables collectively explain approximately 43% of the variation in sustainability reporting quality among the sampled banks. The F-statistic of 16.38 ($p < 0.01$) confirms that the OLS regression model is statistically significant and suitable for inferential analysis. A significant Breusch-Pagan test indicates heteroscedasticity, which typically warrants heteroscedasticity-robust standard errors or Weighted Least Squares (WLS/FGLS). However, M-estimators are primarily designed to address outlier sensitivity and violations of normality. Please provide a clear methodological justification for shifting to a coefficient-altering robust regression based solely on a heteroscedasticity finding, or report standard OLS with robust standard errors instead.

Test for Multicollinearity

Multicollinearity was assessed using the variance inflation factor (VIF). The mean VIF of 1.10 indicates no multicollinearity problem, as this is well below the conventional threshold of 10 (Greene, 2009). Therefore, all independent variables were retained in the model.

Test for Heteroscedasticity

Heteroscedasticity was tested using the Breusch–Pagan/Cook–Weisberg test. The test produced a chi2 statistic of 6.23 with a p-value of 0.013, indicating the presence of heteroscedasticity and a violation of the constant variance assumption. Consequently, robust regression analysis was performed to obtain valid standard errors and reliable inference, in accordance with the recommendation of Greene (2009).

Test of Hypotheses

Given the diagnostic results above, the robust regression model forms the basis for hypothesis testing and discussion of the effects of IT investments on sustainability reporting quality. The results for each hypothesis are discussed below:

H₀₁: Infrastructure investment has no significant effect on sustainability reporting quality of listed international banks in Nigeria.

The robust regression result indicates that infrastructure investment (IFT) [coef. = 0.049, $p = 0.104$] has a positive but statistically insignificant effect on sustainability reporting quality. This suggests that, after accounting for outliers and heteroscedasticity, infrastructure investment alone does not significantly enhance sustainability reporting quality within the sampled banks. Therefore, the null hypothesis is not rejected.

H₀₂: Data analytics capabilities investment has no significant effect on sustainability reporting quality of listed international banks in Nigeria.

The result reveals that data analytics capabilities investment (DACI) [coef. = 0.189, $p = 0.000$] exerts a strong and significant positive effect on sustainability reporting quality. This implies that increased investment in data analytics capabilities significantly improves the quality of sustainability disclosures among the banks. The null hypothesis is therefore rejected.

H₀₃: Cybersecurity investment has no significant effect on sustainability reporting quality of listed international banks in Nigeria.

The robust regression results shows that cybersecurity investment (CSI) [coef. = 0.077, $p = 0.004$] also has a significant positive effect on sustainability reporting quality. This suggests that higher levels of cybersecurity investment are associated with higher reporting quality. Consequently, the null hypothesis is rejected.

Discussion of Findings

The findings of this study indicate that infrastructure investment has a positive but statistically insignificant effect on sustainability reporting quality among listed international banks in Nigeria over the study period. This suggests that, while investments in IT infrastructure such as servers, networks, and hardware provide foundational support, they may not directly or robustly translate into measurable improvements in the quality of sustainability disclosures unless accompanied by more advanced technological capabilities. This outcome is at variance with the results of Okonkwo and Ibrahim (2023), who found that IT infrastructure development had a significant positive effect on sustainability reporting among Nigerian deposit money banks, as well as the work of Balogun and Eze (2024), who observed that digital infrastructure upgrades improved the depth and reliability of sustainability reporting among Tier 1 Nigerian banks. Similarly, Adeyemo et al. (2025) reported that core banking system upgrades enhanced the quality of sustainability data. However, our findings align with the argument of Musa et al. (2024), who noted that hardware investments alone may not suffice for timely and comprehensive sustainability reporting, especially if not paired with investments in analytics or system integration. This divergence in findings suggests that infrastructure forms an essential baseline, but its impact is maximized only when embedded within a broader digital transformation strategy.

The results further reveal that data analytics capabilities investment exerts a strong and statistically significant positive effect on sustainability reporting quality in the Nigerian international banking sector. This means that banks which allocate greater resources to analytics infrastructure, tools, and personnel are better able to produce high-quality, comprehensive, and reliable sustainability disclosures. These findings are consistent with those of Chukwu and Ibrahim (2023), who documented that advanced analytics capabilities enhance ESG disclosure precision among Nigerian banks, and Musa and Adebisi (2023), who demonstrated that data analytics investment supports strategic agility and improved reporting outcomes in emerging markets. The observed effect is also in line with global studies such as Chen et al. (2023) and Zhang and Lee (2022), both of whom highlight the transformational potential of analytics for extracting actionable insights and ensuring the integrity of sustainability reports. These results reinforce the view that data-driven cultures and sophisticated analytical tools are critical in meeting regulatory and stakeholder demands for transparent, timely, and verifiable ESG reporting. By contrast, banks that underinvest in analytics may struggle with fragmented data and inconsistent disclosures, as argued by Ajayi and Mohammed (2025).

Furthermore, the study shows that cybersecurity investment has a significant positive effect on sustainability reporting quality, indicating that efforts to secure digital assets, prevent breaches, and ensure data integrity are crucial for trustworthy ESG disclosures. This result is supported by Dada and Musa (2024), who found that robust cybersecurity governance enhances ESG assurance quality, and Al-Farsi and Khan (2022), who emphasize the necessity of multi-layered security investments for digital resilience. Additionally, Okoro and Musa (2023) argue that proactive cybersecurity investment reduces digital risk and increases stakeholder trust in sustainability reports. This study therefore adds to the literature by highlighting that in a rapidly digitizing banking environment, reporting quality depends not only on data availability and analytics but also on the reliability and security of the systems managing these disclosures.

Taken together, these findings imply that while foundational infrastructure is important, the most substantial improvements in sustainability reporting quality arise from banks' investments in advanced analytics and robust cybersecurity frameworks. These results align with the Resource-Based View theory, which posits that sustainable competitive advantage is built not simply on tangible assets, but on firm-specific, valuable, and hard-to-replicate capabilities such as analytics expertise and secure digital platforms. The results also support the Stakeholder Theory by showing that banks' technology investments help them respond more effectively to stakeholder demands for credible, comparable and secure sustainability information.

5.0 Conclusion

This study was motivated by the critical need to understand how IT investments drive improvements in the quality of sustainability reporting within the Nigerian banking sector, particularly among international banks that face increasing demands for transparency, compliance, and alignment with global ESG standards. The principal problem addressed in this research was the limited empirical evidence on which aspects of IT investment most effectively enhance the quality, credibility, and reliability of banks' sustainability disclosures a key concern in the era of digital transformation and mounting stakeholder scrutiny. The main aim of the study was to investigate the individual and joint effects of infrastructure investment, data analytics capabilities investment, and cybersecurity investment on the sustainability reporting quality of Nigerian international banks, with a view to providing evidence-based recommendations for managers, regulators, and policy makers. The methodological approach was rigorous, combining robust statistical techniques with extensive diagnostics to ensure the reliability of the findings.

The key findings reveal a differentiated impact of IT investment components on sustainability reporting quality. Specifically, data analytics capabilities investment and cybersecurity investment both emerged as significant positive drivers of higher-quality sustainability disclosures, confirming the central role of advanced analytics and digital security in shaping the reporting landscape. In contrast, infrastructure investment alone, while positively associated with reporting quality, did not have a statistically significant effect, suggesting that foundational IT upgrades are most effective when complemented by sophisticated analytics and robust cybersecurity frameworks. The key takeaway from this study is that Nigerian international banks seeking to improve the quality and integrity of their sustainability reporting should prioritize strategic investments in analytics and cybersecurity, as these factors have the most direct and robust impact. While IT infrastructure remains a necessary enabler, the results underscore that value creation in reporting quality is maximized through capabilities that drive data-driven insights and ensure

digital trust. These findings offer actionable insights for managers, policy makers, and other stakeholders committed to advancing sustainable business practices in the financial sector.

In light of the empirical findings, the following recommendations are made for various stakeholders: Corporate managers, board members, regulators, analysts, and investors should recognize that not all IT investments yield the same impact on sustainability reporting quality. Prioritizing the right blend of IT capabilities will enable banks to meet growing ESG expectations and enhance market trust.

Corporate directors and IT managers are encouraged to treat IT infrastructure as a strategic foundation rather than an end in itself. Infrastructure upgrades such as servers, data centres, and connectivity should be aligned with broader digital transformation strategies, integrating analytics and security measures. Regulators and policy makers should develop frameworks that incentivize banks to leverage their infrastructure investments in a way that tangibly improves reporting outcomes.

Bank executives, audit committees, and technology officers should allocate dedicated resources to the acquisition, development, and deployment of advanced data analytics tools and personnel. Investment in analytics should be continuous, with ongoing staff training to maximize the extraction of actionable insights for sustainability reporting. Analysts and investors should consider the presence and sophistication of analytics capabilities as a signal of reporting reliability when making investment decisions.

Boards, risk managers, and compliance officers must prioritize cyber security as an integral part of the reporting process. This involves not only technical upgrades but also policy development, regular vulnerability assessments, and industry benchmarking. Regulators should mandate minimum standards for cyber security in ESG reporting to protect the integrity and confidentiality of disclosed information. Enhanced cyber security will build stakeholder trust and safeguard the bank's reputation.

It is suggested that future studies should extend the analysis by including a wider sample of financial institutions, such as regional and non-bank entities, to enhance the generalizability of the findings and explore sector-specific dynamics. Researchers could also examine the moderating role of regulatory quality, board composition, or digital maturity on the relationship between IT investments and sustainability reporting quality. Additionally, it is recommended that future research adopts mixed methods, combining quantitative panel analysis with in-depth case studies or interviews, to gain richer insights into the qualitative drivers and barriers to effective sustainability reporting in the digital era.

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