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EFFECT OF GREEN MANAGEMENT AND GREEN INNOVATION ON SUSTAINABLE BANK PERFORMANCE IN NIGERIA: MEDIATING ROLE OF GREEN LEADERSHIP

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Abstract

This study investigates the effect of Green Management and Green Innovation on the Sustainable Performance of Commercial Banks in Nigeria, with Green Leadership examined as a mediating variable within the Nigerian Banking Context. Anchored in Stakeholder Theory and the Resource-Based View (RBV), the study employs a quantitative research design using survey data collected from 150 bank managers of five major Tier-One banks working in commercial banks within Kano Metropolis, Nigeria across operations, risk management, IT, marketing, and general administration. The sample size is two hundred (108) of the total population and was determined using the Krejcie and Morgan's (1970) formula. 5% of 108 was added to give the total of 114 samples used in the study. Purposive sampling technique was adopted to select respondents for the study. The total sample of 114 valid responses analyzed via Partial Least Squares Structural Equation Modeling (PLS-SEM) with the aid of SmartPLS 4. The findings of the study reveal that both green management and innovation positively influence sustainable performance, with green innovation having the strongest direct effect. Additionally, green leadership significantly mediates the relationships between both predictors and sustainable performance, confirming its strategic role in translating green practices into measurable sustainability outcomes. Theoretically, the study extends the application of stakeholder and resource-based perspectives in green banking literature, while empirically providing evidence from an under-researched emerging market. The study concludes by highlighting the need for stronger investments in green innovation and leadership development to drive sustainable banking outcomes. These findings offer actionable insights

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for policymakers, bank executives, and sustainability strategists seeking to embed environmental responsibility within institutional performance frameworks. It also, enriches our understanding of how environmental capabilities are developed and operationalized within financial institutions, especially in emerging markets such as Nigeria.

Keywords: Green Management, Green Innovation, Green Leadership, Sustainable Bank Performance

1. Introduction

In an era increasingly defined by climate change, financial instability, and socio-environmental disparities, the pursuit of sustainable bank performance has emerged as a global imperative. Financial institutions worldwide are facing rising pressure not only to deliver shareholder value but also to align their operations with broader environmental and social goals. This shift is being driven by investors' demand for ESG transparency, tightening regulatory standards, and the reputational risk associated with environmental negligence (Agbakwuru, et al. 2024). As economies transition towards green and circular models, the banking sector plays a vital role in mobilizing capital for sustainable development, financing green infrastructure, promoting financial inclusion, and aligning with the United Nations' Sustainable Development Goals (SDGs) (Hamdan & Braendle, 2024; United Nations Environment Programme Finance Initiative [UNEP FI], 2021). The challenge of achieving sustainable bank performance, however, is even more acute in emerging markets, where issues such as macroeconomic instability, institutional inefficiencies, and limited technological capacity often undermine the consistent application of sustainability frameworks (Beck et al., 2013; Caprio & Levine, 2020). Many banks in these contexts face significant regulatory asymmetries and resource constraints, which limit their ability to operationalize green practices and integrate ESG principles into core strategy (Adusei, 2021). Furthermore, the sustainability agenda in these regions is still evolving, and the integration of environmental, social, and governance (ESG) dimensions remains largely fragmented and reactive rather than proactive (Abubakar & Handayani, 2023).

Despite these limitations, empirical evidence shows that sustainable banking practices in emerging markets can enhance financial stability, reduce default risk, and improve institutional legitimacy in the eyes of both stakeholders and regulators (Hidayat-ur-Rehman & Hossain, 2024; Mhlanga, 2024). Sustainable banking also promotes long-term resilience by aligning business models with climate risks and future regulatory trajectories. These benefits are particularly vital in countries where banks have historically contributed to economic volatility and financial exclusion. The Nigerian banking sector offers a compelling case study for understanding the role of sustainability in enhancing bank performance. Over the past two decades, Nigeria has experienced several waves of banking crises, stemming from weak corporate governance, inadequate risk oversight, regulatory capture, and pervasive short-termism in business strategy (Mordi, et al. (2015) & Sanusi, 2010). In an effort to restore trust and stability, the Central Bank of Nigeria (CBN) initiated a series of regulatory reforms aimed at improving financial sector governance, culminating in the launch of the Nigerian Sustainable Banking Principles (NSBP) in 2012. These principles aimed to integrate sustainability into risk management, lending practices, and institutional reporting. However, more than a decade later, the adoption of green management systems and innovative financial instruments such as green bonds, carbon trading mechanisms, and AI-driven ESG analytics remains limited, under-

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researched, and inconsistently implemented across Nigerian banks (CBN, 2022; Oyegunle & Weber, 2015).

This persistent gap underscores the need to better understand the organizational and leadership dynamics that can enhance sustainability performance. Specifically, variables such as green management—which refers to institutional governance and operational strategies aimed at environmental responsibility—and green innovation—the development of environmentally friendly financial products and technologies—are increasingly recognized as key enablers of bank sustainability (Bouyé et al., 2021). Yet, the extent to which these practices lead to measurable outcomes often depends on the presence of strong green leadership: visionary executives and top managers who embed sustainability principles into the strategic DNA of their organizations (Oyegunle & Weber, 2015). Leadership, therefore, may act as a mediating force that enables the translation of green practices into sustainable outcomes.

While some prior studies have explored green banking in Nigeria and other emerging economies, there remains a significant knowledge gap at three levels. Empirically, few studies have tested integrated models involving green management, innovation, and leadership using robust statistical techniques. Theoretically, limited work has applied sustainability or stakeholder theory to understand the internal drivers of sustainable bank performance. Methodologically, existing literature often relies on case studies or qualitative assessments, lacking quantitative, mediation-based analysis to test causal pathways. This study addresses these gaps by examining the effect of green management and innovation on sustainable bank performance, with green leadership as a mediating variable, within the Nigerian context. This study, therefore, aims to deepen the understanding of green banking mechanisms by investigating the effect of green management and innovation on the sustainable performance of commercial banks, with green leadership as a mediating variable, offering both theoretical contributions and actionable insights for banking regulators and practitioners. Based on the above background the following hypothesis were formulated.

1.2 Hypotheses

H_{01}: Green management has no significant effect on sustainable bank performance.

H_{02}: Green innovation has no significant effect on sustainable bank performance.

H_{03}: Green management has no significant effect on green leadership.

H_{04}: Green innovation has no significant effect on green leadership.

H_{05}: Green leadership has no significant effect on sustainable bank performance.

H_{06}: Green leadership does not mediate the relationship between green management and sustainable bank performance.

H_{07}: Green leadership does not mediate the relationship between green innovation and sustainable bank performance.

2.0 Literature Review

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This section provides a review of literature related to the Green Management, Green Innovation, Green Leadership and Sustainable Bank Performance.

2.1 Concept of Sustainable Bank Performance

Sustainable performance in banking refers to the ability of financial institutions to balance economic profitability with social responsibility and environmental sustainability in an integrated manner. It is measured using a composite method that combined financial, environmental, and social indicators. Consequently, banks that achieve sustainable performance experience long-term financial stability, strong regulatory compliance, and enhanced stakeholder confidence (Mhlanga, 2024).

Sustainable banks' performance is increasingly recognized as a multidimensional construct that encompasses the economic, environmental, and social outcomes of banks. Traditionally, bank performance was evaluated primarily through financial metrics such as profit margins, revenue growth, return on investment (ROI), and operational efficiency (Neely, 1999). This financial-centric view, while still relevant, has been criticized for neglecting non-financial dimensions that are critical for long-term business viability and societal welfare. As sustainability emerged as a strategic concern for businesses, a paradigm shift occurred, requiring firms including banks to consider their environmental and social responsibilities alongside financial success.

The turning point in performance conceptualization came with Elkington's (1997) Triple Bottom Line (TBL) framework, which proposed that businesses measure their success not only in terms of economic value but also in terms of environmental stewardship and social equity. This model fundamentally altered how performance is understood in banks, especially in sectors where resource constraints and community interaction are more pronounced. It reinforced the idea that financial metrics alone are insufficient in capturing the full scope of a firm's contributions and long-term sustainability. For banks in particular, where informal structures dominate and regulatory oversight may be limited, the TBL framework became a guide for embedding sustainability into core operations without compromising profitability.

2.2 Concept of Green Management

Green management refers to the deliberate integration of environmental sustainability principles into the strategic and operational frameworks of organizations. In the context of financial institutions, particularly banks, green management involves adopting internal policies and governance mechanisms that prioritize environmental stewardship alongside profitability. According to Chen et al. (2020), green management encompasses environmentally responsible decision-making processes such as eco-friendly procurement, energy-efficient operations, environmental audits, and the minimization of ecological risks in business practices. It represents a shift from compliance-oriented environmental responses to a more strategic and institutionalized approach that aligns long-term environmental goals with business objectives. In this regard, green management forms a critical component of sustainable banking, providing the foundation for institutions to mitigate environmental risks, enhance stakeholder trust, and align with global sustainability frameworks like the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement (UNEP FI, 2021).

In the Nigerian banking sector, green management practices have been increasingly promoted through policy instruments such as the Nigerian Sustainable Banking Principles (NSBP) issued

by the Central Bank of Nigeria in 2012. These principles emphasize sustainable lending, environmental and social risk management, and sector-specific guidelines for high-impact industries (CBN, 2022). Moradi et al. (2024) posit that green management in emerging economies must transcend mere regulatory compliance and instead focus on embedding sustainability into the cultural and strategic fabric of banking institutions. Thus, for the purpose of this study, green management is treated as a unidimensional construct that captures the presence and effectiveness of environmental governance within banks. It is operationalized through the existence of formal environmental policies, the implementation of sustainable practices such as energy-efficient operations and green procurement, and the degree of institutional alignment with national and international environmental banking standards. This operationalization allows for a focused and measurable assessment of how green management influences broader sustainability outcomes in the Nigerian banking context

2.3 Concept of Green Innovation

Green innovation, also referred to as eco-innovation, involves the design, development, and application of environmentally sustainable financial products, technologies, and services that support both ecological preservation and economic advancement. In the banking sector, green innovation plays a vital role in transforming traditional financial models by incorporating climate-conscious solutions into product development, service delivery, and operational processes. Horbach et al. (2012) conceptualize green innovation as innovation motivated by the goal of reducing environmental harm, often driven by regulatory pressure, technological advancement, and market demand. Within financial institutions, this includes instruments and platforms such as green bonds, AI-enabled environmental, social, and governance (ESG) analytics, blockchain for supply chain transparency, and mobile banking solutions that reduce paper use and carbon footprints. These tools enable banks to align with emerging climate finance mandates while appealing to environmentally conscious investors and customers (Kammerer, 2021).

According to Bouyé et al. (2021), green innovation in finance is characterized by the intentional embedding of environmental sustainability into the innovation lifecycle—from ideation to implementation. This strategic integration helps banks not only reduce their ecological footprint but also unlock new revenue streams and gain competitive advantages in increasingly ESG-sensitive markets. In the context of emerging economies, including Nigeria, green innovation is essential to bridge technological gaps and support the transition to a low-carbon financial system (Agyemang et al., 2022). For the purpose of this study, green innovation is treated as a unidimensional construct, focusing specifically on its technological and financial dimensions. It is operationalized through three indicators: (1) the bank's investment in or adoption of green financial instruments (e.g., green loans, bonds), (2) the use of technology for ESG reporting or climate risk assessments, and (3) the deployment of digital channels that reduce the environmental costs of service delivery. This operational framework provides a focused lens to assess the tangible contributions of innovation to sustainable bank performance.

2.4 Concept of Green Leadership

Green leadership refers to the capacity of organizational leaders—particularly senior executives and management—to embed environmental sustainability into the strategic

orientation, cultural values, and operational systems of their institutions. It reflects a leadership paradigm where environmental stewardship is not treated as peripheral, but as central to core business practices and decision-making. As Oyegunle and Weber (2015) argue, green leaders are proactive visionaries who prioritize environmental, social, and governance (ESG) values, influence employee behavior through sustainability-centered incentives, and integrate eco-consciousness into the corporate ethos. This form of leadership is critical in the banking sector, where aligning financial services with climate resilience and stakeholder expectations requires top-down commitment and strategic foresight. In emerging economies like Nigeria, where environmental governance systems may be less institutionalized, green leadership becomes an even more pivotal internal driver of sustainability outcomes (Agyemang et al., 2022).

Green leadership is conceptually grounded in transformational leadership theory, which emphasizes inspirational motivation, idealized influence, individualized consideration, and intellectual stimulation (Bass & Avolio, 1994). Within the sustainability context, these traits translate into the leader's role in shaping long-term sustainability visions, championing sustainable financing mechanisms, fostering innovation in ESG integration, and promoting transparent environmental reporting (El Khoury, 2024). Empirical evidence suggests that such leadership enhances stakeholder trust, regulatory compliance, and overall sustainable performance in financial institutions (Hossain & Rehman, 2023). For this study, green leadership is treated as a unidimensional construct that mediates the relationship between green-oriented practices and sustainability outcomes. It is operationalized through three measurable indicators: (1) top management's commitment to environmental and sustainability goals, (2) the presence of dedicated sustainability leadership roles or cross-functional green teams within the bank, and (3) the integration of ESG principles into strategic decision-making processes. This operationalization captures the essence of leadership as both a strategic enabler and cultural anchor of green banking transformation.

2.5 Review of Empirical Studies

Empirical research on the intersection of green management, green innovation, green leadership, and sustainable bank performance has expanded significantly in the last decade, largely driven by mounting global urgency to achieve climate resilience and embed sustainability across financial systems. As financial institutions are increasingly held accountable for their environmental and social impacts, many scholars have shifted their focus from traditional profitability models to evaluating how banks operationalize ESG frameworks and align with climate finance targets. In particular, studies from emerging and resource-constrained economies have gained momentum, as these regions face compounded challenges of institutional fragility, environmental degradation, and limited green finance infrastructure. Within this context, empirical studies have highlighted the value of green-oriented strategies in fostering banking resilience, improving risk-adjusted returns, enhancing regulatory compliance, and boosting institutional legitimacy among environmentally conscious stakeholders (Bouyé et al., 2021; Hossain & Rehman, 2023).

2.5.1 Green Management and Sustainable Bank Performance

Among these strategies, green management has been widely associated with enhanced environmental compliance, operational efficiency, and long-term stakeholder engagement. Moradi et al. (2024), in a multi-country study involving financial institutions in the Global

South, demonstrated that banks implementing robust environmental management systems (EMS) reported better loan quality, reduced default risk, and fewer penalties from environmental regulators. Their findings emphasized the importance of environmental screening in credit evaluations, as banks with formal green governance structures were better equipped to assess sustainability risks in lending decisions. Likewise, Asadi et al. (2021) provided evidence from Iranian banks showing that structured green management practices including formal sustainability committees, internal audits, and eco-efficiency monitoring were positively linked to long-term financial stability and customer loyalty. These institutions were perceived as more trustworthy and future-oriented by both regulators and clients, thereby gaining competitive advantage in a sustainability-sensitive market environment. These empirical insights reinforce the argument that green management, beyond being a regulatory checkbox, can serve as a strategic driver of sustainable banking performance when institutionalized effectively within governance and operational systems.

2.5.2 Green Innovation and Sustainable Bank Performance

Empirical evidence increasingly positions green innovation as a core enabler of sustainable performance in the banking sector. In a cross-regional study involving African and Asian financial institutions, Bouyé et al. (2021) found compelling evidence that the adoption of environmentally focused financial technologies such as AI-based ESG analytics, green digital bonds, and blockchain platforms for sustainable finance substantially improved institutional performance indicators. These innovations were linked to stronger credit ratings, lower incidences of non-performing loans (NPLs), and enhanced reputational capital among environmentally conscious stakeholders. Moreover, the adoption of such tools allowed banks to respond more dynamically to regulatory changes, manage climate-related financial disclosures, and unlock access to green investment markets. Green innovation, therefore, does not only serve environmental goals but also redefines financial competitiveness by enabling operational agility, product differentiation, and compliance efficiency. Similarly, Hossain and Rehman (2023), using panel data from Southeast Asia, demonstrated a positive and statistically significant association between green innovation intensity and both financial (Return on Assets ROA) and non-financial performance (sustainability scores), underscoring the dual impact of innovation on profit and purpose in financial institutions.

2.5.3 Green Leadership and Sustainable Bank Performance

Empirical research increasingly highlights green leadership as a vital determinant of sustainable performance in both SMEs and banking institutions. Green leadership, rooted in transformational and sustainability-oriented practices, inspires employees and stakeholders to align with environmental and social goals. Vasudevan, Mathushan, and Nirojan (2024), in their study of Sri Lankan SMEs, found that green transformational leadership significantly enhanced green innovation and environmental performance by fostering pro-environmental employee behaviors. Their findings demonstrate that leadership commitment directly strengthens the adoption of sustainability practices and indirectly enhances firm performance through innovation. Similarly, Elshaer, Azazz, and Fayyad (2023) reported that in hospitality SMEs, leaders who champion green values improved sustainable performance outcomes, with employees' pro-environmental attitudes acting as a crucial moderating factor.

Evidence from banking contexts reinforces this linkage. Rehman et al. (2023) examined Chinese SMEs and revealed that green leadership amplified the effects of green finance and CSR initiatives on sustainable performance by ensuring top-level managerial commitment and resource allocation. Umair et al. (2023), in their study of banks in Oman, showed that green leadership positively influenced innovative work behavior among employees, which in turn improved organizational sustainable performance. These studies confirm that leadership support is indispensable in translating sustainability strategies into actionable outcomes.

Collectively, empirical studies affirm that green leadership acts as both a direct driver and a moderating/enabling factor in the sustainability–performance nexus. Leaders who integrate environmental values into strategy and culture not only strengthen CSR, green innovation, and fintech adoption but also ensure that these practices translate into measurable performance gains. For Nigerian banks, where sustainability frameworks are still evolving, strong green leadership can provide the vision, accountability, and strategic alignment needed to overcome institutional challenges, enhance stakeholder trust, and drive long-term sustainable performance.

2.5.4 Mediating Role of Green Leadership on Green Management and Sustainable Bank Performance

The role of green leadership as a mediating mechanism in the relationship between green practices and bank performance has also gained empirical traction. Early evidence from the Nigerian context which emphasized that while the presence of green management systems and eco-innovation tools provides the necessary infrastructure, leadership commitment is the critical factor that ensures implementation fidelity, employee engagement, and alignment of sustainability strategies with institutional goals. Their study found that banks with visionary and environmentally driven leaders were more likely to embed ESG criteria into credit evaluation, adopt sustainability reporting practices, and incentivize green behaviors internally. Expanding on this line of inquiry, El Khoury (2024) applied structural equation modeling (SEM) to data from banks across the Middle East and North Africa (MENA) region and found that leadership orientation toward sustainability significantly mediated the relationship between green innovation and organizational performance. His findings underscore that without dedicated leadership to champion green initiatives, the benefits of innovation and management frameworks may remain latent or inconsistently realized. These studies collectively affirm that green leadership is not merely a supportive element but a strategic lever that amplifies the impact of sustainability practices on long-term bank performance, particularly in emerging and environmentally vulnerable markets.

2.5.5 Mediating Role of Green Leadership on Green Innovation and Sustainable Bank Performance

Within the Nigerian banking context, empirical research on the relationship between green management, innovation, leadership, and sustainable performance is gradually emerging, yet remains relatively underdeveloped. Adebayo et al. (2022), in their study of 15 Nigerian commercial banks, revealed a positive and significant association between the volume of green loan portfolios and institutional profitability. However, the strength of this relationship was found to be contingent upon the commitment of executive leadership to sustainability principles, suggesting that managerial orientation plays a pivotal role in translating green

financial instruments into measurable outcomes. Similarly, Yusuf and Dangana (2021) examined the role of green product innovation such as eco-loans and low-carbon savings products and found it to be a key predictor of banks' environmental performance. Importantly, their study indicated that this relationship was influenced by the degree of regulatory enforcement and the prevailing leadership style within each institution. These findings highlight the relevance of internal and external enablers in shaping sustainability outcomes, but they also point to a fragmented understanding of how these factors interact in a cohesive, integrated model.

Despite the value of these contributions, notable empirical gaps persist. Firstly, the majority of Nigerian studies treat green management, innovation, and leadership as discrete variables, rarely examining their interdependent dynamics within a unified framework. This limits insight into the mechanisms through which these internal capabilities collectively influence bank performance. Secondly, methodological limitations are evident, as most prior studies adopt cross-sectional designs and basic regression techniques, which are inadequate for capturing causal or mediating effects over time. Thirdly, the application of advanced analytical techniques, such as Structural Equation Modeling (SEM) or Partial Least Squares SEM (PLS-SEM), remains sparse, thereby reducing the statistical power and predictive relevance of findings in this domain. In response to these limitations, the current study proposes a quantitative mediation model that integrates green management and green innovation as predictors of sustainable bank performance, with green leadership as a mediating construct. By focusing on Nigerian commercial banks—a sector undergoing regulatory reform and increasing environmental scrutiny this research aims to provide context-specific, data-driven insights into how internal organizational capabilities foster sustainable outcomes in an emerging market context, while also advancing methodological rigor in green banking research.

2.3 Theoretical Framework for the Study

This study is anchored on two complementary theoretical perspectives: Stakeholder Theory and the Resource-Based View (RBV) of the firm. Together, these frameworks offer a robust lens through which to understand the internal and external drivers of sustainable performance in commercial banks, particularly within the context of an emerging economy like Nigeria.

Stakeholder Theory, originally articulated by Freeman (1984), posits that organizations must balance the interests of a broad range of stakeholders not just shareholders, but also customers, employees, regulators, communities, and the natural environment. From this perspective, a bank’s legitimacy and long-term performance are contingent on its ability to respond ethically and effectively to stakeholder expectations, especially in matters concerning sustainability and environmental impact. In the context of this study, stakeholder theory underlines the importance of embedding green management and green innovation practices into banking operations in ways that reflect transparency, inclusivity, and environmental responsibility. When green practices are institutionalized across various stakeholder interfaces, banks are more likely to gain stakeholder trust, regulatory support, and reputational capital, which in turn enhance their sustainable performance.

On the other hand, the Resource-Based View (RBV) of the firm, introduced by Barney (1991), emphasizes that sustained competitive advantage stems from the possession and strategic

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deployment of valuable, rare, inimitable, and non-substitutable (VRIN) resources. In this study, internal capabilities such as green management systems and green innovation mechanisms are conceptualized as strategic organizational resources. These capabilities enable banks to design and implement unique sustainability-oriented solutions that competitors may find difficult to replicate. Crucially, green leadership is theorized as the transformative mechanism that mobilizes and integrates these resources translating green intent into operational outcomes and aligning them with organizational goals. By applying the RBV framework, the study recognizes leadership not merely as a managerial function but as a strategic asset that mediates the relationship between green practices and sustainable bank performance. The dual application of Stakeholder Theory and RBV thus provides a multidimensional understanding of how banks in Nigeria can leverage internal capabilities to meet external sustainability demands while achieving competitive and sustainable outcomes.

3.0 Methodology

This study will adopt a cross-sectional survey research design, which entails collecting data from a defined sample of respondents at a single point in time. The population of this study will consist of 150 bank managers of five major Tier-One banks working in commercial banks within Kano Metropolis, Nigeria across operations, risk management, IT, marketing, and general administration. The population of this study comprises managerial staff of selected Tier-One commercial banks operating within Kano Metropolis, Nigeria. Kano is strategically selected due to its status as the largest commercial hub in Northern Nigeria and one of the most financially active cities in the country, hosting a high concentration of banking institutions and corporate clients (Central Bank of Nigeria [CBN], 2024).

The sample size is two hundred (108) of the total population and was determined using the Krejcie and Morgan's (1970) formula. 5% of 108 was added to give the total of 114 samples used in the study. Purposive sampling technique was adopted to select respondents for the study. Data were collected through structured questionnaire survey.

The total sample of 114 valid responses analyzed via Partial Least Squares Structural Equation Modeling (PLS-SEM) with the aid of SmartPLS 4. PLS-SEM is suitable for this study due to its robustness in handling complex models, its ability to test both reflective and formative constructs, and its appropriateness for predictive-oriented research with relatively small sample sizes (Hair et al., 2017; Ringle, Wende, & Becker, 2020).

4.0 Results and Discussion

The test of hypotheses using PLS-SEM approach starts with assessment of measurement model as seen in figure 1, and Table 1 – 3.

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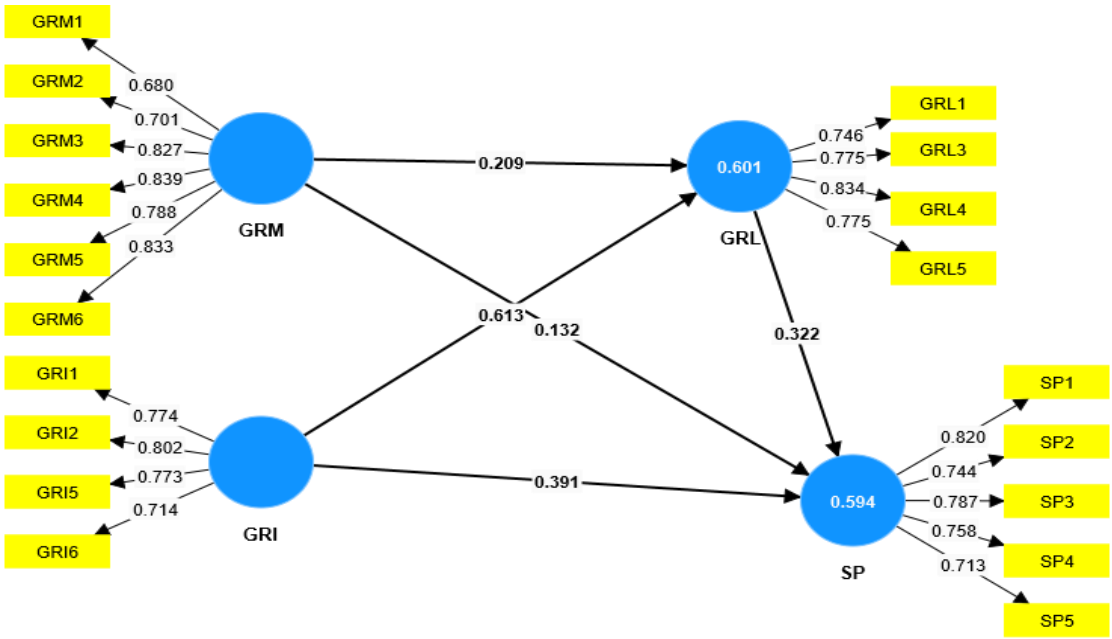

Figure 1. PLS Algorithm

Source: Research Survey 2025

Table 1. Individual item reliability

Construct	Items	Composite reliability (rho_c)	Average variance extracted (AVE)
Green Innovation		0.85	0.587
GRI1	0.774		
GRI2	0.802		
GRI5	0.773		
GRI6	0.714		
Green Management		0.903	0.61
GRM1	0.68		
GRM2	0.701		
GRM3	0.827		
GRM4	0.839		
GRM5	0.788		
GRM6	0.833		

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Green Leadership		0.864	0.613
GRL1	0.746		
GRL3	0.775		
GRL4	0.834		
GRL5	0.775		
Sustainable Bank Perf		0.876	0.585
SP1	0.82		
SP2	0.744		
SP3	0.787		
SP4	0.758		
SP5	0.713		

Source: Research Survey 2025

Table 1, The assessment of individual item reliability was conducted by examining the outer loadings of each indicator. Most items exceeded the recommended threshold of 0.70, indicating satisfactory reliability. Although a few items such as GRM1 (0.680) and GRM2 (0.701) fell slightly below the threshold, they were retained due to their theoretical importance and acceptable proximity to the cutoff point, in line with the guidelines of Hair et al. (2017). In terms of internal consistency, the composite reliability (CR) values for all constructs ranged between 0.85 and 0.903, surpassing the minimum acceptable level of 0.70. This confirms that the indicators within each construct consistently measure the same underlying concept. Furthermore, the Average Variance Extracted (AVE) values for all constructs were above 0.50, demonstrating sufficient convergent validity, as each construct accounts for more than 50% of the variance in its associated items (Fornell & Larcker, 1981). Collectively, these results indicate that the measurement model possesses strong item reliability, internal consistency, and convergent validity, thereby providing a sound foundation to proceed with the assessment of discriminant validity and the structural model.

Discriminant Validity - HTMT Criterion

The Heterotrait-Monotrait (HTMT) ratio is a robust and widely recommended approach for assessing discriminant validity in Partial Least Squares Structural Equation Modeling (PLS-SEM). This technique measures the extent to which latent constructs are empirically distinct from one another. As proposed by Henseler et al. (2015), HTMT values should be below 0.85 for conservative interpretation, and below 0.90 in more liberal assessments of discriminant validity. The result is shown in Table 3.

Table 3: Discriminant Validity - HTMT Criterion

Consturct	GRI	GRL	GRM	SP
GRI				

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GRL	0.872		
GRM	0.861	0.769	
SP	0.816	0.872	0.726

Source: Research Survey 2025

In Table 3, all HTMT values fall within the acceptable threshold of ≤ 0.90, thereby confirming adequate discriminant validity among the constructs. The HTMT value between Green Innovation (GRI) and Green Leadership (GRL) is 0.872, which, while slightly exceeding the conservative 0.85 benchmark, remains within the acceptable 0.90 range indicating a moderately strong but acceptable correlation. Similarly, the HTMT value between GRI and Green Management (GRM) is 0.861, also within permissible limits. The relationship between GRI and Sustainable Performance (SP) yields a value of 0.816, which satisfies both conservative and liberal thresholds, affirming discriminant validity. The HTMT ratio between Green Leadership (GRL) and Sustainable Performance (SP) is 0.872, marginally above 0.85 but still acceptable under the 0.90 criterion. Finally, Green Leadership and Green Management (0.769), as well as Green Management and Sustainable Performance (0.726), both fall well below the 0.85 threshold, indicating clear and strong discriminant separation between these constructs.

Assessment of Structural Model

The structural model assessment evaluates the hypothesized relationships between constructs by examining path coefficients, t-values, and p-values, as well as key model fit indicators such as R^2, f^2, and predictive relevance (Q^2). This analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS software. The significance of path relationships was tested using bootstrapping with 5,000 resamples. Path coefficients indicate the strength and direction of relationships, while t-values and p-values assess their statistical significance. An R^2 value of 0.60 or above is considered substantial, suggesting strong explanatory power of the model (Hair et al., 2017). Additionally, effect sizes (f^2) provide insights into the contribution of each exogenous variable to the endogenous constructs, and Q^2 values greater than zero confirm predictive relevance. The result is presented in figure 2, and Table 4.

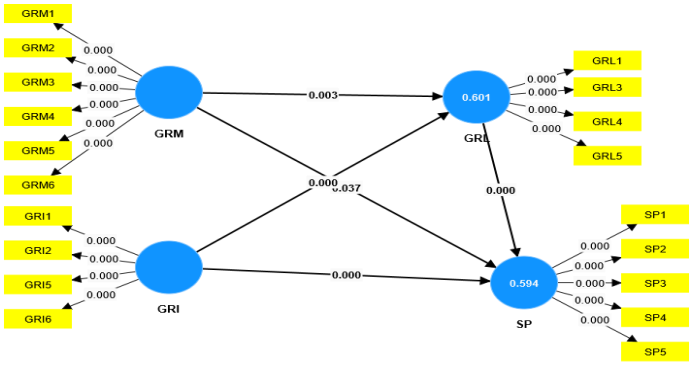

Figure 2. Bootstrapping

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Source: Research Survey 2025

Table 4. Size and Significance of the Path Coefficients

Hypotheses	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
GRI -> SP	0.589	0.066	8.860	0.000
GRM -> GRL	0.208	0.071	2.950	0.003
GRL -> SP	0.321	0.072	4.499	0.000

Source: Research Survey 2025

Table 4 presents the path coefficients, t-statistics, and p-values, which together indicate the magnitude and significance of the hypothesized effects. The path from Green Innovation (GRI) to Sustainable Bank Performance (SP) yielded a strong and statistically significant effect with a path coefficient of 0.589, a t-value of 8.860, and a p-value of 0.000. This confirms that green innovation has a substantial positive influence on the sustainable performance of commercial banks. The path from Green Management (GRM) to Green Leadership (GRL) is also statistically significant, with a coefficient of 0.208, a t-value of 2.950, and a p-value of 0.003. This suggests that strong green management practices positively influence the emergence and strength of green leadership within banking institutions. Finally, the relationship between Green Leadership (GRL) and Sustainable Performance (SP) is confirmed with a coefficient of 0.321, a t-value of 4.499, and a p-value of 0.000, indicating that leadership significantly contributes to the banks' ability to achieve sustainability outcomes.

While the direct relationships between green management, green innovation, and sustainable bank performance are significant, it is essential to test the mediating effect of green leadership to understand how and to what extent leadership facilitates or enhances the translation of green practices into sustainable outcomes. Mediators provide insight into the underlying mechanism driving these effects, and in this context, green leadership may serve as a critical pathway through which internal capabilities are strategically aligned to deliver sustainability performance.

Table 5. Size and Significance of the Indirect Effects

Hypotheses	**Sample mean (M)**	**Standard deviation (STDEV)**	**T statistics (|O/STDEV|)**	**P values**
GRI -> GRL -> SP	0.197	0.047	4.170	0.000
GRM -> GRL -> SP	0.067	0.029	2.345	0.019

Source: Research Survey 2025

Table 5 presents the results of the mediation analysis, evaluating the indirect effects of green innovation and green management on sustainable bank performance through the mediating role

of green leadership. The results confirm that both indirect paths are statistically significant, providing evidence of mediation. The indirect effect of Green Innovation (GRI) on Sustainable Performance (SP) through Green Leadership (GRL) is significant, with a path coefficient of 0.197, a t-statistic of 4.170, and a p-value of 0.000. This implies that green leadership partially mediates the relationship between green innovation and sustainable performance, reinforcing the idea that innovative practices are more impactful when guided by strong sustainability-oriented leadership. Similarly, the indirect effect of Green Management (GRM) on Sustainable Performance (SP) through green leadership is also significant, with a path coefficient of 0.067, a t-value of 2.345, and a p-value of 0.019. This result indicates that green management contributes to sustainable performance not only directly but also indirectly by fostering leadership that champions environmental initiatives. The findings validate the mediating role of green leadership, highlighting its strategic importance in enhancing the effectiveness of green practices on banks' sustainability outcomes.

Table 6. Blindfolding Predictive Relevance

SSO	SSE	Q^2 (=1-SSE/SSO)
1052	1052	000
1052	672.069	0.361
1578	1578	000
1315	873.503	0.336

Source: Research Survey 2025

The blindfolding procedure was conducted to assess the predictive relevance of the structural model using Stone-Geisser's Q^2 statistic. Q^2 values provide insight into how well the model can predict the indicators of endogenous constructs. According to Hair et al. (2017), a Q^2 value greater than zero indicates predictive relevance, while higher values reflect stronger predictive accuracy.

As shown in Table 6, the Q^2 value for one of the key endogenous constructs is 0.361, and another construct reports a Q^2 of 0.336. Both values are well above the threshold of 0, confirming that the model has substantial predictive relevance for these constructs. Meanwhile, constructs with a Q^2 of 0 are exogenous or not predicted within the model and are not expected to exhibit predictive power.

Table 7. Predict Accuracy (Qpredict)

Items Indicator	Q^2predict	PLS-SEM_RMSE	PLS-SEM_MAE	LM_RMSE	LM_MAE
SP1	0.391	0.963	0.716	0.982	0.711
SP2	0.312	0.977	0.724	1.014	0.738
SP3	0.302	0.899	0.671	0.92	0.686
SP4	0.269	0.83	0.618	0.861	0.635

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SP5	0.292	0.877	0.664	0.928	0.693

Source: Research Survey 2025

Table 7 presents the item-level predictive relevance (Q^2) and compares the prediction errors generated by the PLS-SEM model against a linear regression benchmark model using RMSE (Root Mean Square Error) and MAE (Mean Absolute Error). The purpose of this comparison is to assess whether the PLS-SEM model offers superior predictive accuracy over a naïve linear model (LM). All Q^2 values for the indicators of Sustainable Bank Performance (SP1–SP5) are greater than zero, with values ranging from 0.269 to 0.391. This confirms that the model demonstrates predictive relevance at the item level, consistent with the earlier construct-level Q^2 values. When comparing PLS-SEM RMSE and MAE to LM RMSE and MAE, the results show that PLS-SEM yields lower or comparable error values across all items. For instance, SP1 shows a lower MAE in the PLS-SEM model (0.716) than in the linear model (0.711), and SP4 has the lowest RMSE (0.830) and MAE (0.618) among all indicators. These patterns indicate that the PLS-SEM model offers better or equal predictive accuracy across the indicators of sustainable performance.

4.1 Test of Hypothesis

Coefficients of Determination (R^2)

Construct	R-square	R-square adjusted
GRL	0.601	0.598
SP	0.594	0.589

Source: Research Survey 2025

Table 8 presents the coefficients of determination (R^2) and adjusted R^2 values for the two key endogenous constructs in the model Green Leadership (GRL) and Sustainable Performance (SP). These values indicate the amount of variance in each construct that is explained by the independent variables in the structural model. The R^2 value for Green Leadership is 0.601, suggesting that 60.1% of the variance in green leadership is explained by green management and green innovation.

Similarly, the R^2 value for Sustainable Bank Performance is 0.594, indicating that nearly 59.4% of its variance is accounted for by green innovation, green management (indirectly), and green leadership. Both R^2 values fall within the moderate to substantial explanatory power category (Hair et al., 2017), confirming that the structural model demonstrates strong predictive accuracy and that the proposed variables are meaningful predictors of the outcome constructs. The adjusted R^2 values, which account for model complexity, remain closely aligned with the unadjusted R^2 values (GRL = 0.598; SP = 0.589), further supporting the model's stability and robustness.

Importance Performance Map Analysis

The Importance Performance Map visually represents the total effects (importance) of each construct on Sustainable Bank Performance (SP) alongside their performance levels as seen in Figure 3.

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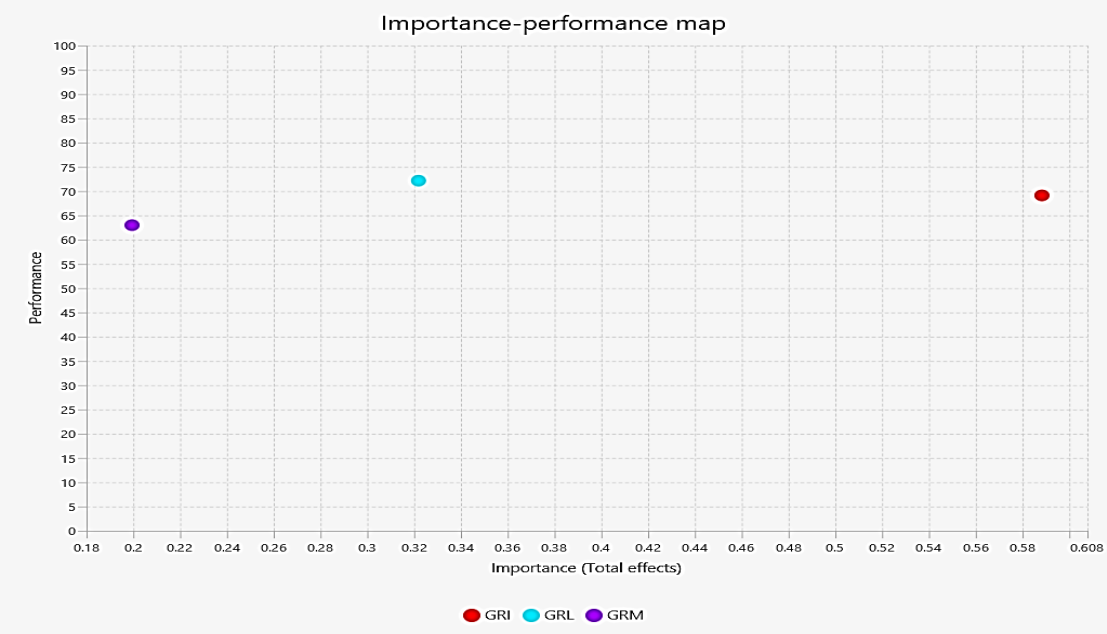

Figure 3. Importance Performance Map Analysis

Source: Research Survey 2025

4.2 Discussion of Findings

From the figure 3, Green Innovation (GRI), demonstrates the highest importance (total effect ≈ 0.58) but a moderate performance level (~69). This indicates that GRI is the most influential factor in predicting sustainable bank performance. However, since its performance is not the highest, it represents a strategic improvement opportunity which banks should prioritize investments and initiatives in green innovation to enhance sustainability outcomes further. Green Leadership (GRL), has moderate importance (~0.36) and the highest performance (~72) among the three constructs. This suggests that banks are already doing relatively well in integrating leadership-driven sustainability. The high performance suggests no urgent managerial intervention is required. Green Management (GRM), shows the lowest importance (~0.20) and lowest performance (~64). Although its direct influence is limited, the lower performance level indicates that basic environmental governance structures still need strengthening, particularly since GRM indirectly contributes to GRL.

5 Conclusion

This study investigated the effect of Green Management and Green Innovation on Sustainable Bank Performance, with a focus on the mediating role of Green Leadership within the Nigerian banking sector. Drawing on Stakeholder Theory and the Resource-Based View (RBV), the study developed and tested a structural model using PLS-SEM based on responses from bank managers across various departments. The findings provide robust empirical support for the hypothesized relationships, affirming that green-oriented practices and leadership are central to achieving sustainability in banking. From an empirical perspective, the results demonstrate that Green Innovation exerts the strongest direct influence on sustainable performance,

indicating that technologically-driven, environmentally conscious financial products and services are critical levers for sustainability. Green Management was shown to significantly influence Green Leadership, which in turn had a substantial positive effect on sustainable performance, confirming the partial mediating role of leadership. These findings underscore the importance of not only adopting green policies and innovations but also fostering leadership that actively promotes and aligns these initiatives with institutional strategy. The theoretical implications are equally significant. By integrating Stakeholder Theory, the study confirms that banks must balance profitability with environmental and social responsibility to meet stakeholder expectations. The use of RBV highlights how internal capabilities specifically innovation and strategic leadership serve as unique, inimitable resources that provide sustainable competitive advantage. This dual-theoretical framing enriches our understanding of how environmental capabilities are developed and operationalized within financial institutions, especially in emerging markets.

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