“Moderating role of modular innovation in sustainable development financing and SME performance in emerging economies”

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MODERATING ROLE OF MODULAR INNOVATION IN SUSTAINABLE DEVELOPMENT FINANCING AND SME PERFORMANCE IN EMERGING ECONOMIES

Abstract

Globally, small and medium-sized enterprises (SMEs) are facing increasing pressure to achieve sustainability goals through vital financing mechanisms, including green financing, social impact investments, and microfinancing. This study examines the impact of modular innovation on the relationship between sustainable development financing (SDF) and the performance of SMEs in an emerging economy. The research used a cross-sectional survey of 740 SMEs across Nigeria from January 2024 to March 2024. After cleaning the data, 612 responses were valid. These responses were analyzed using Partial Least Squares-Structural Equation Modeling (PLS-SEM). The findings reveal that all three sustainable financing mechanisms have a significant and positive influence on SME performance. Modular innovation, specifically incremental, architectural, and radical innovation, notably moderates these relationships. Incremental innovation exhibited the strongest moderating effect (β = 0.543), followed by radical innovation (β = 0.473), and architectural innovation (β = 0.441). This suggests that innovative capacity enhances the impact of sustainable financing. Consequently, these results underscore the crucial role of modular innovation in improving the effectiveness of sustainable financing for SMEs. They also emphasize the need to incorporate innovation policies that support SME growth via green financing, social impact investments, and microfinancing in emerging economies like Nigeria.

Keywords sustainable finance, innovation, SMEs, green finance, microfinance, impact investing, emerging economies

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INTRODUCTION

In emerging economies, small and medium-sized enterprises (SMEs) play a vital role in promoting inclusive growth, job creation, and innovation. However, their ability to achieve sustainable performance is often hindered by limited access to capital, inadequate technological infrastructure, and weak policy environments. At the same time, the global push for sustainability has increased pressure on businesses, including SMEs, to adopt environmentally and socially responsible practices. This has heightened interest in sustainable development financing (Zhang et al., 2022). Sustainable development financing is a financial mechanism that integrates environmental, social, and governance (ESG) factors into SME investment decisions, aiming to support long-term economic viability while fostering sustainability (Adebayo et al., 2024). This approach encompasses various mechanisms, including green financing, social impact investment, microfinancing, and commercial bank loans, which channel capital toward projects that generate positive environmental and social impacts (Kaur et al., 2023; Chand & Kour, 2024). Though gaining prominence, questions remain

about its effectiveness in enhancing SME performance, especially in the volatile and resource-limited environments of emerging markets like Nigeria. Additionally, Umar et al. (2024) found that the complexity of adopting innovation among SMEs in emerging economies negatively affects SME financing.

Innovation, particularly modular innovation, increasingly plays a crucial role in strengthening SME capacity (Zhang et al., 2022). Modular innovation involves modifying a system's components without changing its overall architecture, covering incremental, architectural, and radical innovations. Incremental innovations improve existing products, while architectural reconfigurations connect components in new ways, opening new markets (Henderson & Clark, 1990; Gancarczyk et al., 2017). Radical innovation develops entirely new components and systems, leading to groundbreaking products (Sari et al., 2024). These innovations are expected to help SMEs improve processes gradually, reducing the need for major overhauls and supporting adaptive, sustainable development. However, doubts remain about the effectiveness of modular innovation in driving sustainable financing in emerging economies. Specifically, a limited understanding of how modular innovation interacts with sustainable financing mechanisms has restricted SMEs' access to sustainable finance. Additionally, SMEs' ability to adopt sustainable development practices is constrained by weak policy support, such as taxation laws, economic vulnerabilities, infrastructural gaps, and socio-political instability (Omoyele et al., 2023; Omowole et al., 2024). Based on these gaps, Umar et al. (2024) mentioned that modular innovation could provide a pathway for addressing these challenges by enabling SMEs to adapt and improve their processes incrementally, reconfigure existing systems, or implement transformative changes; however, they did not empirically identify which aspects of sustainable financing this innovation could influence.

While evidence supports the positive impact of sustainable practices on firm performance (Chisom et al., 2023), little research has examined the moderating role of modular innovation in the relationship between sustainable development financing and SME performance in emerging economies. Most studies focus on developed economies or large enterprises (Lwesya & Mwakalobo, 2023), leaving a notable gap in understanding these dynamics in developing markets like Nigeria. Therefore, the main problem this study addresses is the limited empirical clarity on whether and how modular innovation enhances the effectiveness of sustainable development initiatives, particularly in improving SME performance. Solving this issue is vital for designing integrated policies that promote both financial inclusion and innovation capacity among SMEs in regions with weak institutional support.

1. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Small and medium-sized enterprises (SMEs) are widely recognized as essential drivers of economic growth through job creation, innovation, and sustainable practices (Aminu & Sheriff, 2015; Gajere, 2023). In emerging economies, SMEs encounter persistent challenges such as limited access to finance, inadequate infrastructure, and policy barriers (Omowole et al., 2024). Sustainable development financing (SDF) has emerged as a strategic mechanism to address these obstacles by integrating environmental, social, and governance (ESG) factors into financial systems through instruments like green financing, microfinancing, and social impact investments (Myronchuk et al., 2024; Amolo, 2024). Despite the increasing adoption of SDF, questions remain regarding its effectiveness in enhancing SME performance in resource-constrained environments. Equally important is the role of firms' innovative capacity, particularly modular innovation, in optimizing the use of financial inputs to support sustainable SME growth (Zhang et al., 2022; Onyemaobi et al., 2023; Umar et al., 2024).

SDF mechanisms provide SMEs with access to capital intended to promote growth while safeguarding environmental and social objectives (Myronchuk et al., 2024). Through instruments such as green bonds, microfinancing, impact investing, and public–private partnerships, SDF supports both profitability and the creation of long-

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term social and environmental value (Trandafir, 2024; Joshipura et al., 2024). In emerging economies, where SMEs struggle with financial exclusion, embedding Sustainable Development Goals (SDGs) in SME strategies becomes essential. Studies show that SDF enhances operational efficiency, technology adoption, and alignment with global sustainability standards (Ojochenimi et al., 2022; Chisom et al., 2023; Kato et al., 2024). It also reduces environmental risks, fosters stakeholder trust, and builds resilience (Tolstaia & Gorbacheva, 2024; Kripa, 2024). Evidence from Nigeria reveals that SMEs participating in SDF programs achieved lower costs and higher productivity (Omowole et al., 2024). Other findings show that SDF promotes the adoption of green technologies and competitiveness (Ogunyemi & Omowumi, 2024), with similar positive effects reported in Southeast Asia (Lin & Chong, 2024; Indriastuti & Riansyah, 2024). Since SMEs' financial performance directly influences GDP growth, employment, and innovation, SDF becomes a central driver of sustainable development (Alamandi, 2025).

Green financing (GF) involves investments that target projects with positive environmental outcomes such as renewable energy, energy efficiency, and waste reduction (Kudryavtseva et al., 2024; Adebayo et al., 2024). For SMEs, GF reduces energy costs, ensures compliance with environmental standards, and improves overall competitiveness (Zhang & Wang, 2019; Hu & Gan, 2025). GF aligns economic activities with environmental goals, ensuring growth without ecological harm (Wang et al., 2022). In emerging economies where SMEs are central to economic development and job creation, the relationship between green financing and SME performance is particularly critical (Rashid & Ullah, 2023). Empirical research shows that green financing enhances clean technology adoption, efficiency, and profitability among SMEs (Ali et al., 2024; Karimov, 2024; Adeyemi et al., 2024). It also provides environmental and social benefits by lowering emissions and conserving resources (Devi, 2023). Furthermore, GF drives innovation by encouraging SMEs to produce eco-friendly goods and services (Mohan & Muhammad, 2024; Singh, 2024). Nevertheless, limited awareness and restrictive eligibility conditions constrain its reach in emerging economies.

Social impact investments (SII) provide financial returns alongside measurable social benefits (Rosyadi et al., 2024; Goel & Sahay, 2024). Directed at SMEs in critical sectors such as health, education, and poverty alleviation, SII delivers both capital and non-financial support such as mentorship and networks (Islam, 2021; Panagopoulos & Tzionas, 2023; Muniandy, 2024). SMEs receiving SII demonstrate higher productivity, greater trust from stakeholders, and improved innovation capacity compared to those reliant on conventional financing (Yarima et al., 2023; Tiurina, 2023). These investments also strengthen business models to withstand shocks and align with SDGs (Gamtkitsulashvili et al., 2023; Sharma, 2023; Boulongne et al., 2023). In contexts like Nigeria, where SMEs face barriers to finance and infrastructure, SII plays a vital role in promoting sustainability and long-term competitiveness (Yarima et al., 2023).

Microfinancing (MF) provides small-scale financial services, including loans, savings, and insurance, to low-income individuals and SMEs that usually lack access to traditional banking (Haider et al., 2017; Sonam et al., 2024). In Nigeria, microfinancing has played a key role in helping SMEs start, grow, or stabilize their operations, especially in informal sectors (Bakle & Mangkut, 2024). MF institutions often offer flexible, tailored terms and customized loan products, making them accessible to SMEs with irregular cash flows (Kamara & Kamara, 2023). Besides the capital, many MF institutions also provide business development support, such as training and mentorship, to improve SME performance (Lwesya & Mwakalobo, 2023; Sarfo et al., 2024). This comprehensive support not only boosts SME productivity and profitability but also enhances their long-term financial stability. MF empowers SMEs to contribute to broader socio-economic development, generate employment, and reduce poverty. SMEs working with MF report improved cost management and operational efficiency. These institutions also help SMEs adopt more innovative models in response to market changes, promoting resilience and long-term growth (Mohammed et al., 2023; Olufolahan et al., 2023). Therefore, microfinancing acts as both a financial lifeline and a strategic driver of sustainable growth and development for SMEs in emerging markets (Rodríguez-Espíndola et al., 2022).

Modular innovation involves adopting or reconfiguring components within a system without changing its overall structure (Henderson & Clark, 1990; Bouchard et al., 2023). This approach is flexible, allowing firms to adjust to shifting market conditions, technological advances, and evolving customer preferences (Bouncken et al., 2016). It is classified into three types: incremental improvement (e.g., process tweaks), architectural innovation (e.g., reorganizing systems), and radical innovation (e.g., developing disruptive technologies). Incremental innovation enables SMEs to enhance efficiency through small, continuous improvements to existing products or processes, without significantly altering their structure or function (Zhang et al., 2022). Architectural innovation involves reconfiguring existing components, products, or technologies to develop new functionalities or applications while maintaining the core design concepts (Gancarczyk et al., 2017). Radical innovation entails creating entirely new products or services that differ significantly from current offerings, often leading to the emergence of new markets and disruption of existing ones (Kasmire et al., 2012). Modular innovation is particularly relevant in volatile or resource-constrained environments, as it offers cost-effective flexibility. In the Nigerian SME sector, modular innovation facilitates adaptation to financial, technological, and regulatory challenges (Toromade & Chiekezie, 2024; Faiz et al., 2024). Additionally, modular innovation enhances the impact of sustainable financing by enabling firms to better absorb and utilize external financial support (Onyemaobi et al., 2023; Mudra et al., 2024). Empirical studies also associate modular innovation, including incremental, architectural, and radical approaches with improved adaptability, product performance, and market responsiveness (Sun & Lau, 2019; Gancarczyk et al., 2017; Bouchard et al., 2023; Bouncken et al., 2016; Kasmire et al., 2012; Habib et al., 2020). Although few studies directly test its moderating role, existing evidence indicates that modular innovation strengthens the relationship between SDF and SME performance, with calls for more examination in emerging economies (Umar et al., 2024).

The literature provides strong empirical evidence on the impact of sustainable development financing (SDF) on SME performance. However, the magnitude of this impact varies according to firms' capabilities, particularly their capacity for innovation. Although several studies have examined these dynamics in developed economies (Zhang et al., 2022; Rodríguez-Espíndola et al., 2022; Onyemaobi et al., 2023; Umar et al., 2024), limited attention has been given to the moderating role of modular innovation in emerging contexts such as Nigeria. Also, while research has examined how financing impacts SMEs in developed economies (Nguyen & Kecskés, 2020; Höchstädter & Scheck, 2014), studies in emerging markets, especially Africa, remain scarce. Nigeria's vibrant SME sector and developing financial system offer a unique context, given its need for sustainable growth and innovation. Cultural and structural differences suggest that findings from developed economies may not be fully applicable to Nigeria, where informal systems and institutional challenges significantly influence SME performance (Madrid-Guijarro et al., 2016). Modular innovation, encompassing incremental, architectural, and radical types, is crucial for enhancing sustainable financing tools (Damanpour & Aravind, 2011). However, the link between these innovations and financing in Nigeria remains underexplored, despite cultural and institutional variation in innovation adoption (Adeyemi et al., 2024). Prior research on sustainable financing in emerging economies has yielded mixed results, largely due to diverse contexts and methods employed (Kato, 2024).

This study aims to address this gap by investigating the moderating role of modular innovation on sustainable development financing and SME performance in emerging economies. Accordingly, the following research hypotheses were developed to guide the study:

H_1: *Green financing has a positive impact on the performance of SMEs.*

H2: Social impact investments have a positive influence on SME performance.

H3: Microfinancing has a positive influence on SME performance.

H4: Incremental innovation moderates the relationship between sustainability development financing and SME performance.

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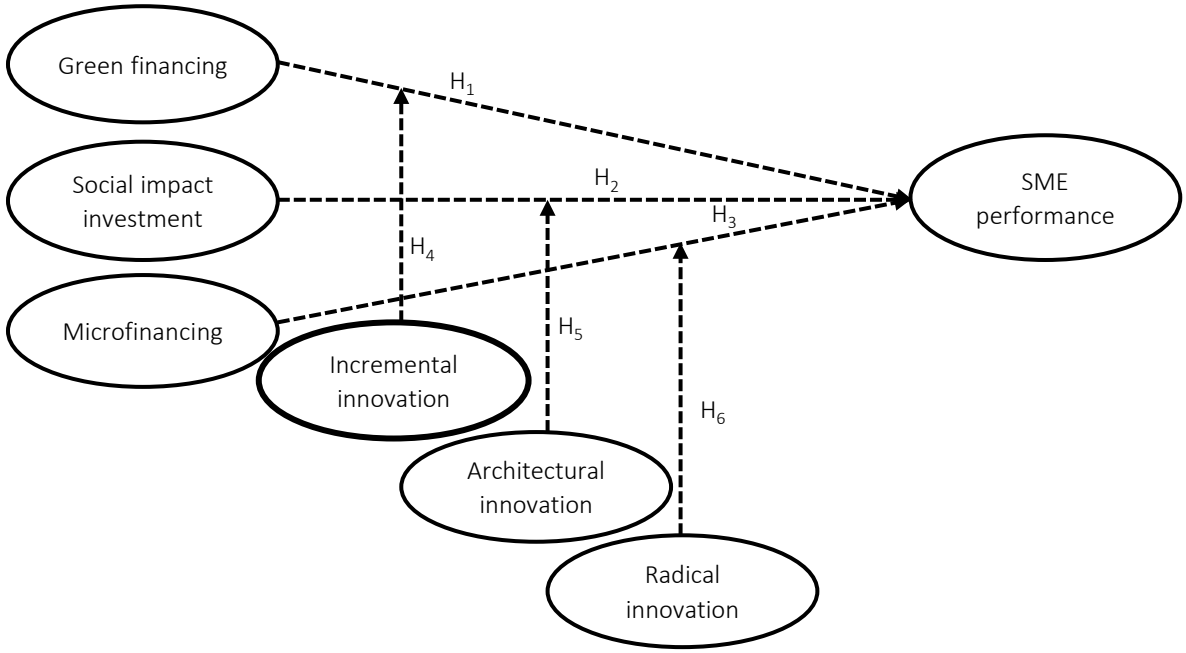

Figure 1. Conceptual model

H5: Architectural innovation moderates the relationship between sustainability development financing and SME performance.

H6: Radical innovation moderates the relationship between sustainable development financing and SME performance.

Figure 1 illustrates the research model.

2. METHODOLOGY

The study employed a cross-sectional survey design to investigate the relationship between SDF and SME performance, with modular innovation serving as a moderating variable. This approach enables the collection of quantitative data from a large sample at a specific point in time, supporting hypothesis testing and generalization within the Nigerian SME context (Creswell & Creswell, 2018; Saunders et al., 2019). Due to resource limitations and structural challenges common in emerging economies, the Nigerian SME sector presents an ideal environment for examining how innovation affects the effectiveness of sustainable financing mechanisms. This study focused on SMEs in Nigeria that exhibited characteristics typical of an entrepreneurial business, across the 36 states and the federal capital territory. Firms were selected using purposive sampling based on the following criteria, including consistent operation for at least ten years, a formalized business structure, a workforce of 10 or more employees, and a demonstrated history of modular innovation within the past decade. The selected firms also possess an asset base ranging from ₦5 million and ₦500 million. Documented evidence of adopting modular innovation (incremental, architectural, or radical). The study employed purposive sampling, contacting a total of 740 SMEs using databases from the National Bureau of Statistics (NBS) and the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN). Structured questionnaires were administered between January and March 2024. Respondents were typically owners, managers, CEOs, or financial managers with a minimum of 5 years of leadership experience, ensuring adequate knowledge of the firm's financial and innovation practices. After data cleaning, 612 valid responses resulted, yielding a response rate of 82.7%. This approach aligns with similar studies on SME financing and innovation in emerging markets, making the chosen design, sampling, and data collection method replicable (Madrid-Guijarro et al., 2016).

The questionnaire was structured into four sections: (1) Demographics and firm-level information, (2) Use of sustainable financing mechanisms; Green Financing, Social Impact

Investment, Microfinancing, (3) Performance indicators; Revenue growth, Market share, Asset Returns, and (4) Modular innovation practices; Incremental, Architectural, and Radical innovation. Measurement items in each variable group were adapted and validated from previous studies by Höchstädter and Scheck (2014), Aminu and Sheriff (2015), Gancarczyk et al. (2017), Sun and Lau (2019), Habib et al. (2020), Zhang et al. (2022), Gajere (2023), Yarima et al. (2023), Olowe et al. (2013), Adeyemi et al. (2024), Karimov (2024), Ali et al. (2024), Muniandy (2024), Sonam et al. (2024), and Bakle and Mangkut (2024). A 5-point Likert scale was used to measure the level of agreement or disagreement with measurement questions. To provide full transparency and replicability of this study's measurement instruments, the complete questionnaire can be adapted from Table 2.

A pilot test was conducted with 30 SMEs to ensure clarity and reliability. Cronbach's alpha value exceeded 0.70 percent for all measurement scales, confirming internal consistency. The pilot study enabled analysis of how sustainable financing interacts with modular innovation over time, forming the basis for the main survey (Agrawal et al., 2024). The analysis revealed sectoral disparities, with manufacturing and agribusiness SMEs more engaged in sustainable financing and innovation than service firms. To ensure rigor, the study focused on firms that have been operational for at least ten years, have a formal structure, and a record of modular innovation over the past decade. Based on SME research by Madrid-Guijarro et al. (2016), firms with assets between ₦5 million and ₦500 million were selected, including established enterprises that still rely on external financing. To minimize bias, firms were stratified by workforce size or assets and industry sector (see Table 1). A quasi-retrospective cohort approach collected data via questionnaires from owner-managers, CEOs, or financial managers who had been in their positions for at least five years (2018–2023), ensuring in-depth knowledge of financing, innovation, and performance. Data cleaning yielded 612 responses (82.7%), used to refine the research framework and measurement scales, following established methodologies (Damanpour & Aravind, 2011; Höchstädter & Scheck, 2014) to ensure robustness in causal assessment. Table 1 presents the demographic and structural profile of the participating SMEs.

Table 1. Characteristics of respondent SMEs

Source: Authors' field data output (2025).

Characteristics	Category	Frequency	Percentage
Sector	Manufacturing	192	31.4
	Agribusiness	143	23.4
	Services	163	26.6
	Retail/trading	114	18.6
	N	612	**100%**
Workforce Size	10-49	221	36.1
	50-99	163	26.6
	100-149	128	20.9
	150+	100	16.3
	N	612	**100%**
Asset Base	₦5M – ₦149M	276	45.1
	₦150M – ₦229M	180	29.4
	₦300M – ₦449M	93	15.2
	₦450M +	63	10.3
	N	612	**100%**
Region	North-Central	97	15.8
	North-East	63	10.3
	North-West	86	14.1
	South-East	96	15.7
	South-South	108	17.6
	South-West	162	26.5
	N	612	**100%**

2.1. Ethical considerations

The study adheres to the ethical guidelines for research involving humans. Participation was voluntary, and informed consent was obtained before administering the questionnaire. Confidentiality was assured, and participants could withdraw from the study at any time. The researcher was neutral and did not use coercive incentives. Because the research involved minimal risk and no sensitive topics, formal ethics approval was unnecessary. Nonetheless, the study adhered to general ethical principles.

3. RESULTS

The measurement of variables was designed to capture the study's constructs. Measures of sustainable development financing – green financing (GF), social impact investments (SII), and microfinancing (MF) – were drawn from previous research (Nguyen & Kecskés, 2020; Höchstädter & Scheck, 2014) and adapted to fit the current study's objectives. Respondents were asked to indicate how much their firms used various sustainable financ-

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ing mechanisms. SME performance, the dependent variable, was assessed through both financial and operational indicators. Following the approach of Fu et al. (2015) and Kaufman (2014), this study used subjective assessments from knowledgeable respondents because reliable objective financial data from Nigerian SMEs are difficult to obtain. This method has shown a strong correlation with objective measures in similar developing economy contexts (Ramdani et al., 2009). Modular innovation, serving as the moderating variable, was defined through its three components: incremental (Inc), architectural (Arc), and radical innovations (Rad). The measurement scale was adapted from Damanpour and Aravind's (2011) framework. Respondents were asked to evaluate their firm's adoption of various innovation strategies, with items specifically designed to distinguish between minor process improvements (incremental), structural reorganizations (architectural), and transformative market innovations (radical). The measurement tool was assessed using a five-point Likert scale. Table 2 presents the measurement instrument along with the study's descriptive statistics.

Table 2. Measurement instrument showing descriptive statistics

Variables	ITEMS	Sources	Mean	SD	Skewness	Kurtosis
GF	Our SME has access to financial products specifically designed to support environmentally sustainable projects.	Adeyemi et al. (2024); Karimov (2024); Ali et al. (2024)	4.231	0.0522	–1.321	0.314
	We prioritize investments in renewable energy initiatives.					
	The availability of green bonds has facilitated our investment in eco-friendly technologies.					
	We allocate resources to projects that contribute to reducing our carbon footprint.					
(SII)	Our company invests in projects that generate measurable social benefits alongside financial returns.	Muniandy (2024); Yarima et al. (2023)	4.421	0.0522	–1287	–1.232
	Our investment portfolio includes ventures focused on enhancing social welfare.					
	Social impact investments have enabled us to scale our operations, benefiting underserved communities.					
	We consider the social impact of our investments as a key criterion in our decision-making process.					
(MF)	Access to microfinancing has been crucial for meeting our short-term capital needs.	Sonam et al. (2024); Bakle & Mangkut (2024); Olowe et al. (2013)	4.221	0.0701	–1.221	–1.421
	Microfinance institutions provide us with flexible repayment options tailored to our cash flow.					
	We have utilized microloans to fund incremental innovations in our products or services.					
	The interest rates offered by microfinance institutions are manageable for our financial planning.					
SMEs Performance	Our SME has experienced consistent revenue growth.	Aminu & Shariff (2015); Gajere (2023)	4.321	0.0831	–.0834	–1.251
	Our SME has experienced an increased market share.					
	Our SME has experienced an increase in the overall market performance.					
	Our SME has experienced increased returns on assets.					
(Inc)	We consistently implement minor improvements to our existing structure, products, or services.	Zhang et al. (2022); Sun & Lau (2019)	4.324	0.0821	–1.331	–1.711
	Our company culture promotes the ongoing improvement of operational processes.					
	We systematically upgrade our technologies to stay competitive.					
(Arc)	Our firm has undergone structural reorganization in the last five years.	Gancarczyk et al. (2017)	4.621	0.0862	–1.113	–.321
	We have reconfigured existing technologies to create new products or services.					
	Our organizational structure supports the integration of architectural innovations.					
(Rad)	Our SMEs have carried out transformative market innovations.	Habib et al. (2020)	4.341	0.334	–1.271	–1.421
	Our company has developed entirely new products or services that disrupt existing markets.					
	We invest in research and development projects that have the potential to revolutionize our sector.					

Table 3 assesses the convergent validity of the measurement instrument using standardized factor loadings (SFL), average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha (α). Each construct, including green financing (GF), social impact investments (SII), microfinancing (MF), SME performance (SMEsP), and types of modular innovation (incremental, architectural, radical), meets accepted thresholds (AVE > 0.5, CR > 0.7, α > 0.7) (Hair et al., 2014), confirming that the items reliably and validly capture the intended constructs. Collinearity statistics (VIF < 5) (Kyriazos & Poga, 2023) also indicate no multicollinearity issues, supporting the robustness of the measurement model.

Table 4 evaluates discriminant validity using the Fornell-Larcker (1981) criterion. Diagonal values show the square root of AVE for each construct

Table 3. Results of convergent validity for the measurement instrument

Source: Authors' field data output (2025).

Variables	Items Codes	SFL	AVE	CR	Cronbach Alpha A	Collinearity Statistics Tolerance	VIF
(GF)	GF1	0.932	0.588	0.843	0.877	.433	1.462
	GF2	0.841					
	GF3	0.822					
	GF4	0.774					
(SII)	SII1	0.784	0.632	0.842	0.985	.431	1.461
	SII2	0.942					
	SII3	0.831					
	SII4	0.866					
(MF)	MF1	0.945	0.543	0.871	0.972	.463	1.466
	MF2	0.882					
	MF3	0.844					
	MF4	0.821					
SMEsP	SMEsP1	0.811	0.573	0.833	0.832	.431	1.453
	SMEsP2	0.843					
	SMEsP3	0.832					
	SMEsP4	0.921					
(Inc)	Inc1	0.862	0.531	0.822	0.861	.463	1.481
	Inc2	0.822					
	Inc3	0.853					
(Arc)	Arc1	0.872	0.611	0.861	0.841	.464	1.441
	Arc2	0.891					
	Arc3	0.952					
(Rad)	Rad1	0.821	0.673	0.827	0.953	.422	1.472
	Rad2	0.833					
	Rad3	0.763					

Summary of model fit indices			
CMIN/DF	RMSEA	CFI	GFI
2.931	0.0581	0.942	0.932

Table 4. Discriminant validity

Variables	SMEsP	GF	SII	MF	Inc	Arc	Rad
SMEsP	0.811						
GF	0.526	0.623					
SII	–0.251	–0.167	0.703				
MF	0.514	0.528	0.464	0.621			
Inc	0.472	0.492	0.531	0.367	0.732		
Arc	0.311	0.431	0.513	0.541	0.536	0.711	
Rad	–0.231	–0.122	0.483	0.567	–0.443	–0.232	0.594

Note: Fornell and Larcker (1981) criterion.

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Source: Authors' field data output (2025).

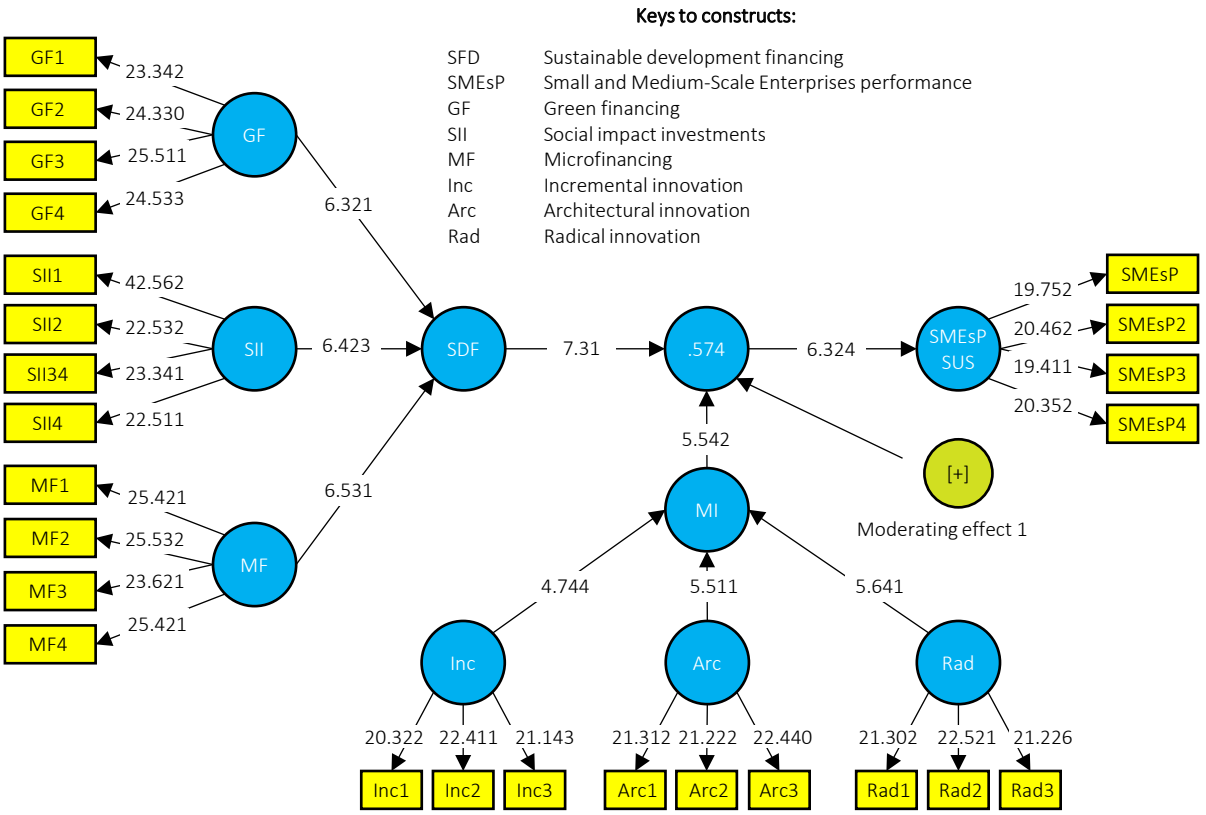

Figure 2. PLS-SEM model with moderating effect

and are higher than the correlations between constructs in the same row and column, indicating strong discriminant validity (Henseler et al., 2016). This demonstrates that each construct is empirically distinct from the others, confirming that each one uniquely contributes to the model without excessive overlap.

Figure 2 illustrates the Partial Least Squares Structural Equation Modeling (PLS-SEM) model, visually demonstrating the relationships and moderating effects explored in the study. It shows direct paths from green financing, social impact investments, and microfinancing to SME performance, as well as how incremental, architectural, and radical innovation moderate these paths. The outer weights highlight the relative importance of each indicator within the Sustainable Development Financing (SDF) construct. These weights also indicate how much each SDF construct influences SME performance. The model confirms that modular innovation improves the translation of sustainable financing into better SME performance.

Table 5 presents the results of hypothesis testing from the structural equation modeling. All six hypotheses (H1–H6) are statistically supported.

Table 5. Summary of hypotheses testing and moderating results

Source: Authors' field data output (2025).

Hypotheses	Relationships	β	t-value	p-value	LL	UL	Decision
H1	GF → SMEsP	0.753	7.321	0.0001	0.084	0.622	Supported
H2	SII → SMEsP	0.653	6.434	0.0000	0.710	0.831	Supported
H3	MF → SMEsP	0.652	6.352	0.0002	0.084	0.732	Supported
H4	Inc → SDF → SMEsP	0.543	4.321	0.0000	0.043	0.541	Supported
H5	Arc → SDF → SMEsP	0.441	4.320	0.0000	0.045	0.532	Supported
H6	Rad → SDF → SMEsP	0.473	4.362	0.0001	0.042	0.551	Supported

Green financing (β = 0.753, p < 0.001), social impact investments (β = 0.653, p < 0.001), and microfinancing (β = 0.652, p < 0.001) significantly and positively affect SME performance. The moderating effects of modular innovation are also significant: incremental innovation (H4) boosts the impact of sustainable development financing on SME performance (β = 0.543), along with architectural (H5: β = 0.441) and radical innovations (H6: β = 0.473), all supported by strong statistical evidence. These results confirm that modular innovation moderates the relationship between sustainable financing and SMEs' performance.

4. DISCUSSION

Amid the increasing focus on sustainable development financing (SDF) and its potential to boost SME performance, this study provides empirical evidence supporting the positive effects of green financing, social impact investments, and microfinancing on SME success. Consistent with H1, the analysis confirms that green financing has a strong positive influence on SME performance (β = 0.753, p < 0.001). This aligns with previous research showing that access to environmentally focused financial products allows SMEs to invest in renewable technologies and resource-efficient processes, thereby improving operational efficiency and competitiveness (Adeyemi et al., 2024). Likewise, support for H2 indicates that social impact investments significantly positively impact SME outcomes (β = 0.653, p < 0.001). This highlights the dual benefits of such investments, which not only provide capital but also promote social value through capacity-building and innovation. The importance of social impact capital in emerging economies may reflect a shift in investor priorities toward inclusive growth and measurable societal benefits, as noted by Rosyadi et al. (2024) and Yarima et al. (2023). H3 is also supported, revealing a positive and significant relationship between microfinancing and SME performance (β = 0.652, p < 0.001). The accessibility and flexibility of microfinance make it an effective financial tool for underserved SMEs, supporting expansion, innovation, and market entry. These findings align with earlier research by Olowe et al. (2013), emphasizing the role of microfinancing in improving business resilience and operational capacity among SMEs. Importantly, the study offers new insights through its analysis of modular innovation as a moderator. H4 confirms that incremental innovation enhances the positive impact of SDF on SME performance (β = 0.543, p < 0.001). This suggests that SMEs that regularly adopt small-scale improvements are better positioned to leverage sustainable financing for better outcomes (Sonam et al., 2024). H5 and H6 further confirm that architectural (β = 0.441, p < 0.001) and radical innovation (β = 0.473, p < 0.001) also significantly strengthen this relationship. These results suggest that more transformative innovation strategies, although less common, provide substantial performance benefits when supported by sustainable financing, especially in contexts characterized by high volatility and limited infrastructure (Bakle & Mangkut, 2024). Overall, the findings show that modular innovation in all its forms acts as a catalyst that enhances the effectiveness of SDF tools. This supports the idea of Damanpour and Aravind (2011) that innovation capability is essential for turning external resources into strategic advantages. The evidence suggests that for sustainable financing to deliver real results, SMEs must incorporate adaptive innovation processes that align with their growth goals and market conditions.

CONCLUSION

This study examined modular innovation as a moderator of sustainable development financing on SME performance, using data from Nigerian SMEs. The research enhances both theoretical and practical understanding by empirically demonstrating that green financing, social impact investments, and microfinancing have a positive impact on SME performance. More importantly, it demonstrates that modular innovation, whether incremental, architectural, or radical, significantly strengthens this relationship. From a policy and management perspective, the findings indicate that increasing access to various forms of sustainable financing, combined with innovation support frameworks, can substantially boost SME resilience and growth. Policymakers and financial institutions should consider integrated sup-

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port models that merge funding access with innovation training and infrastructure. Additionally, SME managers are encouraged to formalize innovation practices to maximize the benefits of sustainable financing mechanisms. This study makes valuable theoretical contributions by integrating innovation theory with financing literature within a developing economic context. It underscores the strategic importance of innovation as a moderating variable and broadens the scope of sustainable finance research to entrepreneurial environments in sub-Saharan Africa, which are often underexplored. However, the study has limitations. Its cross-sectional design limits causal inferences, and the reliance on self-reported data might introduce response bias. Although the sample is geographically and sectorally diverse within Nigeria, the results may not be generalizable to SMEs in other emerging markets with different institutional and cultural conditions. Future research should employ longitudinal and mixed methods approaches to validate and expand these findings, as well as examine additional contextual moderators, such as regulatory frameworks, digital infrastructure, and market maturity.

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