

Sustainable Business Practices and Competitive Advantage of Fast-Moving Consumer Goods Firms: The Moderating Role of Technological Innovation in Lagos State.

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Abstract

This study examines whether technological innovation strengthens the effect of sustainable business practices on competitive advantage among fast-moving consumer goods (FMCG) firms in Lagos State, Nigeria. Drawing on the Natural Resource-Based View and Dynamic Capabilities Theory, the study conceptualises sustainable business practices through sustainable product design, operational sustainability, social sustainability and environmental sustainability, while technological innovation captures product/process innovation and digital adoption capacity. A quantitative cross-sectional survey was conducted among managers in four quoted FMCG firms. Of 475 questionnaires distributed, 445 usable responses were analysed using multiple linear regression and hierarchical moderated regression. The results show that sustainable business practices jointly exert a positive significant effect on competitive advantage, explaining 61.0% of its variance. Environmental sustainability and social sustainability recorded the strongest contributions. The moderation analysis further indicates that technological innovation adds explanatory power to the model and significantly strengthens the relationship between sustainable business practices and competitive advantage ($\beta = 0.142$, $p < 0.001$). The findings extend sustainability strategy research by demonstrating that the competitive value of sustainability depends partly on complementary technological capabilities. For managers, the results suggest that sustainability initiatives should be integrated with investments in automation, digital supply-chain systems, data analytics and process innovation. The study also provides evidence from an under-researched emerging-market FMCG context and highlights the importance of combining sustainability and technological capability in competitive strategy.

Keywords: *Competitive Advantage; Fast-Moving Consumer Goods; Sustainable Business Practices; Technological Innovation.*

1. Introduction

The intensifying pressure on firms worldwide to reconcile profitability with environmental stewardship and social responsibility has repositioned sustainability from a peripheral compliance concern to an important component of competitive strategy. Sustainable practices can shape competitive advantage by improving resource efficiency, reducing environmental impacts and strengthening stakeholder value (Hart, 1995; Ahmadi-Gh & Bello-Pintado, 2022). Organisations are therefore increasingly expected to embed sustainable product design, operational efficiency, social responsibility and environmental

stewardship into their business models rather than treat sustainability as a stand-alone compliance activity. This imperative is particularly relevant to fast-moving consumer goods (FMCG) firms because high-volume production, packaging and distribution create significant resource and environmental pressures. Beyond the environmental dimension, sustainability also encompasses employee welfare, fair treatment and wider stakeholder wellbeing, making it a multidimensional strategic concern rather than a narrow environmental one (Missimer & Mesquita, 2022).

In Nigeria, and particularly in Lagos State, FMCG firms operate in a highly competitive commercial environment in which price, product differentiation, operational efficiency and responsiveness to customer expectations are strategically important. When firms offer products with limited distinctive value, competition can become increasingly price based, putting pressure on margins and constraining the resources available for innovation and market development. By contrast, innovation can help firms strengthen differentiation and improve their competitive position through new products, processes and business practices (Distanont & Khongmalai, 2020). Operational efficiency is equally important because sustained cost competitiveness depends partly on firms' ability to improve their relative cost position and deploy resources productively (Boundi-Chraki & Perrotini-Hernández, 2021). These interrelated pressures of cost, differentiation and efficiency underscore the need to understand which strategic resources and complementary capabilities enable sustainable business practices to translate into competitive advantage within the FMCG sector.

A growing body of literature has responded to this challenge by examining how sustainable business practices shape organisational outcomes, including competitive advantage. Evidence from manufacturing shows that different sustainability practices are associated with sustainability outcomes and competitive advantage (Ahmadi-Gh & Bello-Pintado, 2022). Continuous-improvement practices have also been linked to business sustainability in an emerging-market setting (Bernal-Torres et al., 2021), while socially responsible practices can strengthen competitive positioning by creating value for important stakeholders (Eyasu & Arefayne, 2020). Nevertheless, much of this literature models the sustainability–competitiveness relationship as direct, giving less attention to the organisational capabilities that may determine when sustainable practices are converted into stronger market outcomes. This omission matters because strategic management research has long recognised that valuable resources do not automatically create sustained advantage. Their conversion into market value depends on complementary capabilities that allow firms to sense opportunities, reconfigure assets and deploy resources efficiently as conditions change (Teece et al., 1997; Chatterjee et al., 2022).

Technological innovation is one such complementary capability. Several strands of research suggest that technology and innovation-related capabilities influence how effectively firms combine sustainability with performance objectives. Within the FMCG sector, Ismail (2023) found that technological absorptive capacity played an important role in business sustainability alongside enviropreneurial orientation and green marketing, highlighting the relevance of technological capability in a closely related emerging-market context. Chege and Wang (2020), examining SMEs in Kenya, similarly found that technology innovation and environmental sustainability practices were positively associated with firm performance. These findings do not establish the exact moderation proposed in the present study, but they indicate that technological capability and sustainability are closely connected rather than independent strategic levers. They therefore provide a strong theoretical and empirical basis for examining whether technological innovation changes the strength of the relationship between sustainable business practices and competitive advantage among Nigerian FMCG firms.

This gap is both theoretical and contextual. Theoretically, the antecedent empirical model left approximately 39.0 per cent of the variance in competitive advantage unexplained after accounting for sustainable product, operational, social and environmental sustainability, suggesting the operation of an omitted contingency factor. Contextually, Lagos State FMCG firms exhibit markedly heterogeneous technological capabilities, ranging from firms with advanced automation, data analytics, and digital supply

chain systems to firms that remain largely manual in their operations, providing fertile empirical ground for examining whether technological innovation systematically alters the strength of the sustainability–competitiveness relationship. Addressing this gap matters in practice because, absent an understanding of this contingency, firm managers risk investing in sustainability initiatives whose competitive returns are muted by weak innovation infrastructure. In contrast, policymakers risk designing sustainability incentives that overlook the complementary role of technology adoption. Accordingly, the following research questions objectives are raised:

RQ1: *What is the effect of sustainable business practices on the competitive advantage of selected FMCG firms in Lagos State, Nigeria?*

RQ2: *To what extent does technological innovation moderate the relationship between sustainable business practices and the competitive advantage of selected FMCG firms in Lagos State, Nigeria?*

2. Literature Review

2.1. Conceptual Review

Sustainable business practices refer to organisational activities that balance economic viability with environmental responsibility and social considerations in long-term value creation. From the Natural Resource-Based View, firms can build strategic value through capabilities related to pollution prevention, product stewardship and sustainable development (Hart, 1995). Empirical evidence likewise indicates that manufacturing sustainability practices can influence sustainability outcomes and competitive advantage (Ahmadi-Gh & Bello-Pintado, 2022). In this study, sustainable business practices are conceptualised as a multidimensional construct comprising sustainable product, operational sustainability, social sustainability and environmental sustainability. Sustainable product concerns the design and delivery of goods in ways that reduce adverse environmental effects across the product life cycle and reflects the product-stewardship logic of the NRBV (Hart, 1995). Operational sustainability concerns internal production, logistics and resource-use practices that reduce waste while maintaining efficiency. Social sustainability captures the organisation’s responsibility for employee and stakeholder wellbeing, fair treatment and broader social value (Missimer & Mesquita, 2022). Environmental sustainability concerns efforts to manage ecological impacts, conserve resources and strengthen environmental accountability (Hart, 1995; Alsahlawi et al., 2021).

Collectively, these practices can create strategic benefits through efficiency, risk reduction and stronger stakeholder perceptions. Sustainability may also contribute to reputation and brand value when it is credibly embedded in business activity rather than treated only as symbolic communication (Flores-Hernández et al., 2020). These benefits, however, are not automatic. Sustainability initiatives often require upfront investment, changes in operational routines and credible measurement systems before their benefits become visible. Firms must therefore manage the tension between short-term implementation costs and longer-term strategic returns. Continuous improvement can help embed sustainability within day-to-day operations rather than confine it to isolated projects (Bernal-Torres et al., 2021).

Competitive advantage refers to the resources, capabilities or strategic positions that enable a firm to create superior value and outperform rivals over time (Peteraf, 1993). It is more sustainable when it rests on resources that are valuable, rare, difficult to imitate and organisationally embedded, thereby limiting competitors’ ability to reproduce the source of advantage (Barney, 1991). Innovation is also an important basis of competitive advantage because it can improve products, processes and organisational responsiveness to changing market conditions (Distanont & Khongmalai, 2020). Consistent with the study framework, competitive advantage is operationalised through four dimensions: cost advantage, market advantage, product differentiation and improved efficiency. Cost advantage reflects the ability to produce or deliver at a favourable relative cost and can be strengthened through process improvement and technical change (Boundi-Chraki & Perrotini-Hernández, 2021).

Market advantage reflects the firm's ability to secure and defend a favourable position relative to competitors. Product differentiation refers to the creation of distinctive product attributes or value propositions that customers recognise, while improved efficiency concerns better use of resources, processes and organisational routines. Both differentiation and efficiency are closely connected with innovation capability and firm performance (Rajapathirana & Hui, 2018). Prior EJB evidence also illustrates that organisational practices transferred or implemented across firms can differ in ways that affect the creation of competitive advantage (Ranjan & Edwards, 2018). Taken together, the four dimensions provide a broad representation of competitive advantage relevant to the operational and market realities of FMCG firms. Competitive advantage also has a temporal dimension. A position that is valuable today may weaken when competitors imitate it, customer preferences change or new technologies alter the basis of competition. Firms therefore need to renew the resources supporting their advantage rather than assume that an existing market position will remain defensible. This consideration is particularly relevant to FMCG firms, where product cycles, distribution systems and consumer preferences can change rapidly.

Within the competitive advantage construct, each dimension carries distinct strategic implications. Cost advantage can be relative, dynamic and process based: a firm may operate at a lower cost than competitors, or it may improve its cost position more rapidly over time through innovation and technical change (Boundi Chraki, 2019; Boundi-Chraki & Perrotini-Hernández, 2021). Market advantage extends beyond immediate market share to include the capacity to protect a favourable position, respond to changing demand and deploy resources in ways that competitors find difficult to match. Product differentiation depends on offering products or services with distinctive features, quality or functionality that customers perceive as valuable. Improved efficiency, in turn, reflects the ability to reduce waste, streamline processes and use organisational resources more productively. These dimensions are not independent of technological development.

Firms that build stronger innovation capability can improve processes, introduce new product attributes and respond more quickly to market change, thereby strengthening both operational and market-based sources of advantage (Distanont & Khongmalai, 2020; Rajapathirana & Hui, 2018). This technology-sensitive character of competitive advantage reinforces the plausibility of the moderating role proposed in the study. A strong cost position can increase pricing flexibility, while market advantage can improve bargaining power and access to distribution channels. Differentiation can support loyalty and reduce direct price comparison, whereas efficiency can release resources for innovation and market development. Yet overreliance on any single dimension may create vulnerability if competitors imitate the source of advantage or if market conditions change. The four dimensions are therefore treated as complementary rather than interchangeable indicators of competitive strength.

Technological innovation refers to the successful development, adoption and application of new or significantly improved products, processes or digital systems that enhance organisational performance (OECD/Eurostat, 2018; Rogers, 2003). Drawing on the organisational innovativeness framework developed by Wang and Ahmed (2004) and the innovation-capability approach of Rajapathirana and Hui (2018), technological innovation in this study is conceptualised through two complementary strands. The first, product/process innovation, captures the firm's capacity to introduce new production technologies, automate operations, redesign processes and improve product quality or resource efficiency. The second, digital adoption capacity, captures the extent to which a firm uses digital tools, enterprise systems, data analytics and digital supply-chain platforms to support decision-making, traceability and market engagement. This conceptualisation is consistent with FMCG evidence on technological absorptive capacity (Ismail, 2023) and with wider evidence showing that innovation capabilities contribute to business sustainability (Hanaysha et al., 2022).

Digital transformation can also support sustainable manufacturing by improving process visibility, resource management and the integration of sustainability objectives into operational decisions (Moghrabi

et al., 2023). Firms with stronger technological innovation capability should therefore be better positioned to translate sustainability investments into measurable competitive outcomes. Technology can also improve the traceability and visibility of environmental and social performance by enabling firms to monitor resource use, track supply-chain activities and communicate relevant information more quickly. In addition, digital systems can shorten decision cycles and make it easier to adjust production or distribution when sustainability-conscious customer preferences change. These functions provide a clear mechanism through which technological innovation may amplify the competitive consequences of sustainable business practices rather than simply affect competitive advantage independently.

2.2. Theoretical Review

The study draws on two complementary theories: the Natural Resource-Based View (NRBV) and Dynamic Capabilities Theory (DCT). The NRBV, proposed by Hart (1995) as an environmental extension of the Resource-Based View, argues that firms can develop competitively valuable capabilities through pollution prevention, product stewardship and sustainable development. Such capabilities may be difficult for rivals to imitate because they are embedded in routines, knowledge, stakeholder relationships and organisational learning accumulated over time. The NRBV also recognises that environmental constraints, resource pressures and stakeholder expectations increasingly shape strategic choices, meaning that proactive environmental and social stewardship can become a source of differentiation rather than merely a cost. The theory therefore provides the foundation for Hypothesis One: firms that internalise sustainable product, operational, social and environmental practices can develop capabilities that translate into cost, market, differentiation and efficiency advantages.

The NRBV alone, however, does not fully explain why the strength of the sustainability–competitiveness relationship may vary systematically across firms with different technological capabilities. Dynamic Capabilities Theory addresses this issue by arguing that sustained advantage in changing environments depends on a firm’s ability to sense opportunities, seize them and reconfigure its asset base as conditions evolve (Teece et al., 1997). Empirical evidence also connects dynamic capability with business sustainability, while showing that organisational conditions such as supply-chain risk management can shape this relationship (Chatterjee et al., 2022). Technological innovation is treated in the present study as a dynamic capability because it enables firms to identify shifts in demand, redesign production and supply-chain processes, integrate digital information, and reconfigure resources more efficiently. When this capability is strong, firms may be able to convert a given level of sustainable business practice into stronger competitive outcomes. Integrating DCT with the NRBV therefore provides the theoretical basis for Hypothesis Two: technological innovation is expected to strengthen the relationship between sustainable business practices and competitive advantage rather than operate only as an independent predictor.

Alternative theoretical lenses were considered and set aside in favour of this NRBV–DCT integration. The Triple Bottom Line (TBL) perspective, which evaluates firm performance across economic, social and environmental pillars, offers a useful descriptive account of sustainability’s scope but does not, on its own, specify the resource-based mechanism through which sustainability translates into a defensible competitive position, nor does it accommodate a technological contingency. Resource Dependency Theory, which emphasises firms’ management of external resource dependencies, is similarly informative about why firms adopt sustainable sourcing and stakeholder management practices, but is less suited to explaining the internal capability-based mechanism, technological innovation, proposed here as a moderator. The NRBV-DCT integration was therefore judged the most theoretically parsimonious and empirically tractable framework for the study’s two objectives, combining a well-established explanation for the direct sustainability→competitiveness effect with a capability-based account of why that effect might vary in strength across firms.

2.3. Empirical Review and Hypotheses Development

Empirical evidence broadly supports a positive relationship between sustainability-oriented practices and competitive outcomes across different sectors and institutional settings. Ahmadi-Gh and Bello-Pintado (2022) found that manufacturing sustainability practices were associated with sustainability outcomes and competitive advantage, providing direct support for the strategic value of sustainability. Bernal-Torres et al. (2021) reported a positive relationship between continuous-improvement practices and business sustainability among companies in an emerging market, reinforcing the operational logic through which efficiency and resource management can support long-term performance. Eyasu and Arefayne (2020) likewise found that corporate social responsibility contributed to competitive advantage, indicating that social and stakeholder-oriented practices can carry strategic value. Lee and Kim (2019) showed that government support was associated with the business sustainability of Korean start-ups, illustrating the importance of the wider institutional environment. In a different sectoral setting, Risitano et al. (2022) found that competitive advantage played an important role in the relationship between sustainability, marketing strategy and business performance in Italian fisheries.

Although these studies differ in context and operationalisation, they converge on the view that sustainability-related practices can become strategically valuable rather than merely compliance driven. This convergence provides the empirical foundation for expecting sustainable business practices to contribute positively to competitive advantage among the sampled FMCG firms. Accordingly, the study hypothesises: The studies also suggest that the route from sustainability to competitive outcomes is multidimensional. Some benefits arise through efficiency and continuous improvement, others through stakeholder relationships, legitimacy or market positioning. This variation is important for the present study because its measure of competitive advantage includes cost, market, differentiation and efficiency dimensions rather than a single financial outcome. It also supports examining the four sustainability dimensions together, since different practices may contribute to competitive advantage through different organisational pathways.

H₀₁: Sustainable business practices have no significant effect on the competitive advantage of selected FMCG firms in Lagos State, Nigeria.

With respect to the moderating role of technological innovation, the empirical literature is thinner than the literature on direct sustainability effects, but several studies provide closely related evidence. Ismail (2023), studying FMCG firms in Tanzania, found that technological absorptive capacity played an important role in business sustainability together with enviropreneurial orientation and green marketing, providing sector-specific evidence that technological capability matters to sustainability outcomes. Chege and Wang (2020) found that technology innovation and environmental sustainability practices contributed positively to SME performance in Kenya, suggesting a complementary relationship between technological and environmental capabilities. More directly, Ch'ng et al. (2021) demonstrated that market turbulence moderated the relationship between eco-innovation practices and sustainable business performance in Malaysia's technology industry, showing that the performance implications of eco-innovation depend on contextual conditions. Sarfraz et al. (2021) similarly found that organisational competitiveness moderated the relationship between business sustainability and organisational performance in the circular-economy context.

Complementary evidence also points to the wider relevance of digital capability. Pardiman et al. (2022) found that business digitalisation contributed positively to SME sustainability in Indonesia; Moghrabi et al. (2023) linked digital transformation with sustainable manufacturing and business practices; and Sivarajah et al. (2020) showed how big-data and social-media analytics can support business-to-business sustainability through better information use and stakeholder engagement. Siampondo's (2023) systematic review likewise identifies digitalisation as an important enabler of sustainable business practices and customer experience. Taken together, this literature does not duplicate the exact Nigerian FMCG moderation model tested here, but it converges on the proposition that technology-related capabilities

can strengthen, enable or condition the translation of sustainability practices into performance outcomes. Extending this reasoning, FMCG firms with stronger technological innovation capabilities are expected to realise a stronger positive relationship between sustainable business practices and competitive advantage because technology can reduce the cost of sustainable redesign, improve information visibility and accelerate responsiveness to changing market expectations. Accordingly, the study proposes:

H₀₂: Technological innovation does not significantly moderate the relationship between sustainable business practices and the competitive advantage of selected FMCG firms in Lagos State, Nigeria.

Importantly, the evidence reviewed does not imply that all technology-related variables perform the same function. Some studies examine direct effects, some examine mediation, and others test moderators that change the strength of an underlying relationship. The present study therefore does not treat those designs as equivalent. Instead, they are used to establish a broader empirical pattern in which the value generated by sustainability depends partly on the organisational and technological conditions surrounding its implementation. This distinction strengthens the rationale for testing the interaction term directly rather than inferring moderation from separate main effects.

2.4. Summary and Gap in Literature

The reviewed literature converges on three broad conclusions. First, sustainability-oriented practices, whether expressed through environmental, social, operational or broader corporate-responsibility dimensions, are positively associated with business sustainability and competitive outcomes across diverse settings (Ahmadi-Gh & Bello-Pintado, 2022; Bernal-Torres et al., 2021; Eyasu & Arefayne, 2020). Second, a smaller but growing stream of research demonstrates that technology, innovation and digitalisation are closely linked with sustainability outcomes and performance. Some studies show complementary direct relationships, while others document moderation by contextual or organisational capabilities (Ismail, 2023; Chege & Wang, 2020; Ch'ng et al., 2021; Sarfraz et al., 2021; Pardiman et al., 2022). These findings suggest that the competitive consequences of sustainability may depend partly on the capabilities available to implement, communicate and scale sustainable practices.

Despite this convergence, no identified study has directly tested technological innovation as a moderator of the specific relationship between sustainable business practices and competitive advantage within Nigeria's FMCG sector. This creates both a theoretical and contextual gap. Theoretical development requires attention to a capability that may explain variation in the sustainability–competitiveness relationship, while the Lagos FMCG setting provides an appropriate context because firms differ substantially in their technological readiness. The present study addresses this gap by incorporating technological innovation as a moderating capability within an integrated NRBV-DCT framework.

2.5. Conceptual Framework

The conceptual model in Figure 1 depicts sustainable business practices, comprising sustainable product, operational sustainability, social sustainability and environmental sustainability, as the exogenous construct predicting competitive advantage, comprising cost advantage, market advantage, product differentiation and improved efficiency. Technological innovation, comprising product/process innovation and digital adoption capacity, is positioned as a moderating construct on the relationship between sustainable business practices and competitive advantage. The framework is grounded in the Natural Resource-Based View, which explains the direct sustainability–competitive advantage relationship, and the Dynamic Capabilities Theory, which explains why technological innovation may condition the strength of that relationship.

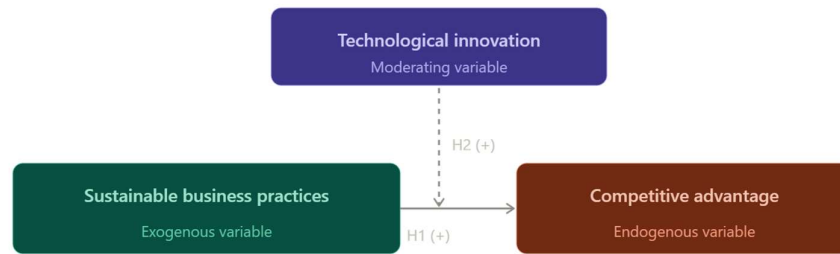


Figure 1. Conceptual Model

Figure 1 summarises the proposed direct and moderating relationships. The direct effect is grounded in the Natural Resource-Based View, while the moderating effect is grounded in Dynamic Capabilities Theory. The empirical models are specified below.

3. Methodology

The study adopted a positivist research philosophy, consistent with its objective of examining observable and quantifiable relationships among the study constructs through an empirical and objective approach (Ryan, 2018). A quantitative, deductive research approach was used because the study specifies hypotheses in advance and evaluates them using structured numerical data and statistical inference (Mohajan, 2020). A cross-sectional survey design was employed, with data collected from respondents at a single point in time. This design was considered appropriate for estimating the relationships among sustainable business practices, technological innovation and competitive advantage within the sampled firms, while recognising that the cross-sectional nature of the data limits strong causal interpretation.

The study context comprised quoted FMCG firms in Lagos State, Nigeria, chosen for their economic significance, resource intensity and heightened exposure to sustainability and competitiveness pressures. Lagos State was purposively selected as Nigeria's commercial hub and one of Africa's fastest-growing cities, offering a dynamic environment in which the effects of sustainable business practices on competitive advantage and the technological capabilities that may condition them can be meaningfully examined. The target population consisted of 5,107 top, middle and low-level managers across four selected quoted FMCG firms chosen for their pivotal roles in strategic decision-making, resource allocation and competitive strategy formulation, and their productivity and visibility as quoted entities on the Nigerian Exchange. Using a standard sample size determination table, a base sample of 365 was obtained, to which a 30 per cent attrition allowance (110) was added, yielding a final sample of 475. Respondents within each firm were selected using simple random sampling to ensure that every member of the population had an equal probability of selection, thereby minimising selection bias.

Primary data were collected using an adapted, structured questionnaire comprising four sections: respondent demographics; sustainable business practices; competitive advantage; and technological innovation. Sustainable business practices were represented by sustainable product, operational sustainability, social sustainability and environmental sustainability. The selection and wording of these dimensions were informed by established sustainability literature, including Ahmadi-Gh and Bello-Pintado (2022), Missimer and Mesquita (2022), and Alsahlawi et al. (2021). Competitive advantage was represented by cost advantage, market advantage, product differentiation and improved efficiency, with the construct definition informed by Peteraf (1993), Boundi-Chraki and Perrotini-Hernández (2021), and Distanont and Khongmalai (2020). Technological innovation covered product/process innovation and digital adoption capacity, drawing on the innovation frameworks of Wang and Ahmed (2004) and Rajapathirana and Hui (2018), the technological absorptive-capacity perspective used by Ismail (2023) in an FMCG setting, and the Oslo Manual definition of innovation (OECD/Eurostat, 2018). All items were measured on a six-point Likert scale ranging from Very High (6) to Very Low (1), thereby requiring respondents to indicate a directional assessment rather than select a neutral midpoint.

Content and construct validity for the sustainable business practices and competitive advantage sections were established through expert review and statistically confirmed using Kaiser–Meyer–Olkin (KMO) measures of sampling adequacy, Bartlett’s Test of Sphericity, and Average Variance Extracted (AVE). All eight constructs recorded KMO values above the 0.5 threshold (ranging from 0.526 to 0.776), statistically significant Bartlett’s tests ($p < .001$), and AVE values exceeding 0.5, confirming adequate construct validity. Reliability, assessed via Cronbach’s alpha and composite reliability during a pilot study, exceeded the 0.70 threshold for all eight constructs (alpha range: 0.725–0.867; composite reliability range: 0.758–0.859), confirming internal consistency.

The direct-effect model is specified as Equation (1), where CA is competitive advantage; SP is sustainable product; OS is operational sustainability; SS is social sustainability; ES is environmental sustainability; α_0 is the intercept; β_1 – β_4 are regression coefficients; and μ_i is the stochastic error term.

$$CA = \alpha_0 + \beta_1(SP) + \beta_2(OS) + \beta_3(SS) + \beta_4(ES) + \mu_i \quad (1)$$

The moderation model is specified as Equation (2). Here, SBP is sustainable business practices; TI is technological innovation; $SBP \times TI$ is the mean-centred interaction term; and β_3 captures the moderating effect. A positive and statistically significant β_3 indicates that technological innovation strengthens the relationship between sustainable business practices and competitive advantage.

$$CA = \alpha_0 + \beta_1(SBP) + \beta_2(TI) + \beta_3(SBP \times TI) + \mu_i \quad (2)$$

For Hypothesis One, data were analysed using multiple linear regression at a 95% confidence level. For Hypothesis Two, hierarchical moderated multiple regression was used. Model 1 entered sustainable business practices as the predictor of competitive advantage; Model 2 added mean-centred technological innovation; and Model 3 added the mean-centred $SBP \times TI$ interaction term. The significance of the interaction coefficient and the associated change in R^2 were used to assess moderation.

Consistent with the theoretical review, the study’s a-priori expectation was that all four sustainable business practice dimensions, sustainable product, operational sustainability, social sustainability and environmental sustainability, would exert positive and statistically significant effects on competitive advantage, in line with the Natural Resource-Based View’s proposition that environmentally and socially embedded capabilities are inimitable sources of advantage. For the proposed moderating relationship, the a priori expectation, grounded in the Dynamic Capabilities Theory and the convergent empirical evidence reviewed in Section 2.3, is that the interaction between sustainable business practices and technological innovation would carry a positive and statistically significant coefficient, indicating that technological innovation strengthens, rather than weakens or leaves unchanged, the sustainability-competitiveness relationship.

4. Results and Discussion

Of the 475 questionnaires distributed across the four sampled firms, 445 were correctly completed and found usable for analysis, representing a response rate of 93.7 per cent ($445/475 \times 100$). The 445 usable responses therefore represent 8.7 per cent of the stated target population of 5,107 managers, which is considered adequate for survey-based organisational research. Descriptive analysis of the sustainable business practices items indicated that respondents rated their firms’ engagement with sustainable product design, operational sustainability, social sustainability, and environmental sustainability variably, with environmental and social sustainability items receiving comparatively stronger perceived engagement than sustainable product design items. A similarly varied pattern was observed across the competitive advantage dimensions, with cost advantage and improved efficiency attracting the strongest ratings among the four dimensions, suggesting that, from the respondents’ vantage point, sustainability-linked efficiency and cost gains are more visible than market-level or differentiation-level gains. This pattern is consistent with the operational logic of the Natural Resource-Based View, under which resource-conserving

practices most directly and visibly reduce waste and input costs before their effects fully propagate into market share or brand-level differentiation outcomes, which typically require longer periods of sustained sustainability signalling to materialise in consumer perception.

4.1. Respondent Demographics

Table 1. Demographic Characteristics of Respondents (N = 445)

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	258	58.0
	Female	187	42.0
Age	21–30 years	74	16.6
	31–40 years	156	35.1
	41–50 years	137	30.8
	51–60 years	61	13.7
	61 years and above	17	3.8
Marital Status	Single	126	28.3
	Married	289	64.9
	Divorced/Separated	18	4.0
	Widowed	12	2.7
Highest Educational Qualification	Diploma/NCE	42	9.4
	Bachelor's degree/HND	243	54.6
	Master's degree	142	31.9
	Doctorate	18	4.0
Total		445	100.0

Table 1 presented the demographic characteristics of the 445 respondents included in the study. The gender distribution shows that 258 respondents (58.0%) were male, while 187 (42.0%) were female. Regarding age, respondents aged 31–40 years constituted the largest group, with 156 respondents (35.1%), followed by those aged 41–50 years, representing 137 respondents (30.8%). In terms of marital status, married respondents constituted the majority, with 289 respondents (64.9%), while 126 respondents (28.3%) were single. With respect to educational qualification, 243 respondents (54.6%) possessed a Bachelor's degree or HND, followed by 142 respondents (31.9%) with Master's degrees. The demographic profile indicates that the respondents were predominantly working-age adults with tertiary-level educational qualifications. Table 2 summarises the results of the validity and reliability assessment underpinning these descriptive results.

Table 2. Summary of Validity and Reliability of the Research Instrument

Construct	KMO	Bartlett's Sig.	AVE	Cronbach's Alpha	Composite Reliability
Sustainable product	.776	< .001	.569	.751	.794
Operational sustainability	.717	< .001	.784	.758	.825
Social sustainability	.768	< .001	.582	.792	.788
Environmental sustainability	.528	< .001	.624	.797	.778
Cost advantage	.606	< .001	.676	.867	.828
Market advantage	.581	< .001	.591	.725	.796
Product differentiation	.526	< .001	.601	.740	.758
Improved efficiency	.625	< .001	.609	.772	.859
Technological Innovation	.681	< .001	.641	.811	.873

Table 2 shows that all constructs recorded KMO values above the 0.5 threshold, significant Bartlett's tests ($p < .001$), and AVE and reliability coefficients above their respective 0.5 and 0.7 thresholds, supporting the validity and internal consistency of the instrument for the subsequent analyses.

4.2. Pre-estimation Diagnostic Tests

Normality was assessed using skewness and kurtosis. Following Kline (2011), values within ± 3 for skewness and ± 10 for kurtosis were treated as indicating no extreme departure from normality. As shown

in Table 3, skewness ranged from -2.301 to -1.311 and kurtosis from 3.488 to 9.495, which fall within these thresholds.

Table 3. Skewness and Kurtosis

Variable	N	SE		SE	
Sustainable product	445	-1.495	.116	4.090	.231
Operational sustainability	445	-1.346	.116	4.827	.231
Social Sustainability	445	-1.530	.116	4.292	.231
Environmental Sustainability	445	-2.301	.116	7.605	.231
Cost Advantage	445	-1.765	.116	5.309	.231
Market Advantage	445	-1.713	.116	4.877	.231
Product Differentiation	445	-1.447	.116	3.488	.231
Improved Efficiency	445	-2.145	.116	9.495	.231
Technological innovation	445	-1.311	.116	4.181	.231

Linearity was assessed using Pearson product-moment correlations between each sustainability dimension and competitive advantage, as reported in Table 4.

Table 4. Linearity Assessment

Statistic		Competitive Advantage
Sustainable product	Pearson Correlation	.282**
	Sig. (2-tailed)	< .001
	N	445
Operational sustainability	Pearson Correlation	.511**
	Sig. (2-tailed)	< .001
	N	445
Social Sustainability	Pearson Correlation	.432**
	Sig. (2-tailed)	< .001
	N	444
Environmental Sustainability	Pearson Correlation	.576**
	Sig. (2-tailed)	< .001
	N	443

All four sustainability dimensions were positively and significantly associated with competitive advantage: sustainable product ($r = .282$, $p < .001$), operational sustainability ($r = .511$, $p < .001$), social sustainability ($r = .432$, $p < .001$) and environmental sustainability ($r = .576$, $p < .001$), with N ranging from 443 to 445 because of item-level missingness. These results support the presence of linear bivariate associations. Multicollinearity was assessed separately using tolerance and VIF statistics. Figure 2. shows the residual scatterplot for homoscedasticity assessment.

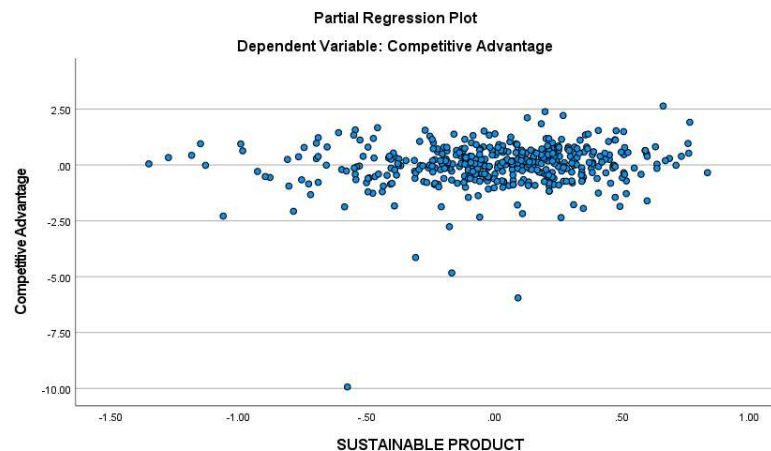


Figure 2. Residual Scatterplot for Homoscedasticity Assessment

Figure 2 constant error variance was assessed graphically using scatterplots of the standardised regression residuals against predicted values for competitive advantage and each sustainability dimension. The plots showed no systematic funnelling or curvilinear pattern, supporting the homoscedasticity assumption. Table 5 report Variance inflation factor (VIF) and tolerance statistics used to assess multicollinearity.

Table 5. Multicollinearity Diagnostics

Independent Variable	Tolerance	VIF
Sustainable Product	0.762	1.312
Operational Sustainability	0.638	1.567
Social Sustainability	0.704	1.420
Environmental Sustainability	0.591	1.692
Technological Innovation	0.784	1.322

The multicollinearity diagnostics in Table 5 indicate no problematic multicollinearity. VIF values ranged from 1.312 to 1.692, while tolerance values ranged from 0.591 to 0.784. These values are within conventional acceptable ranges and support the simultaneous inclusion of the predictors in the regression models. Table 6 reports Harman's single-factor diagnostic for common method bias.

Table 6. Harman's Single-Factor Diagnostic for Common Method Bias

Test criterion	Result	Benchmark
Variance explained by first factor	28.673%	< 50%
Number of factors with eigenvalue > 1	8	More than one factor
Common-method-bias indication	Not evident	First factor < 50%

Table 6 unrotated factor analysis produced eight factors with eigenvalues greater than one, and the first factor accounted for 28.673% of the total variance, below the commonly used 50% benchmark. This result does not indicate dominance by a single factor, although Harman's test should be interpreted as a diagnostic rather than definitive evidence that common method bias is absent (Podsakoff et al., 2003).

4.3. Hypothesis Testing

Test of Hypothesis One. Table 7 presents the multiple regression results for the effect of sustainable business practices on competitive advantage.

Table 7. Multiple Regression Analysis of Sustainable Business Practices and Competitive Advantage (N = 443)

Predictor	B	t	p-value
(Constant)	1.185	40.175	< .001
Sustainable product	.010	2.977	.003
Operational sustainability	.021	6.456	< .001
Social sustainability	.149	7.890	< .001
Environmental sustainability	.177	10.814	< .001
Model summary: R = .783; adjusted R ² = .610; F(4, 438) = 172.056; p = .001.			

Table 7 shows that using complete cases (N = 443), all four dimensions of sustainable business practices had positive and statistically significant coefficients. Environmental sustainability recorded the largest coefficient (B = .177, p < .001), followed by social sustainability (B = .149, p < .001), operational sustainability (B = .021, p < .001) and sustainable product (B = .010, p = .003). The model explained 61.0% of the variance in competitive advantage (adjusted R² = .610) and was statistically significant, F(4, 438) = 172.056, p = .001. Accordingly, H01 was rejected, indicating that sustainable business practices have a significant positive effect on competitive advantage among the sampled FMCG firms. The estimated equation is:

$$CA = 1.185 + .010(SP) + .021(OS) + .149(SS) + .177(ES) + \mu_i$$

The result is consistent with research linking sustainability practices to competitive advantage and business sustainability (Ahmadi-Gh & Bello-Pintado, 2022; Bernal-Torres et al., 2021; Eyasu & Arefayne, 2020).

The comparatively larger environmental and social coefficients suggest that these dimensions were more strongly associated with competitive advantage in this sample. The finding also complements FMCG evidence showing the relevance of environmental and technological capabilities to business sustainability (Ismail, 2023).

Table 8. Hierarchical Moderated Regression of Sustainable Business Practices, Technological Innovation and Competitive Advantage (N = 445)

Step	Variables Entered	R ²	ΔR^2	F / ΔF (df)	p-value
Model 1	SBP (composite)	.613	—	704.21 (1,443)	< .001
Model 2	SBP + Technological Innovation (TI)	.658	.045	58.34 (1,442)	< .001
Model 3	SBP + TI + SBP $\times$ TI (interaction)	.682	.024	32.87 (1,441)	< .001

Note: Model 1 reports the overall F statistic, whereas Models 2 and 3 report the F-change associated with the additional predictor(s) entered at each step. Degrees of freedom are reported to provide complete model statistics.

Table 8 hierarchical regression was conducted in three stages to determine whether technological innovation adds explanatory power and, more importantly, whether it changes the strength of the relationship between sustainable business practices and competitive advantage. Model 1 included sustainable business practices and produced $R^2 = .613$, indicating that the composite SBP measure explained 61.3% of the variance in competitive advantage. Model 2 added technological innovation, increasing R^2 from .613 to .658. The resulting increase in explained variance was statistically significant ($\Delta R^2 = .045$; $\Delta F(1, 442) = 58.34$, $p < .001$), showing that technological innovation made an additional contribution beyond sustainable business practices alone. Model 3 then introduced the SBP $\times$ TI interaction term. R^2 increased further from .658 to .682, producing an additional 2.4% of explained variance ($\Delta R^2 = .024$; $\Delta F(1, 441) = 32.87$, $p < .001$). The interaction coefficient was positive and statistically significant ($\beta = .142$, $t = 4.32$, $p < .001$), indicating that the positive association between sustainable business practices and competitive advantage becomes stronger as technological innovation increases. H02 was therefore rejected.

The results from Models 2 and 3 distinguish the main effect of technological innovation from its moderating role. The increase in R^2 after technological innovation entered Model 2 indicates that technological innovation has an independent relationship with competitive advantage. The additional increase after the interaction term entered Model 3 addresses the moderation hypothesis directly. Because the SBP $\times$ TI term was positive and statistically significant, the effect of sustainable business practices on competitive advantage is not constant across different levels of technological innovation. Rather, the positive sustainability–competitiveness relationship is stronger where technological innovation is higher. This pattern provides the statistical basis for rejecting H02 and supports the proposition that technological capability enhances the competitive returns associated with sustainable business practices.

Table 9. Model 3 Coefficients

Predictor	β	t	p-value
(Constant)	1.092	38.60	< .001
Sustainable Business Practices (SBP)	.341	9.87	< .001
Technological Innovation (TI)	.198	5.44	< .001
SBP $\times$ TI (interaction)	.142	4.32	< .001

Table 9. Model 3 coefficients reinforce the moderation result. Sustainable business practices ($\beta = .341$, $t = 9.87$, $p < .001$) and technological innovation ($\beta = .198$, $t = 5.44$, $p < .001$) were both positively associated with competitive advantage. More importantly, the SBP $\times$ TI interaction was positive and significant ($\beta = .142$, $t = 4.32$, $p < .001$), showing that firms with stronger technological innovation capabilities obtain a stronger competitive association from sustainable business practices.

This study examined the effect of sustainable business practices on competitive advantage among selected FMCG firms in Lagos State, Nigeria, and tested technological innovation as a moderating capability. Sustainable product, operational sustainability, social sustainability and environmental sustainability jointly explained 61.0% of the variance in competitive advantage, with environmental and social sustainability recording the largest positive coefficients. The moderation analysis further showed that technological innovation significantly strengthened the relationship between sustainable business practices and competitive advantage. These findings support the NRBV explanation of sustainability-oriented capabilities and extend it with a Dynamic Capabilities Theory account of technological innovation as a boundary condition.

The moderation result is consistent with prior evidence that technology-related and organisational capabilities can shape sustainability-linked outcomes. Ismail (2023) identified technological absorptive capacity as an important element of FMCG business sustainability, while Ch'ng et al. (2021) showed that a contextual condition can moderate the relationship between eco-innovation practices and sustainable business performance. Sarfraz et al. (2021) similarly found organisational competitiveness to moderate the relationship between business sustainability and organisational performance. Chege and Wang (2020) add complementary evidence by showing that technology innovation and environmental sustainability practices both contribute to SME performance. The present study extends this line of work by locating the contingency directly in technological innovation and testing its moderating effect on the sustainability–competitive advantage relationship within the Nigerian FMCG setting.

5. Conclusion and Recommendations

The study makes three specific contributions. First, it provides empirical evidence on the sustainability–competitiveness relationship among quoted Nigerian FMCG firms using validated measures and 445 usable survey responses. This adds evidence from an emerging-market setting that has received less attention than developed-country manufacturing contexts. Second, it operationalises technological innovation as a capability spanning product/process innovation and digital adoption capacity, thereby recognising that technological capability in FMCG firms involves both physical/process changes and the use of digital systems. Third, and most centrally, the study demonstrates that technological innovation significantly moderates the relationship between sustainable business practices and competitive advantage. In theoretical terms, this extends the NRBV by adding a Dynamic Capabilities Theory explanation of a boundary condition under which sustainability practices are more strongly associated with competitive outcomes. The finding remains associational because of the cross-sectional design, so longitudinal and multi-source research is still required to strengthen causal interpretation and broader generalisability.

5.1. Theoretical Implications

The study extends sustainability-strategy research in two related ways. First, it provides emerging-market evidence consistent with the NRBV proposition that sustainability-oriented capabilities can contribute to competitive advantage (Hart, 1995; Ahmadi-Gh & Bello-Pintado, 2022). This is important because the strategic value of sustainability may depend on market, institutional and organisational conditions that differ across countries and industries. Second, the study integrates Dynamic Capabilities Theory to identify technological innovation as a boundary condition on the sustainability–competitiveness relationship. In doing so, it connects research on sustainability and competitive advantage with evidence showing that technological, contextual and organisational capabilities can influence sustainability-related outcomes (Ismail, 2023; Ch'ng et al., 2021; Sarfraz et al., 2021). The resulting framework offers a more contingency-based explanation of when sustainable business practices are more strongly associated with competitive advantage rather than assuming that sustainability produces the same competitive return across all firms.

5.2. Social Implications

The findings have social implications for employees, consumers, communities and other stakeholders connected to FMCG operations. Stronger social and environmental sustainability practices can support responsible labour practices, stakeholder wellbeing, resource conservation and more transparent corporate engagement. The positive moderating role of technological innovation also suggests that digital systems and process technologies can be used to improve traceability, monitoring and accountability in sustainability-related activities. Technology adoption should nevertheless be accompanied by employee participation, capability development, appropriate data governance and stakeholder inclusion so that technological upgrading supports the social objectives of sustainability.

5.3. Practical Implications

Practically, the results indicate that sustainability initiatives should be designed as integrated business capabilities rather than isolated environmental or corporate-social-responsibility programmes. Managers can align sustainable product development, operational efficiency, social responsibility and environmental management with technological investments in automation, digital supply-chain systems and data analytics. The significant interaction effect indicates that the competitive value of sustainability is associated with the technological capability available to the firm; therefore, implementation plans should specify both the sustainability objective and the technological resources required to support it.

5.4. Managerial and Policy Implications

For FMCG managers, the findings indicate that environmental and social sustainability recorded the largest positive coefficients among the four sustainability dimensions, while sustainable product and operational sustainability were also statistically significant. Managers should therefore treat sustainability as a portfolio of complementary practices rather than focus on a single dimension. The significant SBP $\times$ TI interaction further indicates that sustainability programmes should be supported by appropriate technological capabilities, including automation, digital supply-chain systems, data analytics and product/process innovation. For policymakers and industry regulators, the findings support approaches that connect sustainability requirements with technology-adoption support while recognising firms' resource constraints. Based on the findings, the study recommends that:

- (i) FMCG firms in Lagos State institutionalise environmental and social sustainability practices as strategic priorities rather than peripheral compliance activities, given their demonstrated competitive returns.
- (ii) Firm management should deliberately invest in technological infrastructure and digital capability alongside sustainability programmes, in line with the significant moderating effect observed in this study.
- (iii) Industry associations and regulators develop joint sustainability-technology adoption frameworks to help resource-constrained firms realise the competitive benefits documented in this study.

5.5. Limitations and Future Research

The study is limited by its cross-sectional design, which restricts causal inference and does not establish the temporal ordering of the observed relationships. It also relies on self-reported data collected through a common questionnaire, creating a potential common-source bias. Although Harman's single-factor diagnostic did not indicate that one factor dominated the variance, this diagnostic cannot rule out common method bias completely. The focus on four quoted FMCG firms in Lagos State may also constrain the generalisability of the findings to smaller or unlisted FMCG firms and to firms operating in other Nigerian regions. Future research should therefore use longitudinal and multi-source designs, extend the sample to unlisted and small- and medium-scale FMCG firms, and examine other plausible moderating or mediating capabilities such as absorptive capacity, organisational agility and digital leadership. Researchers may also combine moderated regression with qualitative case studies of firms that have contrasting technological profiles. Such designs could provide richer process-level evidence on how product/process innovation and digital adoption change the ways in which sustainable product, operational, social and environmental practices are converted into competitive outcomes.

Declarations

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Conflict of Interest

The author declares no conflict of interest.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon request.

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