Linking Sustainable Logistics Management to Environmental and Operational Performance: Evidence from Nigeria's Manufacturing Sector

[1]Abdulsalam Kamara; [2]Silas Ndace (PhD);
[3]Koroma, Fatmata Madiana

[1] School of Management, Jiangsu University
orcid.org/0009-0006-9873-3131

[2] Department of Entrepreneurship Studies, Edusoko University, Bida, Niger State
orcid.org/0000-0001-8556-1648

[3] School of Environmental Science, Jiangsu University, Zhejiang, China
orcid.org/0009-0001-2042-4260.

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Abstract:

Purpose: *This study examines how sustainable logistics management (SLM) practices emissions reduction, resource efficiency, green packaging, and eco-friendly transportation affect both environmental and operational performance. It highlights implications for global supply chain competitiveness with a focus on emerging markets.* ***Design/methodology/approach:*** *Survey data from 412 supply chain professionals in manufacturing industries were analyzed using partial least squares structural equation modeling (PLS-SEM). SLM practices were assessed at strategic, tactical, and operational levels, and their effects on service quality, firm performance, and environmental outcomes were evaluated.* ***Findings:*** *Results show that SLM practices significantly improve environmental performance and moderately enhance operational performance. Firm performance mediates the SLM–environmental performance relationship, underscoring the interconnected roles of sustainability, service quality, and competitiveness in supply chains.* ***Originality/value:*** *This research extends the Resource-Based View (RBV) and Triple Bottom Line (TBL) perspectives to network-level sustainability. It offers actionable insights for managers in emerging and advanced economies on aligning logistics practices with global sustainability and performance goals.*

Keywords: *Emerging Markets, Environmental Performance, Firm Performance, Service Quality, Sustainable Logistics, Supply Chain Sustainability, Resource Efficiency.*

1. Introduction

The 21st century has witnessed rapid technological advancements and urbanization, which have amplified the challenges of managing critical infrastructure such as buildings, transportation systems, factories, and communication networks (Roy & Mohanty, 2024). To address these challenges, sustainable logistics management (SLM) has emerged as a vital strategy, integrating environmentally responsible practices into logistics operations to achieve both ecological and operational benefit (Martínez-Falcó et al., 2024).

(Akubia et al., 2024) examined that logistics, once narrowly focused on transportation, is now recognized as a critical lever for promoting environmental sustainability. Practices such as emissions reduction, resource efficiency, green packaging, and eco-friendly transportation are increasingly important in global supply chains. Green logistics directly influences costs, reliability, speed, and customer service key drivers of national and firm competitiveness (Garrido et al., 2024). In response, companies are adopting SLM strategies to reduce operational costs, streamline processes, and improve logistics performance while minimizing environmental impacts (Pasupuleti et al., 2024).

This research is anchored in the Resource-Based View (RBV) and the Triple Bottom Line (TBL), which provide a theoretical foundation for understanding how SLM practices shape both environmental and operational performance. Specifically, the study explores the effects of emissions reduction, resource efficiency, green packaging, and eco-friendly transportation on key performance metrics such as carbon footprint, delivery accuracy, and cost efficiency. Accordingly, this study addresses the following research questions:

RQ1: How do sustainable logistics practices affect environmental and operational performance?

RQ2: What is the role of service quality and firm performance in mediating these effects?

RQ3: How do SLM practices contribute to competitive advantage in emerging market supply chains?

By integrating SLM into core operations, firms can discover sustainable methods to create value, balancing cost-effectiveness, and reliability with environmental responsibility. Service quality plays a pivotal role, amplifying the effect of SLM on both firm performance and sustainability outcomes.

This study makes several contributions. First, it advances theoretical understanding by extending RBV and TBL beyond dyadic buyer supplier relationships to the broader network level of logistics systems. Second, it provides empirical evidence from emerging markets, addressing a gap in existing literature dominated by developed economy contexts. Finally, it delivers practical insights for managers and policymakers, showing how sustainable logistics

practices enhance both operational efficiency and environmental performance, thus contributing to global supply chain competitiveness.

2. Theoretical Background and Hypothesis Development

2.1 Resource-Based View (RBV)

The Resource-Based View (RBV) posits that firms achieve competitive advantage when they possess valuable, rare, inimitable, and non-substitutable (VRIN) resources (Wernerfelt, 1984; Barney, 2020). Logistics capabilities such as resource efficiency, eco-friendly transportation, and sustainable packaging can be conceptualized as strategic resources under this framework. Prior studies argue that when firms effectively deploy these resources, they not only improve cost efficiency and operational reliability but also strengthen long-term competitiveness (Liou, 2009). Within sustainable logistics management (SLM), RBV explains how firms can convert unique logistics practices into performance outcomes that competitors cannot easily replicate. Thus, RBV provides the theoretical foundation for hypothesizing that SLM practices positively influence firm performance, service quality, and competitiveness.

2.2 Triple Bottom Line (TBL)

The Triple Bottom Line (TBL), proposed by Elkington (1997), emphasizes that organizational success should be measured across three dimensions: profit (economic performance), people (social outcomes), and planet (environmental responsibility). This framework has become central in sustainability research and is particularly relevant to supply chain and logistics contexts (Khan et al., 2021). Sustainable logistics practices embody the TBL perspective: eco-friendly transportation reduces emissions (planet), green packaging promotes social responsibility (people), and resource efficiency enhances profitability (profit). Previous research shows that integrating TBL principles in supply chains leads to both environmental protection and operational efficiency (Negri et al., 2021). Accordingly, TBL complements RBV by framing SLM practices not only as resources that drive competitiveness but also as pathways to achieving balanced environmental, social, and economic outcomes.

2.3 Integrating RBV and TBL in Sustainable Logistics

Together, RBV and TBL offer a robust theoretical lens for understanding the impact of SLM. RBV highlights the strategic value of logistics capabilities, while TBL ensures that these capabilities are assessed across multiple performance dimensions. By integrating the two, this study examines how logistics practices at the strategic, tactical, and operational levels contribute simultaneously to environmental and operational performance. This dual-theory approach extends prior research by moving beyond manufacturing and procurement to emphasize logistics-specific sustainability and by contextualizing findings in emerging

markets where the pressures and opportunities for sustainability differ significantly from those in advanced economies.

2.4 Sustainable Logistics Practices and Firm Performance

Sustainable logistics (SL) has evolved from a peripheral concern to a core strategic priority for firms seeking to balance efficiency with environmental responsibility. Practices such as emissions reduction, resource efficiency, green packaging, and eco-friendly transportation not only reduce ecological externalities but also enhance organizational competitiveness (Xie et al., 2024). Research has demonstrated that firms integrating sustainable logistics into their operations achieve both ecological and financial benefits. (Nazir et al., 2024) found that green supply chain management (GSCM) practices significantly improved manufacturers' environmental performance, mediated by institutional pressures. (Abdallah et al., 2024) likewise reported that GSCM positively influences circular economy outcomes, with green innovation acting as a mediator. These findings suggest that sustainability-oriented logistics capabilities constitute valuable firm resources.

However, much of this literature tends to subsume logistics under the broader umbrella of supply chain management or procurement. For example, (Waqar et al., 2025) emphasized sustainable procurement as a driver of green logistics outcomes but treated logistics only as an adjunct to sourcing practices. This under-theorization of logistics as a standalone operational capability leaves a knowledge gap in understanding how firms leverage logistics practices specifically for competitive advantage (Li, 2024). Drawing on the Resource-Based View (RBV), sustainable logistics practices can be understood as VRIN resources that enhance profitability, market reputation, and customer loyalty.

H_1: *Sustainable logistics practices have a positive effect on firm performance.*

2.5 Green Supply Chain Management, Circular Economy, and Environmental Outcomes

The GSCM literature consistently emphasizes environmental benefits through recycling, reverse logistics, eco-design, and waste minimization. For instance, (Scrioşteanu & Criveanu, 2024) modeled how cultural and policy variations influenced recycling rates of plastic packaging across the EU, highlighting the institutional embeddedness of sustainability. (Freihat et al., 2024) further underscored the role of government regulation in supporting sustainable labor practices, climate action, and responsible consumer behavior.

These perspectives align closely with the Triple Bottom Line (TBL) framework, which insists that businesses must balance economic viability, environmental responsibility, and social well-being. Yet, a recurring limitation is that most of these studies remain at the macro or policy level, with limited attention to firm-level operational mechanisms (Naz et al., 2024). Circular economy discussions,

for example, often centre on manufacturing waste reduction and eco-innovation, overlooking logistics activities such as route optimization, energy-efficient warehousing, and sustainable last-mile delivery (Garrido et al., 2024). This gap is especially problematic given that logistics often represents a sizeable portion of a firm's carbon footprint. From a TBL standpoint, SLM directly addresses the "planet" dimension by reducing emissions, waste, and energy consumption, while indirectly contributing to profitability through cost savings. Therefore, sustainable logistics practices are expected to enhance environmental performance.

H_2: *Sustainable logistics practices have a positive effect on environmental performance.*

2.6 Digitalization, Technology Adoption, and Operational Performance

The digital transformation of logistics has accelerated the integration of sustainability into core operations. Emerging technologies such as block chain, artificial intelligence, and IoT-driven analytics are reshaping logistics processes to be more transparent, efficient, and environmentally responsible. Yu et al. 2024 demonstrated that digital transformation significantly improved environmental, social, and governance (ESG) performance in Chinese logistics firms, mediated by green innovation. Similarly, (Saqib & Qin, 2024) showed that digital adoption improved environmental and financial performance in SMEs, using diffusion of innovation theory as the analytical lens.

Despite these advances, the bulk of existing research prioritizes technological capabilities rather than connecting them to logistics performance outcomes. For example, blockchain has been analyzed as a transparency mechanism (Khan et al., 2024), yet studies rarely explore how such technologies enhance delivery reliability, cost efficiency, or customer responsiveness. The RBV provides a useful lens here: digital tools embedded within logistics can be conceptualized as firm-specific capabilities that are rare, difficult to imitate, and strategically valuable (Liu et al., 2024). Sustainable logistics practices, supported by such technologies, are therefore likely to strengthen operational performance by improving service consistency, reducing inefficiencies, and optimizing processes.

H_3: *Sustainable logistics practices have a positive effect on operational performance.*

2.7 Service Quality and Firm Performance in Sustainable Logistics

Service quality (SQ) has long been recognized as a cornerstone of competitive advantage in logistics and supply chain management. In the context of sustainability, SQ takes on new importance as customers increasingly value not only speed and reliability but also eco-friendly practices. Studies show that green logistics enhances delivery accuracy, customer trust, and long-term loyalty (Khan et al., 2024). By embedding sustainability into logistics, firms not only

meet environmental regulations but also differentiate themselves in the marketplace.

Nonetheless, service quality has often been treated as an outcome rather than as a strategic mediator in the relationship between sustainability and firm performance. RBV conceptualizes SQ as an intangible capability that is difficult for competitors to replicate, while TBL frames it as contributing to both social (customer satisfaction) and economic (profitability) sustainability. Few studies have empirically tested how SLM directly strengthens SQ, and in turn, how SQ amplifies firm performance. Addressing this gap, this study positions SQ as a critical pathway through which sustainable logistics enhances competitiveness.

H_4: *Sustainable logistics practices have a positive effect on service quality.*

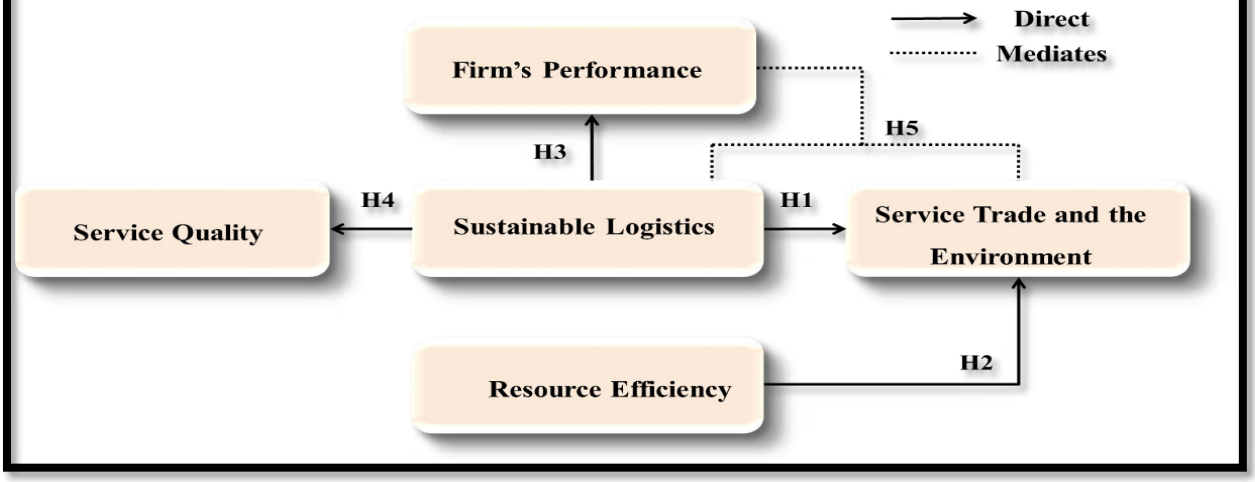
2.8 Mediating Role of Firm Performance

While SLM practices directly improve environmental and operational outcomes, their broader effects are often realized through firm performance. For example, firms that achieve cost savings and efficiency gains from green logistics can reinvest in cleaner technologies, expand eco-friendly service offerings, and comply more easily with environmental regulations (Micheli et al., 2020). This mediating role is consistent with RBV, which posits that superior firm performance results from the accumulation and deployment of strategic resources (Ndace et al., 2024), and with TBL, which suggests that firms balancing profit with environmental stewardship are better positioned to sustain long-term competitiveness. However, few empirical studies explicitly test firm performance as a mediator between logistics sustainability and environmental outcomes, particularly in emerging market contexts. By examining this relationship, the present research extends the literature by explaining how improvements in financial and strategic performance act as a channel through which SLM enhances environmental outcomes.

H_5: *Firm performance mediates the relationship between sustainable logistics practices and environmental performance.*

The framework examines how sustainable logistics practices influence environmental and operational performance, both directly and indirectly, through firm performance and service quality (Figure 1).

Figure 1 Conceptual Framework



Source: Researchers Review 2026

3. Materials and Methods

This study investigates the influence of sustainable logistics (SL) practices on environmental and operational performance in Nigeria. A quantitative, survey-based research design was adopted, and data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The framework incorporates strategic, tactical, and operational dimensions of SL practices, assessing their direct and indirect effects on firm outcomes.

3.1 Participants and Sampling

Data were collected from 412 supply chain professionals employed in manufacturing industries across Nigeria. The sample included respondents engaged in procurement, transportation, warehousing, and distribution functions, thereby providing a comprehensive view of SL practices. Purposive sampling was used to ensure that only respondents with relevant experience in logistics and sustainability contributed to the study.

3.1.1 Inclusion Criteria

i. Manufacturing firms actively engaged in logistics, transportation, warehousing, or distribution in Nigeria.
ii. Supply chain professionals with at least one year of relevant experience.
iii. Organizations that had already implemented or were in the process of adopting SL practices such as emission reduction, green packaging, or eco-friendly transport.
iv. Availability of reliable data on sustainability practices and performance indicators (e.g., carbon footprint, delivery accuracy, cost efficiency).

3.1.2 Exclusion

i. Participants from functions unrelated to logistics or supply chain management (e.g., HR, marketing).
ii. Firms not engaged in sustainability initiatives or logistics-related practices.
iii. Professionals without relevant experience in logistics, supply chain, or sustainability.

3.2 Statistical Analysis

Data analysis was conducted using SmartPLS 4.0 and SPSS 26. The PLS-SEM technique was selected because of its suitability for complex models involving multiple constructs and mediation effects. Reliability and validity were assessed through Cronbach's alpha, composite reliability, AVE, and VIF testing. Structural path modeling was employed to evaluate the hypothesized relationships between SL practices, firm performance, service quality, and environmental and operational performance. The robustness of the results was confirmed through bootstrapping with 5,000 subsamples. Statistical significance was set at $p < 0.05$, and standardized path coefficients (β) were reported to indicate effect sizes.

4. Result and Discussion

The purpose of this section is to evaluate the influence of sustainable logistics (SL) practices on environmental and operational performance, with particular emphasis on how these practices enhance firm performance (FP), service quality (SQ), and competitiveness in the Nigerian manufacturing sector.

4.1 Demographic Analysis

Table 1 presents the demographic characteristics of the 412 respondents. The majority (48.5%) were from the manufacturing sector, followed by retail (29.1%) and transportation (22.4%). In terms of experience, 36.4% had 1–3 years of logistics experience, 31.6% had 4–6 years, and 32.0% had over 7 years. Role distribution shows that 38.2% were operations managers, 33.9% supply chain managers, and 27.9% logistics coordinators. Notably, 88.7% of participants reported using digital tools in their logistics operations, underscoring the growing integration of technology in sustainable logistics practices.

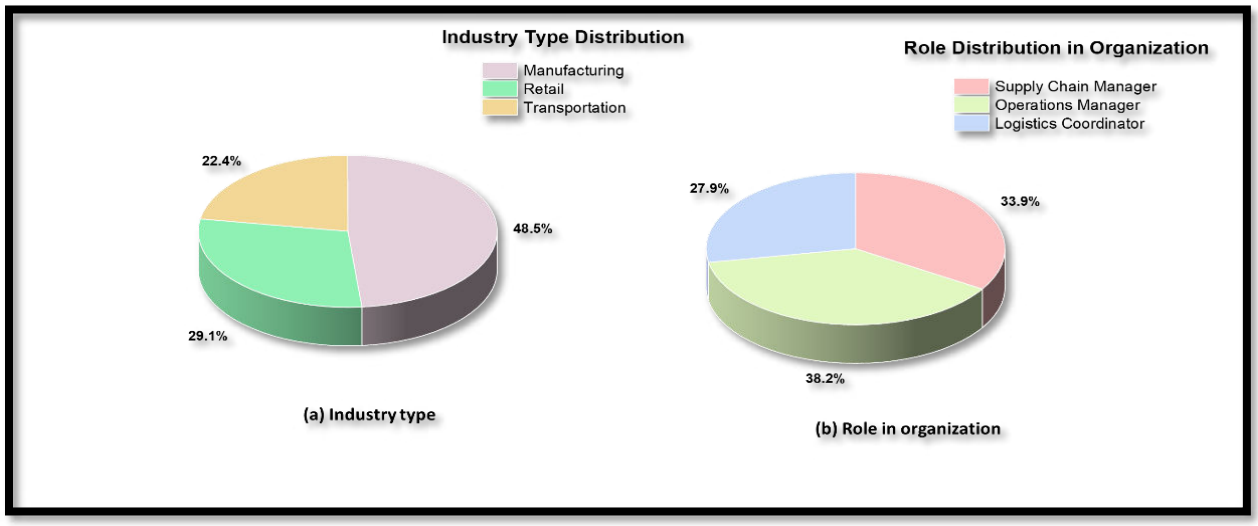
Table I: Demographic characteristics of respondents

Demographic Variable	Category	Frequency (n)	Percentage (%)
Industry Type	Manufacturing	200	48.5%
	Retail	120	29.1%
	Transportation	92	22.4%

Experience in Logistics	1-3 years	150	36.4%
	4-6 years	130	31.6%
	7+ years	132	32.0%
Role distribution in Organization	Supply Chain Manager	140	33.9%
	Logistics Coordinator	115	27.9%
	Operations Manager	157	38.2%
Use of Digital Tools	Yes	365	88.7%
	No	47	11.3%

Source: SPSS Output, (2026)

Figure 2: Distribution of demographic variables (a) industry type (b) role in enterprise



Source: SPSS Output, (2026)

The demographic research sheds light on persons involved in SL methods. As seen in Table 1, the majority of respondents (48.5%) came from the manufacturing sector, followed by retail (29.1%) and transportation (22.4%). Experience levels varied, with 36.4% having 1-3 years of logistics experience, 31.6% with 4-6 years, and 32.0% with 7+ years. The roles of participants were diverse, with 38.2% serving as operations managers, 33.9% as supply chain managers, and 27.9% as logistics coordinators. The large proportion (88.7%) of participants used digital tools in their logistics operations.

4.2 Reliability Analysis

Table 2 shows Cronbach's Alpha (CA), Composite Reliability (CR), Average Variance Extracted (AVE), and Item Loadings (IL). All constructs exceeded the

recommended thresholds (CA > 0.70, CR > 0.70, AVE > 0.50), confirming strong reliability and validity. For example, Green Packaging (CA = 0.84, CR = 0.89) and Carbon Footprint Reduction (CA = 0.85, CR = 0.90) demonstrated excellent internal consistency. These results ensure that the constructs used to measure SL, FP, SQ, and environmental outcomes are robust and reliable.

Table 2: Performance outcome of reliability analysis

Construct	Items	CA	CR	AVE	IL
SL	Emissions Reduction	0.82	0.88	0.72	0.79
	Green Packaging	0.84	0.89	0.77	0.83
	Eco-Friendly Transport	0.79	0.85	0.73	0.78
RE	Energy Efficiency	0.80	0.86	0.75	0.81
	Waste Minimization	0.82	0.87	0.78	0.80
FP	Cost Efficiency	0.81	0.87	0.74	0.79
	Resource Utilization	0.78	0.84	0.71	0.77
SQ	Delivery Accuracy	0.83	0.88	0.76	0.82
STE	Carbon Footprint Reduction	0.85	0.90	0.80	0.85

Source: SEM-PLS Output, (2026)

***Notes**: Cronbach's Alpha (CA), Composite Reliability (CR), Average Variance Extracted (AVE), and Item Loading (IL)*

4.3 Variance Inflation Factor (VIF)

Table 3 presents the VIF values, which ranged between 3.12 and 5.01. Although RE (5.01) and SQ (4.39) were slightly higher, all values remained below the critical threshold of 10, indicating that multicollinearity was not a significant issue in the model.

Table 3: Variance Inflation Factor results

Variable	VIF Value
SL	3.12
STE	4.74
RE	5.01
FP	3.56
SQ	4.39

Source: SEM-PLS Output, (2026)

4.4 Exploratory Factor Analysis (EFA)

The EFA results (Table 4) revealed satisfactory factor loadings (≥ 0.75) across all items. Sustainable logistics (SL1–SL3) explained 50% of the variance, while RE (39%), FP (34%), SQ (37%), and environmental performance (STE, 33%) also

showed strong explanatory power. These results confirm that each construct is empirically distinct and contributes meaningfully to the model.

Table 4: Exploratory Factor Analysis results

Factor	Variable	Factor Loading	Eigenvalue	Variance Explained	Cumulative Variance
Sustainable Logistics	SL1	0.85	4.75	35%	35%
	SL 2	0.78	1.10	8%	43%
	SL 3	0.81	0.95	7%	50%
Resource Efficiency	RE 1	0.80	2.50	20%	20%
	RE 2	0.76	1.30	10%	30%
	RE 3	0.79	1.10	9%	39%
Firm Performance	FP1	0.82	2.00	16%	16%
	FP2	0.75	1.20	10%	26%
	FP 3	0.78	1.05	8%	34%
Service Quality	SQ 1	0.84	3.10	24%	24%
	SQ 2	0.77	0.95	7%	31%
	SQ 3	0.80	0.85	6%	37%
Service Trade and the Environment (STE)	STE 1	0.83	2.30	18%	18%
	STE 2	0.79	1.10	8%	26%
	STE 3	0.76	0.85	7%	33%

Source: SEM-PLS Output, (2026)

4.5 Partial Least Square-Structural Equation Model (PLS-SEM)

The PLS-SEM results (Table 5) provide strong support for all hypotheses. Sustainable logistics practices positively influenced environmental performance ($\beta = 0.41$, $p < 0.001$), operational performance (through RE: $\beta = 0.35$, $p < 0.01$), firm performance ($\beta = 0.33$, $p < 0.01$), and service quality ($\beta = 0.45$, $p < 0.001$). Importantly, firm performance mediated the relationship between SL and environmental performance ($\beta = 0.50$, $p < 0.001$), highlighting its pivotal role as a transmission mechanism.

Table 5: Result of SEM-PLS parameter estimations

Hypothesis	Path	Standard Error	Path Coefficient (β)	p-value	t-value	Significance
H_1	SL-STE	0.03	0.41	0.000	13.67	Significant

H_2	RE-STE	0.02	0.35	0.001	15.00	Significant
H_3	SL-FP	0.04	0.33	0.005	8.25	Significant
H_4	SL-SQ	0.05	0.45	0.000	9.00	Significant
H_5	FP-SL-STE	0.06	0.50	0.000	11.67	Significant

Source: SEM-PLS Output, (2026)

These results confirm that sustainable logistics practices significantly enhance environmental performance, both directly and by boosting firm performance, while also improving firm performance and service quality. All effects are statistically significant, consistent with PLS-SEM criteria (e.g. $p<0.05$, $t>1.96$) in bootstrapped tests. Reliability and collinearity diagnostics support the model's validity (composite reliability and AVE exceed recommended thresholds). The structural model developed from the study's findings illustrates a comprehensive framework of relationships between sustainable logistics (SL) practices and various performance metrics within the Nigerian manufacturing sector. The model, validated through Partial Least Squares Structural Equation Modeling (PLS-SEM), reveals both direct and indirect pathways through which sustainability initiatives translate into tangible business and environmental outcomes.

The relationships above can be written as simultaneous equations:

$STE=0.41\cdot SL+0.35\cdot RE+0.50\cdot FP+\varepsilon_1$

$FP=0.33\cdot SL+\varepsilon_2$

$SQ = 0.45\cdot SL + \varepsilon_3$

Here ε_i are disturbance terms and each β is the path coefficient from the PLS-SEM. Figure 3(below) illustrates the SEM (with latent variables in ovals and significant paths labeled by β).

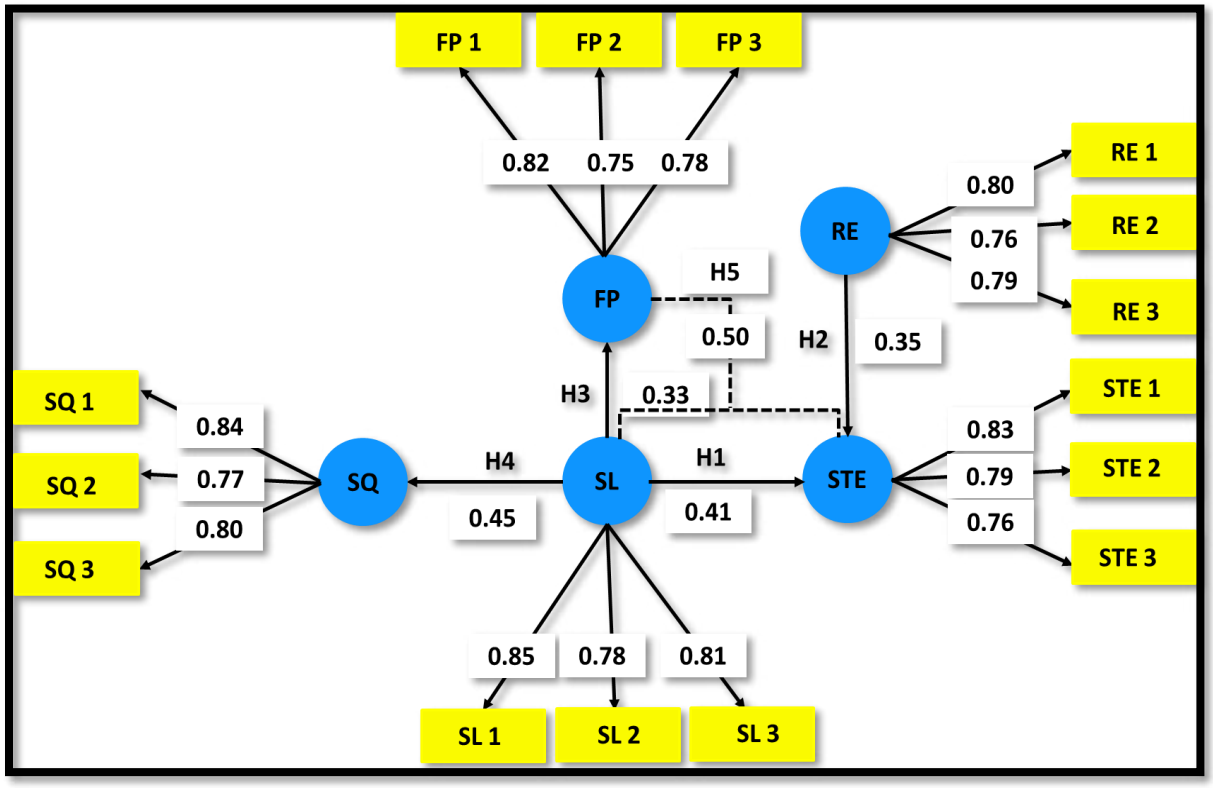


Figure 3: Measurement Model

Source: SEM-PLS Output, (2026)

The findings of the reliability analysis, VIF, EFA, and PLS-SEM are strong supporting evidence for the validity and robustness of the model. However, FP mediates the relationship between SL and STE and SL improves FP (β = 0.33), and higher FP, in turn, improves STE (β = 0.50). This indirect effect of SL on STE (0.33×0.50 ≈ 0.17) is significant, reflecting a partial mediation. All constructs were reliable (Cronbach's α, CR, AVE exceeding 0.70/0.50 benchmarks and multicollinearity was acceptable (VIFs < 10)

Measurement model: The constructs were operationalized by their indicators (SL with items Emissions Reduction, Green Packaging, Eco-Friendly Transport; RE with Energy Efficiency, Waste Minimization), and all factor loadings were high (≥0.75). The measurement model exhibited convergent validity and reliability (CR > 0.70, AVE > 0.50. The Composite Reliability and high values of Cronbach's Alpha ensure construct reliability, and the VIF values show moderate multicollinearity with no serious threat. These results show that sustainable logistics management techniques have a favorable influence on company and environmental performance, with an emphasis on comprehensive methodologies in logistics management.

5. Discussion

The findings of this study demonstrate that sustainable logistics (SL) practices including emissions reduction, green packaging, eco-friendly transport, and resource efficiency significantly enhance both environmental and operational performance. These results provide two key theoretical extensions. First, they advance the Resource-Based View (RBV) by framing SL as a set of strategic and operational resources that build competitive advantage. Second, they reinforce the Triple Bottom Line (TBL) by showing that ecological and economic benefits can be achieved simultaneously, bridging environmental stewardship with operational efficiency.

The significant link between SL and environmental performance aligns with prior evidence (Nazir et al., 2024; Abdallah et al., 2024) but importantly extends these insights to logistics-specific processes, which have traditionally been overshadowed by studies in procurement or manufacturing. Likewise, the positive effect of SL on operational performance demonstrates that green logistics should not be treated merely as a compliance activity but rather as a driver of efficiency, resilience, and service reliability, echoing the findings of (Yu et al., 2024).

A particularly novel contribution lies in identifying firm performance (FP) as a mediator between SL and sustainability outcomes. While earlier research has emphasized institutional pressure or technological innovation as mediating factors (Pournader et al., 2020; Freihat et al., 2024; Khan et al., 2024), this study shows that profitability, cost efficiency, and market competitiveness strengthen the ability of SL to deliver environmental benefits. Moreover, the observed improvements in service quality (SQ) suggest that sustainable logistics does not only benefit firms internally but also enhances customer-facing outcomes, strengthening trust, reliability, and long-term stakeholder relationships.

By situating the analysis within Nigeria's manufacturing sector, this study also contributes to the growing body of research on emerging markets, which remain underrepresented in sustainability and logistics scholarship. Unlike developed economies, emerging markets face unique infrastructural and institutional challenges, yet the results show that SL practices still deliver measurable ecological and operational benefits. This underlines their universal relevance and highlights the potential for sustainable logistics to become a cornerstone of competitive advantage in resource-constrained settings.

5.1 Theoretical Implications

This study offers several important theoretical contributions to the fields of sustainable logistics and supply chain management. First, it extends the Resource-Based View (RBV) by demonstrating that sustainable logistics practices such as emissions reduction, green packaging, and eco-friendly

transport can be conceptualized as strategic resources that are valuable, rare, inimitable, and non-substitutable. These capabilities are not only operational tools but also sources of long-term competitive advantage, enabling firms to achieve superior efficiency and differentiation. Second, the study integrates the Triple Bottom Line (TBL) perspective, showing that economic and environmental performance outcomes are not mutually exclusive but complementary. The evidence that sustainable logistics improves both operational reliability and ecological outcomes supports the notion that firms can pursue profit, people, and planet objectives simultaneously. Third, the identification of firm performance as a mediating mechanism adds a novel pathway to existing theoretical frameworks. While earlier studies emphasized institutional pressures, regulatory factors, or innovation as mediators, this research positions firm performance itself as a central explanatory factor that amplifies the benefits of sustainable logistics.

Collectively, these contributions refine theoretical models by linking sustainability, competitiveness, and firm performance in a more integrated way, and they open opportunities for replication in both developed and emerging market contexts.

5.2 Practical and Managerial Implications

The findings also carry strong practical relevance for managers, policymakers, and industry professionals. For managers, the results confirm that sustainable logistics is not only an environmental or compliance requirement but also a driver of operational efficiency, service quality, and financial success. Firms that adopt green packaging, optimize transport routes, and invest in eco-friendly vehicles can simultaneously reduce costs and improve delivery accuracy, thereby enhancing both customer satisfaction and competitiveness. This highlights that sustainability initiatives should be framed as performance-enhancing strategies rather than as external obligations. For policymakers, the evidence from Nigeria underscores the need to support logistics sustainability in emerging markets, where infrastructure limitations often constrain operational efficiency. Targeted policies, such as incentives for energy-efficient transport or tax breaks for green packaging, could accelerate adoption.

Furthermore, the study shows that firms with stronger performance are better positioned to reinvest in sustainability initiatives, suggesting that industry leaders should strategically allocate resources to ensure a cycle of profitability and environmental stewardship. Finally, benchmarking against global leaders such as Amazon or IKEA illustrates that logistics sustainability can be scaled across different contexts, but local adaptation remains critical. For Nigerian firms and similar economies, the lesson is that even incremental improvements in logistics sustainability can yield meaningful benefits for both business

competitiveness and ecological responsibility. For industry practitioners and decision-makers, this research carries practical implications, offering insights into the management of SL and optimization of environmental and operational performance.

6. Limitations and Future Research Directions

Like all empirical research, this study is subject to certain limitations that should be acknowledged when interpreting the findings. First, the analysis was restricted to manufacturing firms in Nigeria, which may limit the generalizability of the results to other industries or geographical contexts. Different institutional environments, regulatory pressures, or cultural values may shape how sustainable logistics (SL) practices are adopted and perceived. Second, the study employed a cross-sectional design, capturing practices and outcomes at a single point in time. While this provides useful insights into immediate associations, it prevents us from drawing strong causal inferences or understanding the long-term evolution of sustainability initiatives. Third, the reliance on self-reported survey data introduces the potential for common method bias and social desirability bias, as respondents may overstate their organizations' sustainability efforts.

Finally, although PLS-SEM provides a robust analytical framework for testing complex models, it does not account for potential endogeneity issues that might arise from reciprocal relationships among constructs such as performance and sustainability.

Future research should address these limitations by adopting longitudinal research designs to capture the dynamic interplay between logistics practices and performance over time. Comparative studies across multiple countries, including both developed and emerging economies, would provide richer insights into the contextual factors influencing SL adoption. Researchers should also consider using objective performance indicators such as actual emission levels, delivery records, or cost savings to triangulate self-reported measures. In addition, future studies could examine alternative mediators and moderators such as digital transformation, institutional pressures, leadership styles, or organizational culture to deepen understanding of the mechanisms linking SL practices to firm outcomes. By broadening the scope of contexts, measures, and theoretical perspectives, future research can provide a more holistic picture of how sustainable logistics contributes to global supply chain competitiveness.

7. Conclusion

This study investigated the impact of sustainable logistics practices on environmental and operational performance in Nigeria, with firm performance

serving as a key mediator. Using PLS-SEM, the analysis confirmed that practices such as emissions reduction, resource efficiency, eco-friendly transport, and green packaging positively influence sustainability outcomes while simultaneously improving operational reliability and firm competitiveness. The results also highlighted that firm performance amplifies the effect of sustainable logistics on environmental performance, underscoring the interconnectedness of financial and ecological outcomes. Theoretically, the study contributes to the supply chain management literature by extending the Resource-Based View and Triple Bottom Line frameworks into a logistics-specific and emerging market context. Practically, it provides actionable insights for managers and policymakers on how to design and implement logistics strategies that enhance efficiency, service quality, and sustainability.

In conclusion, the evidence strongly supports the argument that sustainable logistics is not only a moral or regulatory imperative but also a strategic necessity. By adopting environmentally responsible logistics practices, firms can achieve a balance between profitability and sustainability, positioning themselves for long-term competitiveness in an increasingly demanding global marketplace.

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