VOL. 12 NO. 2,
MAY, 2026
E-ISSN 3027-1533
P-ISSN 3026-8648

African Scholar Publications & Research International
www.africanscholarpub.com

Journal of African Innovation & Advanced Studies (JAIAS)

Effect of Digital Supply Chain Management on Sustainable Performance of Selected Manufacturing Firms in North-Central Nigeria

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DOI: https://doi.org/10.70382/ajaias.v12i2.098

Abstract

This study investigated the effect of digital supply chain management on the sustainable performance of manufacturing firms in North-Central Nigeria, focusing on e-procurement and intralogistics automation as key dimensions. Manufacturing firms remain pivotal to economic growth but face persistent inefficiencies, including weak procurement systems, poor logistics integration, and unsustainable practices that hinder competitiveness. The study adopted a quantitative survey research design, with a population of 74,219 staff of registered manufacturing firms in the region. Using Taro Yamane's formula, a sample size of 498 respondents was determined after accounting for a 20% attrition adjustment. Data were collected through a structured five-point Likert scale questionnaire and analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The findings revealed that e-procurement has a significant positive effect on sustainable performance by improving transparency, reducing costs, and strengthening supplier collaboration. Similarly, intralogistics automation demonstrated a strong positive influence on sustainable performance by enhancing efficiency, reducing wastage, and ensuring safer workplace processes. The study concludes that digital supply chain practices are critical drivers of economic, environmental, and social sustainability in Nigerian manufacturing firms. It recommends that managers increase investment in digital procurement platforms and automation technologies, while policymakers support firms through digital infrastructure development, staff training, and financial incentives to accelerate sustainable transformation.

Keywords: Digital Supply Chain Management, E-procurement, Intralogistics Automation, Sustainable Performance, Manufacturing, North-Central Nigeria.

Introduction

Digital supply chains are rapidly becoming central to the competitiveness and sustainability of manufacturing enterprises worldwide. At the heart of this transition is Digital Supply Chain Management (DSCM), which integrates digital technologies such as automation, e-procurement, Internet of Things (IoT), and analytics into supply chain processes. In manufacturing, DSCM not only optimises operations but also supports long-term sustainable performance by aligning economic, environmental, and social goals. Given that manufacturing is energy- and resource-intensive, digital transformation offers a route to reduce waste, improve resource efficiency, and enhance adaptive capacity in volatile markets. Globally, firms are embedding DSCM within Industry 4.0 strategies to achieve supply chain transparency, agility, and sustainability (Impact of Industry 4.0 on Supply Chain Sustainability, 2025). Adoption of digital procurement platforms, robotics in intralogistics, and blockchain-enabled traceability has become standard practice, enhancing both operational and sustainable outcomes in developed economies. In Nigeria, the push for digital transformation is gaining momentum, especially as manufacturing firms seek to overcome long-standing challenges of weak infrastructure, unreliable power supply, and limited technological diffusion. Still, many small and medium-scale manufacturers lag behind in DSCM adoption due to high costs, low digital literacy, and fragmented institutional support.

E-Procurement refers to the use of digital platforms and electronic systems to manage purchasing and supplier interactions. It enhances transparency, reduces transaction costs, accelerates procurement cycles, and improves supplier relationships through real-time information exchange and automated bidding processes (Chukwu & Ahmed, 2024). Intralogistics automation, on the other hand, emphasizes the application of digital tools and automated systems within warehouses, factories, and distribution centers. This includes technologies such as barcode/RFID scanning, automated storage and retrieval systems, and warehouse management systems (WMS) that facilitate efficiency, reduce errors, and optimize inventory control (Musa et al., 2024).

Sustainable performance, which encapsulates the economic, environmental, and social dimensions of organizational outcomes, has become a key metric for evaluating manufacturing firms. Firms are expected not only to maximize profitability but also to reduce their ecological footprint, ensure efficient resource utilization, and promote worker safety and welfare. Digital supply chain innovations, particularly in e-procurement and intralogistics automation, offer promising pathways for firms to integrate sustainability into their operations by reducing paper usage, minimizing wastage, optimizing energy consumption,

and ensuring ethical sourcing practices (Okafor & Bello, 2025).

The North-Central region of Nigeria hosts a growing cluster of manufacturing firms spanning agro-processing, food and beverages, cement, and packaging industries. Despite their significance, many of these firms continue to face persistent inefficiencies, weak adoption of digital technologies, and limited integration of sustainable practices in their supply chains. This calls for an empirical assessment of how digital supply chain strategies, particularly through e-procurement and intralogistics automation, can improve sustainable performance in the regional manufacturing landscape.

Therefore, this study aims to examine the effect of digital supply chain management on the sustainable performance of selected manufacturing firms in North-Central Nigeria, with a focus on e-procurement and intralogistics automation as key proxies of DSCM.

Statement of Problem

Manufacturing supply chains globally are under increasing pressure to balance efficiency with sustainability. Firms must not only meet traditional performance expectations of cost-effectiveness, reliability, and speed but also address broader economic, environmental, and social responsibilities (Govindan et al., 2020). In recent years, the deployment of digital technologies in supply chains ranging from e-procurement systems to intralogistics automation has been heralded as a solution to many of these challenges. Nevertheless, achieving sustainable performance remains elusive for many firms, especially in developing economies where systemic and structural constraints limit the effectiveness of digitalisation (Shekarian et al., 2022). Supply chain inefficiencies persist as a major barrier to competitiveness in the Nigerian manufacturing sector. Studies highlight recurrent challenges such as poor infrastructure, unreliable electricity, limited logistics capabilities, and lack of digital integration across value chains (Novatia Consulting, 2024). These inefficiencies lead to high operating costs, delays in production, and sub-optimal customer service, all of which undermine economic sustainability. At the same time, environmental sustainability goals remain unmet, as evidenced by persistent issues of waste generation, energy inefficiency, and weak environmental compliance in manufacturing operations (Akinwale & Adepoju, 2022). Social dimensions of sustainability, including employee welfare, community engagement, and stakeholder trust, also lag behind expectations, suggesting a broader systemic weakness in aligning supply chain practices with sustainable development imperatives.

Despite increasing awareness of the potential of digital technologies, adoption in Nigeria's manufacturing sector has been slow and uneven. A number of firms have experimented with e-procurement platforms and elements of intralogistics automation, but the outcomes have been mixed (Digital Transformation in Nigeria's Supply Chain, 2025). While some firms report improvements in efficiency and cost management, others struggle with implementation challenges, including lack of digital infrastructure, limited skilled manpower, and resistance to organisational change. These obstacles not only reduce the effectiveness of digital initiatives but also perpetuate unsustainable performance outcomes. The persistence of these problems despite digitalisation initiatives raises important questions about the true impact of digital supply chain management (DSCM) on sustainability in the Nigerian context. Although

DSCM has been shown to improve performance in advanced economies (Yu et al., 2022), evidence from Nigeria remains fragmented and inconclusive. Some studies suggest that digitalisation enhances transparency, reduces waste, and strengthens resilience (Okon & Etuk, 2021), while others caution that without adequate institutional support and infrastructural investment, digital tools may have little impact or even exacerbate inefficiencies (Adeleke & Adeyemi, 2023). These contradictions underscore the need for context-specific investigations that account for the unique challenges faced by Nigerian manufacturers. Moreover, much of the existing research in Nigeria has concentrated on industrial hubs in Lagos and the South-West, with limited attention to the North-Central region (Novatia Consulting, 2024). This neglect creates a geographical gap in the literature, as the North-Central region faces distinct logistical, infrastructural, and institutional challenges that may influence the adoption and effectiveness of DSCM. Against this backdrop, this study seeks to assess the effect of digital supply chain management on the sustainable performance of selected manufacturing firms in North-Central Nigeria.

Objectives of the Study

The general objective of the study is to examine the effect of digital supply chain management on the sustainable performance of SMEs in North Central, Nigeria. The specific objectives were to:

1. Examine the effect of e-procurement on the sustainable performance of SMEs in North Central, Nigeria.
2. Access the effect of intralogistics automation on the sustainable performance of SMEs in North Central, Nigeria.

Digital Supply Chain Management

Digital Supply Chain Management is seen as the strategic integration of advanced digital technologies into supply chain processes to enhance visibility, responsiveness, efficiency, and sustainability. It emphasizes the use of tools such as data analytics, cloud platforms, and automation to connect stakeholders, streamline operations, and reduce redundancies across the value chain. According to Rajesh (2024), digital supply chains represent a transformation from linear, manually driven processes to connected, intelligent, and automated systems that enable firms to achieve operational excellence while simultaneously aligning with environmental and social goals. Wamba et al. (2023) conceptualized digital supply chain management as a holistic approach to coordinating supply chain activities through interconnected digital technologies that enable seamless information flow, predictive decision-making and collaborative value creation. He describe it as the reconfiguration of supply chain processes using automation, artificial intelligence, and digital platforms to foster agility, resilience, and sustainability in the face of complex and dynamic market demands.

E-Procurement

Okafor and Bello (2025) argue that e-procurement is not merely a cost-reduction mechanism but a strategic tool for improving governance, accountability, and sustainable supplier

relationships by ensuring real-time visibility of purchasing decisions. They further defined conceptually e-procurement as a technology-enabled procurement process that automates sourcing, ordering, and supplier interactions through digital systems designed to enhance transparency and reduce operational inefficiencies. E-Procurement is the digitalization of organizational purchasing and supplier management activities through electronic platforms that facilitate sourcing, bidding, contracting, and transaction monitoring. It enhances efficiency, transparency, and accountability in procurement by minimizing paperwork, reducing transaction costs, and improving supplier collaboration. Chukwu and Ahmed (2024) note that e-procurement extends beyond simple digitization of purchasing to include real-time data exchange, automated workflows, and performance tracking, thereby fostering cost savings and sustainable sourcing practices.

Intralogistics Automation

Intralogistics Automation is conceptually defined as the application of digital tools and automated systems to manage the flow of materials, inventory, and goods within production and warehouse environments. It includes the use of technologies such as barcoding, RFID, automated storage systems, and warehouse management software to enhance accuracy, reduce human error, and optimize resource utilization. Musa et al. (2024) emphasize that intralogistics automation enables firms to improve throughput, minimize wastage, and ensure workplace safety, which collectively contribute to improved economic, environmental, and social performance outcomes. According to Zhang and Liu (2024), it represents a shift from labor-intensive processes to technology-driven workflows that improve accuracy, reduce delays, and support sustainable operations by minimizing waste, energy consumption, and occupational hazards. Also it is the systematic deployment of digital solutions and mechanized systems to optimize the handling, storage, and movement of goods within internal supply chain networks.

Sustainable Performance

Sustainable performance is the continuous process through which organizations integrate environmental, social, and economic considerations into their operations and strategic objectives to achieve long-term value creation. It involves the systematic measurement, monitoring, and improvement of outcomes related to resource efficiency, stakeholder well-being, regulatory compliance, and innovation. Sustainable performance ensures that business activities align with the principles of responsible management, supporting organizational resilience and ethical growth while minimizing negative externalities (John, 2023). Sustainable performance is the strategic integration of triple bottom line outcomes, people, planet, and profit, into organizational decision-making and performance evaluation to ensure long-term viability. It emphasizes enduring productivity, ecological responsibility, and social equity by aligning operational goals with sustainability frameworks and stakeholder expectations, thereby contributing to societal and environmental well-being without compromising economic success (Ji, et al, 2021).

According to Rady (2023) sustainable performance is defined as the combined execution of economic, social, and environmental outcomes. It stems from the triple bottom line framework

introduced by Elkington (2004), emphasizing that organizational success requires more than financial returns it also demands social responsibility and ecological stewardship. As a dynamic, multi-dimensional construct, sustainable performance integrates continual improvement toward long-term viability while balancing resource efficiency, stakeholder well-being, and regenerative practices. This definition explicitly links back to the Brundtland Commission's call for development that meets present needs without compromising future generations.

E-procurement and Performance

Ali and Mensah (2024) examined the impact of e-procurement on organizational performance in selected manufacturing firms in Accra, Ghana. The study adopted a descriptive and explanatory survey design with a sample of 210 procurement officers and supply chain managers selected through stratified random sampling. Data were gathered using structured questionnaires and analyzed with correlation and regression models. The findings revealed that e-procurement significantly improves cost efficiency, transparency, and supplier collaboration, thereby enhancing organizational performance. However, the study was conducted in Ghana, and its findings may not be directly replicable in the Nigerian manufacturing context due to differences in digital infrastructure and regulatory frameworks.
Okeke and Ibrahim (2025) investigated the effect of e-procurement on firm performance in medium-scale manufacturing companies in Lagos State, Nigeria. A total of 156 respondents, comprising procurement managers and IT staff, were purposively selected. Data were collected using self-administered questionnaires and analyzed with Structural Equation Modeling (SEM). The results showed that e-procurement has a positive and statistically significant effect on firm performance, particularly in reducing procurement cycle time and improving accountability in purchasing activities. The study relied heavily on quantitative data, which, while robust, may have overlooked qualitative insights into challenges faced by employees during the transition from manual to digital procurement systems.

Intralogistics Automation and Performance

Smith and Becker (2024) investigated how intralogistics automation affects operational performance in food-processing firms in Bavaria, Germany. The study employed a descriptive-correlational design with a sample of 175 logistics and operations managers randomly selected across multiple facilities. Primary data were collected using structured questionnaires and supplemented with performance data from internal records. Analysis was conducted via multiple regression and path analysis. The findings showed that automation of internal logistics through barcode systems, automated picking, and warehouse management software had a statistically significant positive effect on throughput rates, inventory accuracy, and order fulfillment speed. However, being set within highly advanced logistics infrastructure in Germany, these findings may not fully replicate in the Nigerian manufacturing context, particularly in regions with less infrastructure maturity.
Amadi and Okon (2025) examined the influence of intralogistics automation on performance in medium-sized manufacturing plants in Kaduna State, North-West Nigeria. Using a survey-

based cross-sectional design, the study sampled 122 respondents including warehouse supervisors, production managers, and supply chain coordinators selected via purposive sampling. Data were collected through self-administered questionnaires and analyzed using Structural Equation Modeling (SEM). Results indicated that firms implementing digital mechanisms for internal flow such as barcode scanning, WMS integration, and automated picking systems experienced improvements in operational efficiency, reduction in material waste, and enhanced workplace safety. The study, however, depended entirely on perceptual (self-reported) data and did not incorporate objective performance metrics, which might affect the robustness of its conclusions.

Resource-Based View (RBV) Theory

The Resource-Based View (RBV), advanced by Barney (1991), posits that firms achieve sustainable competitive advantage and superior performance when they acquire and deploy resources that are valuable, rare, inimitable, and non-substitutable (VRIN). In the context of digital supply chain management, technologies such as e-procurement systems, intralogistics automation, and advanced digital platforms are considered strategic resources. These tools enable manufacturing firms to reduce transaction costs, enhance transparency, improve efficiency, and minimize wastage, thereby contributing to sustainable performance. RBV supports the argument that digital supply chain capabilities are not just operational tools but strategic assets that strengthen a firm's ability to respond to environmental challenges, streamline operations, and build long-term resilience. By leveraging digital systems in procurement and intralogistics, firms create unique competencies that competitors may find difficult to replicate, ensuring sustained operational and environmental performance.

Methodology

This study adopted a quantitative survey research design. The design was appropriate because it enabled the researcher to gather numerical data from a sizeable population and statistically test the hypothesised relationships between digital supply chain management (DSCM) and sustainable performance. Survey research is particularly suitable for studies seeking to measure perceptions and behaviours across multiple constructs in real-world organisational settings (Creswell & Creswell, 2018). The population of the study comprised staff of registered manufacturing firms in North-Central Nigeria. According to available data, there are 74,219 staff employed in manufacturing firms across the North-Central region (MAN 2021). This population figure provided the frame for determining the required sample size for the study.

The Taro Yamane (1967) formula was applied to calculate the appropriate sample size:

$n = N / (1 + N(e^2))$

Where:

n = sample size

N = population size (74,219)

e = margin of error (0.05)

n = 74,219 / (1 + 74,219(0.05^2))
≈ 74,219 / 186.55
≈ 398

Thus, the required sample size was 398 staff. To account for attrition, such as non-response and incomplete questionnaires, an additional 20% was added: Adjusted sample size = 398 / (1 - 0.20) ≈ 498. The final sample size was therefore 498 respondents, which ensured adequate representation and statistical robustness.

The study used a stratified random sampling technique. The strata were defined according to industry subsectors represented in North-Central Nigeria, such as cement, agro-processing, metal works, and consumer goods. Within each stratum, respondents were randomly selected proportionate to the size of each sector. Primary data were collected using a structured questionnaire designed to capture the constructs of DSCM—proxied by e-procurement and intralogistics automation—and sustainable performance. Items were adapted from validated scales in previous studies (Yu et al., 2022; Shekarian et al., 2022). A five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5) was used to measure responses. The collected data were analysed using SmartPLS software. The analysis followed the two-step approach typical in PLS-SEM: first, assessing the measurement model for reliability and validity, and then evaluating the structural model to test hypotheses. The structural assessment included analysing path coefficients, coefficient of determination (R^2), effect sizes (f^2), predictive relevance (Q^2), and overall model fit indices. Bootstrapping with 5,000 subsamples was applied to test the significance of the hypothesised paths.

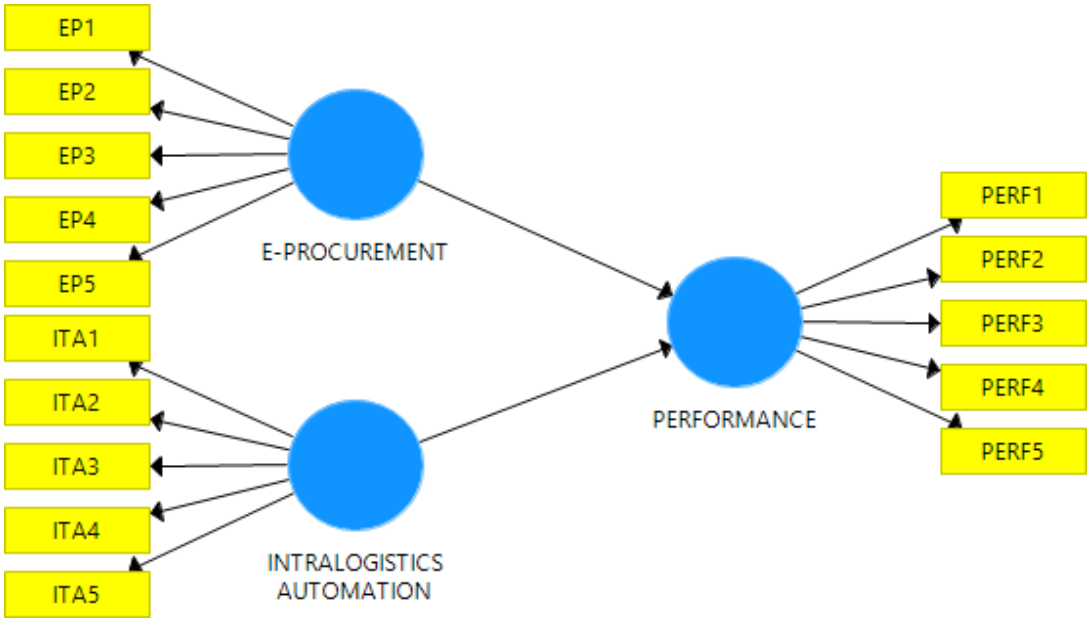


Figure 1 Structural model for direct relationship between training and performance of SMEs

Source: Researcher

Data analysis and Results

A total of 498 copies of the questionnaire were distributed; only three hundred and seventy-five (375) were retrieved, giving a response rate of 96.5%. 17(3.5%) were not properly filled but returned. All further analyses were carried out using 481 responses.

Indicator Reliability

When evaluating the measurement model, we initiate the process by examining the item outer loadings. Generally, it is recommended to consider loadings above 0.708, as they signify that the construct accounts for more than 50 percent of the variance in the indicator, ensuring acceptable item reliability (Hair et al., 2019). However, Hair et al. (2019) also suggest that low but statistically significant indicator loadings (below 0.50) may be included. Conversely, outer loadings below 0.4 should be eliminated, and in exploratory research, loadings between 0.4 and 0.7 may be retained if the average variance extracted is satisfactory (Hair et al., 2014). This justifies the decision not to exclude indicators with loadings below 0.70 and above 0.40 from the model.

Table 1: Factor Loadings of the Constructs

	E-procurement	Intralogistics automation	Performance
EP1	0.713		
EP2	0.597		
EP3	0.724		
EP4	0.770		
EP5	0.709		
ITA1		0.618	
ITA2		0.698	
ITA3		0.844	
ITA4		0.841	
ITA5		0.699	
PERF1			0.738
PERF2			0.817
PERF3			0.834
PERF4			0.748
PERF5			0.815

Source: SMARP-PLS Output, 2025

Convergent Validity

Convergent validity gauges the degree to which a construct converges to elucidate the variance within its items. To evaluate convergent validity, the average variance extracted (AVE) should exceed 0.5. As depicted in Table 2, the AVE values for all constructs surpass 0.5, affirming that our constructs meet the criteria for convergent validity. This observation suggests that the

entire construct accounts for 50 percent or more of the variance present in the items comprising the construct.

Table 2: Construct Reliability and Validity of the Indicators

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
E-procurement	0.745	0.744	0.831	0.597
Intralogistics automation	0.797	0.834	0.860	0.556
Performance	0.851	0.862	0.893	0.626

Source: SMART PLS Output, 2025

Table 3: Heterotrait-Monotrait Ratio (HTMT)

	E-procurement	Intralogistics automation	Performance
E-procurement	**1.000**		
Intralogistics Automation	**0.841**	**1.000**	
Performance	0.753	**0.849**	**1.000**

Source: SMART-PLS Output, 2025

Model Goodness of Fit (GoF)

To validate the PLS model, it is essential to evaluate its goodness of fit, as recommended by Hair et al. (2017). In this study, the standardized root mean square residual (SRMR) was employed for this purpose. The selection of this index was based on the fact that SRMR provides an absolute fit measure, where a value of zero signifies a perfect fit. Following Hu and Bentler's (1998) suggestion that a value below 0.08 represents a good fit when using SRMR for model assessment, the study's result revealed an SRMR value of 0.03. This indicates that the model fits well. Besides the chi-square, other measures corroborate the goodness of fit in the study's model.

Table 4: Model of Goodness of fit Summary

	Saturated Model	Estimated Model
SRMR	0.04	0.04
d_ULS	5.678	5.678
d_G	5.552	5.552
Chi-Square	7328.713	7328.713
NFI	0.395	0.395

Source: SMART-PLS Output, 2025

Test of Hypotheses

The table below shows the path coefficients, t-values and p-values used to test the first four null hypotheses of the study:

Table 5: Path Coefficient of the Model

Variables	Beta	T Statistics (|O/STDEV|)	P Values	Decision	F^2 Value
E-procurement -> Performance	0.387	2.275	**0.000**	Rejected	0.047
Intralogistics Automation -> Performance	0.477	11.129	**0.000**	Rejected	0.276

Notes: (P<0.01), (P<0.05), (P<0.1)

Source: SMART-PLS Output, 2025

Hypothesis One

H_{o1}: e-procurement has no significant effect on the sustainable performance of selected manufacturing firms in North-Central Nigeria.

The result of the test, as shown in Table 5, revealed that e-procurement has a positive and significant effect on the performance of manufacturing firms in North-Central Nigeria, with β = 0.387, T-statistics = 2.275, and p = 0.000, which is less than 0.05. Thus, hypothesis one was not supported and therefore rejected at 5% level of significance. There is adequate evidence to reject the null hypothesis, and the study therefore concludes that e-procurement has a positive and significant effect on sustainable performance of selected manufacturing firms in North-Central Nigeria.

Hypothesis Two

H_{o2}: Intralogistics automation has no significant effect on the sustainable performance of selected manufacturing firms in North-Central Nigeria.

The result from Table 5 shows that intralogistics automation has a strong positive and significant effect on the performance of manufacturing firms in North-Central Nigeria, with β = 0.477, T-statistics = 11.129, and p = 0.000, which is less than 0.05. Thus, hypothesis two was not supported and therefore rejected at 5% level of significance. There is adequate evidence to reject the null hypothesis, and the study therefore concludes that intralogistics automation has a strong positive and significant effect on the sustainable performance of selected manufacturing firms in North-Central Nigeria.

Table 6: R-squared Statistics

	R Square	R Square Adjusted
SMEs Performance	0.585	0.583

Source: Researcher's computation in Smart-PLS (2025)

The R-squared statistic shows the level of determinism of the dependent variable by the independent variables of the study. Table 6 shows that the study has an R-squared value of 0.585, which indicates that the variables used for the study account for about 58.5% of the variability in the dependent variable. Other factors not captured in the model may account for the remaining 41.5%.

Discussion of Findings

E-procurement positively and significantly affected the performance of selected manufacturing firms in North Central, Nigeria, indicating that the adoption of electronic procurement systems enhances efficiency in sourcing, supplier relationships, and cost management. This suggests that e-procurement contributes to reducing transaction costs, improving transparency, and strengthening supply chain responsiveness, all of which enhance overall organizational performance. The finding is in agreement with that of Owolabi and Musa (2024) who found that e-procurement adoption significantly improved operational efficiency and firm competitiveness in Lagos State manufacturing firms. However, the finding disagrees with Okeke et al. (2024), who reported that e-procurement adoption in some SMEs within Enugu State showed only a weak and insignificant effect on performance due to infrastructural and technical limitations.

On the other hand, intralogistics automation has positive and significant effects on the performance of selected manufacturing firms in North Central Nigeria. This implies that automating internal logistics processes such as material handling, inventory movement, and warehouse management enhances efficiency, reduces human error, and accelerates production workflows, leading to superior business outcomes. It suggests that intralogistics automation fosters operational efficiency, flexibility, and precision, which in turn drive productivity, innovation, and competitive advantage. This finding agrees with the results of Adediran and Sule (2025) whose study revealed a strong positive and significant relationship between automation of logistics processes and firm performance in Nigerian manufacturing firms. However, it contrasts with Ibrahim et al. (2024) who found that intralogistics automation had no significant impact on SME performance in Northern Nigeria, largely due to high implementation costs and lack of technical know-how..

Conclusions and Recommendations

Based on the finding that e-procurement positively and significantly affected the performance of selected manufacturing firms in North Central Nigeria, it can be concluded that e-procurement serves as a vital tool for improving procurement efficiency and overall organizational performance. Its significant effect suggests that digitalizing procurement processes provides a sustainable pathway for enhancing transparency, reducing costs, and strengthening supply chain operations.

The conclusion from the finding that intralogistics automation has a positive and significant effect on the performance of manufacturing firms in North Central Nigeria is that automation of internal logistics processes meaningfully contributes to performance improvements. By streamlining material flow, reducing inefficiencies, and minimizing delays, intralogistics automation fosters enhanced productivity and operational excellence, positioning firms for greater competitiveness.

Recommendations

i. Manufacturing firms should invest more in advanced e-procurement systems to leverage automation for efficiency, transparency, and competitiveness.
ii. Firms should adopt intralogistics automation technologies such as automated guided vehicles (AGVs), robotics, and warehouse management systems to boost productivity and minimize operational bottlenecks. Policymakers should create enabling environments such as ICT infrastructure development and automation financing schemes to support the digital transformation of manufacturing firms.
iii. Training and capacity-building programs should be established to ensure employees can effectively utilize both e-procurement and intralogistics automation technologies for sustained performance gains.

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