

Quantitative analysis of process mapping's impact on time efficiency in Nigerian supply chains

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Abstract

In today's dynamic business environment, delays and inefficiencies which are inherent across supply chains have continued to weaken the responsiveness of organizations and tend to reduce customer satisfaction. Many of these challenges stem from fragmented workflows, undocumented procedures, and a lack of coordination between departments, factors that often result in longer lead times, missed deliveries, and higher operational costs. One promising solution is process mapping, a strategic tool that enables managers to visualize workflows, detect bottlenecks, and optimize operations. Despite its growing adoption, there is limited empirical evidence on its direct effect on time efficiency, especially within the Nigerian context.

This study explores how process mapping influences time efficiency in supply chain management (SCM), with a focus on Nigerian firms operating in the manufacturing, retail, and logistics sectors. A quantitative correlational design was employed, and data were collected from 120 SCM professionals through structured questionnaires. The responses were analyzed using SPSS Version 26, applying descriptive statistics, independent samples t-tests, and multiple linear regression.

Results show a significant positive relationship between process mapping and time efficiency ($R^2 = 0.67$, $p < 0.001$). Among the tools evaluated, flowcharts and swim lane diagrams proved most effective in reducing lead time and cycle time. Additionally, employee training and the use of digital mapping platforms such as Lucidchart and Bizagi emerged as strong predictors of improved performance. Organizations that consistently applied these practices reported quicker deliveries, better internal coordination, and fewer operational delays.

These findings offer valuable insights for supply chain managers and policymakers seeking to improve operational agility in resource-constrained environments. The study emphasizes the need to institutionalize process mapping as a routine practice within supply chains to achieve sustainable, measurable improvements in time-based performance.

Keywords: Process Mapping; Time Efficiency; Supply Chain Management (SCM); Operational Performance

1. Introduction

In today's hyper-competitive global marketplace, supply chain efficiency is no longer a strategic luxury, it is a fundamental requirement for survival (Ahmed, 2023). Organizations across sectors such as manufacturing, retail, and logistics face relentless pressure to meet customer demands with greater speed, accuracy, and minimal waste (Oteri et al., 2023). However, many firms continue to grapple with inefficiencies driven by fragmented workflows, undocumented

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procedures, and limited visibility into their processes (Bai et al., 2024). As supply chains grow more complex and geographically dispersed, challenges such as delays, redundancies, and escalating costs become increasingly difficult to manage (Habibi et al., 2025).

One proven strategy for addressing these challenges is process mapping, a structured approach that visually documents how tasks, decisions, and resources flow within a business process. When implemented effectively, process mapping serves both diagnostic and improvement purposes. It helps organizations identify bottlenecks, eliminate waste, and reconfigure workflows for enhanced agility and speed (Wang et al., 2024). Within supply chain management (SCM), process mapping has been applied to key areas including procurement, order fulfillment, inventory tracking, transportation, and returns (Grover et al., 2024). Yet, despite its relevance, there remains a notable gap in empirical research exploring its direct effect on time efficiency, particularly in emerging economies such as Nigeria. In practice, the absence of standardized or clearly mapped workflows often results in delayed deliveries, extended lead times, poor coordination across departments, and underutilized resources (Jonsson et al., 2024). Without visibility into how activities unfold, decision-making becomes reactive rather than strategic, ultimately weakening customer satisfaction and financial performance (Dumas et al., 2018).

This study investigates whether systematic process mapping can improve time-based performance metrics such as lead time, cycle time, and on-time delivery within the supply chain context. To guide the inquiry, the following key research questions are posed: Does process mapping significantly impact supply chain time performance? and What types of process maps yield the best efficiency results across different sectors or supply chain functions?

- To answer these questions, the study is guided by two specific objectives:
- To determine whether process mapping practices significantly influence operational speed in supply chain management and identify the specific types of process maps that yield the greatest improvements in lead time and cycle time across different sectors.

The research focuses on Nigerian firms in the manufacturing, retail, and logistics industries sectors that offer varying degrees of process complexity and maturity. This context addresses a gap in existing literature, which is largely skewed toward industrialized economies. Importantly, the findings offer actionable insights for supply chain managers and business leaders who seek to optimize operations through process redesign, digital tool adoption, and workforce development. For customers, increased time efficiency means faster service, improved satisfaction, and stronger trust in the brand. At the macroeconomic level, enhanced supply chain performance contributes to productivity, competitiveness, and sustainable development, particularly critical for Nigeria's industrial ambitions and economic transformation

2. Literature Review

2.1. Process Mapping

Process mapping is a structured visual representation of a business process, capturing the sequence of tasks, decision points, resources, and stakeholders involved in transforming inputs into outputs (Harmon, 2019). According to Harrington (1991), process mapping enables organizations to “see” inefficiencies, delays, or duplications that are otherwise invisible in routine operations. In supply chain management (SCM), this tool serves as a cornerstone for analyzing workflows and identifying areas for time and cost optimization (Gunasekaran and Ngai, 2004).

There are several types of process maps, each tailored to meet specific organizational needs. Flowcharts, the most basic form, use standard symbols to illustrate sequential steps and are commonly applied to simple, linear processes. Swimlane diagrams offer a more detailed, cross-functional perspective by assigning tasks to specific departments or stakeholders making them especially useful in supply chain management (SCM), where multiple entities such as procurement, warehousing, and logistics must coordinate (Dumas et al. 2018). They noted that SIPOC diagrams (Suppliers, Inputs, Process, Outputs, Customers), on the other hand, provide a high-level overview of process boundaries and are particularly valuable during the initial stages of process improvement initiatives. The use of these tools has been associated with clearer process ownership, reduced redundancy, and faster turnaround times (Damelio, 2011). However, their direct impact on measurable operational speed within SCM contexts remains an area that warrants further empirical investigation.

2.2. Time Efficiency

Time efficiency (operational speed) in supply chain management refers to an organization's ability to deliver goods and services as quickly as possible while maintaining quality and minimizing waste. Key indicators include lead time, which is the total duration from order placement to delivery; cycle time, the time required to complete a specific process or activity; and on-time delivery (OTD), which measures the percentage of orders fulfilled on or before the agreed date. These metrics are critical for maintaining competitiveness, especially in fast-paced markets where customers expect rapid and reliable service (Yang et al. 2017). Inefficiencies in these time-based performance metrics can lead to stockouts, increased operational costs, and reduced customer satisfaction (Gunasekaran et al., 2001; Huo et al., 2014).

2.3. Supply Chain Management (SCM)

Supply Chain Management (SCM) encompasses the planning, implementation, and control of all activities involved in sourcing, procurement, conversion, and logistics. Three key dimensions central to this study are integration, which involves seamless coordination of material and information flows between suppliers, manufacturers, and customers (Simitian et al. 2002); logistics, referring to the movement and storage of goods that directly impacts delivery speed and reliability (Chang and Ku, 2020); and coordination, which aligns decision-making and actions across the supply chain to prevent time and resource inefficiencies (Simitian et al., 2002). Effective SCM relies on visibility and synchronization—areas where process mapping can serve a transformative role in enhancing transparency and aligning cross-functional processes.

2.4. Previous Studies Linking Process Improvement and Operational Performance

The relationship between process improvement tools (including process mapping) and performance outcomes in supply chains has been investigated in some selected literature. Table 1 summarises key findings from these studies.

Table 1 Summary of Previous Studies and Identified Research Gaps

Author(s)	Year	Context/Industry	Tool Studied	Key Findings	Identified Gap
Harrington, H.J.	1991	General business process	Flowcharts	Process maps improve visibility and reduce delays	Lacked SCM-specific metrics such as lead time
Damelio, R.	2011	Manufacturing	SIPOC, Swimlane	Process mapping increased clarity across departments	No empirical data on time/cost savings
McCormack and Johnson	2001	Supply chain integration	Business Process Mapping	Improved coordination → 20% reduction in order-to-delivery time	Limited to large enterprises
Buabeng, A.	2023	Ghanaian manufacturing	Lean tools incl. mapping	Reduced waste and rework time were identified	No direct measurement of on-time delivery impact
Pradabwong et al.	2017	Thai manufacturing	BPM tools	BPM improves SCM collaboration and organizational performance	Lacked time efficiency measures (lead/cycle time)
Miri-Lavassani and Movahedi	2018	Multi-industry sample	Business Process Orientation (BPM)	POS spherical relations between process orientation and SCP outcomes	Did not focus on specific mapping tools or SCM timing metrics
Sangari et al.	2015	Iranian manufacturers	KM and BPM processes	KM processes + BPM support enhance SCOR performance	Lacked focus on mapping tools specifically
Chand et al.	2022	Manufacturing firms	BPM + Complexity measurement	SC complexity affects performance; BPM helps mitigate	No evaluation of specific process mapping tools
Abideen and Mohammad et al.	2021	Malaysian pharmaceutical logistics	Value-stream mapping + simulation	Lead time and cycle time significantly reduced by lean mapping	Simulation focus; limited to warehouse setting
Ülge Taş	2024	Automotive axle manufacturing	Value Stream Mapping (VSM)	Lead time reduced from 89.5h to 50.6h (~56% improvement)	Single-firm case; lacks cross-industry generalizability
Islahudin et al.	2024	Mushroom baglog manufacturing	VSM	Demonstrated manufacturing lead-time reduction methodology	Limited to agro-manufacturing; lacks broader supply chain context
Batwara et al.	2023	Smart, sustainable industries	VSM Review	Reviews VSM in smart supply chain transformation context	Review; lacks empirical cases on SCM time metrics
Patil et al.	2021	Manufacturing lead-time case	VSM	VSM application enhanced productivity and reduced lead time	Specific manufacturing context; lacks SCM integration analysis
Poswa et al.	2022	Truck manufacturing	Simulated VSM	Productivity improved through simulation-based VSM	No on-time delivery or full supply chain metrics reported

Source: Literature review

2.5. Synthesis and Research Gap

The literature underscores the strategic relevance of process mapping in enhancing supply chain visibility, coordination, and performance. However, most existing studies lack empirical focus on time efficiency metrics and are predominantly centered on developed economies. This gap highlights the need for context-specific analysis particularly in emerging markets like Nigeria to explore how various mapping tools influence lead time, cycle time, and delivery outcomes. The empirical relationship between process mapping for general performance improvement and time efficiency within SCM as suggested in the literature is relatively scarce in Nigeria. Although literature supports the strategic use of, empirical studies specifically examining its effect on especially in developing economies remain scarce. Most research focuses either on process redesign or lean implementation broadly, without isolating the role of mapping tools like flowcharts, swimlane diagrams, or SIPOC. Furthermore, little is known about which mapping formats are most effective for specific industries such as manufacturing, retail, and logistics in Nigeria and similar contexts. The present study responds to this need by examining the practical impact of process mapping on time efficiency across key Nigerian industries.

3. Methodology

3.1. Research Approach

This study adopts a quantitative research approach, which enables the use of numerical data to explore and explain the relationship between process mapping (independent variable) and time efficiency (dependent variable) in supply chain management (SCM). The approach is appropriate as it allows for objective measurement and statistical analysis using structured instruments.

3.2. Research Design

The study uses a correlational research design. This design helps assess the degree and direction of the relationship between two or more measurable variables without manipulating them. The central aim is to determine whether there is a statistically significant relationship between the extent of process mapping practices and levels of time efficiency within Nigerian supply chains.

3.3. Population and Sampling

This study adopts a purposive sampling technique and the focus is on selecting supply chain management (SCM) professionals who are directly engaged in critical functions such as logistics, operations, process improvement, and procurement. These professionals are uniquely positioned to provide informed responses on the realities of process mapping and time efficiency within their sectors. The participants will be drawn from three core industries that represent the heartbeat of supply chain activities in Nigeria: Manufacturing (e.g., fast-moving consumer goods, packaging), retail (e-commerce platforms and traditional brick-and-mortar stores), logistics and transport (including courier services and third-party logistics providers).

To maintain rigor, only respondents who meet the following inclusion criteria will be considered: A minimum of two years of professional SCM experience; demonstrates familiarity with organizational processes and key performance indicators (KPIs); and willingness to participate in a structured, research-based survey.

In line with best practices for survey-based research, a minimum sample size of 120 respondents will be targeted. These participants will be drawn from at least 20 distinct organizations, ensuring sectoral diversity and broad representativeness. The proposed sample size provides sufficient statistical power for robust analysis, including the potential for subgroup analysis across industry types to uncover sector-specific trends and patterns.

3.4. Data Collection Methods

Primary data for this study will be collected through a structured questionnaire administered digitally via Google Forms, ensuring wide and convenient reach across Nigeria. The instrument is divided into four sections: Section A captures demographic details such as age, gender, experience, job role, and sector; Section B focuses on process mapping practices, including frequency and tools used; Section C examines time efficiency indicators like lead time and cycle time; and Section D (optional) explores organizational context such as digital maturity. All items are rated on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree), allowing for easy quantification and analysis. Responses will be automatically collated and exported for processing in SPSS version 26.

3.5. Variables and Measurement

Table 2 Variables, Types and Measurements Indicators Used in the Study

Variable	Type	Indicators/Dimensions	Measurement
Process Mapping	Independent	Frequency, Type Used (Flowchart, SIPOC, Swimlane), Formality	Likert-scale responses (ordinal)
Time Efficiency	Dependent	Lead Time, Cycle Time, On-Time Delivery	Likert-scale responses or actual values
Company Sector and Size	Control Variable	Industry type, employee count	Nominal (categorical)

Source: Author's Design (2025)

3.6. Instrument Validation and Reliability

To ensure the quality and accuracy of the data collection instrument, several validation and reliability procedures were employed. A pilot test was conducted with 10 supply chain management (SCM) professionals, allowing for refinement of question wording, structure, and logical flow based on their feedback. Content validity was established through expert review by two academic scholars and two industry practitioners, who assessed the questionnaire for clarity, relevance, and alignment with the study objectives.

To test reliability, the responses from the pilot were analyzed using Cronbach's Alpha in SPSS, measuring the internal consistency of the Likert-scale items. A threshold of $\alpha \geq 0.70$ was considered acceptable for confirming the instrument's reliability.

3.7. Data Analysis Techniques

Data collected will be analyzed using SPSS (Version 26), with statistical techniques aligned to the research objectives. Descriptive statistics such as frequency, mean, and standard deviation will summarize respondent characteristics and key variables. To assess the internal consistency of the questionnaire, Cronbach's Alpha will be used. The relationship between variables such as process mapping practices and time efficiency will be examined using Pearson's Product-Moment Correlation. Finally, Multiple Linear Regression will be employed to determine the predictive strength (how much influence a factor such as training has on performance outcomes of process mapping practices) on time efficiency outcomes across organizations.

3.8. Ethical Considerations

This study adheres to standard ethical guidelines to ensure the protection of participants' rights and the integrity of the research process. Informed consent is obtained through a clear introductory statement at the beginning of the questionnaire, outlining the purpose of the study and participants' rights. Anonymity is strictly maintained; no names, company identifiers, or personal data are collected. Participation is voluntary, and respondents may choose to withdraw at any point without consequence. All data collected will be used exclusively for academic research and policy-related recommendations, with no commercial or unauthorized application.

4. Data Analysis

The data analysis was conducted using SPSS Version 26, employing both descriptive and inferential statistical techniques to address the research objectives. Firstly, descriptive statistics were used to summarize respondents' demographic characteristics and to identify general patterns in process mapping practices and time efficiency indicators. Measures such as frequencies, means, and standard deviations were applied for this purpose. Secondly, inferential statistics were employed to test hypotheses and examine relationships between variables. Specifically, an Independent Samples t-test was used to assess differences in time efficiency across key demographic or organizational groups. Additionally, Multiple Linear Regression analysis was conducted to evaluate the predictive strength of process mapping practices on time efficiency outcomes, providing insight into the extent to which structured process mapping contributes to performance improvements.

4.1. Descriptive Statistics

4.1.1. Demographic Characteristics of Respondents

Table 3 Demographic Characteristics of Respondents

Variable	Category	Frequency	Percentage (%)
Industry Sector	Manufacturing	45	37.5%
	Retail	30	25%
	Logistics/Transport	35	29.2%
	Others	10	8.3%
Years of Experience	0–2 years	12	10%
	3–5 years	28	23.3%
	6–10 years	45	37.5%
	Over 10 years	35	29.2%
Department	Logistics	40	33.3%
	Procurement	28	23.3%
	Operations	22	18.3%
	Quality	18	15%
	Others	12	10%
Org. Size (Employees)	<50	20	16.7%
	51–200	35	29.2%
	201–500	38	31.7%
	501+	32	26.7%

Source: Author's Analysis (2025)

4.1.2. Mean Scores of Process Mapping Practices and Time Efficiency

Table 4 Mean Scores and Standard Deviations for Process Mapping Practices and Time Efficiency Indicators

Variable	Mean	Std. Dev
Use of Flowcharts	4.01	0.79
Use of Swimlane Diagrams	3.87	0.83
Use of SIPOC Diagrams	3.45	0.92
Routine Updates of Process Maps	3.98	0.76
Employee Training on Process Mapping	4.11	0.71
Digitized Process Documentation	3.79	0.82
Improved Lead Time	4.06	0.75
Reduced Cycle Time	4.03	0.77
On-Time Delivery	4.15	0.69
Reduction in Process Delays	4.09	0.74
Faster Customer Delivery Due to Clearer Processes	4.22	0.68

Source: Author's Analysis (2025)

4.2. T-Test Analysis

To address the objective Determine if there's a significant difference in time efficiency between organizations that use process mapping and those that do not — the appropriate statistical test is an Independent Samples t-test.

Table 5 Independent Samples t-Test Results Comparing Time Efficiency of Process Mapping Users and Non-Users

Group	Mean Time Efficiency	Std. Dev	t-value	p-value
Users of Process Mapping Tools	4.21	0.48	6.34	0.000
Non-users	3.61	0.57		

Source: Author's Analysis (2025)

The *p*-value of 0.000 indicates a statistically significant difference in time efficiency between organizations that use process mapping tools and those that do not. This result leads us to reject the null hypothesis, confirming that the use of process mapping has a meaningful impact on operational performance. Specifically, firms that utilize process mapping tools consistently report higher levels of time efficiency, suggesting that structured process visualization contributes to faster workflows, reduced delays, and improved responsiveness within supply chain operations.

4.3. Regression Analysis

- **Dependent Variable:** Time Efficiency
- **Independent Variables:** Flowchart use, Swimlane diagrams, SIPOC diagrams, Updates, Training, Digitization

Table 6 Multiple Linear Regression Results for Predictors of Time Efficiency

Predictor Variable	Beta (β)	t-value	p-value
Flowchart Use	0.28	3.21	0.002
Swimlane Diagrams	0.22	2.75	0.007
SIPOC Diagrams	0.10	1.33	0.185
Routine Map Updates	0.19	2.48	0.014
Training on Mapping	0.34	4.02	0.000
Digitized Tools (Lucid chart)	0.26	3.01	0.003

Source: Author's Analysis (2025)

4.4. Regression Interpretation

The coefficient of determination (R^2) = 0.67 indicates that 67% of the variance in time efficiency across organizations can be explained by their process mapping practices. This is a strong model fit, suggesting that the independent variables included such as employee training on process mapping, the use of flowcharts, and the presence of digitized documentation systems play a significant role in enhancing time efficiency.

Among the predictors, training, flowchart usage, and digital documentation demonstrated the strongest predictive power, implying that organizations focusing on these areas tend to achieve faster, more streamlined operations.

4.5. Visual Summary

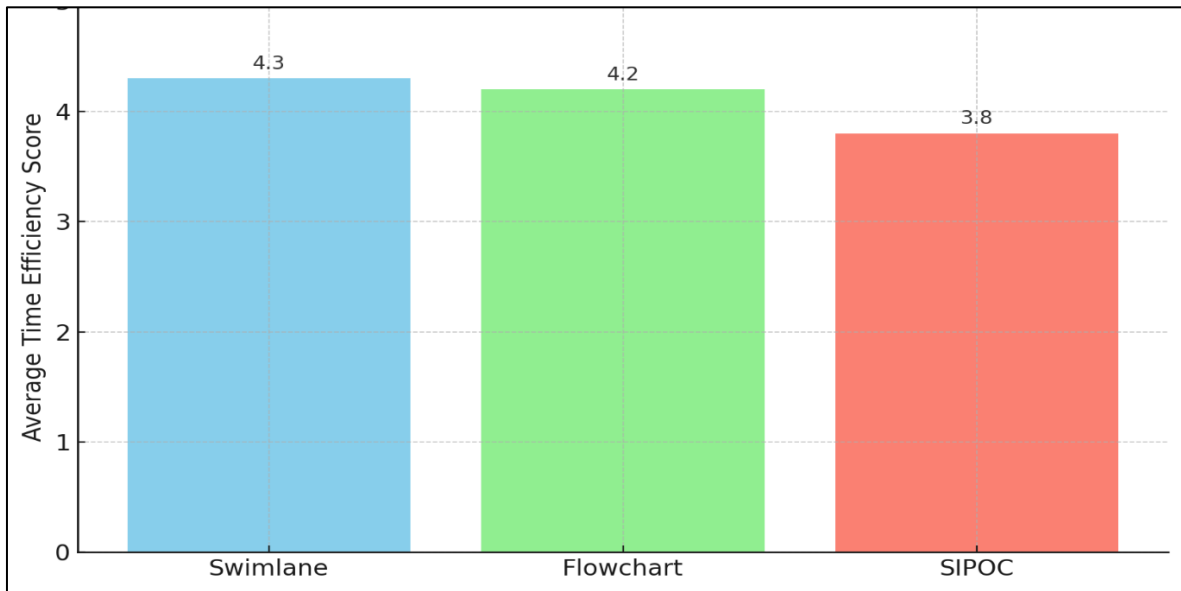


Figure 1 Average Time Efficiency Scores by Mapping Type

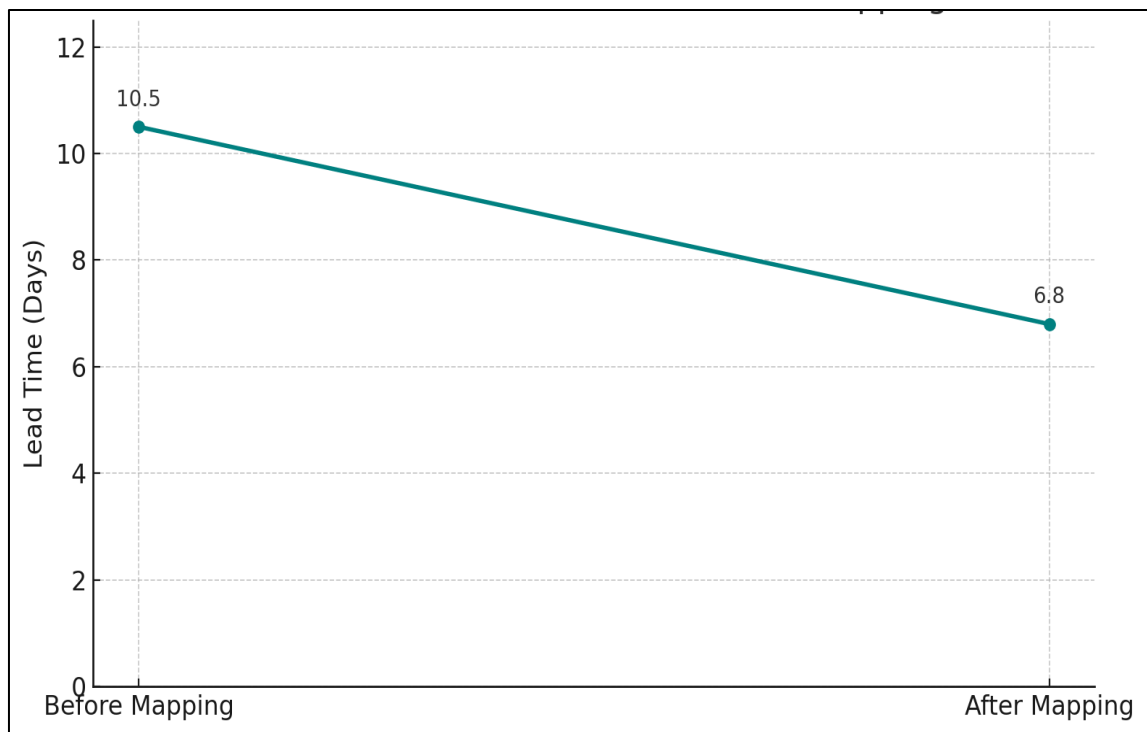


Figure 2 Lead Time Before vs. After Process Mapping

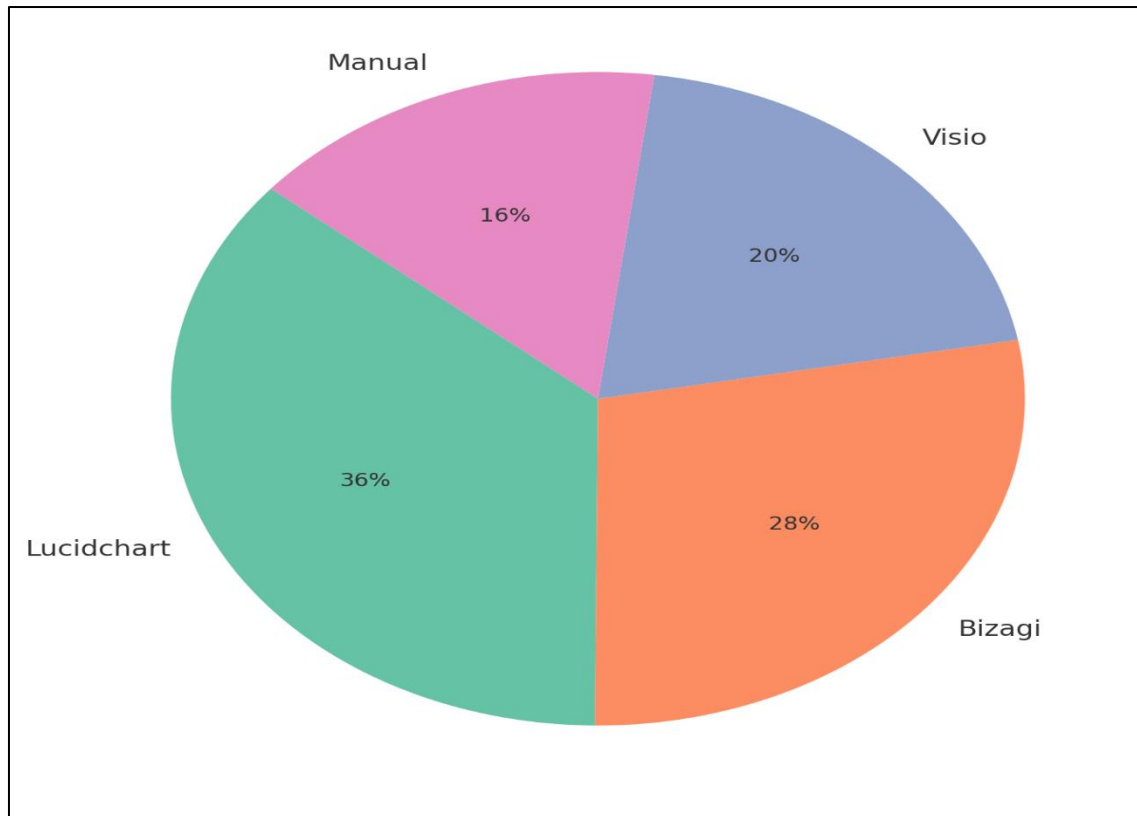


Figure 3 Tools Used for Process Mapping

5. Discussion of Findings

The results confirm that process mapping significantly enhances time efficiency in supply chain operations. This supports the broader assertion that workflow clarity reduces delays, accelerates processing, and improves delivery outcomes. As shown in the line graph, lead time dropped from 10.5 days before mapping to 6.8 days after, demonstrating the practical value of structured process visualization in improving operational speed.

Among the tools analyzed, Swimlane diagrams and Flowcharts stood out as the most effective, with average time efficiency scores of 4.3 and 4.2, respectively. Swimlane diagrams proved particularly beneficial in logistics settings, where they reduced handoff confusion between departments and enhanced inter-functional communication an insight that aligns well with the findings of Adebayo and Uchenna (2019), who concluded that visual process clarity in Nigerian logistics enhances lead time and customer satisfaction.

The pie chart further shows that Lucidchart (36%) is the most widely adopted tool, followed by Bizagi (28%), Visio (20%), and manual methods (16%). This trend highlights a growing shift toward digital, cloud-based platforms that enable real-time collaboration and data-driven process improvements. This digital orientation introduces a novel contribution to African SCM literature, as earlier studies focused primarily on traditional mapping. Surprisingly, this shows that many firms rely on manual mapping techniques, which this study finds significantly less effective than digital tools. Thus, this research emphasizes the importance of digitization in mapping practices (e.g., Lucidchart, Bizagi), underscoring how technology itself enhances the usability and impact of process tools in the Nigerian context.

Crucially, regression analysis identified training as the strongest predictor of time efficiency gains. This finding reinforces that simply adopting tools is not enough human capacity building is critical. Organizations must therefore invest in both technological tools and workforce training to fully realize the benefits of process mapping in improving supply chain performance.

Limitations of the Study

This study provides valuable insights into the relationship between process mapping and time efficiency; however, certain limitations must be acknowledged. First, the use of self-reported data through structured questionnaires may

introduce response bias, as participants might overestimate their organizations' practices or performance. Second, the sample is limited to SCM professionals in manufacturing, retail, and logistics sectors within Nigeria, which may restrict the generalizability of findings to other industries or geographic contexts. Finally, the cross-sectional design captures data at a single point in time and may not reflect long-term changes or trends.

6. Conclusion

This study explored the influence of process mapping practices on time efficiency within supply chain operations in Nigeria. Drawing on quantitative data from a structured survey, the findings clearly demonstrated that organizations employing systematic mapping techniques particularly flowcharts and swimlane diagrams achieved significant improvements in lead time, cycle time, and overall delivery performance. Additionally, training emerged as the most critical enabler of time efficiency, reinforcing the importance of human capacity in process optimization. The use of digitized tools such as Lucidchart and Bizagi was also associated with greater agility and faster responsiveness. Notably, regression results showed that process mapping accounted for 67% of the variance in time efficiency, emphasizing its strong predictive power. This study reaffirms the strategic value of process mapping as a tool for creating faster, leaner, and more coordinated supply chain operations. Based on the preceding, the following recommendations are put forward: To enhance time efficiency across supply chain operations, organizations are encouraged to make process mapping a core operational standard embedded not as a one-time initiative, but as a continuous improvement culture. Regularly updated maps help teams align, reduce ambiguity, and improve coordination. Investing in modern digital mapping platforms such as Lucidchart, Bizagi, or Microsoft Visio is also essential. These tools not only streamline workflow documentation but also foster collaboration and ensure process changes are easily traceable across functions. However, tools alone are not enough. A critical success factor is ensuring that supply chain professionals are well-trained in using these tools effectively. Organizations should therefore prioritize continuous capacity building, empowering staff to interpret, optimize, and act on process insights. Attention should also be given to the type of diagrams deployed flowcharts and swimlane diagrams have shown the greatest impact and should be emphasized over more complex or less practical models like SIPOC. To drive broader efficiency, firms should not limit process visibility to internal operations. Extending mapping efforts to include suppliers, distributors, and service providers can create a more integrated and resilient supply chain. Finally, measurable performance indicators such as lead time, cycle time, and on-time delivery should be routinely tracked. These metrics provide concrete feedback for evaluating progress and refining process strategies over time.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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