INTERNATIONAL JOURNAL OF INNOVATION, ENTERPRISE, AND SOCIAL SCIENCES

ISSN 2454-6186
Volume 5, Issue 1, Pages 391-407, October, 2025
Journal Website: https://scholarnestpublishers.com/index.php/IJIESS

SUPPLY CHAIN MAPPING AND PERFORMANCE OF MANUFACTURING FIRMS IN NAIROBI CITY COUNTY, KENYA

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ABSTRACT

Supply chain efficiency is a critical factor in determining the success and performance of manufacturing firms, especially in dynamic and competitive environments. This study examines the influence of supply chain mapping on the performance of manufacturing firms in Nairobi City County, Kenya, focusing on material mapping and information mapping. Despite extensive research on supply chain management, existing literature does not adequately explore the interrelationships between supply chain mapping and firm performance in developing economies, particularly in Kenya. This study was guided by four theoretical frameworks: the Resource-Based View (RBV), Stewardship Theory, Systems Theory, and Social Exchange Theory. A descriptive survey research design was employed, targeting manufacturing firms operating in Nairobi City County, Kenya. According to the Kenya National Bureau of Statistics (KNBS, 2021), there are approximately 630 manufacturing firms in the county. A sample size of 239 firms were determined using Krejcie and Morgan's (1970) formula, ensuring proportional representation across different manufacturing sectors. Stratified random sampling was applied to categorize firms by industry type and select respondents. Primary data was collected using semi-structured questionnaires and key informant interviews, targeting supply chain managers, procurement officers, operations managers, and finance managers. A pilot test (10% of the sample size) was conducted to assess instrument reliability. The results affirmed the instrument's robustness for the main study. Data analysis involved descriptive statistics (means, standard deviations, frequency distributions) and inferential statistics (multiple regression analysis) to assess relationships between supply chain mapping dimensions and firm performance. Thematic analysis was applied to analyze qualitative data from open-ended responses and interviews. Findings revealed that the variables significantly predicted performance, with information mapping ($B = 0.362$, $p < 0.05$) emerging as the strongest predictor, followed by material mapping ($B = 0.287$, $p < 0.05$). The study concluded that digitalized mapping enhance efficiency, profitability, and competitiveness. It recommended that firms prioritize investment in advanced tracking systems, real-time data integration, automated financial tools, and structural agility, while pursuing these practices in an integrated and holistic manner to maximize performance outcomes.

Key Words: Supply Chain Mapping, Material Mapping, Information Mapping, Performance of Manufacturing Firms Nairobi City County, Kenya

Background of the Study

Manufacturing industries play a critical role in economic growth and development (Fafchamps & Quinn, 2019). Manufacturing provides a significant source of demand for goods and services in other sectors of the economy, however, the sales to other industries are not captured in measures of manufacturing sector GDP but are counted in the broader measure of its gross output. Based on the recent statistics, manufacturing contributes £ 6.7 trillion to the global economy (Suleiman, 2018). The manufacturing sector employed 12.4 million workers in 2015 or about 8.8 percent of total U.S employed population (Suleiman, 2018). Manufacturing industries generated $2.1 trillion in GDP (12.5 percent of total U.S. gross domestic product) in 2013. In the United Kingdom, manufacturing makes up 10% of GVA and 45% of UK exports and directly employs 2.7 million people (Merozwa, 2019).

Although the best performing firms in most African countries are productive even by international standards, and firms in some sectors are as productive as those in East Asia (Banerjee & Majundar, 2018), the average manufacturing firm in Sub-Saharan Africa is three times less productive than the average firm in the best performing East Asian countries. The average firm in Sub-Saharan Africa produces about US$3,300 of output per worker in 2015 dollars (Ajibike & Arema, 2020). In comparison, the average firm in the successful East Asian exporting economies (China, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam) produces about US$6,500 of output per worker. The results are also consistent with the fact that firms in China are more productive than firms in Vietnam and that the latter, in turn, are more productive than firms in the three African countries they studied (Fafchamps & Quinn, 2019).

Supply chain mapping has been used around the world to investigate and improve industry or service sectors or groups of businesses (Porter, 2019). The technique is valid across many economic contexts and settings (Didonet, 2019). Stein and Barron (2020) in their study on mapping actors along value chains in Colombia, Sri Lanka concluded that supply chain mapping is an important means of understanding better the opportunities and or constraints producers face if they are to benefit from participating in value chains. The combination of supply chain mapping with visual network research approaches and participatory statistics has the potential to complement existing supply chain mapping approaches and to generate new insights that would be difficult to obtain using traditional questionnaire surveys alone (Burns & Worsely, 2019).

Organizations engage in a number of activities to meet and exceed their customers and owners needs (Todeva & Rakhmatullin, 2019). These activities are viewed to constitute the supply chain mapping of the organization (Basol, Bellamy & Park, 2020). Supply chain shows the full range of activities that should be carried out by organizations to bring a product or service from its conception to its end use and beyond (Rahul *et al.,* 2018). The Australian Centre for International Agriculture Research (2019) defines supply chain mapping as the process of creating a visual representation of the flow of materials, information, and finances as they move from supplier to manufacturer to wholesaler to retailer to consumer. This map helps businesses understand and optimize their supply chain by identifying key components, processes, and potential bottlenecks (Porter, 2019).

Statement of the Problem

The manufacturing sector has a great potential for promoting economic growth and competitiveness in the country like Kenya. Data shows that the Government of Kenya spends between 10% - 30% of Gross Domestic Product on procurement alone (Maria, 2023). In Kenya, manufacturing sector is the third leading sector contributing to GDP in Kenya. It contributed 11% of the GDP in 2020 (Kenya Association of Manufacturers, 2020). However, since 2020 some manufacturing firms in Kenya closed their business due to poor performance while others

have been forced to relocate their manufacturing plants to other countries. Some companies have also scaled down their manufacturing capacity.

However, the manufacturing sector has experienced the fluctuations over the years under different financial conditions. Data from the Kenya National Bureau of Statistics shows that the manufacturing sector grew by 3.6 percent in the first quarter of 2018, down from 4.1 percent growth in the first quarter of 2020. In the third quarter of 2018, the sector's growth rate was 1.9 percent compared to 3.3 percent in the same quarter in 2020 (Kenya National Bureau of Statistics, 2020). The Kenya Vision 2030 identifies the manufacturing sector as one of the key drivers in the economic pillar for realizing a sustained annual GDP growth of 10 percent geared to make Kenya a middle-income country by the year 2030. Despite the government efforts in improving macroeconomic conditions as well as market de-regulation, the performance of the manufacturing sector according to the Kenya Economic report 2020 regarding contribution to GDP has remained below the medium-term plan and Vision 2030 targets (Njoroge, 2019). Research has shown that supply chain mapping influences firm performance.

Various studies have been conducted on supply chain mapping and organization performance. For instance; Islam and Qamari (2021) researched on Effect of Supply Chain Management on Competitive Advantage and Organizational Performance. Studies on the Batik Industry in Yogyakarta City. Abdul-Rahaman, (2019) conducted a study on Coordination and Impact of Agri-food Value Chains on Farm Performance: Evidence from Smallholder Rice Farmers in Northern Ghana. Anaja, and Bagobiri, (2022) researched on the effect of supply chain management on organizational performance of Selected Fast-Moving Consumer Good in Karu, Nigeria. However, none of these studies focused on performance of manufacturing firms in Nairobi City County, Kenya. To fill the highlighted gaps, the current study sought to examine the influence of supply chain mapping on performance of manufacturing firms in Nairobi City County, Kenya.

Objectives of the Study

The general objective of this study was to examine the influence of supply chain mapping on performance of manufacturing firms in Nairobi City County, Kenya

Specific Objectives

i. To determine the influence of material mapping on performance of manufacturing firms in Nairobi City County, Kenya

ii. To establish the influence of information mapping on performance of manufacturing firms in Nairobi City County, Kenya

LITERATURE REVIEW

Theoretical review

Stewardship Theory

The Stewardship Theory, developed by Donaldson and Davis (1991), posits that managers act as stewards of organizational resources, prioritizing the firm’s success over personal interests. This theory stands in contrast to Agency Theory, which assumes that managers primarily act out of self-interest and require monitoring and incentives to align their goals with those of the organization (Davis, Schoorman, & Donaldson, 1997). Stewardship Theory suggests that when managers are entrusted with decision-making authority, they work towards maximizing firm performance rather than engaging in opportunistic behaviors.

In the context of supply chain mapping, stewardship-oriented managers focus on long-term efficiency, supplier collaboration, and risk mitigation. By implementing transparent procurement strategies and ensuring real-time information flow, firms can enhance their

operational efficiency (Hernández, 2020). Research by Hernández and Luthans (2021) found that firms where managers embraced stewardship principles were more likely to develop integrated supply chain networks, leading to improved firm competitiveness.

However, a major critique of Stewardship Theory is that it assumes all managers are naturally inclined to act in the best interest of the organization. In reality, external market pressures, profit-driven incentives, and corporate governance structures can influence managerial behavior, sometimes leading to suboptimal decision-making (Boyd, Haynes, & Hitt, 2012). Despite these limitations, this theory remains relevant to the study as it highlights the importance of management leadership and accountability in ensuring the successful implementation of supply chain mapping.

Resource Based View Theory

The Resource-Based View (RBV) Theory, originally introduced by Penrose (1959) and later expanded by Wernerfelt (1984) and Barney (1991), argues that a firm's competitive advantage stems from its internal resources and capabilities. According to Barney (1991), firms that possess valuable, rare, inimitable, and non-substitutable (VRIN) resources can achieve sustained competitive advantage. RBV shifts the focus from external market conditions to firm-specific strengths, emphasizing that superior performance is driven by how well a firm utilizes its resources.

In the context of supply chain mapping, RBV is particularly relevant because firms that effectively map their materials, financial resources, and information flow gain a competitive edge through operational efficiency and cost reduction (Hitt, Xu, & Carnes, 2016). A study by Bromiley and Rau (2020) found that firms with well-structured supply chain maps were better able to allocate resources strategically, reducing costs and improving delivery lead times. Additionally, RBV highlights the importance of technological investments in enhancing supply chain visibility and responsiveness (Grant, 2019).

Despite its strengths, RBV has been criticized for focusing too much on internal factors while neglecting external market dynamics and industry-wide disruptions (Priem & Butler, 2001). In highly dynamic environments, such as the manufacturing sector, firms must also consider competitive pressures, regulatory changes, and technological advancements. Nevertheless, RBV remains relevant to this study as it underscores how efficient resource allocation through supply chain mapping contributes to superior firm performance.

Conceptual Framework

A conceptual framework is a device that organizes empirical observations in a meaningful structure (Shapira, 2019). It forms part of the agenda for negotiation to be scrutinized, tested, reviewed and reformed as a result of investigation and it explains the possible connections between the variables (Durham & Stokes, 2015).

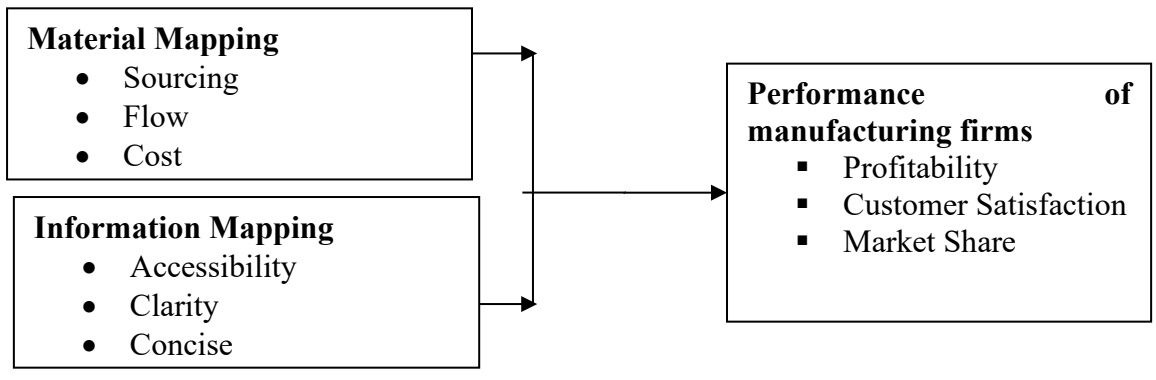

Figure 2. 1: Conceptual Framework

Material Mapping

Material mapping is a critical supply chain management strategy that involves tracking, sourcing, and optimizing the movement of raw materials, components, and finished products within a firm. Efficient material mapping ensures just-in-time inventory management, waste reduction, and operational efficiency, all of which directly impact firm performance (Cohen & Kunreuther, 2021). The ability to visualize the material flow across the supply chain provides firms with real-time insights into supplier performance, production scheduling, and demand fluctuations (Ivanov & Dolgui, 2020).

According to Ghadge et al. (2021), firms that adopt digital material mapping solutions, such as RFID, blockchain, and AI-driven logistics platforms, have witnessed enhanced supply chain visibility, better forecasting accuracy, and cost reductions of up to 30%. Their study on global manufacturing firms found that those using automated material mapping systems reduced their procurement lead times by 40%, enabling them to respond more effectively to market demands.

A more recent study by Wamba et al. (2022) highlights that material mapping is no longer just about tracking physical materials but also includes sustainability considerations. The concept of circular supply chains, where firms integrate recycled materials into production processes, is becoming a global trend. Their study found that firms implementing sustainable material mapping strategies improved customer trust, regulatory compliance, and brand reputation, which in turn enhanced financial performance.

However, challenges persist. Xu, Duan, and Luo (2023) argue that disruptions caused by geopolitical tensions, supply chain bottlenecks, and fluctuating raw material costs make material mapping a complex task. They emphasize the need for AI-driven predictive analytics to anticipate supply chain shocks and proactively adjust procurement strategies.

Overall, effective material mapping contributes to improved manufacturing performance by enhancing production efficiency, ensuring resource optimization, and reducing supply chain risks. Firms that invest in intelligent, real-time material tracking and automation technologies are more likely to gain a competitive advantage in volatile markets.

Information Mapping

Information mapping refers to the systematic structuring, analysis, and dissemination of supply chain data to enhance decision-making, demand forecasting, and production planning (Tjahjono et al., 2020). The integration of real-time data exchange and cloud-based supply chain platforms has revolutionized the way firms manage their operations (Van Hoek, 2021). A study by Nguyen et al. (2021) found that firms adopting cloud-based ERP systems experienced increased operational transparency, improved supplier coordination, and faster response times to market fluctuations. Their findings indicate that real-time data exchange among supply chain stakeholders reduced demand uncertainties and enhanced overall firm agility.

Additionally, Kaur et al. (2022) argue that the implementation of big data analytics in supply chain mapping has led to higher accuracy in demand forecasting, optimization of warehouse inventory, and improved production planning. Their study on automotive manufacturers revealed that firms utilizing machine learning algorithms for information mapping reduced order fulfillment errors by 25% and improved supply chain efficiency by 18%.

Despite these advancements, information mapping remains a challenge in many firms due to data fragmentation, cybersecurity risks, and lack of system interoperability. Shaikh et al. (2023) found that 65% of manufacturers struggle with fragmented supply chain data, leading to delayed decision-making and inefficiencies in production cycles. The authors recommend blockchain-based supply chain networks as a potential solution to enhance information security, improve data accuracy, and foster greater trust among supply chain partners.

Thus, information mapping is a vital enabler of supply chain resilience. Firms that leverage AI-driven analytics, cloud integration, and blockchain security for supply chain data management are better positioned to adapt to disruptions and optimize operational performance.

Performance of Manufacturing Firms in Nairobi City County, Kenya

Firm performance is a key measure of an organization's success and sustainability, particularly in the manufacturing sector, where supply chain efficiency, cost management, and innovation significantly impact business outcomes. It refers to how well a firm achieves its strategic and operational goals in areas such as profitability, operational efficiency, competitive positioning, and customer satisfaction (Agyabeng-Mensah et al., 2020). The effectiveness of supply chain management, including material mapping, information sharing, and financial structuring, plays a vital role in firm performance (Lee et al., 2022). This section reviews firm performance in terms of its dimensions, measurement approaches, and how supply chain mapping influences its outcomes.

Customer satisfaction is a fundamental aspect of firm performance, as it influences market positioning and long-term profitability. Research by Wang et al. (2020) on the impact of digital supply chains in Malaysian manufacturing firms found that real-time information mapping enhances order fulfillment accuracy and reduces delivery delays by 20%, leading to greater customer loyalty. Additionally, competitive advantage is closely linked to a firm's ability to respond to market changes, supply chain disruptions, and technological advancements. Nilashi et al. (2021) examined the role of AI and IoT-driven supply chain mapping and found that firms using digital supply chain systems gained a 25% competitive advantage over those with traditional models.

Several models are used to measure firm performance in relation to supply chain management. Kaplan and Norton’s (1996) Balanced Scorecard (BSC) is a widely adopted framework that assesses performance through financial, customer, internal process, and learning/growth perspectives. The Supply Chain Performance Measurement System (SCPMS) proposed by Gunasekaran et al. (2020) emphasizes the importance of inventory turnover, order fulfillment rates, and cost efficiency as indicators of firm success. Furthermore, Alshurideh et al. (2022) explored the role of trust and supply chain integration in organizational performance, demonstrating that firms with well-integrated supply chain partnerships achieve 30% higher supply chain reliability.

In conclusion, firm performance is a multi-dimensional concept influenced by supply chain efficiency, financial stability, customer satisfaction, and competitive agility. Recent studies confirm that supply chain mapping enhances firm performance by improving material tracking, financial transparency, and supplier collaboration. However, firms in developing economies like Kenya face challenges such as technological constraints, high costs of digital adoption, and resistance to change. This study aims to bridge these gaps by examining how supply chain mapping impacts firm performance in the Kenyan manufacturing sector, providing empirical insights for improved decision-making in supply chain management.

Empirical Review

Material Mapping

Material mapping ensures effective tracking and movement of raw materials, reducing supply chain inefficiencies and enhancing firm performance. A study by Zelbst, Green, and Sower (2020) in North America examined the impact of RFID, Industrial Internet of Things (IIoT), and blockchain technologies on material flow transparency. The study adopted a quantitative survey approach, collecting data from 312 manufacturing firms. Using structural equation modeling (SEM), the study found that firms implementing RFID and blockchain-based material mapping experienced a 30% improvement in supply chain visibility and a 25%

reduction in material loss. The study underscores the role of digital technologies in enhancing material flow and operational efficiency.

In South Africa, Madzimure (2020) investigated supply chain robustness, firm competitiveness, and performance in logistics firms. The study employed a mixed-method research design, combining questionnaires and interviews to collect data from 300 logistics firms. The study revealed that firms with structured material mapping systems experienced higher supply chain resilience, minimized stock-outs, and improved delivery efficiency. Regression analysis showed a strong correlation between material flow management and firm performance, emphasizing the role of digital material tracking systems.

Similarly, Müller and Schwarzkopf (2020) in Germany analyzed multi-tier material flow transparency in the automotive industry. A longitudinal case study method was used, tracking material flows across 50 suppliers over three years. Findings revealed that firms implementing supplier-integrated material mapping reduced lead times by 40% and improved production efficiency. The study recommended AI-driven analytics for enhanced material mapping.

Waqas and Tan (2023) in South Africa explored the role of big data analytics (BDA) in sustainable material mapping. Using panel data from 150 South African manufacturers, the study applied econometric modeling and found that firms leveraging BDA in material tracking reduced production waste by 35% and achieved sustainability compliance. The study emphasizes the need for digital innovations in material flow optimization.

In Nigeria, Aigbedo (2021) examined the effect of financial performance on environmental sustainability in supply chains. A quantitative survey of 472 Nigerian firms using logistic regression found that companies with strong material mapping practices had better environmental compliance and reduced waste generation. The findings highlight the financial benefits of adopting sustainable material mapping practices.

Information Mapping

Information mapping improves supply chain coordination, transparency, and decision-making. Recent studies have explored its impact on firm performance in diverse industrial contexts. A study by Mikalef and Gupta (2021) in Europe explored the relationship between business intelligence systems and supply chain information mapping. The study used a quantitative research design, surveying 310 European manufacturing firms. Employing regression analysis, findings showed that firms using AI-driven information mapping experienced a 35% increase in supply chain agility and a 28% reduction in stock misallocation errors.

Lis, Sudolska, and Tomanek (2020) in Poland investigated sustainable supply chain information mapping. Their case-study methodology analyzed ten multinational corporations, finding that companies with advanced information mapping capabilities achieved sustainability compliance and improved environmental performance.

In South Africa, Chen, Li, and Zhang (2021) conducted a meta-analysis on supply chain leadership and firm performance, focusing on information mapping practices. Their study analyzed secondary data from 600 South African manufacturing firms using logistic regression models. The results indicated that firms integrating real-time information mapping systems reported 20% faster production cycles and higher customer satisfaction.

In Nigeria, Salam and Bajaba (2023) examined the role of supply chain resilience and information mapping in improving firm performance. Using a cross-sectional study design, the study surveyed 350 firms across different manufacturing sectors. Regression analysis showed that firms with effective information mapping practices mitigated supply chain disruptions by 45%. Wanasida et al. (2021) in Kenya studied supply chain agility and information mapping during the COVID-19 crisis. Using case-study analysis, the study found that firms with digitalized supply chain information mapping were more adaptable to market disruptions.

RESEARCH METHODOLOGY

For this study, descriptive research design was utilized to investigate and additionally clarify existing status of affairs pertaining the objectives of a research. The major purpose of descriptive research design is to describe the state of affairs as it is at the time, and as Cooper & Schindler (2018) observe, a descriptive research design is a process of collecting data in order to answer questions concerning the current status of the subjects in the study in their natural set up, as they occur. The target population for this study was manufacturing firms in Kenya. Information on the firms was retrieved from Kenya Association of Manufacturers (KAM, 2022). The manufacturing firms were the unit of analysis while the top manager were the unit of observation. According to KAM (2024), the total number of manufacturing firms is 105. This study therefore targeted senior management employees (1 top management employee, 2 middle level management employees and 3 lower management employees) in all the 105 firms. The total target population was therefore 630 employees. The study's sample size was reached at using Krejcie and Morgan sample size determination formula (Russell, 2013).

Table 1: Sample Size

Category	Target Population	Sample Size
Top Management Employees	105	42
Middle Level Management Employees	210	77
Lower Management Employees	315	120
Total	**630**	**239**

The 239 respondents were chosen with the help of stratified random sampling technique. This study used semi-structured questionnaires and Secondary Data Collection Sheet to collect the primary data for the study. According to (Mugenda & Mugenda, 2018) questionnaire is a pre-formulated written set of questions to which the respondents record the appropriate responses as indicated and in accordance with the question's options provided if any.

Pilot study facilitated pre-testing and validation of the questionnaire. Cronbach's alpha methodology, which measures internal consistency, was used. Cronbach's alpha provides the average of the measures of the items that are measurable and their correlations. This is in line with the research design to be used in this study. The main aim of the pilot test is testing how reliable the data collection tool is. A total of 24 respondents participated in the pilot test which represents 10% of target population. Findings of pilot test was not included in the actual study.

Quantitative and qualitative data was generated from the closed-ended and open-ended questions, respectively. Qualitative data was analysed on thematic basis and the findings provided in a narrative form. Inferential and descriptive statistics were employed for analysis of quantitative data with the assistance of Statistical Package for Social Sciences (SPSS version 28). Descriptive statistics such as frequency distribution, mean (measure of dispersion), standard deviation, and percentages were used. Inferential data analysis was conducted by use of Pearson correlation coefficient, and multiple regression analysis.

RESEARCH FINDING AND DISCUSSION

Out of the 239 questionnaires distributed to the target respondents, a total of 202 were duly filled and returned, representing an effective response rate of 84.5%. According to Mugenda and Mugenda (2003), a response rate of above 70% is considered excellent for survey studies, implying that the data collected in this study is sufficient for valid statistical analysis and generalization to the population.

Descriptive Analysis

This section presents the descriptive statistics of the study variables in order to provide an overview of respondents' perceptions regarding material mapping, information mapping, and performance of manufacturing firms. All items were measured on a five-point Likert scale ranging from 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Somehow Agree, and 5 = Agree. The interpretation of mean scores was guided by the following thresholds: 1.00–1.80 (Strongly disagree), 1.81–2.60 (disagree), 2.61–3.40 (Moderate), 3.51–4.20 (agree), and 4.21–5.00 (Strongly agree). Standard deviation (SD) was used to assess variability in responses, where SD < 0.5 indicates high consensus among respondents, SD between 0.5–1.0 indicates moderate variability, and SD > 1.0 suggests diverse views. The results provide a foundation for interpreting patterns and trends in supply chain mapping practices and their relationship with organizational performance.

Material Mapping

This section examines how material tracking, sourcing, and inventory management influence supply chain performance. Respondents were asked to indicate their level of agreement with eight statements on material mapping. Table 2 presents the mean and standard deviation (SD) scores for each item.

Table 2: Descriptive Statistics for Material Mapping

Statement	Mean	SD
Our firm uses real-time tracking systems (e.g., RFID, barcode) for material flow monitoring.	3.742	0.671
Material mapping has improved our inventory accuracy and minimized stock-outs.	3.856	0.613
We have clear visibility of our raw material sources and suppliers.	3.781	0.592
Digitalization of material tracking has improved operational efficiency in our firm.	3.912	0.548
Supplier coordination has improved due to material mapping strategies.	3.733	0.657
Material mapping has helped in reducing procurement lead times.	3.678	0.629
Our company applies predictive analytics to forecast material requirements.	3.691	0.701
Material tracking has enhanced the overall supply chain responsiveness in our firm.	3.843	0.566
Aggregate Score (Material Mapping)	**3.780**	**0.622**

The analysis of material mapping reveals varying levels of agreement among respondents on its contribution to supply chain performance. The results show that digitalization of material tracking improving operational efficiency received the highest support (M = 3.912, SD = 0.548). The low dispersion demonstrates that most respondents consistently acknowledge digital technologies such as RFID, barcoding, and ERP systems as effective in streamlining operations. Likewise, inventory accuracy and minimized stock-outs were strongly affirmed (M = 3.856, SD = 0.613), indicating that material mapping systems enhance reliability in demand fulfillment. Visibility into raw material sources and suppliers was also rated highly (M = 3.781, SD = 0.592), showing that respondents recognize the value of mapping in understanding upstream dependencies.

Improvements in overall supply chain responsiveness were evident, with respondents agreeing that tracking enhances flexibility and agility (M = 3.843, SD = 0.566). Coordination with suppliers was also positively rated (M = 3.733, SD = 0.657), reflecting progress in aligning procurement and replenishment decisions. However, the findings indicate weaker agreement on the role of material mapping in reducing procurement lead times (M = 3.678, SD = 0.629). Although viewed positively, external bottlenecks such as transport delays and supplier constraints may limit the extent to which mapping shortens lead times. Similarly, the adoption

of predictive analytics to forecast material requirements received a moderate score (M = 3.691, SD = 0.701), with the higher variability suggesting uneven adoption across firms. Finally, the use of real-time tracking systems was moderately supported (M = 3.742, SD = 0.671), showing that while many firms apply such systems, others may still rely on manual or partially digitalized processes.

The aggregate score for material mapping was M = 3.780 (SD = 0.622), placing it within the "High" interpretation range. This indicates that firms in the study have embraced material mapping to a significant extent, with general consensus on its benefits despite some variation in advanced practices like predictive analytics. These findings align with the conceptual framework, which positions material mapping as a central supply chain strategy influencing firm performance. They are consistent with Cohen and Kunreuther (2021), who highlight that mapping ensures just-in-time inventory and waste reduction, and with Ivanov and Dolgui (2020), who emphasize its role in enhancing responsiveness and production scheduling. Moreover, the uneven benefits around forecasting and lead-time reduction mirror Ghadge et al. (2021), who found that while digital solutions improve forecasting accuracy and efficiency, adoption challenges often create disparities. Overall, the evidence suggests that material mapping contributes significantly to performance of manufacturing firms by improving visibility, coordination, and efficiency, though firms must strengthen predictive capabilities to fully unlock its potential.

Information Mapping

This section explores how firms utilize data, real-time tracking, and information sharing in their supply chains. Information mapping was assessed through eight statements focusing on digital platforms, demand forecasting, system integration, disruption management, big data analytics, transparency, AI-driven insights, and communication efficiency. Respondents expressed their level of agreement on a five-point Likert scale, where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Somehow Agree, and 5 = Agree. The results are summarized in Table 3.

Table 3: Descriptive Statistics for Information Mapping

Statement	Mean	SD
Our firm uses digital platforms for real-time supply chain data tracking.	3.889	0.564
Information mapping has enhanced our demand forecasting accuracy.	3.821	0.611
We have seamless integration between suppliers and our internal information systems.	3.768	0.653
Supply chain disruptions are minimized due to efficient data sharing.	3.843	0.587
Our firm applies big data analytics in supply chain decision-making.	3.713	0.696
Data transparency has improved supplier relationships and performance.	3.799	0.609
Our company uses AI-driven insights for supply chain efficiency.	3.702	0.689
Information mapping has helped in reducing communication errors across the supply chain.	3.776	0.574
Aggregate Score (Information Mapping)	**3.789**	**0.623**

The analysis of information mapping highlights how data utilization, real-time tracking, and information sharing enhance supply chain management. The results show that the highest-rated item was the use of digital platforms for real-time supply chain data tracking (M = 3.889, SD = 0.564). Respondents largely agreed that digital platforms such as ERP and cloud-based systems provide timely visibility across supply chain operations, and the relatively low variability suggests broad consensus on this practice. Similarly, enhanced demand forecasting accuracy through information mapping was strongly affirmed (M = 3.821, SD = 0.611), indicating that access to structured data enables firms to predict demand more reliably and reduce mismatches in production planning. The integration of suppliers with internal

information systems was also rated highly (M = 3.768, SD = 0.653), reflecting growing adoption of integrated IT solutions that link suppliers directly with firm operations.

Respondents also indicated agreement that supply chain disruptions are minimized due to efficient data sharing (M = 3.843, SD = 0.587). This finding shows that firms recognize information transparency as an important resilience mechanism, helping them respond faster to shocks and uncertainties. At the same time, the use of big data analytics in decision-making received moderate to high support (M = 3.713, SD = 0.696). The higher variability suggests that while some firms have embraced analytics-driven insights, others remain at early stages of adoption, pointing to gaps in technological readiness and analytical capacity. Furthermore, respondents noted that data transparency improves supplier relationships and performance (M = 3.799, SD = 0.609), confirming that open information exchange enhances collaboration, reduces opportunism, and builds trust.

Emerging digital practices such as the use of AI-driven insights for supply chain efficiency were positively rated (M = 3.702, SD = 0.689), though again with moderate variation across firms. This implies that while AI applications are recognized as valuable, adoption is uneven and possibly hindered by resource constraints or lack of technical expertise. Lastly, respondents agreed that information mapping reduces communication errors across the supply chain (M = 3.776, SD = 0.574), demonstrating that systematic data sharing minimizes misinterpretations, improves accuracy, and supports smoother operations.

The aggregate score for information mapping was M = 3.789 (SD = 0.623), which falls within the “High” range. This result suggests that overall, firms in the study have embraced information mapping practices and perceive them as essential to forecasting, disruption management, and efficiency. These findings closely align with the conceptual framework, which emphasizes information mapping as a systematic structuring of supply chain data to improve decision-making and agility. They are consistent with Van Hoek (2021), who observed that cloud-based platforms enhance operational transparency, and Nguyen et al. (2021), who reported improved forecasting and supplier coordination in firms adopting ERP systems. They also resonate with Kaur et al. (2022), who found that big data analytics significantly reduced errors in demand forecasting and improved efficiency. Taken together, the evidence underscores that information mapping not only strengthens internal processes but also improves resilience and collaboration across supply chains, thereby positioning firms to achieve higher performance outcomes.

Performance of Manufacturing Firms in Nairobi City County, Kenya

This section examines how supply chain mapping practices, encompassing material, and information, translate into overall performance of manufacturing firms. The items assessed efficiency, cost reduction, lead-time improvement, responsiveness, financial stability, supplier reliability, customer satisfaction, and competitiveness. Respondents rated their agreement on a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Agree. The results are presented in Table 4.

Table 4.: Descriptive Statistics for Performance of Manufacturing Firms

Statement	Mean	SD
Supply chain mapping has improved our overall operational efficiency.	3.889	0.547
Material, information, and financial mapping have contributed to cost reduction in our supply chain.	3.821	0.589
Effective supply chain mapping has helped our firm improve delivery lead times.	3.776	0.606
Supply chain mapping has enhanced our ability to respond to market changes and disruptions.	3.843	0.561
Financial mapping has contributed to improved financial stability and profitability.	3.864	0.573
Our firm has experienced improved supplier reliability due to supply chain mapping practices.	3.799	0.597
Supply chain mapping has increased customer satisfaction by ensuring timely delivery of products.	3.832	0.582
The integration of supply chain mapping strategies has strengthened our firm's competitiveness in the market.	3.868	0.559
Aggregate Score (Performance)	**3.836**	**0.577**

The findings show strong agreement that supply chain mapping enhances operational efficiency (M = 3.889, SD = 0.547). Respondents consistently viewed mapping as a driver of streamlined processes and resource optimization. Likewise, financial stability and profitability linked to financial mapping was highly rated (M = 3.864, SD = 0.573), suggesting that better allocation and tracking of financial flows directly translate into stronger performance outcomes. Competitiveness also emerged as a key benefit, with respondents agreeing that the integration of mapping strategies strengthens market positioning (M = 3.868, SD = 0.559), reflecting the role of mapping in building adaptive and resilient supply chains.

Respondents affirmed that supply chain mapping improves responsiveness to market changes and disruptions (M = 3.843, SD = 0.561), underscoring the role of visibility and information flow in ensuring resilience. Similarly, mapping was associated with greater customer satisfaction through timely deliveries (M = 3.832, SD = 0.582), which demonstrates how efficiency gains translate into improved service levels. Improvements in supplier reliability were also evident (M = 3.799, SD = 0.597), highlighting that mapping enhances supplier coordination and performance consistency.

Although all items scored in the “High” range, slightly lower agreement was observed in cost reduction (M = 3.821, SD = 0.589) and delivery lead-time improvement (M = 3.776, SD = 0.606). While these remain positive, they suggest that external bottlenecks such as supplier delays, logistics inefficiencies, and market volatility may limit the full realization of mapping’s benefits in reducing costs and compressing delivery cycles.

The aggregate score for performance of manufacturing firms was M = 3.836 (SD = 0.577), which falls in the “High” range. This confirms that supply chain mapping is perceived as a critical contributor to organizational success, enhancing efficiency, responsiveness, profitability, and competitiveness. These findings align with Agyabeng-Mensah et al. (2020), who emphasized that efficient supply chain management drives both operational and strategic performance outcomes. They are also consistent with Wang et al. (2020), who found that real-time information mapping improves order fulfillment and customer loyalty, and with Lee et al. (2022), who showed that integrated supply chain practices reduce costs and strengthen long-term sustainability.

The results therefore affirm that firms adopting comprehensive supply chain mapping strategies are better positioned to achieve multidimensional performance gains. This evidence reinforces

the conceptual framework, which posits supply chain mapping as a fundamental driver of competitiveness and resilience in manufacturing firms.

Correlation Analysis

Correlation analysis was conducted to examine the strength and direction of the relationship between the independent variables, material mapping, information mapping and the dependent variable, performance of manufacturing firms. Pearson's correlation coefficient (r) was used, with values ranging from -1 to +1. Positive values indicate a direct relationship, while negative values suggest an inverse relationship. The results of the analysis are presented in Table 4.10.

Table 5: Correlation Matrix

		Performance	Material Mapping	Information Mapping
Performance of manufacturing firms	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	105		
Material Mapping	Pearson Correlation	.623**	1	
	Sig. (2-tailed)	.000		
	N	207	207	
Information Mapping	Pearson Correlation	.671**	.376	1
	Sig. (2-tailed)	.000	.123	
	N	207	207	207

Correlation is significant at the 0.05 level (2-tailed).

The correlation results indicate a strong positive association between material mapping and performance of manufacturing firms ($r = 0.623$, $p < 0.05$). This suggests that improvements in tracking systems, supplier visibility, and inventory accuracy significantly enhance operational efficiency and responsiveness, ultimately leading to better firm outcomes. These findings resonate with Müller and Voigt (2018), who established that firms adopting advanced material tracking technologies achieve higher operational efficiency and reduced production waste. The implication for this study is that the ability to manage material flows effectively remains a cornerstone of performance improvement in manufacturing firms.

A strong positive correlation was observed between information mapping and performance of manufacturing firms ($r = 0.671$, $p < 0.05$), the highest among the predictors. This implies that structured data sharing, digital platforms, and real-time visibility greatly enhance forecasting accuracy, coordination, and responsiveness. Similar results were reported by Dubey et al. (2019), who found that big data and information-sharing platforms significantly improved supply chain agility and adaptability in manufacturing firms. For the current study, this highlights that information mapping is the most influential driver of performance of manufacturing firms, enabling organizations to anticipate changes and maintain competitiveness in volatile markets.

Regression Analysis

To determine the combined and individual influence of material mapping, information mapping, on performance of manufacturing firms, a multiple regression analysis was conducted.

Table 6: Regression Coefficients

Variable	Unstandardized B	Std. Error	Standardized Beta (β)	t	Sig.
Constant	0.742	0.211		3.52	0.001
Material Mapping	0.287	0.077	0.228	3.74	0.000
Information Mapping	0.362	0.067	0.314	5.41	0.000

The unstandardized coefficient for material mapping was B = 0.287, $p < 0.05$, indicating a statistically significant effect on performance of manufacturing firms. This means that a one-unit increase in material mapping leads to a 0.287-unit improvement in performance of manufacturing firms, when the other variables are held constant. The significance of this result implies that strengthening material tracking, inventory accuracy, and supplier visibility makes a measurable contribution to performance outcomes. This finding resonates with Gupta, Modgil, and Gunasekaran (2020), who demonstrated that digitalized material flow processes directly improved responsiveness and reduced waste in Indian manufacturing firms.

Information mapping recorded the highest unstandardized coefficient, B = 0.362, $p < 0.05$, making it the most influential predictor in the model. This shows that for every one-unit increase in information mapping, performance of manufacturing firms improves by 0.362 units, controlling for the other variables. The highly significant p-value underscores that digital data platforms, seamless information flows, and analytics-based decision-making are critical drivers of organizational success. These results align with Büyüközkan and Göçer (2018), who found that information transparency and analytics-based mapping significantly improved firm competitiveness and customer service levels in supply chain contexts.

Here's the fitted regression equation for predicting performance of manufacturing firms:

Performance of Manufacturing Firms = 0.742 + 0.287 Material Mapping + 0.362 Information Mapping

Conclusions

The study concludes that material mapping significantly enhances the performance of manufacturing firms by improving visibility, accuracy, and coordination across the supply chain. Firms that embraced digital tools such as real-time tracking and automated inventory systems experienced fewer stock-outs, more efficient procurement processes, and stronger supplier coordination. While challenges were noted in areas such as predictive analytics and reducing procurement lead times, the overall evidence demonstrated that material mapping remains a cornerstone of supply chain management. It provides firms with greater control over material flows, reduces inefficiencies, and contributes to sustained improvements in operational performance.

The study concludes that information mapping is the most influential determinant of firm performance among the four variables. Firms that adopted real-time data sharing platforms, big data analytics, and integrated supplier information systems were better positioned to forecast demand accurately, minimize disruptions, and adapt swiftly to market changes. These practices enhanced supply chain agility, resilience, and overall competitiveness. Although the adoption of advanced technologies such as AI-driven insights varied, the findings consistently emphasized the importance of data transparency and integration. Thus, information mapping emerges as a critical enabler of decision-making and agility, offering firms a strategic advantage in an increasingly volatile business environment.

Recommendations

Material Mapping

Based on the findings, it is recommended that manufacturing firms invest more in advanced material tracking technologies such as RFID, barcoding, and automated warehouse management systems. These tools will strengthen inventory accuracy, minimize stock-outs, and improve supply chain responsiveness. Firms should also develop predictive analytics capabilities to forecast material requirements more effectively, which would help address current gaps in lead-time reduction and proactive procurement planning. Additionally, supplier coordination should be institutionalized through shared platforms for material visibility, ensuring that both firms and their suppliers can monitor material flows in real-time. This will reduce bottlenecks, build trust, and enhance efficiency across procurement and production processes.

Information Mapping

Given its strong influence on performance, firms should prioritize the integration of digital platforms that allow real-time data sharing across supply chain partners. Manufacturing firms should establish centralized data repositories where suppliers, distributors, and internal departments can seamlessly access and update critical information. To build forecasting accuracy and resilience, firms should expand the use of big data analytics and AI-driven insights. This includes deploying algorithms to detect patterns in demand, anticipate disruptions, and recommend agile responses. Furthermore, firms should enhance cybersecurity and system interoperability, since data integrity and secure information flows are essential for sustaining trust and reliability in digitalized supply chains.

Areas for Further Research

Future research should extend this study by employing longitudinal or panel designs to capture dynamic effects and lag structures between supply chain mapping capabilities and firm performance outcomes. Researchers could also integrate objective operational and financial indicators, such as On-Time in Full (OTIF), Inventory Record Accuracy (IRA), Days Payable Outstanding (DPO), and logistics costs, to triangulate perceptual measures and provide a more comprehensive assessment of performance. In addition, examining interaction and mediation effects would enrich understanding of the relationships among the variables. For instance, future studies could investigate whether information mapping mediates the effect of material mapping on performance, or whether supply chain structure moderates the effectiveness of mapping practices in high-volatility environments. Comparative analyses across industries, counties, or regions would further test the generalizability of the findings, while cost–benefit evaluations of analytics adoption and automated payment systems could guide investment decisions for small and medium-sized enterprises.

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