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Supply Chain Performance in the Manufacturing Sector: The Role of Lead-Time Management Strategies

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Abstract

This research aimed to evaluate the effectiveness of lead-time management strategies in influencing the operational efficiency of manufacturing enterprises. While prior studies have recognized lead time as a crucial factor impacting supply chain performance, scant attention has been paid to the specific contribution of lead-time management strategies in this context. Hence, this study aimed to bridge this gap. Using a descriptive survey research design, data were collected from a sample of 153 manufacturing firms selected through purposive sampling. The primary data collection instrument was a structured questionnaire, and statistical analyses were conducted using SPSS software. The findings indicate that early involvement of suppliers in product design and dissemination of accurate customer specifications significantly reduces lead time. Process automation and efficient transport management, including route planning and vehicle scheduling, were found to enhance supply chain performance. Consequently, the study concludes that early supplier involvement, process automation, and effective transport management positively impact supply chain performance. Based on these findings, it is recommended that manufacturing companies prioritize initiatives aimed at reducing lead time, such as minimizing waiting times, engaging suppliers early in the process, automating processes, and improving transport management in order to enhance overall supply chain performance.

Keywords: Lead Time Management, Supply Chain Performance, Manufacturing Sector

A. INTRODUCTION

In the contemporary business landscape, there is a notable emphasis on minimizing lead time, a factor increasingly recognized for its significant impact on customer satisfaction and overall organizational effectiveness. Given the heightened competitiveness in today's global markets, customers exhibit reduced tolerance towards service delays, compelling suppliers to prioritize timely product delivery. Consequently, businesses strive to gain a competitive advantage and enhance profitability by streamlining operations, improving product quality, and optimizing lead time (Nuruzzaman, 2021). In industries characterized by intense competition, a shorter lead time is a distinguishing factor that can bolster sales and overall performance (Jamshidi & Ghomi, 2015). The management of lead time encompasses the development of strategies and procedures aimed at minimizing customer wait times while maintaining product quality and minimizing costs (Bernado & Salido, 2018). Organizations are deploying a range of strategies to reduce lead time and augment customer satisfaction, including early engagement with suppliers, collaboration with multiple suppliers, expediting cumbersome processes, and leveraging diverse transportation methods (Priyan & Uthayakumar, 2015; Godinho & Veloso, 2012; Keller & Ozment, 2014).

In Kenya, local companies have not given significant emphasis to lead time management strategies, resulting in persistent challenges related to customer satisfaction. This, in turn, impacts their overall revenue and competitive standing (Kimani, 2013). Across various industries in Kenya, reducing lead time within the supplier production distribution chain is perceived as a crucial element of time-based competition. Adequate lead time management can be a competitive advantage, ultimately enhancing customer satisfaction. Time management is often linked to quality, costs, innovation, and productivity (Mukunju, 2014). To address lead time issues, it is imperative to embrace the principles of Just in Time philosophy and prioritize continuous improvement initiatives, such as the implementation of flexible manufacturing cells (FMC) or flexible manufacturing systems (FMS), utilization of automation tools, and leveraging efficient information technology solutions (Tarty, 2012).

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Research conducted by (Nyamasege & Biraori, 2015) delineated lead time management as more than a mere task; instead, it is portrayed as a systematic process. This process entails the organization's initial comprehension of customer requirements concerning timelines and product/service quality, followed by concerted efforts to fulfill these timelines while ensuring product/service quality is upheld. The optimal duration of planned lead time for an item is contingent upon factors such as demand variability, the resource utilization rate for the item's production, and disparities in holding costs between the item and the final product in which it is utilized.

The procurement process relies heavily on the efficiency of the supply chain, which plays a pivotal role in determining overall procurement performance. Supply Chain Management (SCM) involves coordinating a network of interconnected entities that supply products, services, or service packages to end-users (Johnston et al., 2012). Efficient supply chain performance is crucial for meeting market demand promptly, underscoring the importance of performance measurement due to the interdependent nature of supply chain partners, which is essential for a firm's survival and prosperity. Supply chain performance is characterized by operational excellence that results in superior customer experiences (Potter, Towill, & Christopher, 2015). Various factors, including external influences, internal corporate dynamics, and the management of extended supply chains, impact supply chain performance. Organizations have shifted focus from individual company performance to supply chain performance to enhance the overall bottom-line performance of the entire chain (Samaranayake, 2013). However, determining relevant metrics for measuring supply chain performance, such as cost, time, quality, flexibility, and innovation, is essential. These metrics vary across firms, which makes it challenging to select appropriate measures to avoid potential degradation in supply chain performance (Manyega, 2015).

The manufacturing sector in Kenya has recently experienced a notable downturn, characterized by the closure of several major manufacturing entities, with others resorting to downsizing to sustain their operations. Key factors contributing to this decline include inadequate customer satisfaction, escalating operational expenses, mismanagement, and volatility in operating markets, all impacting various facets of supply chain performance. Previous empirical research has highlighted the significance of lead-time management practices, encompassing planning for waiting times, early engagement with suppliers, process automation, and efficient transport management, in enhancing supply chain performance (Stolyar & Qiong, 2018). However, these studies have not delineated the relationship between lead-time management practices and supply chain performance within the Kenyan context, particularly in the manufacturing sector. Hence, this study aims to address these gaps by examining the impact of lead-time management practices on the supply chain performance of manufacturing firms operating in Kenya.

The primary objectives of this research are threefold. Firstly, the study aims to identify and analyze the lead-time strategies of manufacturing firms operating in Kenya. Secondly, it seeks to evaluate the current status of supply chain performance within these manufacturing firms in Kenya. Lastly, the research investigates the correlation between the lead-time strategies adopted by manufacturing firms and their respective supply chain performance levels in the Kenyan context. Through these objectives, the study intends to understand better how lead-time strategies influence supply chain performance within Kenya's manufacturing sector.

Theoretical Review

The study was rooted in lean and agile supply chain theory principles. Lean management, renowned for its emphasis on continuous improvement, originated in Japan during the mid-1950s and has since been embraced by organizations worldwide. The concept of "lean thinking," introduced by (Womack et al., 1992), encapsulates various lean practices initially applied within manufacturing contexts. However, lean thinking has transcended its manufacturing origins to permeate diverse sectors, including services, commerce, and the public domain (Womack & Jones, 2005). Despite its expanding application, the widespread adoption of lean thinking beyond manufacturing spheres remains relatively constrained.

At the core of lean thinking is the Japanese concept known as "muda," which originates in Japanese automobile companies' manufacturing practices (Lysons & Farrington, 2012). Muda translated as waste, refers to any human activity that consumes resources without adding value. Within the framework of lean principles, activities that consume resources without generating value for the consumer are identified as waste and should be eliminated (Womack & Jones, 2003). Lean supply chain management prioritizes resource optimization, aiming to minimize time, space, inventory, and expenses in the production process. Central to this approach is identifying and eliminating seven types of waste: overproduction, waiting, transportation, inventory, defects, and over-processing.

The primary goals of implementing the lean management philosophy within an organization include improving flexibility, lowering costs, optimizing inventory turnover, reducing lead times, and preventing defects. One of the most notable examples of lean manufacturing is the Toyota Production System, which attributes its supply chain success to achieving economies of scale in manufacturing and procurement through small-batch production units (Holweg, 2007). Lean supply chains prioritize the reduction of cash-to-cash cycle times as a critical performance metric. A prolonged period for converting inventories into cash requires more working capital, whereas any reduction in this timeframe signifies the release of working capital and, consequently, cost reduction (Christopher & Gattorna, 2005).

Agile manufacturing was pioneered by the Iaccoca Institute of Lehigh University in 1991. Agile manufacturing underscores the importance of responsiveness to dynamic market demands regarding volume and variety. Its origins trace back to flexible manufacturing systems, primarily focusing on reducing lead times, which is particularly beneficial in environments characterized by short product life cycles and unpredictable market demands (Towill & McCullen, 1999). Studies (Lumsden, 1998) suggest that agile supply chains adapt to changing environmental dynamics, enhancing customer satisfaction swiftly. (Yusuf et al., 1999) define agility as successfully exploring competitive advantages in speed, flexibility, innovation, proactivity, quality, and profitability by integrating reconfigurable resources and best practices within a knowledge-rich environment to deliver customer-centric products and services in a rapidly evolving market landscape. (Christopher, 2000) asserts that fostering supplier relationships enables companies to develop agile supply chains by minimizing lead times between organizations. (Lee, 2004) underscores the pivotal role of agility in enabling supply chains to respond promptly to short-term fluctuations and effectively manage external disruptions.

Review of Empirical Literature

In today's business landscape, many companies face a significant challenge in establishing processes conducive to promptly addressing customer demands (Christopher, 2011). These demands may encompass requirements for product differentiation and competitive pricing to maintain market competitiveness (Zong, 2010). Additionally, the prompt delivery of ordered products is widely acknowledged as crucial for meeting customer expectations (Hoque & Goyal, 2014). The ability to meet satisfactory levels across these three competitive dimensions—price, product differentiation, and delivery time—is contingent upon the lead time required to fulfill customer orders and replenish materials from suppliers (Thorsen & Yao, 2017). (Arıkan et al., 2014), their analysis of transportation lead-time variability's impact on economic and environmental performance in inventory systems in Pakistan underscored lead time as a significant determinant of firm competitiveness and performance by facilitating product differentiation and enhancing customer satisfaction. Product differentiation enables the customization of products, adding value for customers and creating a competitive edge for the offering company (Christopher, 2011). However, maintaining a stock of all possible product variants entails substantial inventory holding costs; thus, producing customized products before customer orders becomes impractical, resulting in prolonged lead times and diminished demand for customized products (Daaboul et al., 2011).

In China, (Li et al., 2018) characterize lead time as the capacity to meet customer requirements promptly and effectively. They propose that one strategy to mitigate the impact of random demand fluctuations within supply chains is to maintain inventories at various points along the chain. Alternatively, (Boute et al., 2014) contend that adjusting lead times dynamically within the supply chain network is another viable approach. They advocate for several lead time management practices to optimize lead time management, including collaboration with multiple suppliers, utilization of diverse transportation options, expediting specific processes, ensuring smooth workflow, controlling queues, and reducing variability.

In Africa, particularly Sub-Saharan Africa, numerous companies grapple with supply chain challenges, prompting some to adopt lead time management practices to bolster supply chain efficacy. (Georgise et al., 2014) conducted an analysis of supply chain integration and lead time within manufacturing firms in Ethiopia, concluding that effective lead time management involves devising strategies to diminish lead time while maintaining product quality and realizing cost savings. According to (Georgise et al., 2014), lead time management practices encompass supplier engagement, integration of new information technology solutions into the supply chain, and provision of adequate training to enhance human resources. The impracticality of maintaining a comprehensive stock close to all customers also applies to non-customized items due to cost-related constraints, posing limitations on product availability. Consequently, an extended lead time complicates the alignment with fluctuations in demand volume and product specifications, resulting in product unavailability and subsequent customer dissatisfaction (Kouvelis & Tang, 2012).

In South Africa, (Marinagi et al., 2015) explored the concept of lead time, emphasizing its significance in meeting customer demands and improving performance through cost reduction and gaining a competitive edge. The researchers delineated lead management practices as tactics aimed at diminishing lead time, citing examples such as managing waiting times, optimizing transportation, and engaging suppliers early. A close relationship exists between cost and lead time, both from the supplier and procurement perspectives (Zong, 2010). On the procurement side, lead time is proportional to inventory size and safety stock levels required to avert stockouts. Consequently, prolonged lead times escalate safety stock expenses, attributable to tied-up capital, inventory obsolescence, damaged goods, and warehouse operations and maintenance (Christopher, 2011). Elevated safety stock levels also decrease inventory turnover rates, incurring costs associated with immobilized capital and delaying product updates, thus hindering their market penetration.

The textile industry in Ghana (Oelze, 2017) scrutinized supply chain management and lead time, highlighting lead time as a measure of how effectively a company is aligned with meeting customer needs and enhancing efficiency in supply chain processes. Oelze characterized lead time management practices as akin to strategies for competitive advantage aimed at positioning the organization favorably relative to competitors. (Taticchi et al., 2013) conceptualize lead time management as an integral component of supply chain management, indicating the extent to which a company has aligned its supply chain systems to fulfill order requirements and prioritize meeting customer demands.

Several strategies for managing lead time include planning for waiting times, engaging suppliers early in the process, automating processes, and optimizing transportation. Waiting time, as defined by (Nuruzzaman, 2011), denotes the duration an organization must wait after placing an order from a supplier before the order is processed and delivered to the customer. It is distinct from lead time, which refers to the period between the initial supply of raw materials and the final delivery of the product to the customer (Aberdeen-Group, 2013). Variability in lead time may be influenced by production dynamics and inventory costs, as suggested by (Penfield, 2013).

Supplier involvement refers to the extent to which a supplier actively participates in co-designing and developing new products with their customers in exchange relationships (Sarkaret et al., 2017). This collaborative engagement of suppliers in new product development is widely acknowledged as a crucial factor driving successful innovation through inter-firm cooperation. Early supplier involvement entails initiating partnerships with suppliers before placing orders to nurture mutually advantageous relationships and formulate strategies to improve cost-effectiveness and product quality while fulfilling customer requirements.

Process automation enhances workforce productivity by streamlining operations through centralization and standardization. It involves analyzing, documenting, optimizing, and automating business processes, aiming to eliminate redundant procedures, restructure human resources, and integrate software applications. In the supply chain context, automation entails the development of technology-driven systems to oversee various aspects such as production, packaging, transportation, and delivery of goods and services to customers.

Transportation management is becoming increasingly critical in Kenya's logistics operations, with organizations acknowledging its evolving significance, shaped by technological advancements. When internal adoption of these technologies is impractical, organizations often turn to external service providers with greater expertise in efficiently delivering these advancements. As outlined by (Jossep, 2017), transportation management technologies encompass the adoption and application of innovative technologies and best practices related to logistical activities, specifically focusing on transport management. These technologies cover various categories, including Telecommunication and Information Technologies, Intelligent Transport Systems, and Emerging Technologies.

B. RESEARCH METHOD

The research adopted a descriptive research design, specifically employing a descriptive survey approach. This type of research design is typically employed when the problem is well-defined, and the researcher aims to conduct a field survey to gather insights directly from the population of interest, enabling respondents to elucidate specific aspects of the problem under investigation (Creswell, 2013). This design was deemed suitable as it offers a precise and accurate method for systematically describing events in a meticulously planned manner (Babbie, 2012).

The research targeted a population of 187 manufacturing firms located in Nairobi, Kenya, according to data provided by KAM (2021). The respondents chosen for observation were procurement heads or their representatives within these firms. A purposive sampling technique was utilized to select the sample size. Among the 187 manufacturing companies registered under KAM, 153, representing 81.9%, are in Nairobi. This notable

concentration of manufacturing entities in Nairobi justifies the city's selection as the study's focal point. Each company contributed one procurement head or personnel as the observation unit, resulting in 153 respondents for the study.

The study employed a questionnaire as the primary data collection method, comprising both closed and open-ended questions. Closed-ended questions were utilized to streamline the process and facilitate easier analysis, given that they provide immediately usable data. Conversely, open-ended questions were incorporated to encourage respondents to provide detailed and candid responses without inhibitions. The data collection procedure involves obtaining the necessary data or information from respondents within the study (Daniel & Aroma, 2011). The questionnaire was distributed electronically via Google Forms, allowing respondents to complete the form online and submit it for analysis. Measures were taken to ensure the receipt of most respondents' questionnaires. Quantitative data analysis was conducted using the Statistical Package for Social Sciences (SPSS), employing descriptive and inferential statistical techniques.

C. RESULTS AND DISCUSSION

Response Rate

The study aimed to assess the level of participation among the targeted respondents. With a sample size of 153 respondents surveyed through a structured questionnaire, the study achieved a response rate of 81.2%, equivalent to 124 respondents whose data was analyzed. This response rate validates the study's suitability for drawing conclusions and making recommendations, as indicated by (Creswell, 2014), who suggests that a response rate ranging from 30% to 60% is considered adequate for such purposes.

Adoption of Lead-Time Strategies in Manufacturing Firms in Kenya

The study investigated the degree of adoption of fundamental lead-time management strategies within the surveyed manufacturing firms. As illustrated in Table 1, the findings reveal a limited implementation of crucial lead-time management practices among these firms. For instance, waiting-time planning scored 2.81, early supplier involvement scored 2.37, process automation scored 2.35, and transportation management scored 2.61. These findings align with those of (Arıkan et al., 2014), who emphasized that effective management of transportation mechanisms and meticulous route planning are instrumental in reducing lead time and ensuring customer satisfaction, which is critical for sustained firm performance. (Mfwaya, 2013) advocates for prioritizing transport management in the supply chain process through strategic route planning and adopting sustainable practices to optimize cost and time efficiencies.

Additionally, (Boas et al., 2014) suggest that automating processes within the supply chain eliminates impediments to process flow, enhancing operational efficiency and accuracy, consequently saving time and reducing lead time, thus elevating customer satisfaction levels (Oelze, 2017). Furthermore, (Ellram, 2015) contends that sustained early engagement with suppliers before customer requests fosters effective collaboration to align with customer preferences. (Xue & Ge, 2018) procurement personnel should proactively anticipate future customer needs, engaging suppliers early to devise improved strategies to meet customer expectations.

These results align with the research conducted by (Lee et al., 2012), which indicated that thorough scheduling of waiting times enables efficient synchronization of the supply chain process, reducing lead time and increasing customer satisfaction. (Palawatta, 2015) emphasizes that minimizing waiting time within the supply chain is crucial for lowering supply chain expenses and maintaining a steady flow of materials, thereby enhancing overall customer satisfaction.

Table 1: Extent of Embrace of Lead-Time Management Strategies

Aspect	Mean	Std. Deviation
Waiting-time planning	2.81	0.91
Early Supplier Involvement	2.37	1.11
Process Automation	2.35	1.25
Transport Management	2.61	1.37

Source: research data, 2023

Status of Supply Chain Performance among Manufacturing Firms

The study aimed to evaluate the supply chain performance of the manufacturing firms surveyed in Kenya. This assessment was conducted using specific parameters: customer satisfaction, quality of supplies, and cost

savings. Respondents were tasked with rating these dimensions based on their realization within their respective organizations, using a scale where one denoted the lowest level and five indicated the highest. As depicted in Table 2, the results indicated that quality supplies received the highest rating with a mean score of 2.43, followed by cost savings with a mean score of 2.41, and customer satisfaction with a mean score of 2.35. These findings suggest that a significant portion of the surveyed manufacturing firms in Kenya did not effectively achieve crucial aspects of supply chain performance, including ensuring high-quality supplies, achieving cost savings, and enhancing customer satisfaction. The failure to attain these objectives could lead to a decline in organizational performance. Ellram (2015) emphasizes the importance of upholding supply chain performance from the perspective of meeting customer needs and ensuring that these needs align with customers' satisfaction rather than solely focusing on organizational objectives.

Table 2: Rating the Aspects of Supply Chain Performance

Aspect	Mean	Std. Deviation
Customer Satisfaction	2.35	0.75
Quality Supplies	2.43	0.96
Saving on Costs	2.41	1.02

Source: research data, 2023

Relationship Between Lead-Time Management Strategies and Supply Chain Performance of Manufacturing Firms

The third aim of the study was to investigate the association between lead-time strategies and the supply chain performance of manufacturing firms in Kenya, which was accomplished by applying a regression model. This model incorporated various statistical metrics, including the model summary, variance (ANOVA), and standardized coefficients, to elucidate the relationship between the variables. The results regarding model fit, as illustrated in Table 3, demonstrated a robust impact of all examined lead-time management strategies on supply chain performance. This conclusion is supported by the R^2 value of 0.564, indicating that waiting time management, early supplier involvement, process automation, and transport management collectively explained 56.4% of the variance in supply chain performance among Kenyan manufacturing firms. Additionally, the ANOVA analysis for the overall model, presented in Table 4, indicated a significant predictive capability regarding the association between lead-time management strategies and the supply chain performance of manufacturing firms in Kenya. This significance is underscored by a P-value of 0.000, below the conventional significance threshold of 0.05, and an F-calculated value of 120.155, significantly surpassing the F-critical value.

Table 3: Model Summary and ANOVA

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.751[a]	.564	.551	.108

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	183.520	4	45.880	120.155	.000[b]
	Residual	94.696	119	.795		
	Total	278.216	123			

a. Dependent Variable: Supply Chain Performance

b. Predictors: (Constant), Waiting time management, Early supplier involvement, Process automation, and Transport management

Source: research data, 2023

The regression coefficients for the overall model are outlined in Table 4. The results suggest that waiting time management, early supplier involvement, process automation, and transport management exhibited significant and positive impacts on the supply chain performance of manufacturing firms in Kenya. Per the model's outcomes, a one-unit modification in waiting time planning would yield a 50.1% enhancement in the supply chain performance of manufacturing firms in Kenya. Similarly, a one-unit adjustment in supplier involvement would correspond to a 29.7% improvement in the supply chain performance of manufacturing firms. Moreover, a one-unit change in process automation would lead to a 53.9% increase in the supply chain performance of manufacturing firms. Lastly, a one-unit change in transport management would result in a 39.1% augmentation in the supply chain performance of manufacturing firms in Kenya.

Table 4: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.934	.129		7.240	.000
	Waiting Time Planning	.501	.078	.411	6.423	.000
	Early Supplier Involvement	.297	.074	.236	4.014	.001
	Process Automation	.539	.069	.509	7.812	.000
	Transport Management	.391	.072	.372	5.431	.000
a. Dependent Variable: Supply Chain Performance						

Source: research data, 2023

D. CONCLUSION

The study's findings underscore the pivotal role of lead-time management strategies in bolstering the supply chain performance of manufacturing firms in Kenya. The study elucidates how waiting time can be diminished by prioritizing orders, scheduling products, and decentralizing warehouses, consequently improving order delivery and fostering customer satisfaction. However, the study highlights the ineffectiveness of waiting-time planning among manufacturing firms, potentially contributing to ongoing underperformance in the supply chain domain. Additionally, the study emphasizes the significance of supplier involvement in steering the supply chain performance of manufacturing companies in Kenya.

Moreover, the study emphasizes that lead-time management strategies encompass the automation of manufacturing processes, thereby fortifying overall firm performance. Integrating new technologies into organizational operations is identified as a means to augment the efficacy of the supply chain process, albeit potentially impacting customer satisfaction adversely. Furthermore, the study underscores the critical role of transport management in enhancing the supply chain performance of manufacturing companies in Kenya.

The study suggests that management within manufacturing companies should significantly emphasize reducing waiting times by implementing thorough planning processes. This involves prioritizing orders based on their deadlines and organizing production schedules according to customer demand. Achieving this objective necessitates close collaboration between the supply chain, manufacturing, and procurement departments to streamline the procurement of raw materials and minimize lead times.

The primary responsibility of manufacturing firms under managerial oversight, is to ensure timely delivery of products to customers, meeting specified quantity and quality standards. To achieve this, companies are encouraged to integrate process automation into their operations to enhance efficiency and effectiveness. Given the pervasive role of technology in contemporary business management, it is recommended that manufacturing firms prioritize technological integration in supply chain practices. Embracing automation technologies can improve customer satisfaction, cost savings, and operational efficiency.

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