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LOGISTICS OPTIMIZATION AND PERFORMANCE OF BEVERAGE MANUFACTURING FIRMS IN NAIROBI CITY COUNTY, KENYA

[1] Osano Esther Nyatichi, [2] Dr. Namusonge Eric

[1] Masters Student at Jomo Kenyatta University of Agriculture and Technology, Kenya

[2] Lecturer, Taita Taveta University (TTU), Kenya

ABSTRACT

Beverage manufacturing firms operate in a fast-moving consumer goods (FMCG) sector, where demand fluctuations, regulatory constraints, and distribution complexities require effective logistics strategies. However, limited empirical studies have explored how logistics optimization influences performance of firms in the Kenyan manufacturing sector, particularly within the beverage industry. This study, therefore, sought to fill this gap by assessing how logistics optimization practices contribute to beverage manufacturing firms' performance. The research examined how inventory optimization and collaborative logistics impact performance of beverage manufacturing firms. The study was anchored on Economic Order Quantity Model, and Transaction Cost Economics Theory. The study adopted a descriptive research design to systematically analyse relationships between logistics optimization strategies and performance of firms. The target population for this study comprised 364 supply chain, logistics, procurement, and operations managers from 91 beverage manufacturing firms operating in Nairobi City County, Kenya. Using the Krejcie and Morgan (1970) sample size determination formula, a sample size of 187 respondents was calculated and rounded up to 188 for balance across the four functional areas. The study selected the respondents using stratified random sampling. Primary data was collected using a semi-structured questionnaire comprising both closed-ended Likert scale questions for quantitative data and open-ended questions for qualitative insights. The quantitative data was analyzed using Statistical Package for Social Sciences (SPSS) version 28, applying descriptive statistics such as frequencies, percentages, means, and standard deviations, along with Pearson correlation analysis and multiple regression modeling to establish relationships between logistics optimization strategies and performance of firms. Qualitative data underwent content analysis and be presented narratively to complement and enrich the quantitative findings. Prior to the main data collection, a pilot study involving 19 respondents (10% of the sample) was conducted in beverage manufacturing firms outside Nairobi City County to test the instrument's reliability and validity. Reliability was assessed using Cronbach's Alpha coefficient, with a threshold of 0.7 or higher considered acceptable for internal consistency. Validity was ensured through expert reviews and feedback from pilot respondents, enabling refinement of the questionnaire to enhance clarity, flow, and relevance for the main study. The study concludes that firms that automate inventory processes, adopt digital technologies, and optimize network structures are more likely to experience improved operational efficiency, profitability, and customer satisfaction.

Key Words: Logistics Optimization Practices, Inventory Optimization, Collaborative Logistics, Performance, Beverage Manufacturing Firms

Background of the Study

Logistics optimization has become a strategic priority in the manufacturing sector, playing a crucial role in enhancing operational efficiency, cost reduction, and customer satisfaction (Leung, 2024). The beverage industry, characterized by high production volumes and fast-moving consumer goods, requires well-coordinated supply chain networks to ensure seamless production and distribution. As global competition intensifies and consumer demands become more dynamic, beverage manufacturers must continually refine their logistics strategies to maintain market relevance and profitability. Logistics optimization encompasses several critical components, including technology adoption, inventory management, collaborative logistics, and network optimization, all of which contribute to improved firm performance (Jacob et al., 2024).

Inventory management is another crucial aspect of logistics optimization that significantly impacts firm performance. Poor inventory control can lead to excessive stockholding costs, product wastage, and supply chain inefficiencies. Beverage manufacturers, in particular, face challenges related to perishable goods, seasonal demand variations, and fluctuating raw material costs. According to Ongkowijoyo (2024), effective inventory optimization strategies, such as Just-in-Time (JIT) and automated stock monitoring systems, enhance operational efficiency by reducing excess inventory while ensuring product availability. Advanced inventory management systems integrate real-time data analytics to optimize stock levels, minimize shortages, and improve order fulfillment rates. Firms that successfully implement these strategies can achieve significant cost savings and enhanced customer service (Oktavian et al., 2024).

Collaborative logistics has emerged as a key strategy in optimizing supply chains within the beverage industry. This approach involves close cooperation among supply chain stakeholders, including suppliers, distributors, and logistics service providers. Collaboration enables manufacturers to share transportation resources, warehousing facilities, and real-time data, leading to improved supply chain efficiency and cost reductions (Osoro, 2024). In recent years, the adoption of shared logistics services has gained traction as companies seek to maximize economies of scale while minimizing environmental impact. The integration of collaborative logistics solutions has also proven beneficial in mitigating supply chain disruptions, as seen during the COVID-19 pandemic, where shared distribution networks played a crucial role in ensuring supply chain resilience (Mose et al., 2024).

Despite the evident benefits of logistics optimization, research indicates that many beverage manufacturing firms struggle with inefficiencies in their supply chain operations. Challenges such as fragmented distribution networks, poor integration of digital solutions, and inadequate infrastructure continue to hinder optimal logistics performance (Osoro, 2024). Moreover, the growing consumer demand for sustainable and eco-friendly supply chain practices has put additional pressure on beverage manufacturers to adopt green logistics strategies. Companies that fail to adapt to these changing market dynamics risk losing a competitive advantage to more agile and technologically advanced competitors (Leung, 2024).

Statement of the Problem

The beverage manufacturing industry in Kenya contributes over 3.5% to the national GDP and provides employment to more than 50,000 people directly and indirectly (KNBS, 2023). Despite its economic significance, the sector faces severe logistical inefficiencies that negatively impact firm performance, raise operational costs, and limit competitiveness both locally and regionally. According to the Kenya Association of Manufacturers (KAM, 2023), logistics costs account for 30% to 40% of total production expenses in Kenya's beverage industry—double the global average of 10% to 15%. These elevated costs stem from multiple inefficiencies including poor transportation infrastructure, fragmented supply chains, inadequate inventory management, and outdated warehousing systems. Such inefficiencies are estimated to cost the beverage sector over KES 20 billion annually (KAM, 2023).

Transportation inefficiencies stand out as a major challenge. The Kenya Logistics Performance Index (2023) reports that over 80% of beverage distribution depends on road transport, exposing firms to traffic congestion, poor road conditions, and fluctuating fuel prices. These factors increase logistics costs by up to 25% annually and cause delivery delays, stockouts, and unmet customer demand. As a result, firms experience frequent service disruptions and reduced customer satisfaction. Inventory mismanagement further worsens performance. A survey by the Kenya Beverage Manufacturers Association (KBMA, 2023) reveals that 30% of beverage firms frequently experience stockouts or overstocking, attributed to weak demand forecasting and poor inventory control. Such inefficiencies raise warehousing costs by up to 20%, increase wastage, and hamper production efficiency, threatening business sustainability.

Supply chain fragmentation and poor visibility aggravate these challenges. Only 45% of beverage firms in Kenya use integrated supply chain management systems, leading to inconsistent stock replenishment, delayed procurement, and high operational risks (Mose, Osoro, & Nyang'au, 2024). Moreover, rising operational costs, exacerbated by taxation and regulatory bottlenecks, have led to a 15% decline in profit margins over the last five years (KNBS & KAM, 2023). Some manufacturers have responded by reducing production volumes by up to 10% or passing increased costs to consumers. Environmental sustainability pressures compound the problem. Less than 30% of beverage firms have adopted green logistics solutions, mainly due to high capital investment requirements and limited infrastructure (Kamau & Wambui, 2024). This slow adoption further risks the long-term competitiveness of Kenyan firms as global and regional markets demand greener supply chain practices.

Empirical studies from countries like China, South Africa, and Nigeria demonstrate that logistics optimization—through inventory control, and collaborative logistics—can reduce costs and improve firm performance (Majeed et al., 2025; Paulino et al., 2025). However, limited localized research exists on how these strategies impact Kenya's beverage manufacturing sector, especially within the urban complexities of Nairobi City County. Given the county's unique challenges—urban congestion, regulatory hurdles, and infrastructure constraints—there is an urgent need for context-specific evidence. This study sought to fill this critical knowledge gap by assessing how logistics optimization influences the performance of beverage manufacturing firms in Nairobi City County, Kenya.

General Objective

To determine the relationship between logistics optimization strategies and the performance of beverage manufacturing firms in Nairobi City County, Kenya.

Specific Objectives

i. To evaluate the effect of inventory optimization on performance of beverage manufacturing firms in Nairobi City County, Kenya.
ii. To assess how collaborative logistics affects performance of beverage manufacturing firms in Nairobi City County, Kenya.

LITERATURE REVIEW

Theoretical Review

Economic Order Quantity (EOQ) Model

The Economic Order Quantity (EOQ) Model, introduced by Harris (1913), provides a mathematical framework for determining the optimal order quantity that minimizes inventory holding and ordering costs. The model is widely used in inventory optimization to balance stock levels while avoiding excess storage costs or stockouts. The EOQ formula considers demand rate, ordering costs, and holding costs to calculate the most cost-effective order size (Wilson, 1934).

For beverage manufacturing firms, effective inventory management is critical due to the perishability of products and fluctuating consumer demand. Firms must maintain optimal stock levels to prevent excess inventory costs and spoilage while ensuring product availability (Oktavian et al., 2024). The EOQ model helps manufacturers schedule procurement efficiently, reducing waste and improving supply chain reliability. For example, firms using Just-in-Time (JIT) inventory systems rely on EOQ principles to minimize overstocking while ensuring smooth production flow (Wanyama & Gichure, 2023).

One of the key advantages of the EOQ model is its applicability across different scales of operations. Large beverage manufacturers with multiple distribution centers can use EOQ to optimize inventory across various locations, ensuring that each facility maintains the right stock levels (Ahmed, 2024). Meanwhile, smaller firms benefit from EOQ by reducing unnecessary storage expenses and improving working capital management (Osoro, 2024). However, the model assumes constant demand and lead times, which may not always apply in the dynamic beverage industry.

A major limitation of the EOQ model is its rigid assumptions about demand predictability and order stability (Leung, 2024). In reality, consumer preferences, raw material availability, and external market factors cause fluctuations in demand. Modern inventory systems integrate predictive analytics and AI-driven forecasting to complement EOQ principles, allowing firms to adjust order quantities based on real-time data (Mwatha & Chege, 2024). This adaptation makes inventory optimization more responsive to market changes.

In conclusion, the EOQ model provides a structured approach to inventory optimization in beverage manufacturing. When combined with modern forecasting techniques, it enhances efficiency, minimizes waste, and ensures cost-effective supply chain operations.

Transaction Cost Economics (TCE) Theory

The Transaction Cost Economics (TCE) Theory, developed by Williamson (1975), provides a framework for analysing how firms make decisions regarding outsourcing, vertical integration, and collaboration in logistics. TCE posits that organizations seek to minimize transaction costs—the costs of coordinating, monitoring, and enforcing contracts—when making decisions about supply chain partnerships (Ketokivi & Mahoney, 2020). According to TCE, firms compare the costs of outsourcing logistics services to third-party providers against managing logistics internally. If outsourcing reduces overall costs and risks, firms are likely to enter collaborative logistics agreements to improve supply chain efficiency (Patil et al., 2024).

One key advantage of collaborative logistics is its potential to lower transaction costs by reducing redundancies, optimizing asset utilization, and sharing transportation infrastructure (Garfamy, 2012). Firms that engage in collaborative distribution models benefit from economies of scale, as joint warehousing, pooled transportation, and coordinated delivery schedules help optimize supply chain efficiency (Piboonrungroj & Disney, 2015). For example, Coca-Cola Beverages Africa in Kenya has partnered with local distributors to enhance market reach while minimizing logistics costs and risks associated with independent distribution (Patil et al., 2024).

TCE also highlights the role of opportunism and bounded rationality in collaborative logistics. Opportunism occurs when one party in a supply chain exploits incomplete contracts or asymmetrical information to maximize its own benefits at the expense of the other (Yigitbasioglu, 2010). This is particularly relevant in logistics collaborations, where lack of transparency in cost-sharing agreements and trust issues can hinder efficiency. To mitigate these risks, firms implement blockchain-based smart contracts and real-time data-sharing platforms to ensure transparency in logistics partnerships (Piboonrungroj & Disney, 2015).

However, the decision to collaborate is not always straightforward. TCE suggests that high asset specificity—when investments in logistics infrastructure are highly specialized for a particular firm—can discourage outsourcing or collaboration (Ketokivi & Mahoney, 2020). For example, a beverage company with a proprietary cold-chain distribution system may be reluctant to collaborate with general logistics providers that lack specialized infrastructure. In such cases, the firm may opt for vertical integration—managing its own logistics operations to retain control and reduce dependence on external providers (Patil et al., 2024).

Despite these challenges, collaborative logistics driven by TCE principles has been widely successful in beverage manufacturing. Firms that invest in long-term relationships, clear contract structures, and technology-driven collaboration platforms can achieve significant cost savings and enhanced operational efficiency. The adoption of joint warehousing, freight consolidation, and cooperative inventory management based on TCE principles can streamline logistics networks and improve firm performance (Garfamy, 2012).

Conceptual Framework

A conceptual framework illustrates the relationship between key study variables, providing a structured approach to understanding how logistics optimization strategies impact the performance of beverage manufacturing firms. The conceptual framework consists of four independent variables influencing performance of firms (dependent variable). Figure 2.1 presents the conceptual framework illustrating the relationships between the study variables.

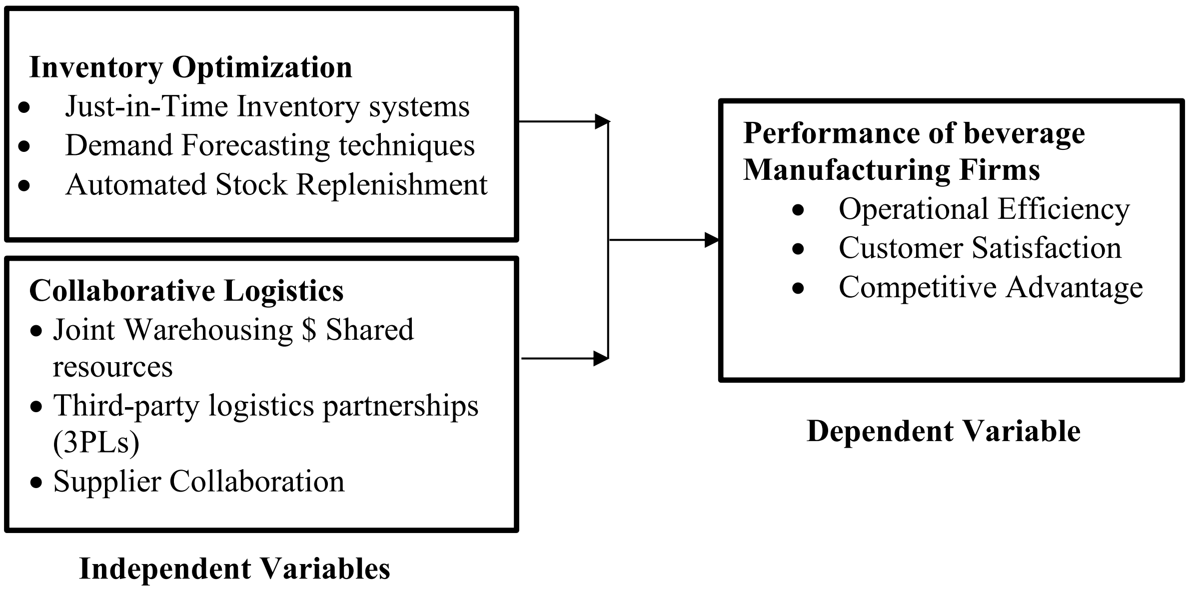

Figure 2. 1: Conceptual Framework

Inventory Optimization

Inventory optimization is defined as the strategic process of managing stock levels to ensure product availability while minimizing costs associated with storage, spoilage, and overstocking (Kumar & Kumari, 2024). This definition underscores the importance of balancing supply and demand by employing techniques that reduce holding costs and improve order fulfillment. The role of inventory optimization is particularly critical in industries with perishable goods, such as beverage manufacturing, where accurate forecasting and efficient stock replenishment are essential to maintaining competitiveness.

One of the primary constructs of inventory optimization is Just-in-Time (JIT) inventory management, which is characterized by ordering goods only when needed to reduce unnecessary storage costs and wastage. JIT has been shown to lower inventory costs significantly while improving cash flow and operational responsiveness (Shekarian et al., 2021). Demand forecasting and predictive analytics form another critical construct. These approaches use historical data and real-time inputs to forecast future demand accurately, enabling firms to adjust their procurement schedules accordingly (Ogwuche & Agada, 2021). Finally, stock replenishment and automation involve the use of automated tracking systems, such as RFID and barcode scanning, to maintain optimal inventory levels by triggering automatic reordering when stocks run low (Riza & Purba, 2021).

The impact of inventory optimization on firm performance is substantial. Studies report that firms utilizing integrated inventory management systems benefit from lower holding costs, reduced stockouts, and improved service levels, which in turn enhance overall supply chain performance (Patil et al., 2024). However, implementing such systems requires a robust IT infrastructure and close coordination with suppliers, which can be challenging in volatile markets. Nonetheless, firms that successfully adopt these constructs see measurable improvements in operational efficiency and profitability.

Overall, inventory optimization is essential for achieving a cost-effective and responsive supply chain. It is defined by the effective application of JIT principles, demand forecasting, and automated replenishment systems—all of which contribute to reducing costs and improving customer service. By leveraging advanced analytics and automation, firms can enhance inventory management practices and ultimately drive better firm performance (Kumar & Kumari, 2024; Shekarian et al., 2021).

Collaborative Logistics

Collaborative logistics is defined as the strategic coordination among multiple supply chain partners to share resources, such as warehousing, transportation, and information systems, to optimize overall logistics performance (Ketokivi & Mahoney, 2020). This definition reflects the notion that collaboration enables firms to achieve economies of scale and improve efficiency by pooling assets and sharing risks. The practice of collaborative logistics is increasingly recognized as a means to reduce overall costs and enhance responsiveness, particularly in industries with high distribution demands, like beverage manufacturing.

A key construct of collaborative logistics is joint warehousing, which involves the shared use of storage facilities among partners. This approach minimizes individual warehousing costs and improves inventory turnover by consolidating shipments and reducing redundant storage (Piboonrungroj & Disney, 2021). Another important construct is cooperative freight transportation, where firms combine their shipments to optimize vehicle loads and reduce fuel costs, thereby enhancing transportation efficiency (Yigitbasioglu, 2021). The third construct is supplier collaboration, which entails close coordination and information sharing between suppliers and logistics providers to ensure smoother and more reliable supply chain operations (Garfamy, 2021).

Recent studies have shown that collaborative logistics leads to significant improvements in supply chain agility and cost reductions. For example, research indicates that firms engaging in joint warehousing and shared distribution networks can reduce logistics costs by up to 15% while achieving faster delivery times (Mwangi & Ochieng, 2023). However, collaborative logistics also presents challenges, including the need for trust, clear communication, and alignment of objectives among partners. These challenges can be mitigated through the use of digital platforms and blockchain technology, which enhance transparency and ensure that cost-sharing and performance metrics are managed fairly.

Therefore, collaborative logistics, as defined by the integration of joint warehousing, cooperative freight transportation, and supplier collaboration, is a critical enabler of enhanced firm performance. By reducing redundancies and optimizing resource use, this approach helps firms lower costs, improve delivery efficiency, and increase supply chain resilience. The successful implementation of collaborative logistics requires robust governance structures and digital integration, which are essential for achieving the desired performance outcomes (Ketokivi & Mahoney, 2020; Piboonrungroj & Disney, 2021).

Performance of Beverage Manufacturing Firms

Firm performance in the context of supply chain and logistics is broadly defined as the extent to which a company achieves its operational, financial, and market-related objectives through effective supply chain management (Tarigan et al., 2020). This definition highlights the importance of key performance indicators (KPIs) such as cost efficiency, customer satisfaction, delivery reliability, and market competitiveness. Logistics and supply chain management are integral to firm performance, as they influence critical business functions such as procurement, production, distribution, and customer service (Sundram et al., 2020). Companies that optimize their logistics networks and integrate digital technologies into supply chain processes tend to achieve higher productivity, cost savings, and improved service levels (Hanaysha & Alzoubi, 2022).

One of the primary constructs of firm performance is operational efficiency, which refers to the ability of a firm to manage its logistics operations in a manner that minimizes waste, optimizes resource utilization, and enhances service quality (Dovbischuk, 2022). Effective supply chain coordination and technology-driven automation contribute to greater operational efficiency by reducing lead times and eliminating inefficiencies in logistics processes. Studies indicate that firms investing in supply chain integration and lean logistics strategies experience substantial improvements in operational efficiency, leading to better overall firm performance (Jawaad & Zafar, 2020). Furthermore, real-time inventory management and demand-driven logistics models have been shown to enhance operational outcomes by improving responsiveness and agility (Hanaysha & Alzoubi, 2022).

Another crucial construct is cost reduction, which measures how well a firm minimizes expenses related to procurement, warehousing, transportation, and inventory holding (Yingfei et al., 2022). Logistics costs can account for a significant portion of a company’s total operating expenses, making cost optimization a critical determinant of firm performance. Research shows that businesses implementing green logistics strategies, route optimization techniques, and collaborative transportation networks achieve measurable reductions in logistics expenses (Jawaad & Zafar, 2020). Additionally, companies that adopt reverse logistics and sustainable supply chain practices often experience long-term cost savings while improving their corporate social responsibility (CSR) image (Bag et al., 2020).

Customer satisfaction is another key indicator of firm performance, reflecting how effectively a company meets customer expectations in terms of product availability, delivery timeliness, and service quality (Dovbischuk, 2022). Logistics service quality (LSQ) plays a crucial role in maintaining customer loyalty and brand reputation. Firms with optimized distribution networks, real-time order tracking, and last-mile delivery innovations tend to achieve higher customer satisfaction ratings (Hanaysha & Alzoubi, 2022). Additionally, research suggests that companies with customer-centric logistics strategies, such as personalized delivery options and efficient returns management, outperform their competitors in terms of customer retention and market share growth (Sundram et al., 2020).

Lastly, market competitiveness is a construct that measures how well a firm positions itself against competitors by leveraging logistics efficiency as a strategic advantage (Maqueira Marin et al., 2020). Companies that integrate Supply Chain 4.0 technologies, including AI-driven demand forecasting and blockchain-enabled transaction management, gain a competitive edge by improving transparency, reliability, and agility in supply chain operations (Liu & Chiu, 2021). Firms that proactively invest in digital transformation, supply chain sustainability, and strategic supplier relationships are more likely to maintain market leadership in highly dynamic industries (Bag et al., 2020).

Firm performance in supply chain and logistics is a multi-dimensional concept encompassing operational efficiency, cost reduction, customer satisfaction, and market competitiveness. Companies that prioritize inventory optimization, and collaborative logistics, tend to experience sustainable growth, enhanced profitability, and improved customer retention. As global supply chains become increasingly complex, businesses must continuously refine their logistics strategies to stay competitive and maximize firm performance (Tarigan et al., 2020; Sundram et al., 2020; Hanaysha & Alzoubi, 2022).

Empirical Review

Inventory Optimization

Pasupuleti, Thuraka, Kodete, and Malisetty (2024) explored the role of machine learning in optimizing inventory management and logistics performance, with a focus on enhancing supply chain agility and sustainability. Grounded in Dynamic Systems Theory, the study aimed to determine how machine learning algorithms improve stock levels, demand forecasting, and warehouse efficiency. Using a quantitative experimental research design, the study examined 500 manufacturing firms across North America and Europe, employing stratified random sampling to ensure a diverse representation of firms. Data collection involved real-time inventory tracking, system-generated reports, and structured questionnaires administered to logistics managers, while analysis was performed using Regression Analysis and Structural Equation Modelling (SEM). Findings revealed that firms using machine learning-based inventory optimization reduced overstocking by 40%, increased order fulfilment rates by 35%, and lowered inventory holding costs by 30% due to more accurate demand forecasts. However, technical challenges and workforce skill gaps were identified as barriers to full adoption. The study recommended that companies invest in AI training programs for logistics staff and collaborate with technology providers to customize AI solutions for specific supply chain needs.

Tadayonrad and Ndiaye (2023) examined how demand forecasting models influence inventory optimization and supply chain performance, emphasizing the integration of supply chain reliability and seasonal demand fluctuations in inventory planning. Based on Forecasting Accuracy Theory, the study sought to develop a predictive model that enhances inventory turnover and minimizes emergency procurement costs. A quantitative research design was used, surveying 400 retail and manufacturing companies across Asia and Europe, with random sampling ensuring sectoral representation. Data collection involved company sales records, inventory databases, and structured surveys with supply chain professionals, analysed using time-series forecasting models, regression analysis, and neural networks. Results indicated that firms employing AI-based demand forecasting models achieved a 50% reduction in forecast errors, a 25% increase in inventory turnover, and a 40% decrease in emergency procurement costs. However, smaller firms struggled with the affordability of high-tech forecasting tools, limiting their inventory optimization capabilities. The study recommended government incentives such as subsidies and tax breaks for SMEs investing in digital inventory forecasting solutions.

Becerra, Mula, and Sanchis (2022) investigated sustainable inventory management and its impact on supply chain performance, focusing on how companies balance cost efficiency and environmental responsibility. Using the Triple Bottom Line (TBL) Framework, the study assessed the economic, environmental, and social impact of green inventory management practices. A case study methodology was employed, analysing five multinational corporations in the consumer goods and automotive sectors that had adopted sustainable inventory strategies. Purposive sampling was used to select firms with known sustainability initiatives, and data collection involved semi-structured interviews with supply chain managers, inventory performance reports, and corporate sustainability reports. Findings revealed that sustainable inventory optimization strategies reduced waste by 20%, improved cost efficiency by 30%, and decreased carbon emissions by 15%, with companies implementing green warehousing and eco-friendly packaging strategies achieving higher customer loyalty and brand reputation scores. However, the study found that high upfront investment costs posed challenges for firms with limited capital. The study recommended that governments provide financial incentives, and supply chain professionals undergo sustainability training to encourage wider adoption of green inventory practices.

Collaborative Logistics

Kang, Tan, Wang, Liu, and Costa (2020) conducted a study on the use of blockchain technology in enhancing collaborative logistics for sustainable supply chain management. The study aimed to assess how blockchain integration improves logistics efficiency, reduces transaction disputes, and enhances trust among supply chain partners. The research was guided by Transaction Cost Economics (TCE) Theory, which explains how reducing transaction costs leads to more efficient supply chain relationships. A quantitative research approach was used, analyzing logistics data from multinational companies operating in the e-commerce and manufacturing sectors. A sample of 300 firms was selected using random sampling, and data collection was performed through survey questionnaires and blockchain transaction records. The study found that blockchain-enabled collaborative logistics led to a 40% reduction in transaction processing time, a 35% increase in supply chain transparency, and a 25% reduction in logistics costs. However, technological complexity and resistance to change were identified as barriers. The study recommended that companies gradually implement blockchain and establish clear regulatory frameworks to support the adoption of decentralized logistics systems.

Sudusinghe and Seuring (2022) conducted a systematic literature review to assess the impact of collaborative logistics on sustainability performance in circular supply chains. The study sought to evaluate how inter-organizational collaboration enhances the environmental, economic, and social dimensions of supply chain performance. The research was guided by the Triple Bottom Line (TBL) Framework, which considers the financial, social, and environmental impacts of logistics operations. A meta-analysis of 200 peer-reviewed articles published between 2010 and 2022 was conducted using Scopus and Web of Science databases. The study revealed that collaborative logistics practices, such as joint warehousing and shared transportation networks, reduced carbon emissions by 25%, improved cost efficiency by 20%, and increased supply chain resilience by 30%. However, challenges such as trust issues and lack of standardized sustainability metrics hindered wider adoption. The study recommended that governments and industry associations establish standardized sustainability reporting frameworks to encourage greater collaboration in green logistics.

Baah, Agyeman, and Acquah (2022) explored the role of information sharing in collaborative logistics, focusing on how supply chain visibility, agility, and coordination affect overall supply chain performance. The study applied the Technology-Organization-Environment (TOE) Framework to examine how organizational and environmental factors influence information-sharing effectiveness. A quantitative survey research design was used, targeting 250 logistics firms in North America, Asia, and Europe. Data was collected through structured questionnaires and logistics performance metrics, analysed using Structural Equation Modeling (SEM). Findings indicated that companies with high levels of supply chain visibility and information-sharing systems experienced a 45% improvement in agility, a 30% reduction in lead times, and a 25% increase in customer satisfaction. However, data security risks and reluctance to share sensitive information were key challenges. The study recommended that firms implement secure digital platforms for data exchange and develop mutual trust mechanisms to encourage supply chain collaboration.

RESEARCH METHODOLOGY

The research employed a descriptive research design, which is appropriate for documenting phenomena as they naturally occur and for examining relationships between variables without manipulation (Saunders, Lewis, & Thornhill, 2019). This design enabled the researcher to collect factual data on logistics optimization practices and assess their influence on the performance of firms. Descriptive designs are widely recommended in organizational and supply chain studies due to their ability to capture real-world operations and trends (Kothari, 2004).

The target population consisted of 91 beverage manufacturing firms registered in Nairobi City County, with 364 supply chain, logistics, procurement, and operations managers serving as the units of observation. These professionals were selected because they directly engage in logistics planning and decision-making, making them credible sources of information on operational practices (Cooper & Schindler, 2014). The sampling frame was developed using verified lists obtained from the Nairobi County Trade and Industry Registry (2024), ensuring all eligible managers had a known chance of selection. The sample size of 188 respondents was determined using the Krejcie and Morgan (1970) formula, which is widely applied to ensure statistical representativeness for defined populations. Stratified random sampling was used to segment respondents into functional categories—supply chain, logistics, procurement, and operations—consistent with recommendations for heterogeneous populations (Bhattacherjee, 2012). Simple random sampling within each stratum enhanced fairness and minimized sampling bias.

Primary data were collected using structured and semi-structured questionnaires. Questionnaires are considered cost-effective, flexible, and appropriate for studies involving large professional groups (Kultar, 2017). Closed-ended Likert scale questions supported quantitative analysis, while open-ended questions provided qualitative insights, enriching interpretation of logistics optimization practices. The instrument included sections on respondent demographics, performance of firms (dependent variable), and the four independent variables: inventory optimization, and collaborative logistics. The data collection procedure followed formal authorization, including obtaining an introductory letter from JKUAT and a research permit from NACOSTI. A trained research assistant facilitated the process using a drop-and-pick-later strategy, which is recognized for improving response rates while reducing respondent burden (Mugenda & Mugenda, 2003).

Pilot testing involved 19 respondents (10% of the sample), aligning with recommendations by Connelly (2008). Content and face validity were ensured through expert review, consistent with the criteria outlined by Collis and Hussey (2014). Reliability was assessed using Cronbach's Alpha, with $\alpha \geq 0.70$ considered acceptable for internal consistency (Zikmund et al., 2013). Items falling below this threshold were revised to enhance instrument reliability.

Both qualitative and quantitative data analysis methods were used. Qualitative responses underwent content analysis, while quantitative data were analyzed using SPSS Version 28. Descriptive statistics—frequencies, means, and standard deviations—were used to summarize data. Pearson correlation analysis was conducted to determine the strength and direction of relationships among variables, following interpretation guidelines by Hair et al. (2010). Multiple regression analysis was used to examine the combined effect of inventory optimization, and collaborative logistics, on the performance of firms, a method widely recommended for assessing predictive relationships (Field, 2018). Results were presented using tables and figures for clarity and interpretability.

RESEARCH FINDINGS AND DISCUSSIONS

To evaluate the effectiveness of logistics optimization among beverage manufacturing firms in Nairobi City County, a total of 188 questionnaires were distributed to supply chain, logistics, procurement, and operations managers as outlined in the sampling design. Of these, 172 questionnaires were fully completed and returned, while 16 were either not returned or rendered unusable due to significant omissions. A response rate of 91.5% was achieved, which is considered excellent in empirical survey research. This high response rate is well above the conventional threshold of 70% deemed acceptable in organizational and social science research (Mugenda & Mugenda, 2003), thereby enhancing the reliability, validity, and generalizability of the study findings

Descriptive Analysis of Study Variables

This section presents a summary of respondents' perceptions regarding the key study variables. Each variable was measured using a five-point Likert scale: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly Agree (5). The mean scores obtained from the responses were interpreted using the following scale: 1.00–1.80 = Strongly Disagree, 1.81–2.60 = Disagree, 2.61–3.49 = Moderate, 3.50–4.20 = Agree, and 4.21–5.00 = Strongly Agree. These interpretation bands help evaluate the extent to which logistics optimization practices are applied and how they influence performance of firms in beverage manufacturing firms within Nairobi City County.

Inventory Optimization

The first objective of the study was to evaluate the effect of inventory optimization on the performance of beverage manufacturing firms in Nairobi City County, Kenya. Respondents were presented with seven statements measuring various aspects of inventory optimization and asked to rate their level of agreement using a five-point Likert scale. The descriptive results are summarized in Table 1.

Table 1: Descriptive Statistics for Inventory Optimization

Statements	**Mean (M)**	**Std. Dev. (SD)**
The company uses automated inventory management systems.	4.147	0.764
Inventory levels are monitored in real time to prevent stockouts.	4.059	0.849
Demand forecasting techniques are applied to manage inventory efficiently.	4.118	0.798
Inventory optimization practices minimize wastage and reduce costs.	4.132	0.736
Safety stock levels are regularly maintained to avoid production interruptions.	4.044	0.873
Supplier lead times are considered in inventory replenishment planning.	4.088	0.821
Inventory optimization enhances order fulfillment and customer satisfaction.	4.221	0.709
Aggregate Score	**4.116**	**0.793**

The highest-rated item was the statement that inventory optimization enhances order fulfillment and customer satisfaction (M = 4.221, SD = 0.709), indicating that respondents see inventory efficiency as central to meeting customer needs. Firms also agreed strongly that they use automated inventory management systems (M = 4.147, SD = 0.764), and apply forecasting techniques to manage inventory (M = 4.118, SD = 0.798), suggesting a high level of technological integration into inventory processes. Respondents also agreed that inventory practices help minimize wastage and reduce costs (M = 4.132, SD = 0.736), reinforcing the operational value of optimization. Monitoring inventory levels in real-time was also widely affirmed (M = 4.059, SD = 0.849), reflecting the importance of visibility in preventing stockouts. Further, respondents indicated that supplier lead times are considered in replenishment planning (M = 4.088, SD = 0.821) and that safety stock is regularly maintained (M = 4.044, SD = 0.873). These practices are consistent with proactive inventory risk management and production continuity.

The aggregate mean score of 4.116 and standard deviation of 0.793 indicate a very high level of inventory optimization among beverage manufacturing firms, with relatively consistent practices across respondents. These findings suggest that firms recognize the strategic value of optimizing inventory to improve both efficiency and customer service. This is supported by recent research such as Jain et al. (2021), who emphasize that automated and real-time inventory systems reduce operating costs while increasing service levels in FMCG and manufacturing sectors. Similarly, Mousavi et al. (2022) found that integrating forecasting and lead time management improves responsiveness and reduces disruptions. Furthermore, Wang and Zhong (2020) highlight that customer satisfaction and order fulfillment are directly tied to robust inventory optimization practices in digitized supply chains. Overall, these results demonstrate that inventory optimization is a core driver of logistics performance and a critical factor for competitiveness in Nairobi's beverage manufacturing sector.

Collaborative Logistics

The second objective of this study was to assess the effect of collaborative logistics on the performance of beverage manufacturing firms in Nairobi City County, Kenya. Respondents were asked to express their level of agreement with seven statements reflecting various dimensions of collaboration in logistics using a five-point Likert scale. The responses are summarized in Table 2.

Table 2: Descriptive Statistics for Collaborative Logistics

Statements	**Mean (M)**	**Std. Dev. (SD)**
The company collaborates with suppliers and distributors to improve logistics efficiency.	4.176	0.742
Information sharing among logistics partners is timely and accurate.	4.088	0.781
Digital platforms are used to coordinate logistics activities with partners.	4.132	0.765
Collaborative logistics practices reduce transportation and storage costs.	4.044	0.812
Joint planning with supply chain partners minimizes disruptions.	4.059	0.797
The company engages in shared transportation or warehousing with partners.	3.971	0.866
Misalignment or trust issues limit the success of collaborative logistics efforts.	3.691	0.983
Aggregate Score	**4.023**	**0.821**

Respondents expressed the strongest agreement with the statement that their firms collaborate with suppliers and distributors to improve logistics efficiency (M = 4.176, SD = 0.742), demonstrating that collaboration is seen as a vital strategy for operational effectiveness.

Similarly, the use of digital platforms for coordinating logistics activities with partners (M = 4.132, SD = 0.765) and timely, accurate information sharing (M = 4.088, SD = 0.781) were also highly rated, highlighting strong technological enablers in collaboration. Additionally, there was clear agreement that collaborative logistics practices help reduce transportation and storage costs (M = 4.044, SD = 0.812) and that joint planning with supply chain partners helps minimize disruptions (M = 4.059, SD = 0.797). These results emphasize the cost and risk reduction benefits of effective coordination among partners. On the slightly lower end, respondents agreed that their firms engage in shared transportation or warehousing with partners (M = 3.971, SD = 0.866), suggesting moderate implementation of shared asset strategies. The statement with the lowest rating was that misalignment or trust issues limit collaborative efforts (M = 3.691, SD = 0.983), which—though still above neutral—points to organizational and relational barriers that may hinder collaboration success.

The aggregate mean score of 4.023 and a standard deviation of 0.821 reflect a strong level of collaborative logistics practice, with moderate variability across firms. These results suggest that beverage firms in Nairobi County actively engage in collaborative practices that improve logistics efficiency, reduce costs, and enhance supply chain responsiveness. These findings align with recent studies in the logistics and supply chain field. Attia and Eldin (2021) found that supply chain collaboration in emerging economies leads to measurable improvements in service delivery and cost control. Furthermore, Zhu et al. (2020) noted that the use of digital platforms and timely information exchange strengthens trust and transparency among logistics partners. The moderate acknowledgment of shared warehousing and transportation is consistent with Mahmood et al. (2022), who observed that while strategic collaborations are growing, shared infrastructure remains underutilized due to logistical complexities. Finally, the observed concern over misalignment and trust issues resonates with Nasiri et al. (2023), who emphasized that cultural alignment and mutual benefit perception are key determinants of collaborative logistics success.

Performance of Firms

The final objective of the study was to assess the effect of logistics optimization on the performance of beverage manufacturing firms in Nairobi City County, Kenya. To evaluate this, respondents rated their agreement with seven statements covering various performance indicators—cost, profitability, competitiveness, customer outcomes, adaptability, and supplier relations—on a 5-point Likert scale. The results are presented in Table 3.

Table 3: Descriptive Statistics for Performance of Firms

Statements	**Mean (M)**	**Std. Dev. (SD)**
Logistics optimization has reduced operational costs significantly.	4.132	0.764
Improved logistics operations have enhanced overall firm profitability.	4.176	0.742
The company's logistics performance gives it a competitive advantage.	4.147	0.781
Customer satisfaction has improved due to logistics efficiency.	4.191	0.709
Timely deliveries have increased customer retention.	4.162	0.721
The company's logistics function is responsive to changing market demands.	4.088	0.798
Logistics optimization has strengthened supplier relationships.	4.029	0.844
Aggregate Score	**4.132**	**0.766**

Respondents expressed a high level of agreement that logistics optimization has contributed positively to several performance indicators. The strongest agreement was for customer satisfaction improvement due to logistics efficiency (M = 4.191, SD = 0.709), followed by enhanced firm profitability (M = 4.176, SD = 0.742) and increased customer retention from timely deliveries (M = 4.162, SD = 0.721). These indicators reflect how optimized logistics contribute directly to both customer outcomes and financial performance. Further, the results show that logistics optimization provides a competitive advantage (M = 4.147, SD = 0.781) and significantly reduces operational costs (M = 4.132, SD = 0.764). These findings are critical because they support the long-held view that efficient logistics systems enhance a firm's cost leadership and differentiation strategies. Although slightly lower, there was still strong agreement that the logistics function is responsive to changing market demands (M = 4.088, SD = 0.798) and that supplier relationships have been strengthened (M = 4.029, SD = 0.844), reflecting a broad scope of benefits linked to optimization.

With an aggregate mean of 4.132 and a standard deviation of 0.766, the results suggest that logistics optimization is perceived to have a highly positive effect on performance of firms across financial, operational, customer, and relational dimensions. These findings are strongly supported by recent research. Singh et al. (2022) observed that logistics efficiency directly enhances firm profitability and operational excellence in manufacturing contexts. Wang and Zhang (2021) emphasize that optimized delivery systems improve customer satisfaction and loyalty aligning with this study's high ratings for customer-related performance. The observed benefit to supplier relationships also aligns with Ali and Raza (2020), who noted that logistics collaboration fosters more agile supply chains, which in turn promote stronger inter-firm partnerships. Lastly, Yousaf et al. (2023) confirm that responsiveness to market dynamics through logistics agility has become a critical success factor, particularly in the fast-moving consumer goods sector.

Correlation Analysis

This section presents the Pearson correlation analysis conducted to examine the strength and direction of the linear relationship between the independent variables; Inventory Optimization, and Collaborative Logistics, , and the dependent variable, performance of firms. The Pearson correlation coefficient (r) ranges between -1 and +1, with values interpreted according to the scale below (Cohen, 1988): 0.00–0.19-Very weak, 0.20–0.39-Weak, 0.40–0.59-Moderate, 0.60–0.79-Strong, 0.80–1.00-Very strong. Table 4 presets the summary of findings obtained.

Table 4. 1: Correlation Analysis Matrix

		Performance of firms	**Inventory Optimization**	**Collaborative Logistics**
Performance of firms	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	172		
Inventory Optimization	Pearson Correlation	.825	1	
	Sig. (2-tailed)	.007**		
	N	172	172	
Collaborative Logistics	Pearson Correlation	.857	.127	1
	Sig. (2-tailed)	.002**	.025*	
	N	172	172	172

Inventory Optimization and performance of firms ($r = 0.825$, $p<0.05$). Inventory optimization also shows a strong positive association with performance of firms. This reinforces findings by Pasupuleti et al. (2024) and Tadayonrad & Ndiaye (2023), who reported that machine learning and forecasting models reduce overstocking, emergency procurement, and stockouts, ultimately enhancing supply chain agility. Efficient inventory systems like JIT and automated replenishment lower holding costs and improve order fulfillment rates, crucial for perishable goods in the beverage sector.

Collaborative Logistics and performance of firms ($r = 0.857$, $p<0.05$). The highest correlation observed is between collaborative logistics and performance of firms. This confirms the work of Kang et al. (2020) and Baah et al. (2022), who found that blockchain-enabled and cloud-supported logistics coordination improved transparency, reduced costs, and increased agility. Shared transportation, warehousing, and information systems allow firms to benefit from economies of scale and reduced redundancies, particularly critical in dynamic FMCG environments like beverages.

Regression Analysis

This section presents the unstandardized coefficients used in the regression model. These coefficients indicate the strength and significance of the relationship between each independent variable and performance of firms.

Table 45: Regression Coefficients

Variable	Unstandardized Coefficient (B)	Standard Error	Standardized Beta (β)	t-Statistic	p-Value
Constant	0.353	0.112		3.148	0.002
Inventory Optimization	0.289	0.077	0.322	3.749	0.000
Collaborative Logistics	0.403	0.099	0.437	4.073	0.000

a. Dependent Variable: performance of firms

The regression model fitted was as follows:

$$\mathbf{Y = 0.353 + 0.289X1 + 0.403X2 + \varepsilon}$$

Where:

Y = performance of firms

X1 = Inventory Optimization

X2 = Collaborative Logistics

ε = Error term

Inventory Optimization had a coefficient of 0.289 and a p-value of 0.000, suggesting a significant positive effect on performance of firms. This indicates that optimizing inventory systems, through predictive analytics, automated stock control, and responsive replenishment mechanisms, enhances a firm's ability to reduce costs and improve order fulfillment. These findings align with Tadayonrad and Ndiaye (2023), who noted that machine learning tools in inventory management contributed to supply chain resilience and efficiency. Pasupuleti et al. (2024) similarly concluded that smart inventory systems minimize losses and elevate service levels.

The coefficient for Collaborative Logistics was 0.403 with a p-value of 0.000, making it the most influential predictor in the model. This strong, positive, and statistically significant result indicates that collaborative practices such as joint warehousing, shared distribution networks, and real-time data sharing produce a 0.403 unit increase in performance of firms for every one-unit improvement. These results confirm findings by Baah et al. (2022) and Kang et al. (2020), who highlighted how trust-based, blockchain-enhanced collaborations led to reduced redundancy, faster deliveries, and improved customer satisfaction.

Lastly, the constant term was 0.353 and statistically significant ($p = 0.002$), indicating that in the absence of the examined logistics strategies, performance of firms remains at a moderate base level. However, the inclusion of the four optimization strategies substantially raises performance outcomes.

Conclusion

It is concluded that effective inventory optimization significantly improves performance of firms by enabling better stock management, reducing wastage, and improving order fulfillment. Practices such as real-time monitoring, accurate forecasting, and automated inventory systems ensure that firms operate leaner, avoid stockouts, and maintain consistent production flows.

The study finds that collaborative logistics is essential for boosting performance of firms through enhanced coordination and trust among supply chain partners. When firms engage in shared planning, information exchange, and joint distribution strategies, they reduce operational inefficiencies and improve overall supply chain responsiveness.

Recommendations

Inventory Optimization

Given the strong influence of inventory optimization on performance of firms, beverage manufacturers should adopt more advanced, data-driven inventory management systems. These systems should include features such as real-time tracking, predictive analytics, and automated replenishment mechanisms. Firms should also refine their demand forecasting models using historical sales, seasonal trends, and market intelligence to minimize errors in stock levels. Moreover, it is recommended that companies adopt a dynamic inventory review policy that regularly adjusts safety stock levels and lead time buffers based on market conditions and supplier reliability. This proactive approach helped prevent both overstocking and stockouts, thereby supporting cost control and customer service consistency.

Collaborative Logistics

To build on the performance benefits derived from collaboration, firms should deepen partnerships with suppliers, distributors, and logistics service providers. This can be achieved through structured collaboration frameworks involving joint planning sessions, performance scorecards, and shared digital dashboards that provide visibility across the supply chain. Organizations should also formalize agreements that facilitate shared warehousing and transportation where feasible. At the interpersonal and inter-organizational level, trust-building remains crucial. Firms should cultivate transparency, equitable information sharing, and mutual benefit alignment to address existing challenges such as misalignment and trust deficits. Periodic partner evaluations and communication forums will further enhance relationship management and collaboration quality.

Suggestions for Further Research

Future studies should consider adopting a longitudinal design to assess the long-term effects of logistics optimization strategies on performance of firms. Expanding the scope beyond beverage manufacturers in Nairobi to include other sectors and regions would enhance generalizability. Additionally, qualitative approaches could uncover contextual and behavioural factors affecting implementation. Researchers may also explore moderating variables such as organizational agility or sustainability practices to better understand the broader impact of logistics optimization on firm competitiveness.

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