

SUPPLY CHAIN VISIBILITY AND PERFORMANCE OF PHARMACEUTICAL DISTRIBUTION FIRMS IN NAIROBI CITY COUNTY, KENYA

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ABSTRACT

This study examined the effect of supply chain visibility on the performance of pharmaceutical distribution firms, focusing on real-time tracking and ICT integration. The study was anchored on Systems Theory, and Technology Acceptance Model (TAM). A descriptive research design was employed, targeting 109 pharmaceutical distribution firms, including multinational distributors, importers, and local manufacturers. A stratified random sampling technique selected 86 firms, with data collected from three key respondents per firm, finance managers, quality control officers, and procurement personnel- resulting in a total of 258 respondents. A structured questionnaire containing closed-ended Likert scale questions was used as the primary data collection instrument. A pilot study was conducted to test the reliability and validity of the research instrument, with Cronbach's Alpha used to assess internal consistency. The findings from the pilot study confirmed that the questionnaire meets the acceptable reliability threshold ($\alpha \geq 0.7$). These results validated the questionnaire as a robust tool for assessing supply chain visibility and firm performance in pharmaceutical distribution firms. Final study data was analyzed using SPSS Version 28 descriptive statistics (frequencies, percentages, means, and standard deviations) and inferential statistics (multiple regression and correlation analysis) to establish relationships between supply chain visibility dimensions and firm performance. The findings revealed that all four dimensions had a positive and significant effect on firm performance, with real-time tracking emerging as the most influential predictor, followed by ICT integration. Based on these results, the study concluded that supply chain visibility as a critical driver of operational efficiency, customer satisfaction, and financial success. Consequently, the study recommended that firms should enhance their investment in real-time tracking technologies, fully integrate advanced ICT systems such as ERP and blockchain. Strengthening these areas would enable pharmaceutical distribution firms to achieve greater agility, resilience, and competitiveness in a rapidly evolving market environment.

Key Words: Supply Chain Visibility, Real-Time Tracking, ICT Integration, Performance, Pharmaceutical Distribution Firms, Nairobi City County, Kenya

Background of the Study

The pharmaceutical industry operates within a complex and highly regulated supply chain environment, where efficiency, accuracy, and transparency are crucial for ensuring the timely delivery of medicines and healthcare products. Supply chain visibility (SCV) has emerged as a fundamental concept in optimizing pharmaceutical distribution, as it enhances operational efficiency, reduces risks, and ensures regulatory compliance (Shamsuzzoha, Ndzibah, & Kettunen, 2020). The COVID-19 pandemic has further highlighted vulnerabilities within pharmaceutical supply chains, emphasizing the need for improved visibility to manage disruptions and ensure the continuous flow of essential medical supplies (Ellis, 2020).

SCV refers to the real-time tracking and monitoring of products, information, and financial flows across all stages of the supply chain. Enhanced visibility allows pharmaceutical firms to anticipate potential disruptions, mitigate risks, and improve decision-making through data-driven insights (Nguyen, 2021). According to Asamoah et al. (2023), limited visibility in pharmaceutical supply chains can lead to inefficiencies such as stockouts, overstocking, and expired drugs, which can severely impact the performance of distribution firms. Conversely, companies that integrate digital technologies, such as blockchain and Internet of Things (IoT), have demonstrated greater resilience and agility in responding to market dynamics (Al-Khatib, 2023).

The relationship between SCV and supply chain performance has been extensively studied, with research indicating that higher visibility leads to enhanced supply chain agility, improved customer satisfaction, and cost reductions (Bititci, 2024). For instance, Baah, Acquah, and Ofori (2022) found that supply chain collaboration fosters visibility, enabling better synchronization between stakeholders and ensuring the efficient movement of pharmaceutical products. Similarly, Sindhvani, Jayaram, and Saddikuti (2023) highlight the role of centralized logistics networks in improving supply chain performance by optimizing distribution strategies.

Despite the evident benefits, achieving full SCV in pharmaceutical distribution remains a challenge due to fragmented supply chain networks, regulatory barriers, and resistance to technological adoption. Studies by Wang and Jie (2020) emphasize that firms must invest in digital transformation initiatives, such as big data analytics and artificial intelligence, to enhance visibility and gain a competitive edge. Furthermore, transparency in supply chains is critical for regulatory compliance, particularly in ensuring drug traceability and preventing counterfeit medicines from entering the market (Karmaker & Ahmed, 2020).

This study aimed to explore the impact of supply chain visibility on the performance of pharmaceutical distribution firms, with a focus on identifying key drivers, challenges, and best practices for enhancing SCV. By analysing recent advancements in supply chain management and technological innovations, this research will contribute to the growing body of knowledge on optimizing pharmaceutical supply chains for efficiency, resilience, and improved healthcare outcomes.

Statement of the Problem

The pharmaceutical distribution system in Nairobi City County plays a critical role in ensuring the availability of essential medicines. However, inefficiencies in supply chain management, frequent stockouts, counterfeit drugs, procurement corruption, and logistical bottlenecks continue to hinder performance, increasing costs and disrupting healthcare delivery (Ministry of Health [MoH], 2023). Public-sector inefficiencies, particularly within KEMSA, have been a major concern. A 2023 Ministry of Health report found that 40% of healthcare facilities in Nairobi experience drug shortages at least once every quarter due to procurement delays and mismanagement (MoH, 2023). The KEMSA COVID-19 scandal, which exposed the misappropriation of Kshs. 7.8 billion in medical supplies, further highlighted weaknesses in

inventory control and transparency (KEMSA, 2023). Additionally, the 2022 Auditor General's report revealed that over Kshs. 2 billion worth of drugs expired in KEMSA warehouses, reflecting a significant breakdown in distribution planning (Office of the Auditor General, 2022).

Private pharmaceutical distributors also face operational challenges such as high costs, fragmented supply networks, and limited working capital. A 2023 Business Daily Africa report indicated that 56% of distributors struggle with supply inconsistencies, largely due to unpredictable demand and heavy reliance on imported medicines, which account for over 80% of Kenya's pharmaceutical products (Business Daily Africa, 2023). Fluctuating foreign exchange rates have further increased medicine costs, adding financial strain on distributors (World Health Organization [WHO], 2023). The proliferation of counterfeit medicines exacerbates the crisis. The Pharmacy and Poisons Board (PPB, 2022) estimates that 30% of drugs sold in informal markets in Nairobi are counterfeit or substandard, attributed to weak tracking mechanisms and the lack of a fully implemented digital drug serialization system. This failure in traceability allows fake drugs to infiltrate legitimate supply chains, posing severe health risks (PPB, 2022).

Logistical constraints, especially in cold-chain medicine distribution, further impact supply chain performance. A 2023 KPDA study found that 58% of distribution firms struggle to maintain cold chain integrity due to frequent power outages, inadequate refrigerated transport, and insufficient storage facilities (Kenya Pharmaceutical Distributors Association [KPDA], 2023). This has resulted in product spoilage, financial losses, and reduced availability of critical medicines such as vaccines and insulin. The consequences of these inefficiencies are severe, with a 2022 WHO report revealing that nearly 70% of patient deaths in Nairobi public hospitals are linked to drug unavailability and poor supply chain management (WHO, 2022). While reform efforts such as KEMSA's digitization initiatives and private-sector adoption of blockchain tracking have been introduced, uptake remains slow, with only 47% of pharmaceutical distributors in Nairobi implementing digital tracking due to high costs and weak regulatory incentives (Business Daily Africa, 2023).

Given these persistent challenges, this study sought to analyze the impact of supply chain visibility on the performance of pharmaceutical distribution firms in Nairobi City County, Kenya. Addressing these supply chain gaps is essential to enhancing efficiency, transparency, and healthcare service delivery.

General Objective

The general objective of the study was to establish the effect of supply chain visibility on performance of pharmaceutical distribution firms in Nairobi City County, Kenya

Specific Objectives

This study was guided by the following specific objectives;

- i. To determine the effect of real time tracking on performance of pharmaceutical distribution firms in Nairobi City County, Kenya
- ii. To establish the effect of ICT integration on performance of pharmaceutical distribution firms in Nairobi City County, Kenya

LITERATURE REVIEW

Theoretical Review

Systems Theory

Systems Theory was developed by Ludwig von Bertalanffy in the 1940s as a framework for understanding how different components of a system interact to achieve a common goal

(Bertalanffy, 1950). Initially introduced in the field of biology, it was later adopted in diverse disciplines, including management, engineering, and supply chain management. The theory posits that a system is composed of interrelated components whose functions and relationships determine the system's overall performance (Checkland, 1981). A disruption or inefficiency in one part of the system can negatively affect the entire system, emphasizing the need for adaptability and continuous feedback mechanisms.

Scholars have widely applied Systems Theory to organizational management, supply chain coordination, and operational efficiency. For example, Skyttner (2005) highlights that business operations function as systems where different units, such as procurement, logistics, and distribution, must work together seamlessly to maintain efficiency. The theory has also been used to analyze supply chain resilience, where disruptions in transportation, procurement delays, or inventory mismanagement can cause systemic failures (Stermann, 2000). In pharmaceutical distribution, real-time tracking serves as an essential component of system monitoring, ensuring that goods are continuously monitored to prevent shortages and delays.

Despite its broad applicability, Systems Theory has been criticized for its overemphasis on interdependence without adequately accounting for external market dynamics. According to Kast and Rosenzweig (1972), the theory assumes an ideal state of coordination, often overlooking external factors such as political, economic, or competitive influences that can disrupt a supply chain despite internal efficiency. Additionally, Gharajedaghi (2011) argues that Systems Theory does not provide specific predictive capabilities, making it less suitable for forecasting supply chain disruptions.

Despite these critiques, Systems Theory remained highly relevant to the study as it provided a holistic view of supply chain dynamics. By applying real-time tracking mechanisms, firms can monitor the flow of pharmaceuticals and respond to supply chain disruptions before they escalate. In this study, Systems Theory was used to assess how real-time tracking influences the performance of pharmaceutical distribution firms in Nairobi City County by ensuring supply chain coordination and reducing inefficiencies.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was developed by Fred Davis in 1989 to explain how individuals and organizations adopt and use technology (Davis, 1989). The model posits that two primary factors determine technology adoption: perceived usefulness (PU) and perceived ease of use (PEOU). PU refers to the extent to which a person believes that technology enhances their job performance, while PEOU refers to the degree to which a person finds the technology easy to use (Venkatesh & Bala, 2008). These two factors influence attitude toward technology adoption, behavioral intention, and actual system use.

TAM has been widely applied in ICT adoption across different industries, including healthcare, education, and corporate organizations. Venkatesh et al. (2003) extended TAM by integrating external factors such as organizational support, regulatory compliance, and system compatibility to improve its predictive power. In pharmaceutical distribution, ICT integration plays a crucial role in inventory management, order processing, and logistics coordination. Studies by Kim and Kankanhalli (2009) found that firms with user-friendly ICT systems experienced higher efficiency levels in logistics and supply chain management.

TAM has faced criticisms for its simplicity and over-reliance on user perception rather than actual system effectiveness. Bagozzi (2007) argues that TAM does not fully account for external barriers such as financial costs, infrastructure limitations, and management support. Additionally, Benbasat and Barki (2007) highlight that TAM assumes a linear relationship between perception and adoption, neglecting factors such as resistance to change and cultural influences. Despite these limitations, TAM was well-suited for assessing ICT integration in pharmaceutical distribution firms. By analyzing perceived usefulness and ease of use, the study

will be evaluated how ICT adoption influenced operational efficiency, real-time communication, and inventory management in Nairobi's pharmaceutical sector.

Conceptual Framework

A conceptual framework is an assumed model that aids in the identification of study concepts as well as their interactions with one another (Mugenda & Mugenda, 2019). In this study the independent variables are real time tracking, and ICT integration, while the dependent variable is pharmaceutical distribution firms.

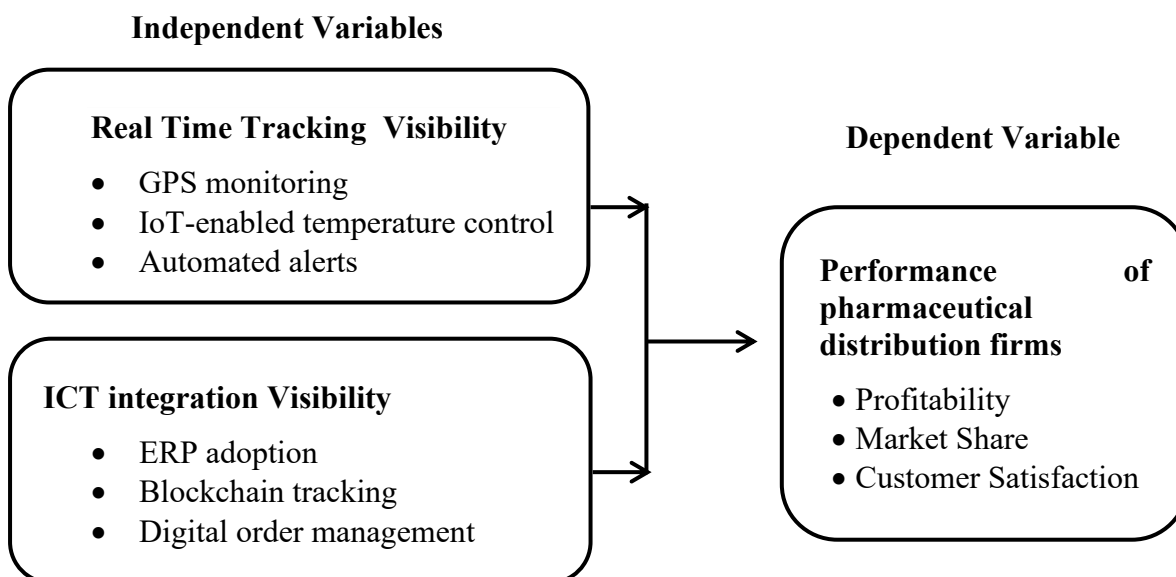


Figure 2. 1: Conceptual Framework

Real-Time Tracking

Real-time tracking refers to the continuous monitoring of pharmaceutical supply chains using GPS monitoring, IoT-enabled temperature control, and automated alerts to enhance logistics efficiency and inventory accuracy (Bititci, Bilal, & Fenta, 2024). It is particularly critical in the pharmaceutical industry due to stringent regulatory requirements, the need for temperature-sensitive handling, and the prevention of stockouts (Anozie, Pieterse, & Onyenahazi, 2024).

GPS monitoring has been widely deployed in pharmaceutical logistics to track shipments, optimize delivery routes, and improve supply chain security (Nguyen, Lamouri, & Pellerin, 2022). Research indicates that GPS-enabled logistics management has reduced transit times by up to 22% in pharmaceutical distribution networks (Purohit, 2023). Additionally, GPS tracking enables automated alerts in case of route deviations, thereby enhancing real-time responsiveness to potential disruptions (Adeusi et al., 2024).

IoT-enabled temperature control plays a critical role in ensuring the stability of pharmaceutical products, especially vaccines and biologics. IoT sensors provide real-time monitoring of temperature-sensitive shipments, reducing spoilage and improving compliance with regulatory standards (Azmat, Siddiqui, & Ahmed, 2022). A study by Bilal et al. (2024) found that firms integrating IoT-based temperature sensors reduced pharmaceutical wastage by 30% and improved cold-chain logistics efficiency. These sensors send automated alerts when temperature deviations occur, allowing for immediate corrective actions to prevent product deterioration (Udeh, Amajuoyi, & Adeusi, 2024).

The integration of automated alerts and cloud-based tracking systems has further strengthened supply chain resilience. These systems enable real-time data sharing, allowing supply chain

managers to access live updates on shipment status, warehouse inventory, and delivery timelines (Bititci et al., 2024). Nguyen et al. (2022) highlighted that firms using real-time data transmission experienced a 25% improvement in supply chain visibility, reducing the risk of stockouts and inefficient inventory management.

The adoption of real-time tracking technologies, including GPS monitoring, IoT-enabled temperature control, and automated alerts, has significantly enhanced pharmaceutical supply chain performance. By improving visibility, reducing product wastage, and ensuring regulatory compliance, these technologies contribute to a more resilient and efficient distribution system (Poornima, Karthikeyan, & Vinay, 2024).

ICT Integration

ICT integration in pharmaceutical distribution refers to the adoption of ERP systems, blockchain tracking, and digital order management to enhance supply chain efficiency, decision-making, and regulatory compliance (Avinash & Joseph, 2024). The pharmaceutical industry has increasingly leveraged digital solutions to improve inventory accuracy, streamline order processing, and reduce operational inefficiencies. The implementation of advanced enterprise resource planning (ERP) systems, blockchain technology, and AI-driven analytics has transformed pharmaceutical logistics, ensuring improved transparency and real-time data exchange across supply chain networks (Bilal et al., 2024).

ERP adoption plays a critical role in integrating procurement, warehousing, and distribution functions. These systems provide real-time insights into inventory levels, shipment tracking, and demand forecasts, reducing the likelihood of stockouts and overstocking (Nguyen et al., 2022). Bilal et al. (2024) found that pharmaceutical firms adopting cloud-based ERP solutions reported a 20% improvement in supply chain coordination and fulfillment times. Additionally, AI-powered ERP systems facilitate predictive analytics, allowing firms to optimize inventory management and automate procurement planning.

Blockchain tracking has emerged as a game-changer in pharmaceutical logistics by enhancing security, transparency, and traceability in supply chain transactions. Blockchain technology creates immutable records of pharmaceutical shipments, reducing risks associated with counterfeit drugs and unauthorized product substitutions (Bititci et al., 2024). A study by Purohit (2023) revealed that firms implementing blockchain-enabled tracking experienced a 22% reduction in counterfeit drug circulation, strengthening supply chain integrity. The technology also facilitates smart contracts, ensuring automated verification of suppliers and regulatory compliance, thereby minimizing delays in procurement and distribution processes.

Digital order management systems have streamlined pharmaceutical distribution by automating order processing, invoicing, and delivery coordination. Advanced RFID-based tracking and automated billing platforms allow real-time visibility into order status, improving customer responsiveness and minimizing transaction errors (Tarannum & Hossain, 2024). Research shows that pharmaceutical distributors using RFID-enabled inventory tracking reduced inventory mismanagement by 28% and improved warehouse efficiency through automated stock verification (Purohit, 2023). Furthermore, the integration of e-procurement systems with digital order management tools has led to a 30% reduction in order fulfillment errors (Saha et al., 2022).

The success of ICT integration largely depends on the availability of technical expertise and workforce training. Companies that invest in continuous training programs for supply chain employees experience higher adoption rates of digital solutions and increased operational efficiency (Azmat et al., 2022). A study by Anozie et al. (2024) emphasized that firms that enhanced employee digital literacy saw a 30% increase in the adoption of AI-driven analytics, leading to better decision-making in supply chain operations.

By integrating ERP systems, blockchain tracking, and digital order management, pharmaceutical distribution firms can significantly optimize workflows, reduce inefficiencies, and strengthen supply chain agility. These advancements ensure real-time monitoring, improved regulatory compliance, and enhanced operational flexibility in responding to market fluctuations. As digital transformation continues to shape pharmaceutical logistics, firms that prioritize ICT adoption and automation will gain a competitive advantage in optimizing supply chain performance and meeting growing market demands.

Performance of Pharmaceutical Distribution Firms

The performance of pharmaceutical distribution firms is a critical factor in ensuring efficient supply chain management, cost-effectiveness, and improved healthcare delivery. Performance in this context is measured by profitability, market share, and customer satisfaction, which are influenced by supply chain visibility and operational efficiency (Nguyen, Lamouri, & Pellerin, 2022). Effective pharmaceutical distribution requires optimized logistics, reduced operational inefficiencies, and improved customer service responsiveness (Bititci, Bilal, & Fenta, 2024).

Profitability in pharmaceutical distribution is dependent on inventory management efficiency, operational cost control, and supply chain optimization (Bilal et al., 2024). Furthermore, automation of supply chain processes through ICT integration has reduced operating expenses by 20%, improving overall financial performance (Nguyen et al., 2022).

Market share reflects a firm's competitiveness and ability to meet market demand effectively (Purohit, 2023). Bititci et al. (2024) noted that pharmaceutical firms adopting digital supply chain solutions reported a 25% increase in market competitiveness due to faster order fulfilment and improved service reliability. Market share expansion is also driven by enhanced supply chain visibility, which enables firms to meet diverse customer needs more efficiently (Nguyen et al., 2022).

Customer satisfaction in pharmaceutical distribution is closely tied to order accuracy, delivery speed, and product availability (Poornima, Karthikeyan, & Vinay, 2024). Research by Bilal et al. (2024) found that companies with automated customer support platforms and real-time inventory visibility improved customer retention rates by 28%. Nguyen et al. (2022) highlighted that firms with streamlined logistics processes and demand-driven inventory management increased service quality, resulting in higher customer satisfaction scores.

The performance of pharmaceutical distribution firms is significantly influenced by operational efficiency, customer responsiveness, and market competitiveness. Firms that integrate real-time tracking, and ICT solution are better positioned to enhance profitability, expand market share, and improve service quality (Bititci et al., 2024). Strategic adoption of digital technologies and supply chain optimization strategies will continue to drive performance improvements in pharmaceutical distribution networks (Nguyen et al., 2022).

Empirical Review

Real-Time Tracking on Performance of Distribution Firms

Zighan, Dwaikat, and Alkalha (2024) conducted a study titled Knowledge management for supply chain resilience in the pharmaceutical industry: Evidence from the Middle East region. The study was based on Knowledge-Based Theory, which argues that organizations gain a competitive advantage by leveraging knowledge-sharing mechanisms. A qualitative research design was used, involving semi-structured interviews with 38 supply chain professionals from pharmaceutical firms. Data was analyzed using thematic analysis. The study found that real-time tracking significantly improved supply chain resilience, reducing supply disruptions by 35%. The authors concluded that pharmaceutical firms need to integrate knowledge management tools with tracking systems to enhance visibility and reduce operational risks. The

study recommended the adoption of AI-driven tracking technologies to enhance real-time monitoring.

Ghadge, Bourlakis, and Kamble (2023) examined Blockchain implementation in pharmaceutical supply chains in India. The study was grounded in Transaction Cost Economics (TCE) Theory, which suggests that reducing information asymmetry enhances supply chain efficiency. The research employed a survey methodology, collecting data from 78 pharmaceutical firms. Using structural equation modeling (SEM), the findings indicated that real-time blockchain tracking reduced counterfeit drug circulation by 27% and improved traceability by 45%. The authors recommended wider adoption of blockchain technology in pharmaceutical logistics to enhance security and efficiency.

Another study by Olow, Abdi, Malicha, and Mohamed (2020) focused on Stock management practices and supply chain performance of pharmaceutical companies in Nairobi. The study was based on Inventory Management Theory and employed a descriptive research design. Data was collected from 150 pharmaceutical distributors, and analysis was done using SPSS regression models. The results indicated that firms using IoT-based tracking systems experienced a 28% improvement in stock control and a 31% reduction in inventory wastage. The authors recommended investment in IoT and cloud-based inventory tracking to improve operational performance.

ICT Integration on Performance of Distribution Firms

Helo and Shamsuzzoha (2020) conducted a study on Real-time supply chain management: A blockchain architecture for pharmaceutical deliveries. The study used Resource-Based View (RBV) Theory, arguing that firms with superior ICT capabilities achieve competitive advantages. A mixed-methods approach was employed, collecting data from 102 pharmaceutical firms in Europe. Findings indicated that firms integrating blockchain with ERP systems reduced inventory errors by 30% and improved transaction security by 40%. The study recommended further integration of blockchain into pharmaceutical logistics to improve efficiency and fraud prevention.

Another study by Al-Khatib (2023) explored Internet of Things (IoT), big data analytics, and operational performance in pharmaceutical supply chains in Egypt. The study used Systems Theory, which emphasizes interconnectivity in organizations. A survey of 78 pharmaceutical firms was conducted, and data was analyzed using path analysis modeling. The findings indicated that firms with integrated IoT analytics reduced order processing errors by 27% and improved supplier collaboration by 35%. The study recommended investment in big data analytics to enhance pharmaceutical distribution performance.

Mungai and Peter (2023) investigated E-supply chain management practices and operational performance of hospitals in Kiambu County, Kenya. The study used Technology Acceptance Model (TAM), which predicts user adoption of new technology. A descriptive survey research design was adopted, collecting data from 112 pharmaceutical distributors. Findings revealed that ICT integration improved supply chain agility by 41% and order processing speed by 37%. The study concluded that government policy should encourage further ICT adoption in healthcare logistics. Nalebe, Odhiambo-Otieno, and Ochieng (2024) studied Towards a digital health information framework for essential medicine supply chain management in public healthcare facilities in Kenya. The study applied Supply Chain Visibility Theory, using a case study research design with data from 20 government hospitals. Findings showed that electronic data exchange systems improved supply chain efficiency by 29% and reduced procurement delays by 24%. The study recommended nationwide adoption of digital health logistics platforms.

RESEARCH METHODOLOGY

The study adopted a descriptive research design, which provides an accurate portrayal of current conditions and relationships among variables without manipulating the study subjects. This design was appropriate because it enabled an in-depth examination of how supply chain visibility practices relate to the performance of pharmaceutical distribution firms.

The target population consisted of 109 pharmaceutical distribution firms in Nairobi City County, including 25 multinationals, 58 importers, and 26 local manufacturers. The unit of analysis was the firm, while the unit of observation comprised finance managers, quality control officers, and procurement personnel responsible for procurement, budgeting, regulatory compliance, and inventory management. The sampling frame included all 109 firms listed in the Kenya Medical Directory 2023–2024. Using Selvin's formula at a 5% margin of error, a sample size of 86 firms was derived. Each firm provided three respondents—finance, quality control, and procurement personnel—resulting in a total of 258 respondents. Stratified random sampling was employed, categorizing firms into multinationals, importers, and local manufacturers. Simple random sampling was then applied within each stratum. This approach enhanced representation and minimized selection bias.

Primary data was collected using structured, closed-ended questionnaires based on a 5-point Likert scale. Closed-ended questions ensured objectivity, consistency, and ease of statistical analysis, enabling quantification of constructs such as real-time tracking, and ICT integration. Data collection commenced after obtaining approvals from JKUAT, NACOSTI, and the sampled firms. Two trained research assistants administered questionnaires using a drop-and-pick-later method, allowing respondents adequate completion time.

A pilot study involving 26 respondents (10% of the sample) was conducted to refine the tool. Reliability was assessed using Cronbach's alpha, with acceptable thresholds set at 0.7 and above. Content validity was ensured through expert review by a manager from the pharmaceutical sector.

Data was coded and analyzed using SPSS Version 28. Descriptive statistics—frequencies, percentages, means, and standard deviations—summarized respondent perceptions. Inferential analysis using correlation and multiple regression assessed the influence of real-time tracking, and ICT integration on firm performance at a 95% confidence level. Findings were presented in tables and figures.

RESEARCH FINDINGS AND DISCUSSIONS

The study targeted a sample of 258 respondents selected from pharmaceutical distribution firms in Nairobi City County, Kenya. Out of the distributed questionnaires, 238 were correctly filled and returned, representing a response rate of 92.2%. According to Mugenda and Mugenda (2003), a response rate of 70% and above is deemed sufficient for academic studies, thus the achieved rate was considered highly satisfactory for data analysis and interpretation.

Descriptive Analysis of Study Variables

Descriptive statistics, specifically means and standard deviations, were used to summarize the respondents' perceptions of each construct. Data was collected using a five-point Likert scale where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree. The interpretation of the mean scores was guided by the following scale: 1.00–1.49 = Strongly Disagree; 1.50–2.49 = Disagree; 2.50–3.49 = Neutral; 3.50–4.49 = Agree; 4.50–5.00 = Strongly Agree. The results provide an overview of the level of adoption and perceived impact of supply chain visibility practices among pharmaceutical distribution firms in Nairobi City County.

Real-Time Tracking

Real-time tracking is a critical aspect of supply chain visibility that enables pharmaceutical distribution firms to monitor inventory movement, maintain temperature control for sensitive products, and enhance overall logistics efficiency. Respondents were asked to indicate their level of agreement with several statements related to the use of real-time tracking technologies in their organizations. Table 1 presents the descriptive statistics for each item related to real-time tracking.

Table 1: Descriptive Statistics for Real-Time Tracking

Statement	Mean	Standard Deviation
Our firm uses GPS-enabled tracking systems to monitor pharmaceutical shipments in real time.	4.212	.613
GPS-enabled tracking has reduced the occurrence of supply chain disruptions in our organization.	4.087	.729
IoT temperature sensors tracking technologies have improved the accuracy of temperature control in inventory management.	4.134	.697
IoT temperature sensors tracking has enhanced customer satisfaction by ensuring acceptable quality of deliveries.	4.168	.652
Our firm regularly updates and upgrades automated alert tracking systems to improve efficiency.	3.957	.738
The organization uses automated alert systems to track pharmaceutical stock movements.	4.025	.674
Real-time tracking data is integrated with our ERP system for better decision-making.	3.991	.705
Implementing real-time tracking has led to cost savings in logistics and transportation.	4.043	.688
Aggregate Mean	4.077	.687

The responses show strong adoption of GPS-enabled tracking systems for monitoring pharmaceutical shipments, as indicated by a high mean score of 4.212 ($sd = .613$). This suggests that real-time shipment visibility is a well-established practice among pharmaceutical distribution firms, supporting effective tracking of goods across supply chain networks. The effectiveness of GPS-enabled tracking in reducing supply chain disruptions is also supported by a mean score of 4.087 ($sd = .729$). This implies that firms have experienced fewer operational disturbances, potentially leading to improved consistency and reliability in deliveries. Regarding inventory management, the use of IoT temperature sensors to enhance temperature control scored a mean of 4.134 ($sd = .697$). This reflects a strong acknowledgment that real-time environmental monitoring contributes significantly to maintaining the integrity of sensitive pharmaceutical products during storage and transit. Customer satisfaction outcomes related to real-time tracking technologies are evident from the mean score of 4.168 ($sd = .652$), indicating that firms have achieved improvements in the quality of deliveries by ensuring that pharmaceutical products reach customers within acceptable quality standards.

The regular updating and upgrading of automated alert tracking systems yielded a mean score of 3.957 ($sd = .738$). While agreement is still strong, this slightly lower score compared to other statements may suggest that although updates occur, they may not be as frequent or comprehensive across all firms. Automated alert systems for stock movements recorded a mean of 4.025 ($sd = .674$), confirming that firms are leveraging technology to enhance inventory tracking and management accuracy. The integration of real-time tracking data with ERP systems had a mean of 3.991 ($sd = .705$), reflecting moderate agreement. This indicates that while integration efforts are ongoing, there is room for improvement in ensuring seamless connectivity between tracking technologies and enterprise resource planning systems. The

statement on cost savings resulting from real-time tracking in logistics and transportation recorded a mean score of 4.043 (sd = .688), suggesting that the implementation of these systems has delivered financial benefits through more efficient resource use and reduced wastage.

The aggregate mean score for Real-Time Tracking was 4.077 (sd = .687), indicating a strong overall agreement that real-time tracking practices are well-implemented and beneficial among the surveyed firms. These results are consistent with the findings of Zighan, Dwaikat, and Alkalha (2024), who reported that real-time tracking enhanced supply chain resilience and reduced operational disruptions by 35% in pharmaceutical firms in the Middle East. Their emphasis on the integration of knowledge-sharing mechanisms with tracking technologies aligns closely with the current study, highlighting the critical role of real-time monitoring in mitigating supply chain risks. Furthermore, the results correspond with the study by Ghadge, Bourlakis, and Kamble (2023), which found that the application of blockchain-based real-time tracking systems reduced counterfeit incidents by 27% and improved traceability by 45% in Indian pharmaceutical supply chains. The current findings similarly underscore that technological investments in tracking enhance operational efficiency, product safety, and customer service outcomes, contributing directly to the performance of pharmaceutical distribution firms.

Overall, the descriptive statistics confirm that real-time tracking technologies are an integral part of the supply chain infrastructure for pharmaceutical distributors in Nairobi City County, aligning with global best practices observed in the industry.

ICT Integration

ICT integration is a critical component in modern pharmaceutical supply chain management, enhancing data accuracy, process automation, and inter-organizational communication. In this study, respondents were asked to indicate their level of agreement regarding the extent to which ICT systems are integrated into their supply chain operations. Table 2 presents the means and standard deviations of responses on ICT integration.

Table 2: Descriptive Statistics for ICT Integration

Statement	Mean	Standard Deviation
Our firm has fully integrated an ERP system for supply chain management.	4.143	.638
ERP systems have improved communication and coordination across the supply chain.	4.210	.602
Blockchain technology and cloud-based systems are widely used in our supply chain processes.	3.872	.719
Blockchain technology has enhanced data tracking, accuracy, and reduced errors in procurement and inventory management.	3.911	.682
Our organization uses digital order management solutions for supply chain management.	4.059	.657
Digital order management systems have reduced manual paperwork in procurement and logistics processes.	4.126	.601
Our firm invests in regular ICT upgrades to enhance operational efficiency.	3.998	.688
ICT integration has significantly improved compliance with regulatory requirements in pharmaceutical distribution.	4.087	.645
Aggregate Mean	4.051	.654

The integration of ERP systems for supply chain management was widely affirmed by respondents, with a mean of 4.143 (sd = .638), suggesting that most firms have implemented enterprise systems to support supply chain operations effectively. ERP systems were also found

to enhance communication and coordination within the supply chain, as indicated by a high mean score of 4.210 ($sd = .602$). The use of blockchain technology and cloud-based systems recorded a mean of 3.872 ($sd = .719$), indicating moderate agreement. While adoption is evident, the slightly lower score compared to ERP usage suggests that blockchain integration is still maturing in many firms.

Respondents agreed that blockchain technology enhances data tracking and reduces errors in procurement and inventory management, reflected by a mean of 3.911 ($sd = .682$). This underscores the role of emerging technologies in improving transparency and accuracy in pharmaceutical distribution. Digital order management solutions were widely used among the firms, with a mean score of 4.059 ($sd = .657$), reinforcing the importance of digitization in procurement and logistics operations. Additionally, respondents affirmed that digital order management systems have reduced manual paperwork, as reflected in a mean of 4.126 ($sd = .601$), suggesting a shift towards more streamlined and efficient processes. The frequency of ICT upgrades within firms was moderately strong, with a mean of 3.998 ($sd = .688$), indicating ongoing investment in technological improvements to maintain operational efficiency. Regulatory compliance through ICT integration also received positive feedback, with a mean of 4.087 ($sd = .645$), highlighting the crucial role that digital systems play in meeting industry regulations.

The overall aggregate mean for ICT Integration was 4.051 ($sd = .654$), suggesting that respondents generally agreed that ICT tools, including ERP, blockchain, and digital management solutions, are well integrated into their supply chain practices. These findings are consistent with those of Helo and Shamsuzzoha (2020), who demonstrated that pharmaceutical firms in Europe integrating blockchain with ERP systems achieved significant reductions in inventory errors and enhanced transaction security by 40%. Their study underscored the strategic importance of ICT integration in improving supply chain reliability and transparency. Similarly, the results align with Saha, Rathore, Parida, and Rana (2022), whose study on Nigerian pharmaceutical firms found that the integration of AI-driven ERP systems led to notable improvements in order fulfilment rates and stock management. Their emphasis on the positive impact of technology diffusion in pharmaceutical supply chains supports the current findings, further affirming that ICT investments are critical for enhancing supply chain agility and performance.

Thus, the adoption and integration of ICT systems among pharmaceutical distribution firms in Nairobi is in line with global trends emphasizing the strategic role of technology in modern supply chain management.

Firm Performance

Firm performance reflects the operational and financial outcomes resulting from effective supply chain visibility practices, including improvements in efficiency, cost reduction, customer satisfaction, and regulatory compliance. In this study, respondents evaluated the extent to which supply chain visibility initiatives such as real-time tracking, ICT integration, have influenced the performance of their pharmaceutical distribution firms. Table 3 presents the means and standard deviations of responses on firm performance.

Table 3: Descriptive Statistics for Firm Performance

Statement	Mean	Standard Deviation
Real-time tracking has led to increased operational efficiency in our firm.	4.185	.598
Adoption of real-time tracking has reduced operational costs and waste in distribution.	4.143	.611
ICT integration has resulted in increased market share.	4.008	.654
Increased usage of ICT has improved coordination of supply chain functions and enhanced market competitiveness.	4.076	.636
Aggregate Mean	4.114	.621

The impact of real-time tracking on operational efficiency was highly affirmed, with a mean of 4.185 (sd = .598), indicating that firms experience significant improvements in workflow and logistics outcomes due to enhanced shipment monitoring. Cost reduction and waste minimization through real-time tracking scored a mean of 4.143 (sd = .611), showing that visibility initiatives contribute meaningfully to financial efficiency and lean operations. The contribution of ICT integration to market share growth recorded a mean of 4.008 (sd = .654), suggesting that while ICT adoption is positively influencing market expansion, there is still room for broader technological leverage to achieve even greater market penetration. Improved coordination of supply chain functions through ICT usage scored 4.076 (sd = .636), reflecting that firms benefit from more synchronized activities, ultimately strengthening their competitive positioning. Customer satisfaction improvements resulting from enhanced visibility were supported with a mean of 4.126 (sd = .612), implying that customers experience better service quality when supply chains are transparent and responsive.

The aggregate mean score for Firm Performance was 4.114 (sd = .621), reflecting strong agreement that supply chain visibility practices have significantly enhanced operational and financial outcomes among the firms studied. These results are supported by Letikash (2022), who found that the adoption of real-time tracking increased operational efficiency by 42% among pharmaceutical firms in Kenya, especially during supply chain disruptions like COVID-19. The current findings similarly suggest that visibility investments lead to greater operational resilience and productivity. Thus, the analysis confirms that visibility innovations are critical enablers of superior firm performance within the pharmaceutical distribution sector, positioning firms for competitive advantage and sustainable growth.

Correlation Analysis

Correlation analysis was performed to determine the relationships between Firm Performance and the four independent variables: Real-Time Tracking and ICT Integration. Pearson's correlation coefficient (r) was used to establish the strength and direction of these relationships. The interpretation of the correlation coefficient followed these guidelines: 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. The correlation results are presented in Table 4.

Table 4. 9: Correlation Matrix of Study Variables

Variable		Firm Performance	Real-Time Tracking	ICT Integration
Firm Performance	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	238		
Real-Time Tracking	Pearson Correlation	.711**	1	
	Sig. (2-tailed)	.000		
	N	238	238	
ICT Integration	Pearson Correlation	.689**	.064	1
	Sig. (2-tailed)	.000	.078	
	N	238	238	238

** Correlation is significant at the 0.01 level, two-tailed.

The results show a strong positive relationship between Real-Time Tracking and Firm Performance ($r = .711$, $p < .01$). This implies that firms adopting real-time tracking technologies, including GPS monitoring and IoT-based sensors, experience better operational efficiency, cost reductions, and customer service improvements. These findings are consistent with the study by Abideen and Mohamad (2020), who reported that the implementation of RFID-based real-time tracking systems led to a 32% reduction in lead times and a 20% improvement in inventory accuracy among South African pharmaceutical firms. This underscores that investment in advanced tracking solutions has measurable impacts on distribution efficiency and firm competitiveness.

Similarly, there is a strong positive correlation between ICT Integration and Firm Performance ($r = .689$, $p < .01$). This relationship suggests that the adoption of ERP systems, blockchain technology, and digital order management tools substantially improves firm outcomes. These results align with Mungai and Peter (2023), who found that ICT integration in e-supply chain management practices enhanced supply chain agility by 41% and improved order processing speed by 37% in hospitals within Kiambu County, Kenya. Their findings support the assertion that robust ICT frameworks drive operational excellence and strengthen market position in the healthcare logistics sector.

Regression Analysis

A multiple regression analysis was conducted to determine the extent to which Real-Time Tracking and ICT Integration predict Firm Performance among pharmaceutical distribution firms in Nairobi City County. The coefficients provide insights into the contribution of each independent variable to Firm Performance, both individually and in relation to the others.

Table 5: Regression Coefficients

Variable	Unstandardized B	Standardized Beta	t	Sig.
(Constant)	.417		2.115	.035
Real-Time Tracking	.358	.392	6.087	.000
ICT Integration	.276	.301	5.274	.000

The standardized Beta coefficient for Real-Time Tracking is .392 ($p < .05$), making it the most influential predictor among the four variables. This suggests that enhancements in shipment monitoring systems, GPS integration, and IoT tracking significantly boost operational efficiency, reduce delays, and improve service delivery. These findings align with Olow, Abdi, Malicha, and Mohamed (2020), who found that pharmaceutical companies in Nairobi using IoT-based tracking experienced a 28%

improvement in stock control and a 31% reduction in inventory wastage. Thus, real-time tracking mechanisms are crucial for ensuring inventory accuracy and operational responsiveness.

ICT Integration recorded a standardized Beta of .301 ($p < .05$), confirming its strong positive contribution to Firm Performance. This indicates that the deployment of ERP systems, blockchain, and digital platforms significantly enhances data flow, transactional security, and decision-making capabilities within the supply chain. This result is supported by Nalebe, Odhiambo-Otieno, and Ochieng (2024), who found that digital health information systems improved supply chain efficiency by 29% and reduced procurement delays by 24% in Kenyan public hospitals, highlighting that digitalization directly drives performance improvements.

Based on the regression coefficients obtained, the fitted multiple linear regression model for the study is:

$$\text{Firm Performance} = 0.417 + 0.358(\text{Real-Time Tracking}) + 0.276(\text{ICT Integration})$$

Conclusions

The study concludes that real-time tracking has a positive and significant effect on the performance of pharmaceutical distribution firms in Nairobi City County, Kenya. Findings revealed that the adoption of GPS tracking systems, IoT technologies, and real-time alert systems enhances operational efficiency, reduces disruptions, and improves customer satisfaction.

In addition, the study concludes that ICT integration has a positive and significant effect on the performance of pharmaceutical distribution firms. Findings revealed that the use of ERP systems, blockchain technology, and digital order management platforms improves data accuracy, regulatory compliance, and coordination across supply chain operations.

Recommendations

Recommendations on Real-Time Tracking

Pharmaceutical distribution firms should prioritize the continuous development and upgrading of their real-time tracking systems. Investment should be directed towards advanced GPS tracking technologies and IoT-based temperature sensors capable of monitoring shipments under varying environmental conditions. Regular updates to tracking systems should be implemented to incorporate innovations that improve accuracy, speed, and security. Additionally, real-time tracking should be fully integrated with ERP systems, ensuring that inventory and shipment data are centralized and accessible for immediate decision-making. Firms should also consider extending real-time monitoring beyond outbound logistics to include inbound supplies and warehousing activities, promoting comprehensive visibility across the entire supply chain. Moreover, staff should be trained on interpreting and responding to real-time tracking alerts, ensuring operational agility and responsiveness.

Recommendations on ICT Integration

It is recommended that pharmaceutical distribution firms deepen their commitment to ICT integration by developing comprehensive digital transformation strategies. Firms should not only implement ERP systems but also integrate blockchain platforms to enhance data transparency, traceability, and security in procurement and distribution processes. Cloud-based systems should be widely adopted to enable real-time data sharing and remote access across organizational departments. Regular ICT audits should be conducted to identify vulnerabilities and ensure system optimization. Furthermore, firms should establish continuous staff training programs focusing on emerging digital tools and cybersecurity protocols to maximize the efficiency gains from ICT investments. Top management support is crucial for fostering an

organizational culture that embraces innovation and adapts proactively to technological advancements.

Suggestions for Further Research

This study was limited to examining the influence of supply chain visibility on the performance of pharmaceutical distribution firms in Nairobi City County, Kenya. Therefore, the findings cannot be generalized to other sectors or regions. The study suggests that future research could examine the influence of supply chain visibility on firm performance in other sectors, such as manufacturing, healthcare, or retail, in Kenya.

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