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Nairobi City County, Kenya**



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Cold Chain Logistics and the Performance of Private Hospitals in Nairobi City County, Kenya

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ABSTRACT

Purpose: Cold chain logistics has become an essential component of healthcare supply chains, particularly in the management of temperature-sensitive medical products such as vaccines, blood products, and pharmaceuticals. However, inefficiencies in cold chain systems continue to undermine service delivery and operational outcomes in private hospitals. This study examined the effect of cold chain logistics on the performance of private hospitals in Nairobi City County.

Methodology: The study adopted a descriptive research design to facilitate systematic data collection and analysis. The target population comprised 429 private hospitals, from which a sample of 206 respondents was selected using simple random sampling. Primary data were collected using structured questionnaires administered to procurement managers. Data analysis involved both descriptive and inferential statistics, including correlation and regression analysis, to establish the relationship between cold chain logistics and hospital performance.

Findings: The findings revealed that cold chain logistics has a positive and statistically significant effect on hospital performance. Specifically, the use of reliable refrigeration systems, temperature monitoring technologies, and specialized transport mechanisms was found to significantly reduce product wastage, improve inventory management, and enhance operational efficiency. Inferential results confirmed that cold chain logistics is a significant predictor of performance, indicating that improvements in cold chain systems lead to better service delivery and patient safety outcomes.

Unique Contribution to Theory, Policy and Practice: This study contributes to the existing body of knowledge by providing empirical evidence on the role of cold chain logistics in improving healthcare performance within a developing country context.

Keywords: *Cold Chain Logistics, Hospital Performance, Supply Chain Management, Private Hospitals, Nairobi City County*

1. Introduction

The healthcare sector is a fundamental pillar of societal well-being, with its effectiveness largely dependent on the efficiency of underlying supply chain systems. In recent years, healthcare supply chains have attracted increasing attention, particularly in developing countries where systemic inefficiencies continue to constrain service delivery (Schneller & Abdulsalam, 2022). In Nairobi City County, private hospitals play a critical role in complementing public healthcare services, yet they frequently encounter operational challenges linked to weak supply chain systems. These challenges often manifest in delayed service delivery, increased operational costs, and compromised patient outcomes, thereby necessitating the adoption of efficient logistics practices to enhance performance (Kioko & Anthony, 2024).

Healthcare supply chains are inherently complex, involving the procurement, storage, and distribution of diverse medical products, many of which are highly sensitive to environmental conditions. Unlike conventional supply chains, the handling of medical commodities requires strict adherence to quality and safety standards due to their direct impact on human health (Long et al., 2023). Among these, cold chain logistics is particularly critical, as it ensures that temperature-sensitive products such as vaccines, blood products, and certain pharmaceuticals are maintained within prescribed temperature ranges throughout the supply chain. Failure to maintain these conditions can lead to product degradation, loss of efficacy, and potential health risks (Nyirimanzi et al., 2023). Consequently, effective cold chain management is a key determinant of healthcare quality and operational performance.

Globally, the importance of cold chain logistics has been reinforced by advancements in technology and increased demand for high-quality healthcare services. Developed countries have invested heavily in sophisticated cold chain systems incorporating real-time temperature monitoring, automated storage, and specialized transport networks to ensure product integrity (Fahrni et al., 2022). The critical role of cold chain systems was particularly evident during the distribution of vaccines in the COVID-19 pandemic, where maintaining ultra-low temperatures was essential for preserving vaccine efficacy (Daly et al., 2021). These global developments highlight the strategic importance of cold chain logistics in enhancing healthcare system resilience and performance.

In contrast, many developing regions, including those in Africa, continue to face significant challenges in implementing effective cold chain systems due to infrastructural limitations, unreliable power supply, and financial constraints. While some countries have made notable progress through innovations such as solar-powered refrigeration and mobile cold storage solutions, implementation remains uneven (Oleribe et al., 2019). In Kenya, efforts to strengthen cold chain logistics have primarily focused on public health programs such as immunization, supported by government initiatives and international partnerships (Ministry of Health, 2020).

However, within the private healthcare sector, the adoption of advanced cold chain systems remains inconsistent, limiting their potential to enhance operational efficiency and service delivery.

Private hospitals in Nairobi City County operate in a highly competitive and resource-constrained environment, where efficiency, quality, and cost-effectiveness are essential for sustainability. Despite this, many facilities continue to experience challenges related to inadequate cold storage infrastructure, limited technological adoption, and weak logistics coordination (Kelvin, 2024). These limitations often result in product spoilage, increased wastage, and compromised patient safety, ultimately affecting overall hospital performance. Although existing studies have examined general supply chain practices, there is limited empirical evidence focusing specifically on the role of cold chain logistics in improving performance within private hospitals. This study therefore seeks to address this gap by examining the effect of cold chain logistics on the performance of private hospitals in Nairobi City County, Kenya.

1.1 Statement of the Problem

An efficient healthcare system is fundamentally dependent on robust supply chain management to ensure the timely availability of safe and high-quality medical products. As healthcare demand continues to rise in developing economies such as Kenya, the reliability of supply chain systems has become increasingly critical to hospital performance (Chagara, 2020). In Nairobi City County, rapid urbanization and population growth have intensified pressure on healthcare facilities, particularly private hospitals that handle a significant share of service delivery. However, persistent inefficiencies in supply chain operations especially in managing temperature-sensitive medical products have resulted in service disruptions, increased operational costs, and compromised quality of care (Long et al., 2023). Weak cold chain systems, characterized by inadequate refrigeration infrastructure and unreliable temperature control, continue to undermine the effectiveness of healthcare delivery.

Private hospitals form a central pillar of healthcare provision in Nairobi, accounting for a substantial proportion of hospital admissions and urban service coverage. Despite their perceived efficiency and technological advantage, these institutions face notable operational challenges linked to supply chain weaknesses. Empirical evidence indicates that a significant proportion of private hospitals experience frequent stockouts of essential medical supplies and declining service reliability (Ministry of Health, 2021). A major contributing factor to these inefficiencies is the inadequate implementation of cold chain logistics, which leads to spoilage of temperature-sensitive products such as vaccines and pharmaceuticals (Kelvin, 2024). In addition, limited investment in modern logistics technologies and weak infrastructure further exacerbates inventory losses and operational delays, ultimately affecting hospital performance and patient outcomes.

Although global literature underscores the importance of cold chain logistics in enhancing healthcare efficiency, existing studies reveal significant contextual and methodological gaps when applied to private hospitals in Nairobi. Much of the available research is conducted in different

sectors or developed economies, limiting its applicability to the local healthcare context. Furthermore, many studies focus on broad supply chain practices without isolating the specific contribution of cold chain logistics to hospital performance. This lack of context-specific empirical evidence constrains the ability of healthcare managers and policymakers to make informed decisions. Therefore, this study seeks to address this gap by examining the effect of cold chain logistics on the performance of private hospitals in Nairobi City County, Kenya.

1.2 Research objective

The objective of this study is to examine the effect of cold chain logistics on the performance of private hospitals in Nairobi City County.

2. Literature Review

2.1 Theoretical Literature

This study is guided by Resource-Based View (RBV). The RBV theory, originally introduced by Barney (1991) and Wernerfelt (1984) and later expanded by Peteraf (1993), posits that an organization's sustained competitive advantage derives from its unique collection of internal resources and capabilities (Komakech et al., 2024). This perspective emphasizes that the strategic strength of a firm is less a function of its external market environment and more a result of the unique assets it controls. Barney (1991) argued that firms can achieve superior performance when they possess resources that are valuable, rare, difficult to imitate, and non-substitutable, although the focus here is on the broader conceptualization of internal capabilities rather than on specific criteria. Peteraf (1993) further contends that the heterogeneity of resources among firms explains the differences in competitive outcomes, highlighting that sustained competitive advantage is achieved when a firm effectively leverages resources that competitors do not possess or cannot easily acquire.

According to Hitt et al., (2016), this theoretical framework has had a profound impact on strategic management literature, guiding both academic inquiry and managerial practices toward a deeper understanding of what underpins competitive success. Researchers like Dierickx and Cool (1989) have demonstrated that continuous investment in unique operational capabilities leads to the accumulation of a resource base that is both durable and difficult for competitors to replicate. This resource-centric view encourages firms to focus on internal development, innovation, and the strategic deployment of their assets. In sectors where precision, quality, and reliability are critical, such as healthcare, the RBV provides an essential lens for understanding how internal competencies drive superior performance (Nagano, 2019).

Within private hospitals, cold chain logistics represent a quintessential example of a strategic internal resource. Cold chain logistics refer to the specialized systems and processes involved in maintaining temperature-controlled environments for storing and transporting medical supplies, including vaccines, blood products, and certain pharmaceuticals (Kumar et al., 2023). The importance of these logistics cannot be overstated; maintaining the integrity of temperature-

sensitive products is critical to ensuring their efficacy and safety, directly impacting patient outcomes. Investment in robust cold chain infrastructure—such as advanced refrigeration technology, real-time monitoring systems, and highly trained personnel—enables hospitals to protect these vital supplies from degradation (Pajić et al., 2024).

According to the RBV, when private hospitals develop and refine their cold chain capabilities, they are effectively creating a unique resource that provides them with a competitive edge (Chagara, 2020). This resource is valuable because it directly contributes to patient safety and operational efficiency; it is rare because not all hospitals possess the advanced systems and expertise required to manage such complex logistics; and it is difficult to imitate, given the substantial investment and integrated processes necessary for effective implementation (Langarizadeh et al., 2024). By integrating cold chain logistics into their broader operational strategy, hospitals not only reduce waste and minimize costs associated with spoilage but also enhance the overall quality of healthcare delivery.

Thus, the RBV framework offered a robust explanation for the strategic importance of cold chain logistics in private hospitals. It underscores how the development and maintenance of specialized internal capabilities, such as an efficient cold chain system, can lead to sustained competitive advantage and improved performance in a highly competitive healthcare environment. The focus on internal resources, as championed by the RBV, provides a clear rationale for why investments in cold chain logistics are crucial for achieving operational excellence and superior patient care in private hospitals.

2.2 Empirical Review

Recent research underscores the critical role of supply chain management (SCM) practices in ensuring product quality and enhancing organizational performance across various sectors. Narathip (2019) investigated the key performance attributes that influence the efficiency of the cold chain for exporting Thai longan fruit. Utilizing the Analytic Hierarchy Process (AHP) and collecting data through surveys and interviews with export specialists, the study evaluated the factors affecting the cold chain's performance. The findings revealed that maintaining a robust cold chain is essential for reducing fruit losses and waste, while simultaneously ensuring that longan fruit meets stringent quality and safety standards. In effect, a well-managed cold chain not only preserves the product's quality but also extends its shelf life, thereby adding substantial value to the export process.

In a different context, Aboneh (2017) explored the impact of SCM methods on the organizational performance of pharmaceutical businesses in Addis Ababa. Using a descriptive research methodology, Aboneh (2017) demonstrated a significant positive correlation between effective information sharing, customer relationship management, and overall organizational performance. This study provided evidence that efficient SCM practices are integral to improving operational

effectiveness in the pharmaceutical sector, thereby highlighting the importance of strategic supply chain initiatives in achieving superior organizational outcomes.

Expanding on the relationship between SCM and organizational success, Lia and Ragu-Nathan (2016) examined how advanced SCM strategies contribute to competitive advantage and enhanced performance. Data collected from 196 organizations were analyzed using structural equation modeling, revealing that higher levels of SCM practice can substantially boost both competitive advantage and overall organizational performance. Their findings suggest that the implementation of sophisticated SCM strategies enables organizations to outperform competitors by enhancing efficiency and profitability, reinforcing the broader strategic importance of effective SCM practices.

Further, Lenny et al. (2017) evaluated a framework linking SCM practices with operational effectiveness and organizational performance. Their study focused on various SCM dimensions, such as strategic collaboration, lean techniques, outsourcing, and the use of multiple suppliers (OMS). The results indicated that strategic collaboration and the integration of OMS factors exert a direct, positive, and substantial impact on operational efficiency. However, these factors did not exhibit a significant direct effect on overall organizational performance, suggesting that while SCM practices can improve operational metrics, their influence on broader organizational outcomes might be mediated by additional factors.

Focusing specifically on the healthcare sector, Njuguna (2015) examined the impact of cold chain supply logistics on vaccination safety among pharmaceutical distributors in Nairobi County. Employing a descriptive survey design, Njuguna (2015) gathered data from five large pharmaceutical companies out of 16 recognized distributors in the region, with a sample of 67 employees involved in procurement and stores. The study used self-administered questionnaires to evaluate the effectiveness of cold chain logistics. Analysis revealed that technical capacity and optimal storage conditions were strongly correlated with, and significantly influenced, vaccination safety. This finding underscores the critical importance of robust cold chain systems in preserving the integrity of vaccines, which is essential for public health and safety.

Kelvin and Magutu (2021) studied Cold Supply Chain Management and Financial Performance of Pharmaceutical Companies in Nairobi, Kenya. The study adopted a descriptive cross-sectional survey. The target population was senior managers in pharmaceutical companies in Nairobi County, Kenya. The samples were purposively select one senior employee in the supply chain department and finance department; thus, the target population of the study was 74 senior employees working with 37 licensed pharmaceutical companies in Nairobi. The generated quantitative data was examined using descriptive and inferential statistics. Inferential statistics included the correlational and regression analysis. Correlational analysis was conducted to determine the strength of the relationship between the independent and dependent variables. Regression analysis was used to establish the association between cold supply chain management

and the financial performance of pharmaceutical companies in Nairobi. The study found a significant and positive link between cooling systems management and financial performance of pharmaceutical companies.

2.3 Conceptual Framework

Considering the views of Varpio et al., (2020) conceptual framework is the system of concepts, assumptions, expectations, beliefs, and theories that supports and informs the research undertaking. Conceptual framework highlights the independent and dependent variables and shows their interaction with each other. The conceptual framework for this study is presented in figure 1 below

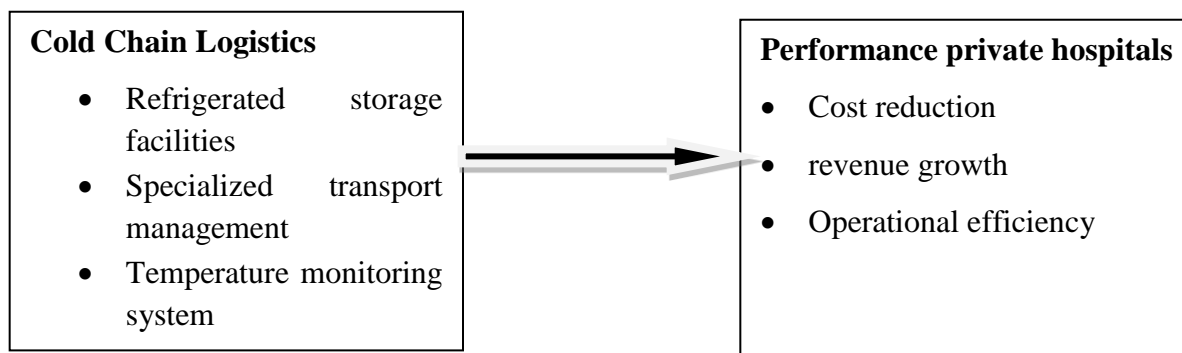


Figure 1: Conceptual Framework

3. Research Methodology

The study adopted a descriptive research design to provide a structured and systematic approach for examining the relationship between cold chain logistics and the performance of private hospitals in Nairobi City County. A research design serves as a blueprint that guides data collection, measurement, and analysis in order to achieve the study objectives effectively (Rahi, 2017). Descriptive design was considered appropriate because it enables the accurate depiction of existing conditions without manipulating variables, thereby capturing real-world operational dynamics (Goertzen, 2017). This approach allowed the study to assess how cold chain logistics practices are currently implemented within private hospitals and how they influence performance outcomes such as efficiency and service reliability. By focusing on naturally occurring processes, the design facilitated the identification of patterns and relationships that form a factual basis for drawing conclusions and making practical recommendations.

The target population comprised all registered private hospitals operating within Nairobi City County, which are regulated by the Kenya Medical Practitioners and Dentists Council (KMPDC). According to KMPDC records, there are 429 licensed private hospitals in the county, forming a comprehensive population for the study. The KMPDC registry served as the sampling frame, ensuring that only legally recognized and compliant institutions were included, thereby enhancing the reliability and generalizability of the findings (Stratton, 2021). From this population, a sample size of 206 respondents was determined using Yamane's (1967) formula with a 5% margin of error.

The unit of analysis was the hospital, while the unit of observation was the procurement manager or equivalent officer responsible for supply chain functions. These respondents were selected because of their direct involvement in procurement, inventory control, and logistics management, making them well-positioned to provide accurate insights into cold chain practices. Simple random sampling was employed to ensure that each hospital had an equal probability of selection, thereby minimizing bias and enhancing representativeness (Kothari, 2004).

Primary data for the study were collected using structured questionnaires, which are widely recognized as effective tools for gathering standardized information from a large population (Dalati & Gómez, 2018). The questionnaire was designed to capture both quantitative and qualitative data, with closed-ended items measured on a five-point Likert scale and a few open-ended questions included to obtain deeper insights. Prior to the main data collection, a pilot study involving approximately 10% of the sample was conducted to test the reliability and validity of the research instrument. Reliability was assessed using Cronbach's Alpha, with a threshold of 0.7 considered acceptable for internal consistency (Clark & Watson, 2019), while validity was ensured through expert review and alignment with the study objectives. Data collection was conducted ethically, with respondents assured of confidentiality, anonymity, and voluntary participation. The collected data were analyzed using both qualitative and quantitative techniques. Qualitative responses were examined through thematic analysis to identify recurring patterns, while quantitative data were analyzed using Statistical Package for Social Sciences (SPSS) to generate descriptive statistics such as means and standard deviations. Inferential analysis, including correlation and regression, was used to determine the strength and nature of the relationship between cold chain logistics and hospital performance, with findings presented using tables and charts for clarity and interpretation.

The model was as follows;

$$Y = \beta_0 + \beta_1 X_1 + \varepsilon$$

Where Y= Performance of private hospitals in Nairobi City County

X_1 = Cold chain logistics

β_0 = Constant

β_1 = Beta Coefficients

ε = Error Term

4. Findings and Discussion

This chapter presents the analysis, findings, and discussion of data collected on the effect of cold chain logistics on the performance of private hospitals in Nairobi City County. The analysis is structured in line with the study objectives and focuses on how cold chain logistics influences key performance indicators of private hospitals, particularly operational efficiency, service reliability,

and reduction of medical product wastage. Data was analyzed using both descriptive and inferential statistical techniques, where descriptive statistics were used to summarize respondents' views, while regression analysis was applied to establish the nature and strength of the relationship between cold chain logistics and hospital performance. The interpretation of findings is supported by relevant theoretical and empirical literature to enhance contextual understanding and to validate the observed patterns within the healthcare supply chain environment.

The study achieved a high response rate, which is critical for ensuring the reliability and validity of the findings. A total of 206 questionnaires were administered to procurement managers and supply chain officers across selected private hospitals in Nairobi City County. Out of these, 169 questionnaires were duly completed and returned, representing a response rate of 82.04%, while 37 questionnaires were not returned, accounting for 17.96%. This response rate is considered very good for survey-based research in organizational studies, as it exceeds the 60% threshold commonly regarded as acceptable and approaches the 80% level considered excellent in empirical research. The high response rate enhances the credibility of the dataset, reduces the risk of non-response bias, and supports the generalizability of the findings to the broader population of private hospitals within the county.

Table 1: Response Rate

Category	Frequency	Percentage (%)
Response	169	82.04
Non-response	37	17.96
Total	206	100.00

4.1 Descriptive statistics on Cold Chain logistics

Cold chain logistics is a critical supply chain practice in private hospitals, as it ensures the safety, quality, and efficacy of temperature-sensitive medical supplies such as vaccines, blood products, and pharmaceuticals. This section presents the descriptive analysis of respondents' perceptions regarding the adoption of cold chain logistics practices in private hospitals in Nairobi City County. The analysis is based on responses measured using a five-point Likert scale, with results summarized using percentages, means, and standard deviations.

Table 2: Descriptive Statistics for Cold Chain Logistics

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
The hospital has adequate refrigerated storage facilities for medical supplies.	1.8%	1.8%	0.0%	55.6%	40.8%	4.32	0.735
Specialized transport management is used for temperature-sensitive medical supplies.	10.1%	5.3%	3.6%	33.7%	47.3%	4.03	1.279
A temperature monitoring system is in place for all cold storage facilities.	4.1%	2.4%	18.9%	27.2%	47.3%	4.11	1.060
Staff handling cold chain logistics are trained in temperature-sensitive supply management.	3.0%	18.9%	10.7%	31.4%	36.1%	3.79	1.206
The hospital follows strict guidelines for handling cold chain medical supplies.	10.1%	8.9%	18.9%	26.6%	35.5%	3.69	1.310
Regular audits are conducted to assess cold chain efficiency.	8.9%	4.7%	11.8%	34.9%	39.6%	3.92	1.227
The hospital has contingency plans for cold chain failures.	5.3%	5.3%	20.1%	22.5%	46.7%	4.00	1.170

The findings indicate a generally high level of adoption of cold chain logistics practices among private hospitals. A substantial majority of respondents (96.4%) agreed or strongly agreed that their hospitals have adequate refrigerated storage facilities, reflected by a high mean score of 4.32 and a low standard deviation of 0.735. This suggests strong consistency across hospitals regarding cold storage infrastructure. Regarding specialized transport for temperature-sensitive supplies, 81.0% of respondents agreed or strongly agreed, yielding a mean of 4.03. However, the relatively higher standard deviation (1.279) indicates some variation, possibly due to differences in outsourcing logistics services or hospital size.

The presence of temperature monitoring systems was also positively rated, with 74.5% agreement and a mean score of 4.11. Nevertheless, 18.9% of respondents remained neutral, suggesting that monitoring systems may not be uniformly automated or consistently applied across all facilities. Staff training in cold chain logistics recorded a moderate mean of 3.79, with 22% of respondents expressing disagreement. This indicates a potential skills gap, despite generally adequate infrastructure. Similarly, adherence to strict handling guidelines yielded a mean of 3.69, reflecting moderate compliance and suggesting room for improvement in policy enforcement.

Regular audits and contingency planning were rated positively, with mean scores of 3.92 and 4.00 respectively. Although most respondents acknowledged the existence of audits and backup plans, the relatively higher standard deviations imply inconsistent implementation across hospitals. Overall, the aggregate means ranging from 3.69 to 4.32 demonstrate that cold chain logistics practices are largely in place, but operational consistency, staff capacity, and procedural enforcement remain areas requiring strengthening.

The findings are largely consistent with existing empirical evidence that emphasizes the importance of robust cold chain systems in enhancing operational effectiveness and organizational performance. The high levels of agreement regarding adequate refrigerated storage, temperature monitoring, and contingency planning align closely with Narathip (2019) findings, which demonstrated that effective cold chain management reduces losses and preserves product quality. Similarly, Njuguna (2015) established that optimal storage conditions and technical capacity significantly influence vaccine safety among pharmaceutical distributors in Nairobi, reinforcing the relevance of cold chain integrity within healthcare contexts. The observed gaps in staff training and guideline enforcement in the current study also mirror Aboneh (2017) conclusions that information sharing and operational practices play a critical role in performance outcomes. Furthermore, the positive perception of cold chain logistics in this study supports Kelvin and Magutu's (2021) findings, which identified a significant positive relationship between cold supply chain management and financial performance among pharmaceutical firms in Nairobi. Collectively, these similarities suggest that effective cold chain logistics remains a foundational driver of quality assurance, safety, and performance within healthcare supply chains.

Analysis of responses to the open-ended questions revealed several recurring themes. Respondents cited power outages, limited real-time temperature monitoring, and high maintenance costs of refrigeration equipment as major challenges affecting cold chain efficiency. Some hospitals also reported reliance on manual temperature checks, increasing the risk of undetected temperature excursions. Suggested improvements included investment in automated temperature monitoring systems, enhanced staff training on cold chain management, and the adoption of backup power solutions such as generators and solar systems. Respondents also emphasized the need for clearer standard operating procedures and more frequent audits to ensure compliance. These qualitative insights complement the quantitative findings by highlighting operational challenges that explain variations in cold chain performance across private hospitals.

4.2 Descriptive Statistics on Performance of Private Hospitals in Nairobi City County

This section presents the descriptive analysis of the performance of private hospitals in Nairobi City County as influenced by supply chain management practices. Hospital performance was assessed using key indicators that capture operational efficiency, financial outcomes, regulatory compliance, and service quality. Respondents evaluated the performance statements using a five-

point Likert scale, and the findings are interpreted using percentages, means, and standard deviations.

Table 3: Descriptive findings for Private Hospitals

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
Efficient supply chain management has reduced wastage of medical supplies.	5.3%	8.9%	10.1%	43.2%	32.5%	3.89	1.120
Revenue growth has been positively impacted by better supply chain practices.	1.2%	5.3%	8.3%	34.9%	50.3%	4.28	.913
Operational efficiency has improved due to better logistics and inventory tracking.	10.1%	11.2%	13.0%	20.1%	45.6%	3.80	1.383
Delays in procurement and inventory shortages have reduced.	10.1%	8.3%	3.0%	32.5%	46.2%	3.96	1.318
Cost savings have been realized through better supply chain management.	8.9%	6.5%	7.1%	30.2%	47.3%	4.01	1.270
Compliance with regulatory standards has improved.	3.0%	11.2%	21.3%	26.6%	37.9%	3.85	1.137
Staff productivity has increased due to improved logistics.	5.9%	11.8%	11.2%	21.3%	49.7%	3.97	1.274

The results indicate that wastage of medical supplies has generally reduced as a result of efficient supply chain management. A combined 75.7 percent of respondents agreed or strongly agreed that efficient supply chain practices had reduced wastage of medical supplies, yielding a mean score of 3.89 and a standard deviation of 1.120. This suggests that effective supply chain systems improve inventory control, enhance forecasting accuracy, and promote better handling of medical supplies, thereby minimizing losses associated with expiry and mismanagement. However, the presence of neutral and negative responses indicates that not all hospitals experience uniform improvements in wastage reduction, pointing to variations in the adoption and effectiveness of supply chain practices.

Revenue growth attributable to improved supply chain practices recorded one of the highest mean scores at 4.28 with a relatively low standard deviation of 0.913. A substantial 85.2 percent of respondents agreed or strongly agreed that better supply chain practices positively impacted revenue growth. This finding suggests that efficient procurement, inventory control, and cost management enhance financial performance by reducing wastage, improving pricing strategies, and supporting service delivery capacity. Operational efficiency improvements due to better logistics and inventory tracking recorded a mean score of 3.80 and a standard deviation of 1.383.

While 65.7 percent of respondents agreed or strongly agreed that operational efficiency had improved, a notable proportion expressed disagreement or neutrality. This variability suggests differences in the maturity of logistics systems and inventory management practices across hospitals. Hospitals with more advanced systems are likely to experience greater efficiency gains than those relying on manual or fragmented processes.

Reduction in procurement delays and inventory shortages was rated positively, with a mean score of 3.96 and a standard deviation of 1.318. Approximately 78.7 percent of respondents agreed or strongly agreed that delays and shortages had reduced. This indicates that improved coordination with suppliers, better forecasting, and enhanced inventory visibility have contributed to more reliable supply availability. However, the dispersion in responses implies that some hospitals continue to experience supply disruptions, possibly due to supplier constraints or demand volatility.

Cost savings realized through better supply chain management recorded a mean score of 4.01 with a standard deviation of 1.270. A combined 77.5 percent of respondents agreed or strongly agreed that cost savings had been achieved. This suggests that practices such as consortium buying, waste reduction, and improved inventory turnover have positively influenced cost containment efforts. The presence of some disagreement indicates that cost savings may vary depending on hospital size, procurement volume, and implementation effectiveness.

Compliance with regulatory standards showed a mean score of 3.85 and a standard deviation of 1.137. About 64.5 percent of respondents agreed or strongly agreed that compliance had improved. This suggests that enhanced supply chain controls and documentation support adherence to regulatory requirements. However, the moderate mean score and variability highlight that compliance improvements are not uniform and may be influenced by differences in monitoring and enforcement mechanisms. Staff productivity as influenced by improved logistics recorded a mean score of 3.97 with a standard deviation of 1.274. Approximately 71.0 percent of respondents agreed or strongly agreed that staff productivity had increased. This indicates that efficient logistics and reduced stock-related disruptions enable healthcare staff to focus more on core clinical and administrative tasks. Nonetheless, the observed variability suggests that productivity gains depend on the extent to which logistics improvements are integrated into daily operations.

4.3 Correlation Analysis

Correlation analysis is a statistical technique used to examine the strength and direction of the linear relationship between two continuous variables (Cohen et al., 2013). It enables researchers to determine whether changes in one variable are systematically associated with changes in another. In this study, Pearson's correlation coefficient was employed to assess the relationships between cold chain logistics and performance of private hospitals in Nairobi City County. Pearson's correlation coefficient (r) ranges from -1 to +1, where values closer to +1 indicate a strong positive relationship, values closer to -1 indicate a strong negative relationship, and values near zero

suggest the absence of a linear relationship (Field, 2013). The results of the correlation analysis are presented in table 4.

Table 4: Pearson correlation among variables

		Cold chain Performance logistics	
Cold chain logistics	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	169	
	Sig. (2-tailed)	.002	
Performance	Pearson Correlation	.491**	1
	Sig. (2-tailed)	.000	
	N	169	169

The correlation results reveal statistically significant and positive relationships among all study variables at the 0.01 level. Cold chain logistics showed a moderate to strong positive correlation with performance ($r = .491$, $p < .01$). This suggests that hospitals with adequate refrigerated storage, temperature monitoring systems, trained staff, and contingency plans are more likely to experience improved performance outcomes. Effective cold chain logistics ensure the integrity of temperature-sensitive medical supplies, reduce losses due to spoilage, and support compliance with regulatory standards, all of which enhance service quality and operational reliability. This finding is consistent with Narathip (2019), who demonstrated that a well-managed cold chain significantly reduces losses and improves product quality. It also aligns with Njuguna (2015), whose study in Nairobi County found that technical capacity and optimal storage conditions strongly influenced vaccination safety. Additionally, Kelvin and Magutu (2021) established a significant positive relationship between cold supply chain management and financial performance among pharmaceutical companies in Nairobi. The present study extends these findings to the private hospital context, confirming that cold chain logistics play a critical role in supporting hospital performance.

4.4 Regression Analysis

A simple linear regression analysis was conducted to examine the effect of cold chain logistics on the performance of private hospitals. Cold chain logistics was treated as the independent variable, while hospital performance was the dependent variable. The model summary, as shown in Table 5, indicates an R-value of 0.491 and an R Square of 0.241. This implies that cold chain logistics explains approximately 24.1 percent of the variation in hospital performance. The adjusted R

Square of 0.237 confirms the stability of the model after adjusting for sample size, while the standard error of the estimate of 7.03692 suggests an acceptable level of prediction accuracy.

Table 5: Model summary for cold chain logistics

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.491 ^a	.241	.237	7.03692

a. Predictors: (Constant), Cold chain logistics

The ANOVA results presented in Table 6 show an F-statistic of 53.169 with a significance level of $p = .000$. This confirms that the regression model is statistically significant and that the relationship between cold chain logistics and hospital performance is not due to random chance. The results indicate that cold chain logistics is a meaningful predictor of performance in private hospitals.

Table 6: ANOVA for cold chain logistics

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2632.840	1	2632.840	53.169	.000 ^b
	Residual	8269.538	167	49.518		
	Total	10902.379	168			

a. Dependent Variable: Performance

b. Predictors: (Constant), Cold chain logistics

The regression coefficients shown in Table 7 further support this conclusion.

Table 7: Regression coefficient for cold chain logistics

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	38.914	2.900		13.420	.000
	Cold chain logistics	.746	.102	.491	7.292	.000

a. Dependent Variable: Performance

Cold chain logistics recorded an unstandardized coefficient (B) of 0.746, a standardized beta coefficient of 0.491, a t-value of 7.292, and a p-value of .000. This indicates a strong, positive, and statistically significant relationship between cold chain logistics and hospital performance. Specifically, a one-unit improvement in cold chain logistics leads to a 0.746-unit increase in hospital performance, holding other factors constant. These findings demonstrate that investments in refrigerated storage, temperature monitoring, staff training, and contingency planning significantly enhance hospital performance by reducing losses, improving service reliability, and supporting regulatory compliance. This finding is consistent with Njuguna (2015), who established

that effective cold chain logistics significantly influence vaccine safety in Nairobi. It also aligns with Kelvin and Magutu (2021), who found a positive relationship between cold supply chain management and financial performance among pharmaceutical firms. Although its relative influence is lower when other variables are controlled, cold chain logistics remains a critical foundation for quality assurance and patient safety.

5. Conclusion

The study established that cold chain logistics is a critical component of hospital supply chain management. Effective temperature-controlled storage, monitoring systems, and trained personnel were found to enhance the reliability and safety of medical supplies, particularly temperature-sensitive products such as vaccines and pharmaceuticals. Hospitals with well-managed cold chain systems demonstrated improved service continuity, reduced losses from spoilage, and better compliance with regulatory requirements, all of which support overall performance. The study thus concludes that cold chain logistics has a positive and significant impact on hospital performance. Proper temperature-controlled storage, effective monitoring systems, and trained personnel were found to enhance the safety and integrity of temperature-sensitive medical supplies. These practices reduce losses due to spoilage, improve service reliability, and support compliance with health and safety regulations. Consequently, cold chain logistics contributes to improved patient outcomes and operational stability in private hospitals.

6. Recommendations

Given the importance of cold chain logistics in ensuring the safety and quality of temperature-sensitive medical supplies, private hospitals should prioritize investment in reliable cold chain infrastructure. This includes modern refrigerated storage facilities, continuous temperature monitoring systems, and backup power solutions to prevent supply spoilage during power outages. Hospitals should also develop and enforce clear standard operating procedures for handling cold chain products across all stages of storage and distribution. Regular training programs should be conducted for staff involved in handling temperature-sensitive supplies to ensure adherence to cold chain protocols. In addition, hospital management should institute routine audits and risk assessments to identify weaknesses in cold chain systems and implement corrective measures promptly. Strengthening cold chain logistics will improve service reliability, regulatory compliance, and patient safety.

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