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An Analysis of the Drivers Contributing to Operational Inefficiencies in Zambia's Pharmaceutical Supply Chain System: A Case Study of the University Teaching Hospital (UTH) Lusaka

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Abstract

This study examined the drivers contributing to operational inefficiencies in Zambia's pharmaceutical supply chain system, with a specific focus on the University Teaching Hospital (UTH) in Lusaka. Efficient pharmaceutical supply chains are critical for ensuring the consistent availability of essential medicines, improving healthcare delivery, and minimizing wastage. However, persistent inefficiencies such as stock-outs, delays, and resource mismanagement continue to affect the performance of healthcare systems in Zambia. This research aimed to analyse the key factors influencing these inefficiencies and propose strategies for improvement. A mixed methods approach was adopted, guided by a pragmatic research philosophy. The study utilized a convergent parallel design, combining both quantitative and qualitative data collection methods. Quantitative data were gathered through structured questionnaires administered to pharmacists, pharmacy technologists, and supply chain managers, while qualitative insights were obtained through semi-structured interviews with key informants. A sample size of 110 respondents was selected for the quantitative component using simple random sampling, while 15 participants were purposively selected for the qualitative aspect. Data were analysed using descriptive and inferential statistics, including the chi-square test of independence and linear regression, alongside thematic analysis for qualitative responses. The findings revealed that operational inefficiencies in the pharmaceutical supply chain at UTH are driven by multiple interconnected factors. Key challenges identified include procurement delays, inaccurate demand forecasting, unreliable supplier performance, insufficient funding, inadequate storage infrastructure, and limited use of information technology systems. Additionally, human resource constraints, such as staff shortages and limited- decision making authority, further exacerbate inefficiencies. The study also found that while the supply chain system is functional, its effectiveness is often undermined by logistical and systemic constraints. The study also found that 35.5% reported that their role involved forecasting medicines, 16.4% indicated they were responsible for distributing medicines, 13.6% reported involvement in placing orders. The study concludes that addressing these inefficiencies requires a comprehensive and integrated approach. Recommended strategies include strengthening procurement processes, improving forecasting and inventory management practices, enhancing staff capacity through training, increasing funding efficiency and adopting advanced digital systems for real-time tracking and decision-making. These interventions have the potential to improve the reliability, responsiveness and overall performance of the pharmaceutical supply chain system. This research contributes to the existing body of knowledge by providing context specific insights into pharmaceutical supply chain inefficiencies in Zambia. It also offers practical recommendations for policymakers, healthcare managers and stakeholders aiming to enhance medicine availability and healthcare outcomes in public health institutions.

1. Introduction

The pharmaceutical supply chain plays a critical role in ensuring the timely availability of essential medicines and health care products. Globally, efficient supply chain systems contribute significantly to improved patient outcomes and overall health systems performance. However, in many developing countries, including Zambia, pharmaceutical supply chains face numerous operational challenges that hinder their effectiveness.

In Zambia, inefficiencies such as poor infrastructure, inadequate storage facilities, delays in procurement processes and limited technological integration have negatively impacted the availability and distribution of medicines. These challenges are particularly evident in major healthcare institutions such as the University Teaching Hospital(UTH), where demand for pharmaceuticals is high. Despite efforts to improve the system, persistent inefficiencies continue to affect service delivery, leading to stock-outs, wastage and delays in patient care. This highlights a critical need to examine the underlying factors contributing to these inefficiencies.

Therefore, this research investigated the drivers leading to inefficiencies in the pharmaceutical supply chain system, using a case study of UTH. The findings of this study are expected to contribute to improved supply chain management practices and inform policy decisions within the healthcare sector in Zambia. In light with the above, the section below presents the back ground to the study, problem statement, aim, research objectives and questions, significance of the study and scope of the study among others.

1.2 Statement of the Problem

Although several studies have been conducted on the pharmaceutical supply chain in Zambia, most have primarily focused on identifying and describing operational challenges such as stock-outs, inadequate storage, and procurement inefficiencies (Musamba and Mwanza, 2025). Empirical evidence highlights the severity of these challenges. For instance, national drug availability levels in Zambia have been reported at approximately 68.4%, which falls below the World Health Organization (WHO) recommended threshold of 70%–80% (Sichula, 2025). In addition, local pharmaceutical production remains significantly limited, with only 10 registered companies, of which 7 are actively involved in manufacturing while the remainder focus on repackaging imported medicines (Lindunda, 2023). This limited production capacity contributes to increased reliance on imports and a higher national pharmaceutical expenditure, further straining the supply chain. While these statistics clearly demonstrate the extent and impact of inefficiencies within the pharmaceutical supply chain, existing studies largely adopt a descriptive approach and tend to examine these challenges in isolation. For example, stock-outs are often reported without sufficient analysis of how they are influenced by procurement delays, poor forecasting, or inadequate inventory management systems. Similarly, infrastructure limitations and human resource constraints are frequently identified, but their combined effect on overall operational efficiency remains underexplored. Consequently, there is limited in-depth and integrated empirical analysis of the underlying determinants of operational inefficiencies in Zambia's pharmaceutical supply chain. In particular, there is a lack of studies that examine how key factors such as procurement processes, inventory management, infrastructure, information systems, and human resource capacity interact to influence supply chain performance. Furthermore, there is insufficient context-specific research focusing on major referral institutions such as the University Teaching Hospital (UTH), where high patient volumes place additional pressure on supply chain systems.

This gap in the literature limits the ability of policymakers and stakeholders to design targeted and evidence-based interventions, as the root causes and interrelationships of inefficiencies are not fully understood. Therefore, this study seeks to address this gap by analysing the key determinants of operational inefficiencies within the pharmaceutical supply chain at UTH, examining their root causes, and exploring how these inefficiencies can be mitigated to improve medicine availability and healthcare outcomes in Zambia.

1.3 Specific objectives of the study

- To examine the pharmaceutical supply chain system at UTH from the demand and supply chain sides.
- To identify the factors causing inefficiencies within the pharmaceutical supply chain system at UTH from the demand and supply chain sides.
- To establish strategies for improving these inefficiencies in the pharmaceutical supply chain system at UTH

1.4 Research questions

- What is the pharmaceutical supply chain system at UTH from the demand and supply chain sides?
- What are the key factors contributing to inefficiencies in the pharmaceutical supply chain at UTH?
- What strategies can be used to improve these inefficiencies in the pharmaceutical supply chain industry at UTH?

1.5 Hypothesis

Null Hypothesis (H_0): Delays in the procurement process have no significant effect on operational inefficiencies in the pharmaceutical supply chain system at the University Teaching Hospital (UTH).

Alternative Hypothesis (H_1): Delays in the procurement process have a significant effect on operational inefficiencies in the pharmaceutical supply chain system at the University Teaching Hospital (UTH).

2 Literature Review

The literature demonstrates that inefficiencies in pharmaceutical supply chains (PSCs) significantly limit the availability of essential medicines, particularly in public health systems such as the University Teaching Hospital (UTH). Globally, regionally, and locally, these inefficiencies arise from interconnected operational, financial, structural, and human resource factors (Alshibli et al., 2024; Dubey et al., 2022). Key operational challenges include poor demand forecasting, weak inventory management, procurement delays, and inadequate logistics systems, which contribute to stock-outs, overstocking, and wastage (Gorani, 2024; Sherbaz et al., 2023; Chopo & Mutono-Mwanza, 2024). Financial and structural constraints—such as limited funding, fragmented supply chains, and bureaucratic procurement processes—further exacerbate these inefficiencies (Shukar et al., 2021; Papalexi et al., 2020; Hedman & WHO, 2021).

Additionally, human resource and managerial capacity gaps, including insufficient training and limited use of information systems, constrain effective supply chain performance despite the critical role of supply chain managers (Bilal et al., 2024; Shore et al., 2022; Moosivand et al., 2019). The literature also highlights the dual influence of supply-side factors (production, procurement, distribution) and demand-side dynamics (utilization patterns and data systems) on overall efficiency (Kapoor et al., 2018; Alshibli et al., 2024).

Although strategies such as improved forecasting, capacity building, inventory management practices, and adoption of digital technologies have been

proposed, their implementation remains inconsistent, particularly in low-resource settings (Acosta et al., 2019; Gorani, 2024; Njuguna et al., 2021). Importantly, existing studies often examine these factors in isolation and lack contextual specificity to Zambia, particularly UTH. There is also limited focus on the interconnected nature of inefficiencies and the role of supply chain managers. Therefore, this study addresses these gaps by providing a comprehensive, context-specific analysis of PSC inefficiencies at UTH.

Table 1: Summary of Literature Review

Author	Title	Findings	Methodology	Research gaps
Ngujuna, Wycliff and Viginia (2021)	Influence of supply chain management strategies on performance of medical supply chain organizations in Kenya	This study revealed that performance of medical supply organizations in Kenya was significantly related with supply chain information integration, warehousing and outsourcing.	Descriptive study approach	There is need for information to be integrated in the pharmaceutical supply chain and a study needs to be done here in Zambia that can bring out these strategies and there is need for outsourcing services that are not offered but maybe needed.
Mwanaumo.E, Dryton, Bupe and Mwanaumo. M(2023)	Assessing last mile delivery logistics of the Zambia Medicines and Medical supplies Agency.	ZAMMSA uses a combined transportation system of own and outsourced vehicles and the challenges of the last mile system at ZAMMSA lead to operational inefficiencies	Quantitative approach	The study only went up to the challenges of the last mile and did not specify what these operational inefficiencies really are hence the need to bridge that gap.
Nduta Kamere et al(2023)	Supply chain factors and Antimicrobial stewardship	The results showed that inefficiency in the supply chain led to use of alternative drugs that lead to resistance, also these challenges led to use of substandard and falsified drugs which eventually lead to suboptimal treatment and finally drug resistance.	Mixed method approach	Other factors of operational inefficiencies were not outlined hence the need for this study to be done
Balfaqih, H., Fatin, A., Khaled, A(2024)	Analyzing the causes and impact of essential medicines and supplies shortages in the supply chain of the ministry of health in Saudi Arabia: A quantitative study survey	Results showed that the causes of medicine shortages in Saudi Arabia were inadequate planning, forecasting and also procurement and also the frequent changes in medication on patients.	Quantitative survey	Study was done in Saudi Arabia on the factors leading to drug shortages, this study is necessary and hence the need to carry it out in Zambia.
George C and Bupe, G,M,M (2024)	Analysis of challenges of the medical supply chain- A case study of Zambia medicines and medical supplies agency	Study revealed that operational challenges leading to drug shortages include procurement delays, incomplete tracking delays, and inadequate storage capacities and also it revealed some of the ways to combat most of these challenges.	Descriptive study-mixed method	This study was done at the source or central supplier and there's need to carry out the factors of drug shortages at the hospitals(UTH)
Chileya, M and Bupe, M (2025)	Enhancing pharmaceutical supply chain efficiency of medicine through the utilization of lean practices: A survey of hospitals and clinics in Ndola district, Zambia.	This study revealed that challenges such as bureaucratic procurement, stock outs and poor inventory management had an impact on the efficiency and also value stream mapping had a positive impact on efficiency.	Mixed methods approach	Even though the study focused more on lean practices, it also brought out most causes of the inefficiencies noted in Ndola district and such a study needs to be done at UTH, Lusaka in order to point out the exact factors leading to inefficiencies.
Dubey et al (2022)	Review article on pharmaceutical inventory management	This study revealed that inventory management makes it easy and effective in dealing with efficiency in the pharmaceutical supply chain industry and reduces handling time and counterfeiting of products up to a high rate.	Article review based study.	This study reveals the importance of the pharmaceutical inventory management system, hence possess a gap as to whether this system is being effectively used at UTH and if at all it also adds to the factors causing these inefficiencies.
Shukar, S et al, 2021	Drug shortage: causes, impact and mitigation strategies	Causes found include supply issues, manufacturing issues, increase in demand, the main impact noted increase	Review based study	Only a few studies have been done in middle- and low-income countries on drug shortages hence the need to carry out this research in Zambia that would bring out the inefficiencies.

		in costs, alteration in treatment and the mitigation strategies include expert training, reduced wastage and proper forecasting.		
Gorani M, (2024)	Optimizing pharmaceutical supply chain: Key challenges and strategic solutions. (New Jersey, USA)	It was noted that the key issues of regulatory compliance, demand forecasting, supply chain visibility, quality assurance and geographical risk significantly affect efficiency and effectiveness.	Qualitative study	This study was done in the US and its results really pointed out to the causes of inefficiencies hence the need for the study to be carried out here in Zambia at UTH so as to know the actual factors in a low-income country.
Franco C, and Lizarazo, A.E(2020)	Optimization under uncertainty of the Pharmaceutical Supply Chain in Hospitals(Colombia)	This study used a mathematical model that helped determine how much drugs are needed from a specific supplier, when to reorder and ways to combat pharmaceutical uncertainties.	Simulation-optimization approach.	This study discovered good strategies that would help reduce drug shortages and in turn enhance the pharmaceutical industry in Colombia and such a study being done Zambia UTH would help combat similar challenges

3 Research Methodology

3.1 Research Design and Paradigm

This research study adopted a convergent parallel research design, which involves simultaneously collecting and analysing data, and this includes both qualitative and quantitative data. This approach was appropriate for addressing the research questions, as it enabled a comprehensive understanding of the factors contributing to inefficiencies in the pharmaceutical supply chain at UTH.

3.2 Study area and target population

The study was conducted at the University Teaching Hospital (UTH) in Lusaka, Zambia. UTH is the largest referral hospital in the country and handles a high volume of patients from across the nation. The study population comprised of pharmacy personnel and supply chain stuff at UTH. This included Pharmacists, pharmacy technologists, and supply chain managers who are directly involved in the management, procurement, storage and distribution of medicines within the hospital

3.3 Sampling Technique and Sample Size Determination

This study involved a dual sampling technique strategy that is suitable for a mixed-method study. In this study, for the quantitative data the researchers selected the participants that were best suitable and were able to respond to the research questions effectively using the simple random sampling technique. These participants were selected from the suitable positions required such as the pharmacists, pharmacy technologists and supply chain managers. For the qualitative data the participants who are rich in information were selected using the purposive sampling technique. This technique helps the researcher intentionally select suitable participants who have specific characteristics, knowledge or experience relevant to the study. The sample size for the quantitative survey was determined using Yamane formula with a 5% margin of error, producing a target of approximately 110 respondents. While 15 informants were selected purposively based on their involvement in the pharmaceutical supply chain system to give us qualitative data based on the principle of data saturation.

3.4 Data collection methods

Primary data were collected using semi-structured questionnaires and semi- structured interviews. Structured questionnaires were used to collect quantitative data that addressed factors that have led to inefficiencies in the pharmaceutical supply chain at UTH while qualitative data was collected using semi-structured interviews and this was mainly focused on the experiences, challenges and perceptions related to inefficiencies in the pharmaceutical supply chain. Secondary data was collected from hospital records to supplement the survey data.

3.5 Data analysis

The quantitative data was analysed using descriptive and inferential statistics, with normality tests which helped determine the appropriate statistical methods that also helped determine factors related to the pharmaceutical supply chain operational inefficiencies and also linear regression. The qualitative data was analysed using a thematic analysis that uses codes. This allowed the researcher to come up with themes from the data that helped identify insights and patterns related to the roles of supply chain managers. Integration of results was performed through triangulation, which allowed comparison of the literature insights and the survey findings.

3.6 Ethical considerations

This research passed through the Ethical committee for clearance which was done by the University of Zambia Ethics Committee board. The research was only carried out once the committee gave a go ahead with a letter that was then presented to the University Teaching Hospital(UTH). The

participants in this study were treated with utmost respect, consent was obtained before conducting the study and their privacy was respected. The researcher explained the purpose of the study to the participants and once the study was done, findings will be shared with the participants.

4 Results

4.1 Demographic Characteristics of Respondents

This section presents the findings on the demographic characteristics of the respondents who took part in the study.

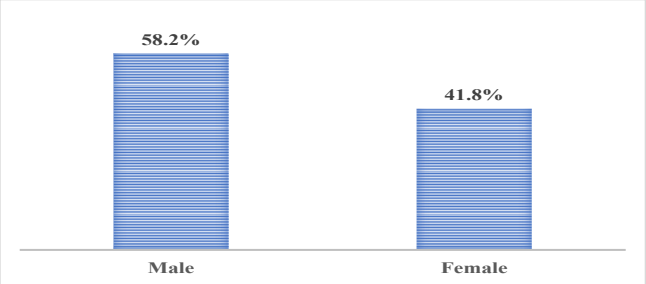

Figure 1: Percentage Distribution of Respondents in Terms of Gender

The figure shows the frequency and percentage distribution of respondents by gender. The findings indicate that 58.2 percent of the respondents were male, while 41.8 percent were female.

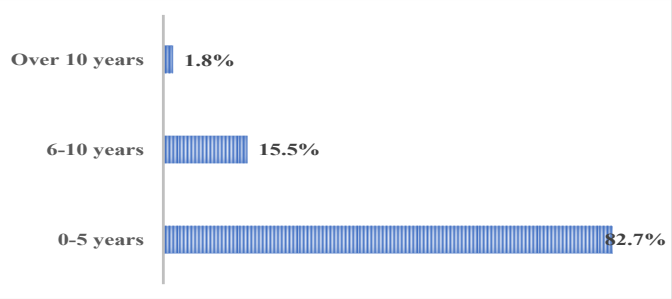

Figure 2: Percentage Distribution of Respondents by Years Of Service at UTH

The findings show that 82.7 percent had worked at UTH for 0 to 5 years, with 15.5 percent indicating that they had worked for 6 to 10 years, and 1.8 percent had worked at UTH for over 10 years, representing the smallest group in the sample.

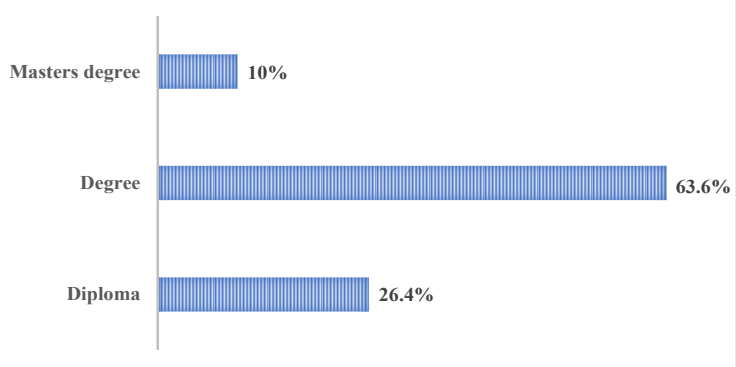

Figure 3: Percentage Distribution of Respondents by Level of Education

The figure shows the frequency and percentage distribution of respondents by level of education, with 63.6 percent indicating that they had attained a degree qualification level, 26.4 percent showing that they had a diploma, and 10 percent held a master's degree.

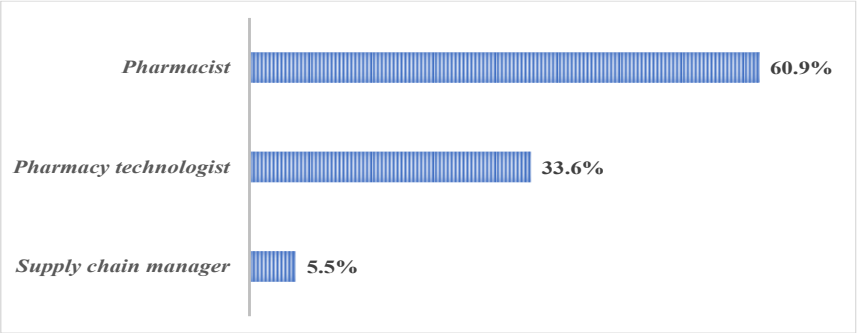

Figure 4: Percentage Distribution of Respondents by Positions Held at UTH

The figure presents the frequency and percentage distribution of respondents according to the positions they held at UTH at the time this study was being conducted. The findings show that 60.9 percent were pharmacists, whilst 33.6 percent accounted for pharmacy technologists and 5.5 percent were supply chain managers.

Table 2: Respondents for Interview Guide

ID	Position	Length of Service	Main Responsibilities
1	Pharmacy Technologist	9 months	Dispensing and Stores Assistant
2	Pharmacist	2 years	Dispensing and Management of Drugs
3	Pharmacy Technologist	2 years	Stores Assistant
4	Pharmacist	7 years	Stores Management and Dispensing
5	Pharmacist	4 years	Dispensing and Stores Management
6	Pharmacy Technologist	2 years	Stores Management
7	Pharmacist	3 years	Stores Manager
8	Pharmacist	5 years	Dispensing
9	Pharmacist	4 years	Dispensing and Stores Management
10	Pharmacist	1 year	Stores Management
11	Pharmacist	2 years	Monitoring Drug Safety, Side Effects, and Adverse Reactions

The table presents the characteristics of respondents who participated in the interview guide, including their positions, length of service, and main responsibilities at UTH. The findings show that the respondents were mainly pharmacists and pharmacy technologists. In terms of length of service, the respondents had varying levels of experience, ranging from 9 months to 7 years. Regarding main responsibilities, most respondents were involved in drug dispensing, store management, and inventory control. Some respondents were responsible for monitoring drug safety, side effects, and adverse reactions.

4.2 Objective 1: Pharmaceutical supply chain system at UTH from the demand and supply sides

This section presents the findings for objective one relating to the pharmaceutical supply chain system at UTH from the perspectives of demand and supply.

Roles of Respondents in Demand-Side Functions

The roles of respondents in the supply chain system at UTH from the perspectives are presented below.

Table 3: Staff Roles in Demand- Side Functions

Staff roles	Frequency	Percent
Forecasting medicine quantities	39	35.5
Placing orders with suppliers e.g. ZAMMSA	15	13.6
Managing inventory levels (stock counts)	13	11.8
Storing and warehousing medicines	12	10.9
Distributing medicines to wards/clinics	18	16.4
Data entry and record keeping	13	11.8
Total	110	100

The table presents the frequency and percentage distribution of respondents according to the staff roles in demand-side functions. The findings indicate that 35.5 percent reported that their role involved forecasting medicine quantities. Additionally, 16.4 percent of respondents indicated that they were responsible for distributing medicines to wards and clinics, and 13.6 percent reported involvement in placing orders with suppliers, such as the Zambia Medicines and Medical Supplies Agency (ZAMMSA), as one Pharmacy Technologist stated; "We order from ZAMMSA, received by pharmacy staff, stored and supplied to consumers". One respondent added: "Monitoring drug safety, side effects and adverse reactions is crucial to avoid wastage and protect patients".

Furthermore,11.8 percent of respondents indicated that they were responsible for managing inventory levels through stock counts, while another 11.8

percent performed data entry and record keeping, and 10.9 percent reported that their role involved storing and warehousing medicines. One of the respondents indicated the following;

"When we receive the medicines from ZAMMSA, we then distribute to designated departments. This helps strengthen inventory management systems, improves forecasting and quantification. The same medicines are then distributed to patients effectively because medicines are received from reliable sources".

Effectiveness of Current Supply Chain Practices

The findings relating to the effectiveness of current supply chain practices show that respondents described the pharmaceutical supply chain at UTH as generally effective, particularly in terms of receiving and distributing medicines from reliable sources. The respondents emphasized that medicines sourced from ZAMMSA and other reliable suppliers are handled carefully and systematically. One pharmacy technologist noted,

"We order from ZAMMSA, received by pharmacy staff, stored and supplied to consumers", while a pharmacist added, "The medicines that are received from ZAMMSA and distributed to designated departments help strengthen inventory management systems, improve forecasting and quantification".

However, respondents also highlighted that the effectiveness of the supply chain is limited by delays and operational constraints. A pharmacist observed, "The supply chain is effective, but they are subject to change due to the process being slow sometimes". Additional issues, such as stock-outs, transport delays, and occasional system lags, were noted as factors that reduce efficiency. One respondent explained, "Monitoring drug safety, side effects, and adverse reactions is crucial to avoid wastage and protect patients". Generally, the respondents indicated that while the supply chain largely performs its intended functions, its effectiveness is vulnerable to external pressures and internal resource limitations.

Demand and Supply Chain Coordination at UTH

Table 4: Interaction Between Demand and Supply

Component	Observations from Respondents
Procurement	Orders placed to ZAMMSA; effective when timely; delays affect patient care.
Storage	Medicines are stored under proper conditions; insufficient storage space is sometimes reported.
Distribution	Medicines supplied to departments and patients; transportation and logistics affect delivery speed.
Patient Demand	High patient load creates variable demand; stock outs occur when demand exceeds forecast.
Communication	Effective staff communication ensures timely requests and redistribution of stock.
Monitoring	Frequent stock monitoring helps mitigate shortages and aligns supply with actual demand.

The table presents respondents' observations on how demand and supply functions interact in the management of medicines at UTH. The findings present several key components that influence the effectiveness of pharmaceutical supply operations at the country's largest referral hospital. Regarding the procurement processes, respondents indicated that medicine orders are primarily placed with ZAMMSA, as stated by one respondent that

The process is generally effective when orders are processed and delivered on time; delays in procurement can negatively affect patient care, particularly when essential medicines are not available when needed.

In terms of storage, respondents reported that medicines are usually kept under proper storage conditions to maintain their quality and safety. Despite this, some respondents stated that there are challenges relating to insufficient storage space, which affect the efficient organization and handling of pharmaceutical supplies.

With respect to distribution, medicines are supplied to different hospital departments and patients. Respondents indicated that the speed and efficiency of distribution are sometimes influenced by transportation and logistical challenges, which sometimes delays the movement of medicines within the hospital.

The findings also show that patient demand plays an important role in supply management. As noted in the table above, the respondents observed that the high patient load at UTH creates fluctuating and sometimes unpredictable demand for medicines, which sometimes result in stock outs when the demand exceeds the quantities that were initially forecasted.

Furthermore, communication among staff was identified as an important factor in ensuring the smooth interaction between demand and supply perspectives. One respondent remarked, "effective communication allows staff to make timely requests for medicines and facilitates the redistribution of available stock between departments when shortages occur".

It was also noted by respondents that regular monitoring of medicine stock levels helps reduce shortages and supports better alignment between supply and actual demand as observed by a pharmacist "frequent stock monitoring enables staff to identify potential shortages early and take corrective action before the situation worsens".

Decision making relating to supply challenges

Table 5: How Much Authority Respondents Have to Make Decisions to Solve Routine Supply Problems

Level of authority	Frequency	Percent
No authority, always get approval	49	44.5
Limited authority for minor issues	27	24.5
A moderate amount of authority	26	23.6
Significant authority to resolve most issues	8	7.3
Total	110	100

The table presents the frequency and percentage distribution of respondents according to the level of authority they have to make decisions when solving routine supply problems at UTH. The findings show that 44.5 percent of respondents indicated that they had no authority and must always obtain approval before making decisions relating to supply challenges of the medicines at UTH. In addition, 24.5 percent reported having limited authority to address minor issues, indicating that some staff members are able to make small operational decisions without seeking full approval whilst 23.6 percent stated that they had a moderate amount of authority, which allowed them to handle certain supply problems within their roles. However, only 7.3 percent indicated that they have authority to resolve most supply challenges.

4.3 Factors causing inefficiencies within the pharmaceutical supply chain system

This section presents the findings relating to factors causing inefficiencies within the pharmaceutical supply chain system at UTH from the perspectives of demand and supply.

Supply Chain Inefficiencies at UTH

Table 6: Factors Causing Inefficiencies in the Pharmaceutical Supply Chain At UTH

Factors	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total %
Inaccurate forecasting of medicine needs	6.40%	16.40%	28.20%	57.30%	9.10%	100%
Delays in the procurement process	6.40%	16.40%	17.30%	34.50%	34.50%	100%
Unreliable suppliers or delayed deliveries	2.70%	8.20%	14.50%	48.20%	26.40%	100%
Inefficient distribution of medicines within the hospital	8.20%	25.90%	14.50%	51.80%	0%	100%
Insufficient or late funding for medicine purchases	2.70%	14.50%	28.20%	29.10%	34.50%	100%
Lack of or failure of technology (inventory software)	11.80%	25.50%	17.30%	31.80%	26.40%	100%
Delays due to transport	8.20%	17.30%	28.20%	29.10%	29.10%	100%
Staff shortages	0%	22.70%	11.80%	22.70%	45.50%	100%
Inadequate storage space or poor warehouse conditions	6.40%	29.10%	20%	25.50%	20%	100%
Wastage of medicines due to expiry or spoilage	0%	22.70%	25.50%	31.80%	20%	100%

The table presents respondents' perceptions of the factors contributing to inefficiencies within the pharmaceutical supply chain system at UTH from both the demand and supply sides.

The findings indicate 57.3 percent of respondents agreed and 9.1 percent strongly agreed that inaccurate forecasting of medicine needs contributes to inefficiencies. Similarly, delays in the procurement process were identified as a major challenge with 34.5 percent agreed and 34.5 percent strongly agreed that procurement delays affect the supply chain.

The issue of unreliable suppliers or delayed deliveries was also noted in this study with 48.2 percent of respondents agreeing and 26.4 percent strongly agreeing that supplier-related delays contribute to inefficiencies. One respondent stated the following:

The greatest challenge in maintaining a steady supply of medicines is delays in procurement and inconsistent deliveries from suppliers, which often result in stock-outs of essential medicines. This makes it extremely difficult to sustain adequate inventory levels and can compromise timely treatment for patients.

With another respondent adding:

Orders of medicines often take an extended period to be processed and received, which disrupts the flow of treatment. The procurement system involves lengthy procedures, and the time required to complete each step frequently delays medicine availability.

In terms of distribution within the hospital, 51.8 percent of respondents agreed that inefficient distribution systems contribute to supply chain problems. The findings also indicate that insufficient or late funding for medicine purchases is a significant challenge, with 29.1 percent of respondent agreeing and 34.5 percent strongly agreeing. A respondent during in-depth interview stated the following:

Insufficient or delayed funding for medicine purchases limits both the quantities and variety of drugs we can procure. The lack of timely financial resources directly affects our ability to maintain essential stock, and delays in funding often exacerbate shortages.

Additionally, respondents identified lack or failure of technology such as inventory management software as a contributing factor to inefficiencies, with 31.8 percent agreeing and 26.4 percent strongly agreeing as stated by one respondent:

We lack advanced technology and integrated hospital systems to track medicines efficiently, which makes it hard to anticipate shortages before they occur. The absence of real-time tracking means we often do not realize a stock-out is imminent until it has already happened.

With another respondent submitting that, "*proper digital systems would ensure accurate prescription tracking and reduce unnecessary wastage or delays in dispensing.*"

Transport delays were also reported as a factor affecting supply efficiency, with 29.1 percent agreeing and 29.1 percent strongly agreeing that transportation challenges slow down the movement of medicines from suppliers to UTH as submitted by respondents; "*Unreliable suppliers and delayed deliveries disrupt the supply chain, affecting patient care*", with another respondent stating the following:

Inconsistent supply from central providers, such as ZAMMSA, frequently leads to stock gaps. Ensuring that deliveries arrive on time, in the correct quantities, and with appropriate expiry dates is essential to maintain continuity of care.

The findings also indicate that staff shortages emerged as one of the most strongly recognized challenges, with 45.5 percent strongly agreeing and 22.7 percent agreeing that limited human resources contribute to inefficiencies in the pharmaceutical supply chain at UTH. This is what was collectively

submitted by respondents:

There is a shortage of staff, which hampers the smooth operation of inventory management and timely distribution of medicine, Work overload and limited personnel make it difficult to manage procurement, stock monitoring, and ward-level distribution efficiently.

Other factors identified include inadequate storage space or poor warehouse conditions, where 25.5 percent agreed and 20 percent strongly agreed, and also wastage of medicines due to expiry or spoilage, with 31.8 percent agreeing and 20 percent strongly agreeing that such losses affect supply chain efficiency.

Training for Supply Chain Duties

Regarding staff training, respondents indicated mixed perceptions of competence. While some respondents feel sufficiently prepared, a substantial proportion reported gaps in training. One respondent explained: "I have received adequate training for my supply chain duties, which helps me manage inventory and track medicine distribution efficiently." However, other respondents revealed insufficient training as one respondent said, "I feel underprepared for some aspects of supply chain management, particularly in forecasting and handling procurement delays."

Staff perceptions regarding performance monitoring also varied. Some respondents mentioned some existing mechanisms. One respondent stated that "The performance of our supply chain is regularly measured and tracked, allowing us to identify gaps and improve processes. Others, however, indicated that performance tracking is inconsistent or insufficient, with a respondent explaining, "While some monitoring exists, it does not cover all aspects of the supply chain, and gaps in tracking can lead to delays or inefficiencies going unnoticed."

Hypothesis Test of Independence

Table 8: Expected Cell Counts

			Inefficient distribution of medicines within the hospital				
			Strongly disagree	Disagree	Neutral	Agree	Total
Delays in the procurement process	Strongly disagree	Count	6	0	0	0	6
		Expected Count	0.5	1.5	0.9	3.1	6
	Disagree	Count	3	6	0	0	9
		Expected Count	0.7	2.3	1.3	4.7	9
	Neutral	Count	0	19	0	0	19
		Expected Count	1.6	4.8	2.8	9.8	19
	Agree	Count	0	3	16	19	38
		Expected Count	3.1	9.7	5.5	19.7	38
	Strongly Agree	Count	0	0	0	38	38
		Expected Count	3.1	9.7	5.5	19.7	38
Total		Count	9	28	16	57	110
		Expected Count	9	28	16	57	110

The assumptions of the Chi-square test were assessed using the expected cell counts presented in Table 11 above. The Chi-square test requires that no more than 20 percent of the cells have expected counts of less than 5, and that no cell should have an expected count of less than 1. However, as can be seen in the table, the results indicate that several cells have expected counts below 5 (e.g., 0.5, 0.7, 0.9, 1.3, 1.5, and 2.8), and at least one cell has an expected count of less than 1 (0.5). Out of the 20 cells in the table, the majority fall below the threshold of 5, clearly exceeding the allowable limit.

This indicates that the assumptions of the Chi-square test are violated, and therefore, the results may not be fully reliable. As a result, the findings should be interpreted with caution due to the increased risk of inaccurate significance. To address this limitation, the researcher merged the categories (for example, combining "Strongly disagree" with "Disagree" and "Agree" with "Strongly agree") to improve expected counts.

Table 9: Chi-Square Test of Independence

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.048E2a	12	0.001
Likelihood Ratio	177.611	12	0.001
N of Valid Cases	110		

P-value=0.001, df= 12, X2 =12

Taking $\alpha = 0.05$

The hypothesis test was statistically significant. A Chi-square test of independence was conducted to examine the relationship between delays in the procurement process and operational inefficiencies, measured by the inefficient distribution of medicines, at UTH. The aim was to determine whether procurement delays significantly impact the hospital's pharmaceutical supply chain system. The analysis included 110 respondents and considered different levels of agreement regarding delays and inefficiencies. The hypothesis was tested using survey questions that measured the independent and dependent variables. Question 6 assessed delays in the procurement process (independent variable), while Question 8 measured inefficient distribution of medicines within the hospital (dependent variable).

The results indicated a statistically significant association between delays in the procurement process and operational inefficiencies (i.e., Pv < α; 0.001). At a significance level of $\alpha = 0.05$, the p-value is less than 0.05, which means the result is statistically significant. Therefore, the null hypothesis (H_0), which stated that procurement delays do not affect operational inefficiencies, was rejected, and the alternative hypothesis (H_1) was accepted.

This result implies that the hospital's operational inefficiencies are largely caused by delays in the procurement process. In particular, higher levels of ineffective distribution of medicines within UTH are linked to longer procurement delays.

Linear Regression Determination

The Statistical Package for Social Sciences (SPSS) was used to calculate the linear regression values for two variables to determine the relationship between Inaccurate Forecasting (independent variable) and Authority to Make Decisions (dependent variable). Below is the summary of the regression analysis.

Linear Regression Analysis: Inaccurate Forecasting vs. Authority to Make Decisions

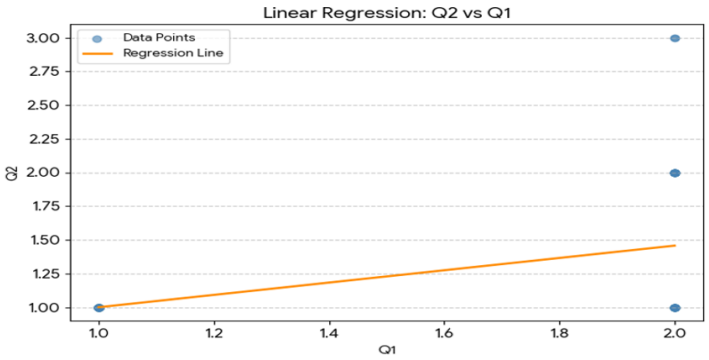

Figure5: Linear Regression Analysis

Linear Regression Analysis: Measurements and Value

Table 10: Linear Regression Analysis: Measurements and Value

Measurements	Value
Intercept (β0)	0.5435
Coefficient (β1)	0.4565
R-squared (R2)	0.2657

Interpretation of linear regression results

Regression Equation:

The relationship between the two variables Q1 (independent variable) and Q2 (dependent variable) is captured by the following linear equation:

Q2=0.5435+0.4565(Q1)

This equation provides a mathematical model that predicts the dependent variable based on the independent variable. This is explained below.

Intercept (β_0 = 0.5435): The intercept value of 0.5435 shows the predicted value of Q2 when Q1 equals zero. In the context of this analysis, this means that if Q1 has no influence or is at a baseline level (e.g., there are no forecasting inefficiencies), Q2 (power to make decisions) should be 0.5435. This baseline may suggest a low level of decision-making authority even when forecasting mistakes or other supply chain inefficiencies are absent.

Coefficient (β_1 = 0.4565): The coefficient of 0.4565 reflects the strength and direction of the association between Q1 and Q2. It should be noted that Q2 (decision-making authority) is predicted to grow by 0.4565 units for every one-unit increase in Q1 (e.g., 1% increase in predicting inaccuracy). UTH staff may need more authority to address supply chain inefficiencies as they occur in Q1. In other words, when issues such as stockouts or procurement delays emerge, employees may need to take more independent steps to address them.

R-squared (R^2 = 0.2657): Q1's inefficiency, indicated by forecasting mistakes, accounts for 26.6% of the variation in Q2 (authority to make decisions) (R-squared = 0.2657). An R^2 of 0.26 indicates a moderate to weak association in behavioural data, particularly in supply chain management. This suggests that while predicting mistakes contributes to some variation in decision-making power, other substantial factors are likely to be at play as well. These may include operational factors, staff responsibilities, management policies, or structural issues at UTH.

Linear Relationship: The linear model shows a positive correlation between forecasting inaccuracy (Q1) and decision-making authority (Q2). As forecasting gets inaccurate or inefficiencies increase, employees may be given additional decision-making ability to address the pharmaceutical supply chain systems at UTH

Although the model explains 26.6% of the variation in decision-making authority, forecasting mistakes alone cannot account for the remaining 73.4%. This shows that other factors influence the authority with which staff at UTH must make supply chain decisions. These elements could include employee experience, leadership practices, corporate policies, or external challenges such as supply chain disruptions and financial restrictions which are beyond UTH management.

The regression results indicate that forecasting inaccuracies lead to an increased need for more decision-making authority in the pharmaceutical supply chain system at UTH among staff, particularly in managing supply chain needs. This entails that improving forecasting accuracy may lessen the need for staff to make autonomous choices on regular supply chain issues, leading to increased operational efficiency. Therefore, focusing on enhancing forecasting methods, inventory management systems, and communication could assist in alleviating the burden on decision-making authorities and allow for more efficient supply chain operations.

4.4 Strategies for Improving the Pharmaceutical Supply Chain at UTH

This section presents the findings of objective three, which establishes the strategies for improving inefficiencies in the pharmaceutical supply chain system at UTH

Strategies for Enhancing Medicine Supply at UTH

Table 11: Strategies that Could Improve Medicine Availability at UTH

Strategies	Frequency	Percent
Better training for staff	43	39.1
Improved technology and software	37	33.6
More reliable funding	8	7.3
Streamlined procurement processes	10	9.1
Better leadership and management	12	10.9
Total	110	100

The table presents the frequency and percentage distribution of respondents' views on the most important change that could improve the supply of medicines at UTH. The findings show that 39.1 percent of respondents identified better training for staff as the most important improvement. The second most common response was improved technology and software, reported by 33.6 percent respondents. A smaller proportion of respondents accounting for 10.9 percent, identified better leadership and management as the most important change in ensuring efficient supply chain operations at UTH. In addition, 9.1 percent of respondents suggested streamlining procurement processes as a key improvement, which could help reduce delays in acquiring medicines, with 7.3 percent indicating that the hospital needs more reliable and adequate funding from the government and/or partners.

Interview Findings on Supply Chain Improvement Strategies

The findings from the interviews indicate the need for better planning and forecasting as a fundamental strategy for improving the pharmaceutical supply chain at the country's biggest hospital. The respondents stressed that accurate forecasting of medicine needs is of paramount importance to prevent stock-outs and ensuring patient care continuity. One respondent stated:

"*To improve the pharmaceutical supply chain at UTH, there should be better forecasting and planning of medicine needs to reduce stock-outs. Improving communication between the pharmacy, procurement units, and suppliers would also help ensure medicines are delivered on time*".

In addition to planning, human resource capacity was repeatedly cited by respondents as an important factor that can be implemented, adding that insufficient personnel affects both procurement and distribution. The recommendations included:

Hiring more staff and improving the procurement process is essential to ensure timely delivery of medicines, more personnel are needed at UTH to handle inventory, distribution, and monitoring effectively, and also investing in training personnel on both technical skills, such as product handling, and managerial skills, such as supply chain planning.

It was also noted that delayed or inadequate funding can disrupt the supply chain of the medicines at UTH thereby leading to stock-outs and delayed treatment. One respondent submitted:

Funding for medicines is key in ensuring that procurement is made on time, more reliable funding is needed to prevent interruptions in supply and orders of medicines should be handled as an emergency because lives depend on it.

A majority of respondents urged the reliability of supplier and procurement efficiency. They noted that having dependable suppliers and reducing bureaucratic delays are essential to maintaining consistent medicine availability. Respondents suggested:

Having reliable suppliers and strengthening supplier relationships, along with improving buffer stock, is critical to maintain continuity of care, procurement processes need to be streamlined to reduce bureaucratic channels that are often lengthy and slow and ensuring that orders are made on time with no delays hence significantly improving service delivery.

Additionally, technology and system upgrades were emphasized as a transformative approach to improving supply chain efficiency. The respondents recommended the adoption of digital solutions, including Artificial Intelligence (AI), integrated hospital systems, and modern inventory management tools. They noted:

Upgrading software and integrating AI into our supply systems will enhance efficiency and reduce human error, expanding warehouses and installing modern handling equipment would cut distribution delays and improve stock management, and a hospital-integrated system should be implemented to provide coordinated and seamless patient care across all departments.

The other aspects that were underscored by the respondents included the importance of leadership, governance, and policy support. It was submitted that effective management, dedicated funding for the pharmacy department, and clear policies were seen as important for a sustainable supply chain. The respondents observed the following:

Improving the pharmaceutical supply chain requires strong leadership and rigorous engagement from senior management, the pharmacy should have its own funding and a dedicated purchasing department solely focused on medicines, and good health policies and effective corporate governance principles should be applied to the hospital's supply management.

4.5 Discussions

This chapter presents the discussion of the study findings, comparing them with existing literature and the theoretical framework. The discussion is structured around the study's objectives.

Objective 1: Pharmaceutical Supply Chain System at UTH from Demand and Supply Sides

The findings from this study indicate that the pharmaceutical supply chain at UTH operates with a framework encompassing both the demand and supply sides. On the demand side, the roles of forecasting, order placement, inventory management, and distribution are well-defined among staff, with 35.5 percent of respondents actively engaged in medicine forecasting and 16.4 percent in distribution to departments. On the supply side, UTH largely relies on the ZAMMSA and other reliable suppliers for procurement, storage, and distribution of medicines.

These findings are in line with the literature reviewed, where Kapoor et al. (2018) argue that efficient pharmaceutical supply chains rely on effective coordination between healthcare facilities, suppliers, and patients to ensure the timely delivery of essential medicines. Similarly, Alshibli et al. (2024) found that both supply and demand perspectives are critical for maintaining the quality and availability of medicines. The observation that UTH's supply chain largely functions effectively in terms of medicine receipt and handling aligns with global studies, such as Dubey et al. (2022), which note that public health facilities often maintain systematic processes for receiving and distributing medicines from trusted suppliers.

However, the study also reveals operational constraints that limit effectiveness, such as delays in procurement, stock-outs, transport delays, and occasional system lags. These challenges resonate with the operational and logistical failures identified in the literature. For instance, Gorani (2024) and Sherbaz et al. (2023) noted that inaccurate forecasting, weak logistics, and poor distribution are common sources of inefficiency in pharmaceutical supply chains. The findings at UTH confirm that these factors are relevant in the Zambian context, particularly given the high patient load and the complexity of UTH operations

The Chi-square test further substantiates the significance of procurement delays, rejecting the null hypothesis (H_0) and confirming that delays in procurement have a statistically significant impact on operational inefficiencies, particularly in medicine distribution. This aligns with the supply chain management theory (Njuguna et al., 2021), which says that timely procurement and integration of processes are critical for maintaining efficiency. The study, therefore, confirms theoretical expectations by demonstrating that delays in key supply chain processes directly affect operational performance.

Furthermore, the findings illustrate that communication and coordination among staff play a significant role in mitigating supply challenges. Regular monitoring and redistribution of stock are reported to improve alignment between demand and supply, resonating with the principles of logistics theory (Musamba and Mwanza, 2025) and lean supply chain theory (Dixit et al., 2024), which emphasize process optimization and reduction of wastage. UTH's reliance on monitoring and effective internal communication suggests that, despite systemic limitations, the hospital applies best practices in process control to manage medicines efficiently.

One new insight from this study is the relatively limited decision-making authority among staff, with 44.5 percent of respondents having no authority to make supply chain decisions without approval, and operational responsiveness is constrained. While the literature identifies managerial capacity as critical, as noted by Bilal et al. (2024) and Moosivand et al. (2019), this study emphasizes how hierarchical decision structures in a hospital environment can worsen inefficiencies, especially during emergencies or high-demand periods. This finding provides practical policy implications, suggesting the need for decentralizing operational authority within UTH to enhance responsiveness and reduce procurement and distribution delays.

It should be noted, therefore, that UTH's pharmaceutical supply chain remains vulnerable to inefficiencies caused by delays, hierarchical constraints, and systemic pressures. In practical terms, the findings suggest that enhancing forecasting, decision-making autonomy, and coordination can significantly improve supply chain responsiveness and medicine availability.

Objective 2: Factors Causing Inefficiencies Within the Pharmaceutical Supply Chain System at UTH

The study identifies multiple factors contributing to inefficiencies, which can be categorized into operational/logistical, financial, technological, human resource, and infrastructural constraints. Among these, inaccurate forecasting of medicine needs, delays in procurement, unreliable suppliers, inefficient internal distribution, insufficient funding, and staff shortages emerged as the most critical, with over 50 percent of respondents agreeing or strongly agreeing that these factors hinder operational efficiency.

These findings are in line with existing literature. For instance, Gorani (2024) and Sherbaz et al. (2023) identify forecasting inaccuracies and poor inventory management as major contributors to stock-outs and overstocking globally. UTH's reported challenges in medicine forecasting directly align with these observations. Similarly, procurement delays, noted by 69 percent of respondents as a significant factor, are consistent with Chopo and Mutono-Mwanza (2024), who found that bureaucratic procedures in Zambia often disrupt the timely acquisition of medicines. The confirmation of this pattern through hypothesis testing strengthens the study's contribution to contextualized knowledge on supply chain performance in Zambian public health facilities especially at UTH.

Financial constraints also emerged as a key driver of inefficiency. The study shows that insufficient or delayed funding limits the hospital's ability to procure medicines in adequate quantities, aligning with Franco and Lizarazo (2020) and Papalexi et al. (2020), who found similar issues in public healthcare systems in both developing and developed countries. This finding underlines the systemic nature of inefficiency, showing that even well-structured supply chain processes cannot compensate for inadequate financing.

Human resource limitations are another critical factor identified in this study. Staff shortages, insufficient training, and limited managerial capacity were widely reported. These findings support previous studies (Bilal et al., 2024; Shore et al., 2022) that stress the importance of qualified and trained personnel for effective pharmaceutical supply management. Notably, the limited decision-making authority highlighted in this study presents a new insight; the interplay between hierarchical constraints and human resource capacity amplifies inefficiencies, a factor not extensively addressed in prior Zambian studies.

Technological constraints were also prominent, with 58.2 percent of respondents indicating that the lack or failure of inventory software contributes to inefficiencies. This confirms global research advocating for the adoption of electronic logistics management systems (eLMIS) and digital tracking tools to enhance supply chain visibility (Gorani, 2024; Dixit et al., 2024). UTH's limited digital integration suggests an opportunity to improve operational efficiency significantly through technological upgrades, including AI-assisted inventory management and real-time tracking.

Infrastructural factors, such as inadequate storage space and poor warehouse conditions, were noted as additional contributors. These observations align with Musamba and Mwanza (2025), who emphasize that storage and transportation capabilities critically affect pharmaceutical supply chain performance. While UTH maintains proper storage conditions in principle, spatial constraints and suboptimal logistics infrastructure impede efficient distribution and timely medicine availability.

A contradiction observed in this study is the perception of the overall effectiveness of UTH's supply chain. While staff report operational limitations, they also indicate that medicines are largely received from reliable sources and distributed systematically. This suggests that, despite systemic

inefficiencies, UTH exhibits resilience and adaptive mechanisms, such as monitoring stock levels and redistributing medicines between departments. Such adaptability echoes the lean supply chain theory (Dixit et al., 2024), where continuous monitoring and process improvement mitigate inefficiencies. Generally, the findings indicate that inefficiencies at UTH are multifaceted and interdependent, which are explained theoretically in inventory management, logistics, and supply chain management theories.

Objective 3: Strategies for Improving Inefficiencies in the Pharmaceutical Supply Chain System at UTH

The findings reveal several strategies proposed by respondents to enhance the efficiency of the pharmaceutical supply chain. The most frequently cited interventions included better staff training (39.1 percent), improved technology and software (33.6 percent), better leadership and management (10.9 percent), streamlined procurement processes (9.1 percent), and more reliable funding (7.3 percent).

These strategies align with solutions recommended in the literature as presented in chapter two. Sherbaz et al. (2023) emphasize strengthening supply chain planning and forecasting to reduce stock-outs, while Ngujuna et al. (2021) highlights the critical role of capacity building and training for supply chain personnel. The respondents' emphasis on training and capacity building underscores the importance of human capital in mitigating operational inefficiencies, particularly in forecasting, inventory management, and distribution. The study confirms that without competent personnel, even robust logistical and financial systems cannot function optimally.

Technology adoption was the second most cited strategy. Respondents submitted the need for integrated hospital systems, modern inventory management tools, and AI-assisted tracking, which is consistent with global best practices in pharmaceutical supply chain management (Gorani, 2024; Acosta et al., 2019). The study supports the supply chain management theory's assertion that visibility, data integration, and automation enhance decision-making, reduce delays, and minimize wastage. The practical implication for UTH is clear, investing in technological infrastructure can significantly improve operational efficiency and reduce the reliance on manual processes that are prone to error.

Streamlining procurement processes and ensuring timely, reliable funding were also highlighted as important. This is consistent with global studies noting that bureaucratic delays and limited financing exacerbate supply chain inefficiencies (Franco and Lizarazo, 2020; Shukar et al., 2021). UTH's experience shows how these factors directly affect medicine availability and patient care, therefore, the need for policy-level interventions to priorities' funding, simplify procurement channels, and foster supplier reliability.

The qualitative interviews revealed additional strategies, including better leadership, governance, and policy enforcement. Respondents emphasized the importance of clear policies, dedicated pharmacy funding, and strong management oversight to coordinate procurement, distribution, and inventory monitoring effectively. These insights highlight the interplay between operational, managerial, and policy factors in shaping supply chain performance, a problem that has been underexplored in prior studies on the Zambian context (Mwanaumo et al., 2023).

A point worth noting from this study is the integration of multiple strategies as a comprehensive, multifaceted approach. Respondents suggested that no single intervention would suffice; rather, combining training, technology adoption, improved funding, streamlined processes, and leadership reforms is essential. This echoes the lean supply chain theory's principle of continuous improvement and value maximization (Dixit et al., 2024) and provides actionable guidance for hospital administrators and policymakers in Zambia.

In other words, the study establishes that enhancing supply chain efficiency at UTH requires addressing operational, human resource, technological, and financial constraints simultaneously. The findings provide both theoretical and practical relevance by confirming the applicability of supply chain and logistics theories in a public health context. Therefore, by implementing these strategies, UTH can reduce stock-outs, minimize wastage, and ensure timely access to essential medicines, thereby improving overall healthcare quality.

5 Conclusion and Recommendations

5.1 Conclusion

Objective 1: To examine the pharmaceutical supply chain system at UTH from the demand and supply chain sides

The study revealed that the pharmaceutical supply chain at UTH operates with multiple interconnected processes, including procurement, inventory management, warehousing, and distribution. On the demand side, medicine requirements are sometimes inaccurately forecasted, leading to mismatches between supply and patient needs. On the supply side, procurement delays, inadequate transportation, and limited storage capacity contribute to disruptions. In other words, the supply chain is working but suffers from gaps in coordination, timely information flow, and integration of processes, which affect the consistent availability of medicines.

Objective 2: To identify the factors causing inefficiencies within the pharmaceutical supply chain system at UTH from the demand and supply chain sides.

The study identified several key factors contributing to inefficiencies. On the demand side, inaccuracies in forecasting and poor prioritisation of critical medicines lead to stock-outs and overstocking. On the supply side, inefficiencies arise from delayed procurement, weak logistics integration, limited warehouse space, and inadequate use of information systems. Human factors, such as limited staff training and insufficient decision-making authority, further exacerbate these challenges. Financial constraints and regulatory delays also contribute to disruptions in the timely delivery of pharmaceuticals. These findings show that inefficiencies are interrelated, requiring comprehensive interventions.

Objective 3: To establish strategies for improving these inefficiencies in the pharmaceutical supply chain system at UTH

The study proposes several strategies to address identified inefficiencies. These include: improving procurement planning and forecasting, adopting digital inventory and supply chain management systems, optimising warehouse and transport operations, and providing continuous staff training. Additionally, better coordination and communication among stakeholders, along with adherence to lean supply chain principles, can reduce waste and bottlenecks. Implementing these strategies would enhance medicine availability, reduce stock-outs, and improve overall operational efficiency at UTH. The study also shows that human, technology, and process-based interventions can be integrated to improve UTH's pharmaceutical supply chain. Practical frameworks for resolving inefficiencies can be obtained by applying concepts from supply chain management theories, logistics, lean supply chain, and inventory management

5.2 Recommendations

Based on the findings of this study, the following recommendations are proposed to improve the pharmaceutical supply chain system at UTH:

- To improve demand forecasting and inventory management, the hospital should first implement accurate forecasting methods and regularly review medicine consumption patterns. ABC analysis should be used to prioritize critical medicines, ensuring that essential stock is maintained. This action is of high priority and requires immediate attention to reduce stock-outs. The responsibility for implementation lies within the Pharmacy Department, the Supply Chain Unit, and the Hospital Management Team
- To enhance supply chain efficiency, the hospital should adopt digital supply chain and inventory systems by integrating electronic logistics management systems (eLMIS) and implementing real-time inventory tracking. This will improve visibility, support timely decision-making, reduce errors, and enhance coordination. The initiative is a high-priority, medium-term action, with implementation led by the Hospital IT Department, Pharmacy Department, and Supply Chain Unit in collaboration with the Ministry of Health.
- To strengthen procurement processes, the hospital should establish clear procurement timelines, cultivate relationships with reliable suppliers, and streamline approval procedures to minimize delays. This high-priority action directly impacts medicine availability and ensures timely access to essential drugs. Implementation responsibilities lie with the Procurement Department, Pharmacy Department, and Hospital Management Team.
- To optimize warehousing and storage infrastructure, the hospital should redesign storage layouts, enhance cold chain management, and expand warehouse capacity to accommodate critical and high-volume medicines. This medium-priority action requires moderate investment but is essential for improving operational efficiency. Implementation will be undertaken by the Hospital Facilities Management, Supply Chain Unit, and Procurement Team.
- To enhance staff capacity, the hospital should provide continuous training in inventory management, logistics coordination, and lean supply chain practices. This medium-priority initiative aims to improve efficiency over time by strengthening the human resource component of the supply chain. Implementation responsibilities rest with the Human Resource Department, Pharmacy Department, and Supply Chain Unit.
- To enhance coordination and communication, the hospital should establish regular cross-departmental meetings to monitor stock levels, track demand fluctuations, and address supply chain challenges. This high-priority action provides quick wins for process integration and ensures timely decision-making. Implementation will involve the Hospital Management, Pharmacy Department, and Supply Chain Unit, with the IT Department providing reporting support
- To implement lean supply chain practices, the hospital should adopt just-in-time ordering, continuous flow principles, and value stream mapping to minimize waste and streamline processes. This medium-priority initiative focuses on long-term efficiency improvements and sustainable operational performance. The Supply Chain Unit, Pharmacy Department, and Hospital Management Team will be responsible for implementation.
- To ensure policy and regulatory alignment, the hospital should collaborate with the Ministry of Health to comply with national pharmaceutical regulations while minimizing bureaucratic delays. This medium-priority, ongoing initiative is essential for sustainable supply chain operations. Implementation responsibilities rest with the Hospital Management, Pharmacy Department, Regulatory Affairs Unit, and the Ministry of Health.
- Future investigations should concentrate on intervention-based studies to evaluate the efficacy of focused tactics for lowering UTH's pharmaceutical supply chain inefficiencies. To assess treatments like digital inventory systems, improved staff training, quicker procurement procedures, and better warehouse management, such studies may employ experimental or quasi-experimental methodologies. While mixed-methods systems might record both quantitative performance indicators and qualitative inputs from supply chain employees, longitudinal monitoring would enable evaluation of results over time. Further, there is a need to have an adequate sample from public hospitals for generalisability purposes.

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The article followed all ethical standards appropriate for this kind of research.

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