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SCHOOL OF COMMERCE

DEPARTMENT OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

IMPACT OF SUPPLY CHAIN PRACTICES ON MEDICINE WASTAGE AND EXPIRATION RATES IN ZEWDITU MEMORIAL HOSPITAL

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DECLARATION

I hereby declare that the work presented in this thesis, Impact of Supply Chain Practices on Medicine Wastage and Expiration Rates in Zewditu Memorial Hospital, is entirely original, hasn't been submitted for credit toward a degree from any other university, and has properly cited all sources.

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ACRONYM

AACHB - Addis Ababa city health bureau

APTS - Auditable pharmaceutical transaction service

ART - Anti-retroviral treatment

DIS - Drug information service

EFY - Ethiopian fiscal year

EPSA - Ethiopian Pharmaceutical Supply Agency

ETB - Ethiopian birr

FEFO - First expired first out

FMOH - Federal ministry of health

JIT - Just in time

RBV - Resource-based view

SOP- Standard Operating Procedure

TOC - Theory of Constraints

UK - United Kingdom

WHO - World Health Organization

ZMH - Zewditu Memorial Hospita

ABSTRACT

Background: *Globally, the amount of wastage and expired medicines is growing at an alarming rate due to lack of effective supply chain management, poor storage management and oversupply of medicines, especially in resource limited setting also medication waste can occur in all stages of the pharmaceutical supply chain and it involves various stakeholders in the medication supply chain, from manufacturer to patient, contributing to medication waste.*

Objective: *This study aimed to investigate the impact of supply chain practices on Medicine Wastage and Expiration Rates in Zewditu Memorial Hospital.*

Methods: *A cross-sectional descriptive study design was employed, involving 78 respondents selected through purposive sampling from pharmacy professionals, nurses, and department heads directly involved in pharmaceutical supply chain management. Data were collected using a structured questionnaire measuring five supply chain practice domains and medicine wastage outcomes on a five-point Likert scale. Secondary data on medicine wastage values (2016–2017 EFY) were abstracted from hospital records. Quantitative data were analyzed using SPSS version 27,*

RESULT: *The response rate was 86.6%. All five supply chain practices demonstrated significant positive correlations with medicine wastage. Inventory management showing the strongest correlation ($r = 0.724$). Inventory management had the strongest effect ($\beta = 0.373$, $p < 0.001$), followed by forecasting ($\beta = 0.237$, $p = 0.004$), procurement ($\beta = 0.224$, $p = 0.005$), storage ($\beta = 0.188$, $p = 0.006$), and information sharing ($\beta = 0.142$, $p = 0.034$).*

The total financial value of wasted medicines in EFY 2016–2017 was 4,310,676 ETB, representing a 0.58% wastage rate. The top three wasted pharmaceuticals by value were Potassium Chloride injection (833,721 ETB), Microbiology Urea Agar (303,922.50 ETB), and Blood collection tubes (150,000 ETB).

Keywords: *Supply Chain Management, Medicine Wastage, Expiration Rates, Pharmaceutical Logistics, Public Hospital, Inventory Management.*

CHAPTER I

INTRODUCTION

1.1 Background

Access to medicines plays a crucial role in the effective functioning of a healthcare system, as they are vital for improving healthcare outcomes in populations (Mabizela et al., 2023). However, one third of the global population does not have regular access to medicines due to various reasons. The extent of the problem is even worse in some of the lowest-income countries in Africa and Asia, where more than half of the populations have no regular access to medicines(Gebremariam et al., 2019).

Globally, the amount of wastage and expired medicines is growing at an alarming rate due to a lack of effective supply chain management, poor storage management, and oversupply of medicines, especially in resource-limited settings (Diriba et al., 2023) . The World Health Organization (WHO) defines medical waste as unwanted pharmaceuticals, which include contaminated, spilled, expired, and unused prescriptions that must be properly disposed of since they are no longer needed. Medication waste can happen at any point in the pharmaceutical supply chain, and it is caused by a number of different parties, including manufacturers and patients. (Guadie et al., 2023).

One of the main issues facing the global healthcare system that puts the pharmaceutical industry's budget at risk is medicine waste. A total of 392 medications were examined (49 per site) in studies carried out at South African public healthcare facilities. Overstocking and expiration-related waste affected 50.6% and 15.2% of medications, respectively, whereas stock outs affected 85.6% of medications. (Mabizela et al., 2023).

Studies conducted in Uganda and Tanzania also revealed that supply chain-related factors are the main contributing factors for medicine wastage. Some of these are irrational procurement practices, supplying medicine without the need and request of a client, neglecting stock monitoring, lack of knowledge on expiry prevention tools, non-participation of clinicians in medicine selection and quantification in hospitals, profit- and incentive-based quantification, third-party procurement by vertical programs, and overstocking (Gebremariam et al., 2019).

Studies across Ethiopian regions, such as South West Shoa Zone and South Gondar Zone, reveal that medicine wastage is not merely a logistical oversight but a multifaceted problem driven by contributing factors like supplier-driven push systems, inadequate forecasting, and poor adherence to first-expired-first-out (FEFO) principles (Guadie et al., 2023). For instance, in Western Ethiopia, expired medicines accounted for an estimated 20 million Ethiopian Birr (ETB) in losses over two years, with tetanus antitoxin (TAT) and liquid dosage forms comprising over 77% of the wastage value (Diriba et al., 2023). Similarly, in South Gondar Zone, expiry rates reached 6.5% in the 2013 Ethiopian Fiscal Year (EFY), primarily due to poor store management and overstocking, which strained already limited healthcare budgets and compromised patient care (Guadie et al., 2023). These patterns underscore the urgent need for targeted interventions to optimize supply chain practices, such as adopting auditable pharmaceutical transactions and services (APTS), implementing electronic inventory systems, and fostering better stakeholder communication.

These difficulties are best illustrated by Zewditu Memorial Hospital, an important referral center in Addis Ababa that serves a varied urban population. The hospital, a public organization that depends on the Ethiopian Pharmaceutical Supply Agency (EPSA) for procurement, frequently deals with medication waste and expiration, which raises operating costs and prevents fair access to life-saving treatments (Semahegn, 2017). The purpose of this study is to look into how Zewditu Memorial Hospital's supply chain procedures, which include distribution, inventory control, storage, and procurement, affect drug waste and expiration rates. This research aims to reduce waste through evidence-based reforms by filling in these gaps and adhering to WHO guidelines and national health policies. Various initiatives have been undertaken to address the problem of medicine wastage and expiration within healthcare facilities. These efforts mainly focus on by implementing real-time stock tracking systems and demand-based forecasting models to reduce overstocking and ensure timely stock rotation, by Provide continuous training on medicine handling, storage techniques, and pharmaceutical inventory planning to elevate practical expertise, enforce WHO cold-chain guidelines, and optimize medicine distribution networks to preserve drug efficacy, establish donor protocols requiring minimum shelf-life guarantees, advance coordination on demand needs, and centralized donation tracking, by strengthen SOP compliance audits, adopt adaptable procurement models, and enforce

performance indicators including expiry tracking metrics (Bwalya & Mutono-Mwanza, 2025), (Gebremariam et al., 2019). The results will ultimately improve patient outcomes, resource efficiency, and environmental stewardship in public healthcare systems through sustainable pharmaceutical management.

1.2 Statement of the Problem

According to a 2025 external audit report, Zewditu Memorial Hospital, one of the oldest public referral hospitals in Addis Ababa, continues to struggle with pharmaceutical supply chain management, which leads to high rates of medication waste and expiration that compromise patient care and resource efficiency.

A literature review in the UK revealed that pharmaceutical waste is created by multiple routes, each of which needs to be addressed by pharmacists and healthcare bodies through the Circular Economy principles (Alshemari et al., 2020).

According to the study done in Choma District of Southern Province of Zambia revealed that medicine expiration is primarily caused by supply chain inefficiencies, logistical misalignments, insufficient cold-chain infrastructure, and lax enforcement of procurement and storage protocols (Bwalya & Mutono-Mwanza, 2025a)

A study done in South Gondar Zone found that the overall medicine wastage in the three consecutive years was 6.3%. The trend over the three years indicated that medicine wastage is 6.5%, 5.9%, and 6.5% in 2011, 2012, and 2013 Ethiopian Fiscal Year (EFY), respectively. The medicine wastage rate has been increasing by nearly 3% between 2011/2012 and 2012/2013 and the main sources of wastage of medicines were expiry (99.3%) (Guadie et al., 2023). Short shelf life, poor requirement forecasting, poor storage techniques, and poor inventory control were found to be the main causes of excessive medication waste in earlier research conducted in Ethiopia and Uganda (Gebremariam et al., 2019). The perceived reasons for such medicine's wastage were near-expiry medicines (<6 months) being delivered to the health facilities by suppliers, poor communication and coordination with key stakeholders, and the presence of overstocked medicines due to improper forecasting of need in the facilities (Guadie et al., 2023)

A study conducted in public health facilities in South West Shoa Zone, Oromia Regional State, revealed that medication waste is occasionally increasing in these facilities due to suppliers

issuing medications without the needs and requests of the health facilities, failing to follow the first expired first out principle when issuing medications from stores to various dispensing units, a lack of communication between the supplier and the health facilities, a shortage of pharmacy staff, and a weak supply chain monitoring system in the health facilities (Diriba et al., 2023).

According to a 2017 assessment done in Zewditu Memorial Hospital staff reported moderate to high agreement on the occurrence of overstocks (mean score 3.16), expirations (mean score 3.22), and especially stock outs (mean score 4.05 on a 5-point Likert scale), attributed to manual inventory systems, bureaucratic procurement delays, inadequate training, and weak management oversight (Semahegn, 2017).

Existing studies highlight these systemic flaws but lack a focused analysis on how specific supply chain practices, such as forecasting, storage, and distribution, directly influence wastage rates at this hospital, hindering targeted reforms. Addressing this gap is essential to reducing expiration-driven wastage, enhancing supply chain resilience, and supporting Ethiopia's goals for universal health coverage.

1.3. Research Questions

To investigate and address the impact of supply chain practices on medicine wastage and expiration rates at Zewditu Memorial Hospital, the study provides answers to the following questions

- ✓ How do supply chain practices influence medicine wastage rates in Zewditu Memorial Hospital?
- ✓ How do supply chain practices affect medicine expiration rates in Zewditu Memorial Hospital?
- ✓ What detrimental effects can pharmaceutical waste and excessive expiration rates have on the whole course of treatment?
- ✓ How much do medicine expiration and waste affect the provision of healthcare services?

By investigating the above questions thoroughly, the impact of supply chain practices that might affect medicine waste and expiration rates at Zewditu Memorial Hospital were identified, and recommendations will be forwarded to the responsible body. The study examine the current state

of these core supply chain practices and their impact on medicine wastage and expiration rates at Zewditu Memorial Hospital

1.4 Objective of the Study

1.4.1 General Objective of the study

- ✓ To investigate the impact of Supply Chain Practices on Medicine Wastage and Expiration Rates in Zewditu Memorial Hospital

1.4.2 Specific objectives of the study

- ✓ To assess the effect of supply chain management practices on medicine wastage rates in Zewditu Memorial Hospital.
- ✓ To examine the impact of supply chain management practices on medicine expiration rates in Zewditu Memorial Hospital.

1.5 Significance of the Study

Zewditu Memorial Hospital and the larger Ethiopian healthcare system will greatly benefit from this study. In addition to reducing the availability of life-saving treatments and undermining the effectiveness of public health service delivery, medicine waste and expiration constitute a significant financial burden. This study offers evidence-based insights that can direct operational improvements within the hospital's pharmaceutical supply chain by looking at how distribution, inventory management, storage, and procurement practices affect waste and expiration rates.

By highlighting systemic issues like supplier-driven deliveries, inadequate communication, and supply chain management capacity gaps, the study also produced useful information for policy makers, such as the Ministry of Health and the Ethiopian Pharmaceutical Supply Agency (EPSA). These insights can help improve the resilience and effectiveness of public health facilities through supply chain reforms, capacity-building initiatives, and policy revisions.

By adding to the body of knowledge already available on pharmaceutical supply chain management in Ethiopia, the study has academic significance. Few studies have specifically focused on the operational context of large urban referral hospitals like Zewditu Memorial Hospital, despite the fact that earlier research has looked at medication waste in other areas.

Thus, by offering context-specific evidence on how supply chain practices impact waste and expiration rates, this study closes a significant gap.

1.6 Scope of the Study

This study focus on the impact of Supply Chain Practices on Medicine Wastage and expiration Rates in ZMH. Zewditu Memorial Hospital is one of the public hospitals in Addis Ababa, directly under supervisory Addis Ababa City Health Bureau/AACHB/.

The data gathered from storekeepers, pharmacy professionals, laboratory specialists, different pharmacy dispensary units, including (outpatient, inpatient, emergency, maternity, and ART pharmacies), and department heads of the ward in the hospital staff, with a particular emphasis on those officers in charge of acquiring and managing hospital stocks.

1.7 Limitations of the Study

First, the study limited to a single referral hospital, thus the findings may not be fully applicable to primary health centers, regional hospitals, or private institutions with differing patient numbers, staffing levels, and procurement methods, the study only examines the facility-level section of the supply chain and does not investigate upstream issues at the Ethiopian Pharmaceutical Supply Agency (EPSA) hubs and importation or distribution stages, which are known to contribute significantly to near-expiry deliveries and over-supply and the small number of identical studies conducted in a single site made it difficult to compare results.

1.8 Operational definition of Terms

- ✓ **Bottlenecks: -** Perceived or observed challenges identified through hospital staff and management.
- ✓ **Supply chain practices: -** The methodical procedures of organizing, locating, acquiring, storing, and distributing medical supplies, medications, and equipment to guarantee they are available for patient treatment at the appropriate time
- ✓ **Expiry date: -** The time period during which the product is known to remain stable, which means it retains its strength, quality, and purity when it is stored according to its labeled storage conditions.
- ✓ **Stock out:- Depleted** supply of a given product a zero-stock balance.

- ✓ **Overstock: -** A supply imbalance that occurs when stocks exceed the established maximum
- ✓ **Inventory: -** Store of goods
- ✓ **Vital/essential/non-essential:- medicines** classified based on hospital list.
- ✓ **Dosage forms: -** the physical forms in which pharmaceutical drugs are presented for administration
- ✓ **Medicine Wastage:** unwanted medications which include expired, unused, spilt and contaminated pharmaceutical products and vaccines

1.9 Organization of the Study

The background, literature review, research design, and methodology are covered in chapters one, two, and three of the study. A synopsis of data analysis, interpretation, and discussions is given in Chapter 4. A summary of the results, conclusions, recommendations, and ideas for additional research are presented at the end of Chapter 5.

CHAPTER II

RELATED LITERATURE REVIEW

2.1 Introduction to Medicine Supply Chain Management

The timely and effective delivery of medical goods and services is largely dependent on the smooth operation of the healthcare industry's supply chain, which is a complex and dynamic ecosystem. In the modern healthcare delivery environment, this complex network known as healthcare supply chain management has grown in importance. To ensure the availability of vital medical resources, the complex nature of healthcare supply chains necessitates the coordination and integration of numerous stakeholders, including manufacturers, distributors, healthcare providers, and regulatory organizations (Apeh et al., 2024a).

The World Health Organization (WHO) states that the second-highest expense in a nation's healthcare system, after personnel expenditures, is related to medications. The pharmaceutical market is expected to grow to almost 1.4 trillion US dollars by 2020, according to figures on global spending on medications. In 2010, overall spending on medicines was 887 billion US dollars (Iqbal et al., 2017a).

The World Bank indicates that in many developing countries, a high percentage of medicine losses occur in the government procurement, storage, distribution, and utilization system. It has also been established that in certain areas, a significant proportion of essential medicines and supplies are misappropriated or diverted (Iqbal et al., 2017).

The patient care processes in hospitals are supported by a range of operational activities, including inventory management and distribution of supplies to point-of-care locations. Large quantities and a wide range of goods are carried by hospitals, and the storage and distribution of these goods across the hospital supply chain are crucial to delivering excellent patient care. The handling of tangible goods (such as pharmaceuticals, surgical supplies, medical equipment, sterile items, linen, food, etc.) and the related information flows, from the hospital's receipt of the goods to their delivery at patient care locations, are all included in healthcare logistics (Moons et al., 2019). Hospital supply chains are responsible for several economic inefficiencies, negative environmental impacts, and social concerns (Smale et al., 2021).

A crucial part of providing healthcare in hospitals is pharmacy services. By guaranteeing the accessibility and sensible use of high-quality, secure, and efficient medications, it helps to improve treatment outcomes. Effective pharmacy services are also essential for early detection and prevention of adverse drug events, dosage errors, and the containment and prevention of antibiotic resistance. Additionally, it encourages the best possible use of limited resources, which raises the standard of care and improves health outcomes (Ethiopian Hospital Management Initiative, 2017).

Overall, the management of a hospital's supply chain presents great opportunities for improvement in healthcare systems, both in terms of cost reduction and increased quality of care (Borges et al., 2020)

2.2 Importance of efficient pharmaceutical supply systems

The essential component in the provision of healthcare services is the supply chain process. In the healthcare industry, the patient is the end-user, and the supply chain plays a vital and life-saving role in ensuring that goods and services are delivered to them. Because healthcare systems are getting increasingly complex and uncertain, managing the healthcare supply chain can be challenging. Uncertainty and hazards are present at every stage of the healthcare decision-making process. Negative effects on the healthcare system could result from ineffective supply chain management (Lau et al., 2022).

The supply chain process is crucial to the delivery of healthcare services. The patient is the final consumer in the healthcare sector, and the supply chain is essential to ensuring that products and services are provided to them. Managing the healthcare supply chain can be difficult since healthcare systems are becoming more complicated and unpredictable. Every step of the healthcare decision-making process involves risks and uncertainty. Ineffective supply chain management may have detrimental implications on the healthcare system.(Bilal et al., 2024).

An efficient supply chain provides an intuitive way to visualize and analyze data, allowing for better decision-making. Centralized virtual supply chain management systems enable greater collaboration between suppliers and customers, helping streamline processes and reduce costs (Mittal & Mantri, 2023).

Good pharmaceutical supply chain procedures reduce stockouts, expiration losses, and theft. Additionally, it ensures that the medication is available in sufficient quantities and enhances the caliber of services rendered (Tefera & Anbessa, 2022)

2.3 Impact of medicine wastage and expiration in healthcare facilities

According to (Guadie et al., 2023) medicines wastage is, Unwanted pharmaceuticals, such as those that are expired, unused, spilled, or contaminated and that must be properly disposed.

Medication waste poses significant economic and environmental challenges, and the multifaceted roles of stakeholders such as manufacturers, distributors, prescribers, pharmacists, and patients in mitigating this issue. Strategies to reduce waste include optimizing packaging sizes, enhancing storage stability data, implementing better prescription practices like dose tailoring and split prescriptions, and establishing systems for redistributing unused medications (Smale et al., 2021)

Medicine wastage not only hampers therapeutic benefit but it also affects financial capability. On average, countries spend about 25% of their total health expenditure on medicines. Of these, according to Management Science for Health estimation, 70% of the total funds invested in essential medicines are wasted in the normal supply system (Gebremariam et al., 2019).

A number of factors, including manufacturers and patients, can contribute to medication waste, which can occur at any stage of the pharmaceutical supply chain. Due to factors including product expirations and theft, supply chain inefficiencies at healthcare facilities have resulted in significant resource waste. Furthermore, the lack of adequate accountability and transparency in the administration of drugs and financial transactions raises the risk of resource theft and misappropriation (Guadie et al., 2023).

The global magnitude of expired drugs increased as a result of a lack of inspection when issuing drugs to stock, a lack of stringent supply chain management, poor storage management, and an excess of drug supply, which increased the burden of expired medicines and their prevalence towards lifesaving drugs (Gebremariam et al., 2019)

2.4 Supply Chain Practices in Healthcare System

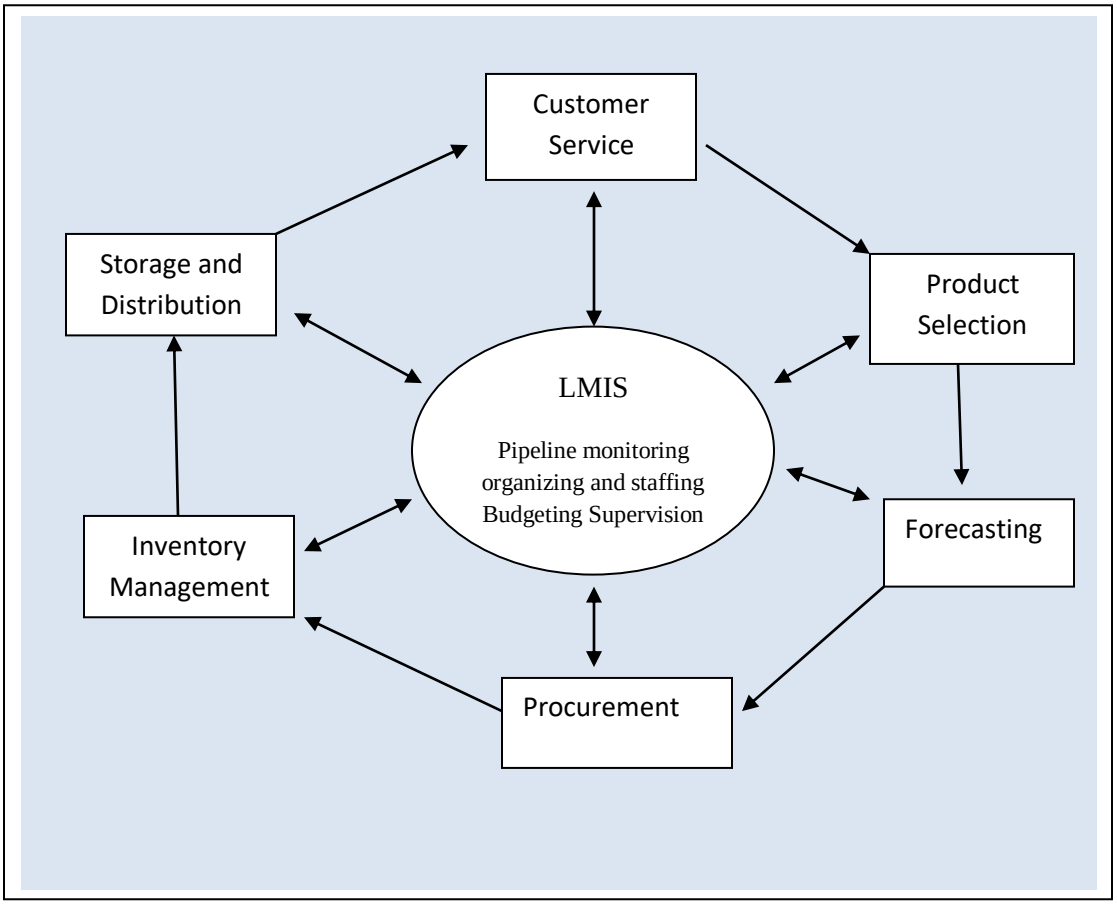
Supply chain management techniques are a collection of several actions taken by a company to facilitate efficient supply chain management. Increasing productivity, reducing lead times, and

minimizing inventory are the short-term goals of supply chain practice, while expanding market coverage and supply chain integration are the long-term goals. (Bahiru Tefera & Tilahun Anbessa, 2022a). A public healthcare supply chain is a network of many interconnected sectors or organizations that guarantees the accessibility of medical supplies to those in need. The public and private healthcare sectors differ greatly in how some supply chain management operations are implemented. Healthcare supply chain system has a huge role on ensuring every clients or patient are able to obtain quality health commodities, however developing a supply chain system that can administer large number of quality products is very difficult (Iqbal et al., 2017).

These days, the public health sector in many nations pays increasing attention to supply chain management since it may help reduce expenses, boost revenue, improve customer satisfaction, and improve the quality of services provided (Omanji, 2018).

According to John Snow, Inc. (2017), when the logistics cycle's operations are not carried out effectively, medicine will be wasted.

Figure 1 The Medicine logistics cycle



Source: "John Snow, Inc. 2017. The Supply Chain Manager's Handbook, A Practical Guide to the Management of Health Commodities (Snow, n.d.).

2.4.1 Medicines Storage Practice and Inventory Management

Proper environmental controls like proper temperature, light, humidity, conditions of sanitation, ventilation and segregation must be maintained wherever drugs and supplies are stored. It is extremely important to have warehouses with sufficient storage space, fitted with heavy-duty racking system to avoid wastage of space along with pallets, hydraulically operated hand-trolleys and pedestrian controlled electric stackers to handle the medicines scientifically and efficiently. Storage areas must be secure; fixtures and equipment used to store drugs should be constructed so that drugs are accessible only to designated and authorized personnel (Iqbal et al., 2017). Proper storage conditions are required to ensure the quality and efficacy of medications. This includes managing temperature, humidity, and other environmental conditions that can impact pharmaceutical product stability (Bwalya & Mutono-Mwanza, 2025).

The American Production and Inventory Control Society (APICS) defines inventory management as the branch of business management concerned with planning and controlling inventories. Outcomes of patients who have been negatively affected could have been prevented through an effective inventory management system which will allow pharmacies to correctly capture the ingredients contained in the inventory such as drug expiry date and quantity (Iqbal et al., 2017b).

To meet the needs of the organization and marketing requirements, inventory management manages the production, purchasing, and distribution process. Included in inventory management are lead time for replenishing, products replenishing, returns of the defective products, cost of holding inventory, physical inventory, asset management, available physical space, inventory visibility, inventory valuation, demand planning, inventory price forecast, and quality management (Beyene et al., 2020).

In Ethiopia the common inventory recording and documentation formats are Internal Facility Report and Resupply Form (IFRR) and Report and Requisition Form (RRF), Bin Card (BC), Stock Record Card (SRC). These documents are collectively known as inventory or stock

records. Stock records provide basic and primary information for inventory management since they capture all transactions involving individual units.

2.4.2 Forecasting

Healthcare forecasting is the process of predicting future health related events or service demand based on historical and real-time data to inform decisions around capacity, resources, and service planning. It is used for both clinical and operational purposes, spanning short-term needs (Ogamba, 2025).

Forecasting methods in healthcare facilities are critical, especially in analyzing drug management. Performing drug management using forecasting methods is essential in decision-making, especially in estimating the number of drug needs in the future. In addition, it can avoid the occurrence of excess or shortage of drug stocks so that it can manage drug supplies more efficiently. Forecasting analysis is carried out using historical data on previous drug use so that it can project drug needs more accurately. Accurate forecasting can make better decisions regarding drug procurement to improve the quality of health services to patients (Wiedyaningsih et al., 2024).

2.4.3 Medicine Procurement

Purchasing the appropriate quantity and quality of goods and services for the company in the appropriate time frame at the lowest possible cost is the primary function of procurement. An integrated approach to the creation of the essential medications list, need assessment, quality control, procurement procedure, and timely supplier payment would all be part of an appropriate healthcare procurement policy. Value for money, which is essential in a nation with several development issues, may be ensured via an effective procurement procedure. Better procurement procedures enable public health facilities to provide higher-quality healthcare services to the population. (Tefera &Anbessa, 2022). Other criteria that are used for procurement management include the quality of goods, timely delivery, and cost considerations, together with risk reduction, competitiveness, and integrity. Among other things, economic considerations, social considerations, green procurement policies, and international trading agreements also form part of procurement policy criteria.(Iqbal et al., 2017a).

2.4.4 Medicine Distribution

In order to guarantee the smooth transportation and delivery of necessary medical supplies to various healthcare facilities, the distribution phase of healthcare supply chain management is crucial. This complex procedure entails thorough analysis, covering elements like route design, mode of transportation selection, and careful last-mile delivery tactics. Temperature-sensitive shipments, demand swings, and possible transportation bottlenecks are some of the difficulties distribution faces. Route optimization, real-time tracking, and the creation of cooperative distribution networks are examples of strategic efforts. Using cutting-edge logistics technologies, integrating cold chain management techniques, and expanding distribution networks become crucial tactics to improve the distribution component's resilience and efficiency. These steps strengthen the healthcare supply chain against unanticipated disruptions and uncertainty while streamlining the delivery process.(Apeh et al., 2024)

2.4.5 Information Sharing and Technology

The process of exchanging information between parties about any information that is crucial for making decisions is known as information sharing. The forecast at the supplier will much improve when the information sharing process is effective because the underestimation or overestimation of the need will be removed. It is evident that public health institutions have not yet attained optimal levels of information sharing, information quality, and IT tool utilization, despite the importance of information in the supply chain management process. Information technology integration in the healthcare supply chain system is currently seen as a chance to improve not just the efficacy and efficiency, and quality of health services but also the transparency of the economic activities (Tefera & Anbessa, 2022.).

2.4.6 Customer Service

The techniques and procedures that guarantee the most responsible use of medications are referred to by a number of phrases, including "rational use of medicines," "quality use of medicines," "responsible use of medicines," "improved use of medicines," and others of a similar nature. One strategy for delivering the best possible healthcare is the prudent use of pharmaceuticals. Giving patients the right medications for their condition in the right quantity, at the right time, and for the least amount of money is known as rational medication use. It includes

things like monitoring drugs, educating people, exchanging information, improving, and delivering medication in compliance with the law. (Iqbal et al., 2017).

2.4.7 Supplier Relationship Management

Supplier relationship management is a complicated business process that is greatly impacted by outside variables and necessitates resource allocation by the supplier and the customer in order to achieve a variety of complex outputs. SRM's primary goal is to facilitate efficient sourcing procedures for healthcare facilities and their suppliers. It also indirectly seeks to enhance supply chain operations' quality. (Tefera &Anbessa, 2022).

2.5 Supply chain enablers:

2.5.1 IPLS (Integrated pharmaceutical logistics system)

Integrated Pharmaceutical Logistics System is the primary mechanism through which all public health facilities in Ethiopia get essential pharmaceutical products from their main supplier (Tefera et al., 2021). IPLS enhances the pharmaceutical supply chain by combining pharmaceutical procurement, distribution, and reporting systems. Its objective is to guarantee that patients always have access to the drugs they need and to be effective, the system must provide the six rights of supply chain management which includesthe right items, in the right amount, of the right quality, at the right time, at the right place, and for the right price (Tefera et al., 2021).

2.5.2 Logistics information system management

Facilities are able to keep an eye on everyday pharmaceutical transactions thanks to this electronic record-keeping and reporting system. It helps with tracking issued items, store stock levels, medication batch and expiration dates, consumption data, and loss and adjustment computations. It helps shop managers create a request and report form (RRF) that they may send to the Ethiopian Pharmaceutical Supply Agency. (EPSA) (Tiye & Gudeta, 2018).

For precise forecasting, financial planning, procurement, and distribution of health commodities, a well-designed LMIS that records and reports regular data is essential. In many poor nations, including Ethiopia, the implementation of integrated pharmaceutical logistic systems (IPLS) has improved supply chain efficiency. Enhancing data quality in terms of accuracy, completeness,

and timeliness was another priority of Ethiopia's Health Sector Transformation Planning II (HSTP-II) agenda (Mekonen et al., 2025).

2.5.3 APTS (Auditable pharmaceutical transaction and services)

Corruption is a major problem in the pharmaceutical industry and makes it difficult to monitor pharmaceutical products and financial transactions as well as to ensure accountability and transparency, the Amhara Regional Health Bureau (ARHB) established Auditable Pharmaceutical Transactions and Services (APTS) for the first time to close these gaps. An enhanced pharmaceutical management system can handle poor pharmaceutical product selection, acquisition, distribution, and misuse (Belachew et al., 2024).

The APTS, which stands for the Accountable Pharmaceutical Transaction System, is a system based on information, which makes it easy to monitor any kind of information about a pharmaceutical transaction. This helps make the transaction efficient and measureable. This system not only makes the use of budgets efficient but also renovates the working style of a professional and makes transactions accountable. (Beyene et al., 2020).

2.6 Supply Chain Management Theories in Healthcare

A wide range of theoretical models and frameworks that have been modified from general supply chain management theories and adapted to the particular complexities of the healthcare industry are used in the field of healthcare supply chain management (Apeh et al., 2024).

2.6.1 Just-in-Time (JIT)

JIT is a cutting-edge approach to stock management. It is a supply-demand method that promotes flow-type production and aims to precisely match supply and demand for care. JIT was first created by Toyota Motor Company in Japan, and it has since been used in many different sectors of the global economy, including healthcare. JIT systems don't require excess inventory in order to react swiftly to demand. JIT systems prevent the issue of overstocked inventory and ultimately save operating expenses by having suppliers deliver small quantities of products to HCOs as needed. JIT is a thorough inventory management strategy that gets rid of non-value-added products and cuts waste (Balkhi et al., 2022)

Many manufacturing companies and healthcare organizations have found that the JIT and stockless approach to provider-supplier interactions is a win-win situation for their partners. The

entire cost structure of the hospital supply distribution chain will be significantly impacted by this method. Innovative material managers are taking the initiative to lower their hospitals' existing operating expenses as a result of the profound changes the health care sector underwent in the 1980s (Siddiqui, 2022).

JIT requires healthcare settings to match item supplies precisely with medical demand at the right time to avoid wastage. The system purchases what is needed, so hospitals do not store much inventory and can avoid expired products while keeping necessary supplies ready for patient care. Medical facilities that correctly use JIT principles reduce costs and improve performance by managing their full spectrum of medical supplies, including regular items and special equipment. Besides saving money, JIT plays a critical role in healthcare beyond its primary functions. The system supports core business development by making resources more effective while delivering better patient results with environmentally conscious solutions. JIT helps healthcare facilities cut down on environmental impact by getting rid of unused supplies as part of industry plans towards sustainability (Pramod Kumar Muppala, 2025).

Because JIT improves the efficiency of every stage of supply management, it helps reduce costs over time in healthcare operations. Quick access to vital supplies enables healthcare professionals to immediately attend to patients' requirements without causing needless issues that raise expenses and harm their reputation. By resolving supply constraints, JIT improves the efficiency of healthcare operations by maintaining departmental flow and reducing patient care delivery times. JIT is a cost-saving strategy since it helps enhance patient satisfaction and medical outcomes by reducing wait times and service disruptions (Pramod Kumar Muppala, 2025).

2.6.2 Lean Management:

Created by Toyota in Japan in the 1950s, lean management has subsequently expanded in the industrial and commercial sectors before being modified and implemented in the healthcare sector (Wang et al., 2025). Lean is a set of operating philosophies and methods that help create maximum value for patients by reducing waste and wait times. It aims to fundamentally change organizational thinking and value, which ultimately leads to the transformation of organizational behavior and culture over time, and it focuses on how efficiently resources are being used and asks, ‘what value is being added for the customer’ in every process (Lawal et al., 2014).

Lean has been embraced across public services, including healthcare, central government, and local government organizations. The application of Lean principles in healthcare, particularly hospitals, should remove duplicate processes and unnecessary procedures, such as recording patient details in multiple places; excessive waiting for staff; and uncoordinated, variable discharge processes resulting in a longer length of stay (Radnor et al., 2012).

To improve the quality of pharmaceutical services, the Lean Management approach presents a promising solution. Lean Management is a process improvement methodology that focuses on eliminating waste and increasing value-added activities within a system. This approach has been widely implemented in the healthcare sector, including pharmaceutical services, and has proven effective in reducing waiting times, streamlining workflows, and enhancing resource utilization. Several studies have reported that the application of Lean Management in pharmacy services can reduce waiting times by up to 66% and significantly improve patient satisfaction (Sallam, 2024).

2.6.3 Bullwhip Effect Mitigation

The Bullwhip effect is a well-researched phenomenon in supply chain management, which consists of the amplification of demand unpredictability from end users to primary suppliers. This kind of information distortion causes production and inventory levels to fluctuate erratically and exaggeratedly throughout the chain, resulting in expenses associated with inefficient turns. Delays in reporting, inaccurate demand forecasting, and domestic replenishment practices that magnify little variations in actual demand are some of the factors causing this issue (Moreno-Baca et al., 2025). The bullwhip effect (BWE), first identified by Forrester (1958), describes a phenomenon in which small variations in downstream demand are amplified as they are transmitted upstream within a supply chain. This concept, also known as the demand amplification effect, has been a central focus of operations and supply chain management research (Almomani et al., 2025).

The detrimental effects of BWE are significant and well-documented across a range of businesses. Excessive inventory, product shortages, ineffective setup, idle and overtime workers, scheduling issues, strained supplier relationships, and lower customer satisfaction are a few of these. The bullwhip effect is a major worry in global operations management because of the potential consequences of these inefficiencies, especially in light of the growing complexity of contemporary supply chains (Almomani et al., 2025).

The bullwhip effect silently undermines hospital supply chains, creating stock outs, wastage, and patient safety risks. It arises from information asymmetry, batching, shortage gaming, and behavioral overreaction. The solution lies in real-time visibility, collaboration, automation, and disciplined policies collectively termed digital supply chain transformation. Hospitals must move from reactive procurement to predictive, patient-driven supply chains, thereby ensuring uninterrupted, efficient, and safe patient care (Singh, 2025).

2.7 Empirical Literature Review

The study conducted in Zambia revealed that a large number of medicines and supplies had expired, implying inefficiencies in inventory management, procurement planning, and supply chain coordination. 78.3% of all drugs in stock were expired, indicating significant gaps in predicted demand and stock rotation policies. Essential pharmaceuticals, which are critical for healthcare service delivery, have a 56.5% expiry rate, raising concerns regarding procurement and storage practices also the expiry rate for donated pharmaceuticals was shockingly high at 65.2%, indicating problems with delivery delays and storage limits. Also the study suggest by Strengthening inventory tracking systems, optimizing procurement tactics, and implementing improved stock management techniques can all help to reduce these issues and minimizing pharmaceutical waste and increasing overall service delivery in healthcare facilities (Bwalya & Mwanza, 2025)

Twenty health facilities were included in the three-year estimates for medicine waste, which showed that the overall wastage rate was 6.3% (6.5%, 5.9%, and 6.5% in 2011, 2012, and 2013 EFY, respectively), according to a study done in Public Health Facilities in South Gondar Zone. Thus, during the course of the three fiscal years, these medical establishments squandered 9,799,789 ETB. Additionally, the study showed that, despite a 0.4% annual rise in the average monetary value obtained the rate of medicine waste rose by about 3% annually (4). According to the study, the two main causes of medication waste were damage (0.7%) and expiration (99.3%), which cost 64,454 ETB and 9,735,335 ETB, respectively. (Guadie et al., 2023).

Two hundred thirty-nine thousand eight hundred one (n=239,801) unit packs containing various anatomical therapeutic classifications (ATC) and dosage forms that are estimated to cost more than twenty million birr (=20,538,198.93 ETB) of money value expired during the study period from August 2012 to June 2013 E.C., according to one study done in the pharmaceutical supply

chain in western Ethiopia. Poor store management was found to be a major contributing factor to the amount of expired medication. (Mabizela et al., 2023)

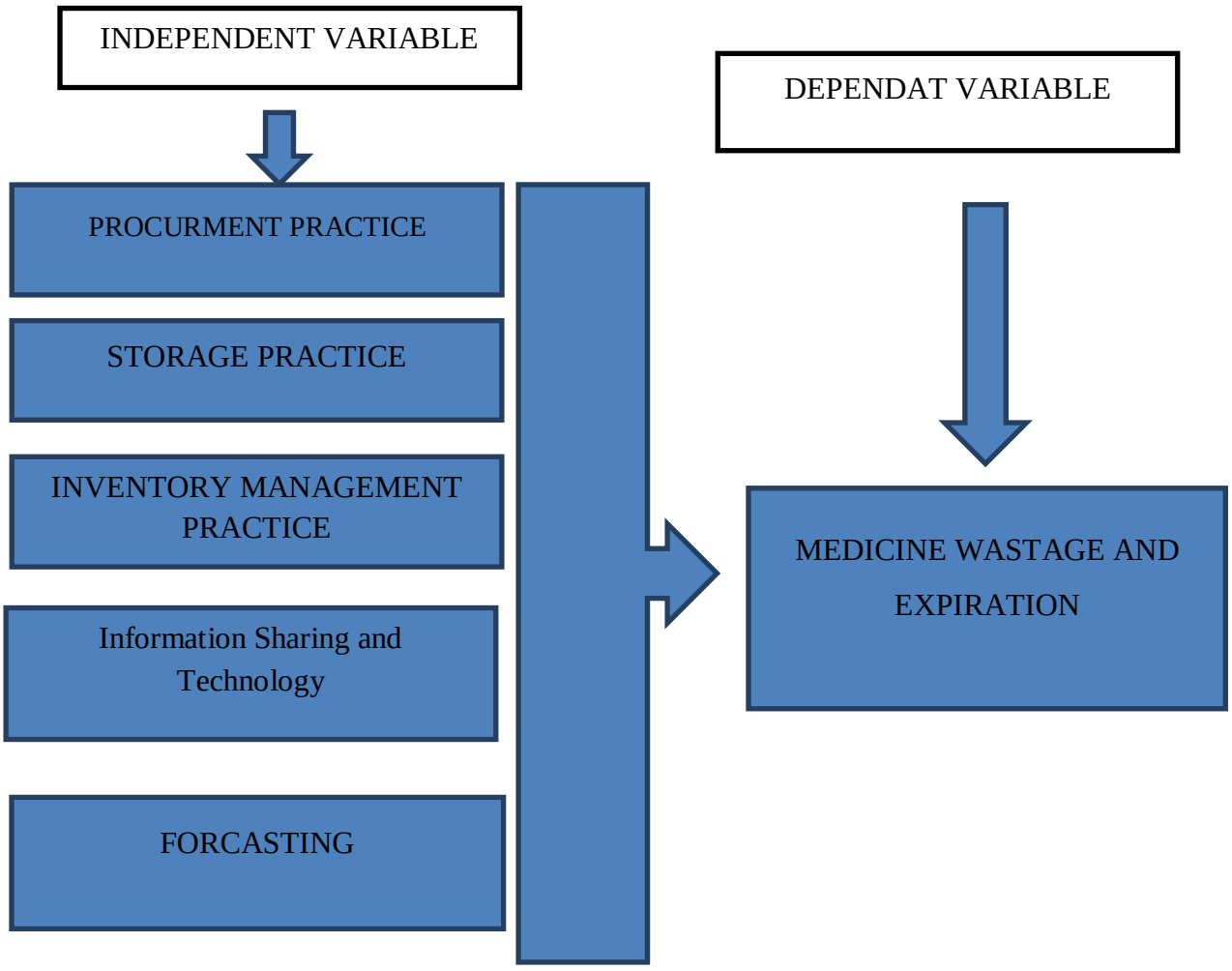
According to a study conducted in South West Shoa Zone public health facilities, medication waste is occasionally rising in these facilities as a result of suppliers issuing medications without the needs and requests of the health facilities, failing to follow the first expired first out principle when issuing medications from stores to various dispensing units, a lack of communication between the supplier and the health facilities, a shortage of pharmacy staff, and a weak supply chain monitoring system in the health facilities. The study also found that one of the main issues affecting their ability to provide services is a tight budget, a shortage of medications, and a crowded store. (Diriba et al., 2023)

2.8 Conceptual Framework of the Study

In conducting the study, a conceptual framework will be developed to show the relationship between the independent variables and the dependent variable.

Figure 2 Conceptual Framework of the Study

Source: ‘‘Adapted and modified; John Snow, Inc. 2017.’’



CHAPTER III

RESEARCH METHODOLOGY

3.1 Description of the Study Area

Ethiopia's Addis Ababa is home to Zewditu Memorial Hospital. The Seventh-day Adventist Church constructed, owned, and ran it until the Derg dictatorship confiscated it around 1976. The Addis Ababa Health Bureau is currently in charge of the hospital. Zewditu Memorial Hospital is currently among the leading suppliers of ART services. The Zewditu Memorial Hospital in Addis Ababa, Ethiopia, served as the study's site.

3.2 Research Approach

This study uses quantitative method. The respondents answer was put on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

3.3 Research Design

A cross-sectional descriptive study design was used to assess the impact of supply chain practices on medicine waste and expiration rates. Questionnaires used to gather study data.

3.4 Population of the study

The target population is the entire group of people who share a common condition or characteristic that the researcher is interested in studying (Capili, 2021). All health professionals taking part in a role in pharmaceutical supply chain management tasks was sampled. According to ZMH HR Directorate data the hospital has 861 technical workers, including 90 medical doctors and 71 specialized in different professions, 389 nurses, 73 Midwifery, 54 pharmacy staff, 41 Laboratory, 30 Anesthetist, 113 other professions, and 266 supportive staff.

3.5 Sample size

Purposive and convenience sampling methods were employed in this investigation. Staff and department employees who purchase and oversee hospital stock were chosen using a purposeful sampling technique; for example, those who purchase and oversee hospital pharmaceutical stock were included. Convenience sampling is utilized to choose a representative sample of the hospital's many departments. Ninety personnel who were directly involved in pharmaceutical supply chain management duties made up the study's sample size. These included all pharmacy

professionals (54), including the head of pharmacy (1), the head of laboratory (1), the heads of all department units, including OPD (28), and DTC members (6).

3.6 Data Collection

The principal investigator gathers quantitative surveys. An organized questionnaire tailored from LIAT (Snow, n.d. 2009). Semi-structured surveys were conducted with employees directly involved in pharmaceutical supply chain management tasks, including all pharmacy professionals, the head of pharmacy, the head of the laboratory, heads of all departmental units (including OPD), and DTC members.

3.7 Data Collection Instrument

A structured questionnaire checklist adapted from the Logistics Indicator Assessment Tool (LIAT) (Snow, n.d.) was used to conduct a facility-based survey to assess premises of drug store conditions, forecasting, procurement processes, and inventory control procedures, storage practices, ordering of supplies, and stock management activities for the collection of quantitative data.

3.8 Ethical Consideration

Before starting data collection, Addis Ababa University School of Commerce was provided ethical approval, and Zewditu Memorial Hospital was granting permission. Before beginning the study, participants were asked for their consent. Throughout the consent process, the researcher informed participants about the study's objectives, the reasons behind their selection for participation, and the confidentiality and anonymity of the data collected because no personal identifiers were used and the data was analyzed in aggregate form.

3.9 Data Analysis Plan

In order to obtain an accurate measure of the variables involved, it is crucial to employ relevant categories to organize the data collected for a research project. In general, analysis and interpretation issues are ubiquitous in any research work that takes into account data from any category (Adu, 2010).

The quantitative answer was sorted using SPSS version 27 once all pertinent data had been gathered and sorted using the data collection tools. The results were then displayed as tables and graphs.

3.10 Validity

Validity of the study

A pilot study was carried out to verify the study's validity, and the researcher carefully examined the findings. Four people from ZMH's stores (1), dispensary pharmacy (2), and DSM head (1) participated in a pilot research to test the validity of the questionnaire. The researcher was accessible to help, and the four individuals had twenty minutes to do the questionnaire. Additionally, respondents were requested to provide feedback on the questionnaire's structure and language. Following a pilot study, some modifications were made to the questionnaire. Some of the modifications had to do with spelling mistakes and the format of the questionnaire. To make sure that every item was comprehensible and clear, a questionnaire had to be tested. This took place prior to the primary investigation. The findings demonstrated that the respondents had a solid grasp of the study's themes and questions.

3.11 Reliability Analysis

The Cronbach's Alpha value of procurement practices was 0.841, showing that the items measuring procurement practices were highly reliable. It means that the items measuring aspects like ordering processes, suppliers' coordination, and budget response are consistent enough to make up the reliable construct. Similarly, inventory management had a Cronbach's Alpha value of 0.821. The results reveal that there is consistency among practices of inventory management.

1Table 1. Reliability Test

Variables	**No. of Items**	**Cronbach's Alpha**
Procurement Practices	5	.841
Inventory Management	7	.821
Storage Practices	7	.812
Information Sharing	6	.798
Forecasting Practices	6	.758
Medicine Wastage (DV)	5	.754
Overall Reliability	36	.922

Source: Own Questionnaire, 2026

The storage practices measured by the survey havea Cronbach's Alpha of 0.812, indicating that the items measuring storage conditions had high reliability. The information sharing Cronbach's Alpha value was 0.798, meaning that the items measuring communication processes within an organization can be termed consistent. The lowest Cronbach's Alpha was recorded against forecasting practices, which was 0.758. However, still above the required level, it indicated moderate reliability.

Finally, the Cronbach's Alpha value for the dependent variable, medicine wastage, was 0.754, suggesting that the items measuring wastage outcomes such as expired stocks, etc., had internal consistency. Furthermore, when it comes to the overall reliability of the instrument, then it must be pointed out that Cronbach's Alpha was 0.922. This reveals that all 36 items included in the questionnaire were highly reliable.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS INTERPRETATION AND DISCUSSION

This chapter presents the results of the data analyses, interpretations and discussion. The analyses were summarized under descriptive and inferential analysis. The descriptive statistics describe the demographic profile of respondents and analysis of responses for each supply chain practice (Procurement, Inventory Management, Storage, Information Sharing, and Forecasting). Inferential statistics include scale correlation tests, assumptions for the linear regression model, and multiple regression analysis.

4.1. Response Rate

2 Table: Response Rate

Questionnaire	Frequency	Percentage (%)
Total distributed	78	86.6
Unreturned questionnaire	12	13.4
Returned questionnaire	78	86.6
Response errors	0	0.0
Total valid and usable returned questionnaires	**78**	**86.6**

Source: Own Survey, 2026

The study's plan to collect data from 90 participants, and 78 of them provided valid responses that were used for analysis, resulting in a 86.66 % response rate. According to Mugenda and Mugenda (1999) this represents response rate of 50% is adequate for analysis and reporting; a rate of 60% is good and a response rate of 70% and over is excellent. Based on the assertion, the response rate was considered to be excellent.

4.2. General Information about the Respondents

Table 3: Demographic Characteristics of Respondents (n = 78)

Character	Category	N	(%)
Gender	Male	42	53.8
	Female	36	46.2
Profession	Pharmacist	53	67.9
	Nurse	25	32.1
Education	Diploma	9	11.5
	Bachelor's	42	53.8
	Master's	23	29.5
	PhD	4	5.1
Years of Service	1-5 years	23	29.5
	6-10 years	32	41.0
	11-15 years	18	23.1
	Over 15 years	5	6.4

Source: Own Survey, 2026

Based on the results of the demographic questionnaire and the findings presented in Table 3, it can be seen that gender balance in this case is quite adequate, with 42 male (53.8%) out of 78 respondents against 36 women (46.2%). As can be seen, the ratio is close to equal, and this fact ensures the fairness of representation of the views of both sexes, preventing gender bias.

Speaking about the professional background of participants in the research, pharmacists prevailed among them with 53 (67.9%), while nurses constituted only 25 people (32.1%). This is quite logical because this study focuses on pharmaceutical chains, which are managed by pharmacists who deal directly with procurement, management, and distribution of medicines. Therefore, their presence in larger numbers will guarantee gathering reliable data on the practices

of ABC/VEN analysis and the FEFO method that could be helpful in minimizing losses in the industry.

As regards the educational level of the respondents, the level can be assessed as high since 42 of the participants hold bachelor's degrees (53.8%). In addition, there are some respondents having a master's degree (23; 29.5%), a diploma (9; 11.5%), and even a Ph.D. (4; 5.1%). Consequently, there are not enough concerns as to whether respondents would be able to comprehend and contribute to the development of the subject under discussion. In this respect, it would be useful for managers of supply chains in the pharmaceutical industry to have such an educated team.

Concerning the last aspect of demographics (experience of the respondents), it can be stated that the period between 1 year and 15 years or more was mentioned. To be more specific, 32 people (41.0%) had 6 to 10 years of experience; 23 (29.5%) had 1 to 5 years of experience; 18 (23.1%) had 11 to 15 years of experience; finally, 5 (6.4%) people had over 15 years of experience. As it can be seen, plenty of practical information is likely to be collected with the help of the questionnaire.

In sum, it can be argued that the combination of demographic characteristics guarantees a highly educated and experienced sample for the study.

4.3. Supply Chain Practices Affecting Medicine Wastage and Expiration Rates

This section provides a descriptive analysis of the study variables, focusing on five supply chain practices (procurement, inventory management, storage, information sharing, and forecasting) and the dependent variable (medicine wastage). Respondents' perspectives were measured using mean and standard deviation. Based on the interpretation scale mean scores between 1.01-1.80 indicate very low influence; 1.81-2.60 low influence; 2.61-3.40 moderate influence; 3.41-4.20 high influence; and 4.21-5.00 very high influence. Standard deviation values > 1.000 reflect substantial differences of opinion among respondents (Sayed et al., 2025).

4.3.1. Procurement Practices

Table4 : Description of Procurement Practices (PRP) (n = 78)

Statement	Mean	STD.
Use of ABC/VEN analysis improves procurement accuracy and reduces wastage	4.38	1.312
Updated procurement SOPs support effective medicine management	3.86	1.749

Adequate procurement budgets enable effective planning and reduce expiry	2.82	1.992
Delivery of near expiry medicines increases the risk of wastage	3.79	1.775
Transparent procurement procedures improve medicine availability and reduce losses	2.59	1.970
Grand Mean	**3.49**	**1.390**

Source: Own survey data (2026)

Referring the results in table 4, the usage of ABC/VEN analysis (mean = 4.38; SD = 1.312) indicates the awareness of the importance of such practices on behalf of hospital personnel. This approach allows prioritizing certain medicines and planning their purchases. By employing this approach properly, hospitals will manage their medicines much better and follow international evidence-based standards of procurement.

Besides, there are two procurement practices that demonstrate average efficiency of implementation. The use of contemporary SOPs (mean = 3.86; SD = 1.749) can be considered an efficient way to make medicine management work better since it provides hospitals with necessary standards to follow. Secondly, the management of near-expiry medicine deliveries (mean = 3.79; SD = 1.775) can improve procurement processes. However, a great variety of scores indicates that there are serious problems in the field of implementation of these practices. It is important to note that standard operating procedures have to be used universally to influence hospital operations and increase procurement efficiency. Moreover, near-expiry deliveries require additional effort on the part of pharmacists, who have to take necessary actions in order to avoid wasting any medicines.

However, procurement practices that demonstrate low efficiency are the usage of appropriate budget allocation (mean = 2.82; SD = 1.992) and procedures' transparency (mean = 2.59; SD = 1.970). Inadequate budgets prevent organizations from conducting regular purchasing, result in stockouts, and increase the likelihood of expiration. In same vein, lack of procedure transparency leads to the appearance of numerous inefficiencies as well as increases opportunities for fraud, which negatively affect hospitals' functioning.

In sum, procurement practices in Ethiopia's public hospitals can be considered moderately efficient since grand mean equals to 3.49 (SD = 1.390). On the one hand, technical practices are rather efficient approaches that are widely acknowledged in these hospitals. On the other hand, structural issues, like lack of proper budgeting, negatively affect procurement efficiency. Indeed,

hospital managers find themselves facing the necessity of working both on organizational and structural sides of their activities. While managers need to implement efficient approaches that are associated with increasing procurement efficiency and medicine management quality, structural barriers prevent them from doing this.

4.3.2. Inventory Management Practices

Table 5: Description of Inventory Management (INM) (n = 78)

Statement	Mean	STD.
ABC/VEN analysis helps prevent overstocking and expiry	4.31	1.241
Adequate staffing in inventory management improves stock control	3.49	1.912
Computerized inventory systems enhance tracking and reduce expiry	4.21	1.463
Consistent ordering practices improve efficiency and reduce wastage	3.78	1.785
Proper separation of expired/damaged medicines improves stock management	3.64	1.690
Regular physical inventory checks help identify medicines nearing expiry	4.44	1.254
Following FEFO ensures timely utilization of medicines	4.24	1.416
Grand Mean	**4.01**	**1.080**

Source: Own survey data (2026)

According to the descriptive statistics provided in Table 5, the grand mean of 4.01 (SD = 1.080) testifies to a very strong positive attitude of the respondents toward inventory management practices as a means of reduction of medicine wastage due to their understanding of the significance of inventory management as an important determinant of supply chain efficiency and a main tool for minimizing medicine losses. Similarly to procurement practices, a relatively large value of the standard deviation demonstrates that there is great variation in opinions about such practices between hospitals.

The highest mean score was assigned to regular physical checking of stocks (M = 4.44, SD = 1.254), which is indicative of staff awareness of the need for constant monitoring and early detection of medicines approaching the date of expiry in order to avoid losses. A good result is also shown by the practice of FEFO (first expiration first out) compliance (M = 4.24, SD = 1.416). This proves that medical workers are familiar with one of the basic principles of

medicine inventory management. Similarly high results can be achieved with the usage of computerized systems for monitoring the state of stocks and alerting the managers about low levels of certain medicines in the hospital, as well as about the risk of overstocking (M = 4.21, SD = 1.463). Finally, a relatively high level of acceptability is shown by the use of ABC/VEN analysis for planning and stratification (M = 4.31, SD = 1.241).

However, there were a number of practices that scored relatively low. Moderate levels of efficiency were indicated by ordering practices (M = 3.78, SD = 1.785) and proper disposal of expired/unusable medicines (M = 3.64, SD = 1.690). The practice that scored the lowest was the provision of sufficient numbers of people to work on inventory management issues (M = 3.49, SD = 1.912). High values of standard deviations for those practices show significant variation in the implementation of practices. The reason for this situation is probably related to resource inequality and uneven workload distribution in addition to temporary personnel shortages and lack of adherence to SOPs.

Generally, the grand mean indicates the consistently high and positive perception of the role of inventory management in reducing medicine wastage. The high scores in relation to systematic physical checking, strict compliance with FEFO, implementation of computerized systems, and ABC/VEN analysis as a stratification and consumption planning tool prove such a perception. Even though the area of inventory management is characterized by high acceptance and effectiveness of technical solutions, which, as compared to the procurement practices discussed previously, lead to more favorable outcomes, some inconsistency in terms of ordering, waste disposal, and staffing still exists and requires management action.

4.3.3. Storage Practices

Table 6: Description of Storage Practices (STP) (n = 78)

Statement	Mean	STD.
Clean and organized storerooms maintain medicine quality	3.68	1.776
Correct stacking prevents damage	2.69	1.936
Proper storage conditions (light, ventilation, temperature) reduce expiry	4.22	1.568
Adequate storage budgets support proper handling and reduce losses	2.31	1.847
Clear labelling and visible expiry dates improve inventory management	4.23	1.528

Protection from water and moisture prevents deterioration	3.59	1.841
Adherence to FEFO in storage reduces wastage	3.45	1.863
Grand Mean	**3.45**	**1.214**

Source: Own survey data (2026)

The analysis of storage practices, shown in Table 6, returned the grand mean of 3.45 (SD = 1.214). This number, slightly higher than the neutral midpoint of the Likert scale, suggests a slightly positive yet ambivalent opinion on storage practices' ability to affect medicine wastage. It is important to note that the grand mean of storage practices is lower than both procurement (M = 3.49) and inventory management practices (M = 4.01). Therefore, storage practices can be considered a weak link of the studied triad, as opposed to the procurement practice, which was already proven to play the role of a bottleneck. The high standard deviation (SD = 1.214) in turn suggests the high degree of inconsistency of the practices used by hospitals in this matter.

Speaking about individual factors within storage practices, high ratings have been obtained for labeling and visible expiry information (M = 4.23, SD = 1.528) as well as storing conditions with consideration of light, ventilation, and temperatures (M = 4.22, SD = 1.568). High scores indicate that the significance of these factors to prevent accidental usage of medicine past the expiration period is commonly recognized. Clean and tidy storerooms (M = 3.68, SD = 1.776) received the moderate scores, implying that basic housekeeping rules are commonly observed in hospitals.

However, several factors have received poor scores, which calls for immediate action to improve the situation. Application of FEFO (First Expiry, First Out) in the storing of medicines has been rated as mediocre (M = 3.45, SD = 1.863), meaning that although this principle is known, it is applied in an inconsistent manner. Protection of medicines against water and humidity has also been rated as mediocre (M = 3.59, SD = 1.841), with very high standard deviations implying that some hospitals have serious problems with their buildings. Proper stacking (M = 2.69, SD = 1.936) has been rated very poorly, indicating the fact that medicines in hospitals are often stacked incorrectly (and thus damaged as a result). Finally, the poorest scores have been obtained for adequate storage budgets (M = 2.31, SD = 1.847), implying severe budget issues.

It is clear that storage practices have emerged as a major concern and, indeed, internal control systems play an important role in influencing the quality of pharmaceutical assets of a hospital despite storage budgets and correct stacking imply certain failures in the governance of hospitals. That mean, managers choose to allocate resources for clinical services rather than warehouses where the medicine storage occurs (thus impacting wastage directly). Moreover, the high variability of responses (indicated by SD exceeding 1.5 for each indicator except one) implies that the quality of storage practices depends on such factors as age of a hospital, priorities set by the hospital management, and funding from donors or governments for improvement works.

The gap between technical expertise, e.g., temperature control (M = 4.22) and implementation of policies (e.g., budgeting, M = 2.31) shows the existence of the classical capability-resource - employees have understanding of best practices but cannot afford to implement them due to budget restraints. Therefore, interventions aimed at overcoming this issue need to focus both on training and budgeting/infrastructure provision.

4.3.4. Information Sharing Practices

3 Table 7: Description of Information Sharing (INS) (n = 78)

Statement	Mean	STD.
An effective LMIS ensures accurate stock records and reduces wastage	3.60	1.861
Access to supplier information supports better planning and reduces expiry	2.51	1.836
Staff training on information systems improves stock control	4.32	1.499
SOPs for information sharing improve stock management	2.78	1.938
Limited budgets for information systems hinder effective stock management	3.42	1.883
Lack of supplier information leads to poor planning and increased expiry	2.10	1.648
Grand Mean	**3.12**	**1.259**

Source: Own survey data (2026)

An assessment of information sharing practices (Table 7) shows that the grand mean equals 3.12 (SD = 1.259) suggesting that information sharing significantly impacts medicine wastage. It is lower than the means in the analysis of procurement (M = 3.49), inventory management (M = 4.01), and storage practices (M = 3.45). Consequently, information sharing seems to be the least

influential factor affecting medicine wastage out of all studied areas. The reason is that its high standard deviation suggests the inconsistency in the use of information systems.

Firstly, regarding the evaluation of individual information sharing practices, staff training on information systems stands out because it has the highest mean (M = 4.32, SD = 1.499). In line with the existing evidence, hospitals understand the significance of proper training of employees to use new technologies. Secondly, the utilization of Logistics Management Information Systems is also relevant because it has a considerable mean (M = 3.60, SD = 1.861). In other words, hospitals understand the significance of information sharing to manage operations more efficiently.

The main problems related to information sharing pertain to the inability of hospitals to acquire data from their suppliers. The lack of supplier information (M = 2.51, SD = 1.836) is one such issue whereas the lack of information from suppliers (M = 2.10, SD = 1.648) is another. Both factors are crucial since they indicate that hospitals fail to obtain data on the availability, prices, and lead time of medicines in the market. As a result, they experience problems when making purchases and end up purchasing unnecessary items at high prices, thus leading to medicine wastage. Moreover, limited budgets for information systems (M = 3.42, SD = 1.883) are another serious problem.

When speaking about information sharing practices, it becomes clear that there are plenty of relevant factors that could negatively impact hospital operations. Although hospitals have shown their willingness to utilize information systems, they face certain challenges because of the inability to cooperate with suppliers and lack of finances. Thus, it is obvious that there is some discrepancy between capabilities of hospitals and available resources. For example, although they can afford an information system, they do not have necessary information from suppliers.

4.3.5. Forecasting Practices

4 Table 8: Description of Forecasting Practices (FOP) (n = 78)

Statement	Mean	STD.
Validating forecasts against past consumption improves procurement accuracy	3.71	1.660
Accurate stock movement records support effective forecasting	3.77	1.743
Accurate forecasting prevents overstocking and expiry	4.31	1.292

Proper forecasting ensures efficient use of procurement budgets	3.45	1.755
Reliable forecasting minimizes financial losses from expired medicines	4.24	1.564
Improved forecasting reduces medicine expiry rates	4.22	1.568
Grand Mean	**3.95**	**1.079**

Source: Own survey data (2026)

The results of forecasting practices are shown in Table 8. It can be concluded that forecasting is regarded as a highly influential determinant (grand mean = 3.95, SD = 1.079) that plays a significant role in reducing the amount of waste in pharmaceutical products. These high mean places forecasting ahead of procurement (M = 3.49), storage (M = 3.45), and information exchange (M = 3.12) practices but below inventory management (M = 4.01). It is possible to assume that the relatively low standard deviation shows a certain consensus between respondents' opinions about the importance of forecasting in managing medicines.

Regarding individual items, prevention of overstocking and expiry due to accurate forecasting obtained the highest mean (M = 4.31, SD = 1.292). This result confirms respondents' opinion about the inevitability of expiry caused by the lack of proper estimation of demand in case of excess stock. Similarly, prevention of financial losses from medicine expiry because of precise forecasting (M = 4.24, SD = 1.564) and improvement of forecasting accuracy to reduce expiry rate (M = 4.22, SD = 1.568) practices were rated quite highly by participants. In general, the high ratings demonstrate that respondents consider forecasting an important part of their operations as it helps prevent inefficiency, such as medicine expiry.

A group of moderately rated practices is formed by validation of forecasts based on past consumption (M = 3.71, SD = 1.660) and proper keeping records for efficient stock movements to support accurate forecasting (M = 3.77, SD = 1.743). As seen, despite the relatively low means, the high standard deviations (more than 1.5) point out variability in respondents' assessment of such practices in terms of their frequency and consistency. The item "proper forecasting to guarantee efficient utilization of procurement budget" (M = 3.45, SD = 1.755) has received a quite low score, indicating respondents' difficulty in assessing forecasting practices in financial terms.

Overall, the results obtained correspond to the hypothesis of this research related to the identification of factors that affect medicine wastage. Based on the relatively high grand mean (3.95), it is reasonable to conclude that forecasting practices are considered highly influential by hospitals. However, although the prevention of wastage due to excess stock was evaluated quite positively, the necessity to improve the forecasting process by means of validation and keeping accurate records was highlighted. Therefore, the identified gap in forecasting practices is associated with the inconsistency and imprecision of relevant records, which hinders the effective evaluation and correction of estimations.

4.3.6. Medicine Wastage and Expiration

Table 9: **Description of Medicine Wastage (MWER) (n = 78)**

Statement	Mean	STD.
Medicine wastage forces patients to buy expensive alternatives	3.72	1.237
Expired medicines increase healthcare costs	4.38	1.261
Wastage decreases efficiency of healthcare service delivery	3.37	1.596
Wastage reduces availability of essential medicines	4.26	1.343
Wastage negatively impacts patient treatment outcomes	4.10	1.088
Grand Mean	**3.97**	**0.934**

Source: Own survey data (2026)

According to Table 9, the grand mean for the consequence of medicine wastage and expiration was 3.97 (SD = 0.934). The relative high figure shows that the participants view medicine wastage as a big problem with severe consequences. In comparison with other grand means (procurement – 3.49; storage – 3.45; information sharing – 3.12), wastage emerges as an important dependent variable since it summarizes the results of various weaknesses in the supply chain practices. The low standard deviation also shows that majority respondents share similar opinions about the problem.

Among the particular consequences, one should pay attention to the relatively high mean score for "Expire medicines increase healthcare costs" (4.38; SD = 1.261). This result demonstrates the direct cost implications of medicine wastage. Specifically, scarce resources are wasted by purchasing medicines that cannot be used for treating patients. Similarly, the second highest

mean belongs to another consequence, which consists in reducing the availability of necessary medicines (4.26; SD = 1.343). Such a result shows that wastage leads to problems in the supply of medicines since the hospital cannot rely on expired medicines and thus must conduct additional procurement processes.

As one of the consequences of medicine wastage and expiration, the participants mentioned that wastage negatively impacts patient treatment outcome (M = 4.10, SD = 1.088). It means that when prescribed medicines are unavailable because of wastage, patients need to get alternative medications or even suspend the treatment process. Such circumstances affect the quality and effectiveness of treatment. Finally, it is worth noting that the relatively low rating in question belongs to "Wastage makes service delivery inefficient" (3.37; SD = 1.596). It can be explained by the fact that cost implication is more significant than inefficiency for some respondents who work in financially restrained departments.

Summing up, it can be stated that 3.97 as the grand mean clearly indicates that medicine wastage is a relevant problem with several negative consequences. In particular, as can be seen, wastage leads to increased expenses, lack of availability, and problems related to patient treatment outcome. Overall, the results obtained confirm that wastage is a critical determinant of pharmaceutical supply chain performance and thus fit the research objective. Moreover, it shows that the problems associated with medicine procurement, storage, inventory management, and information sharing lead to wastage and expiration of medicines. To address this issue, integrated measures should be applied since the discussed problems affect each other.

4.4. Inferential Analysis

Inferential statistics enable the researcher to move beyond descriptive summaries and make generalizations about the broader hospital population from the sample of 78 respondents. This section includes correlation testing, assumption diagnostics, and multiple regression analysis.

4.4.1. Assumptions for Regression Model Test

Before conducting the regression analysis, the four primary assumptions of ordinary least squares (OLS) regression were tested. These assumptions include the tests for multicollinearity, normality, linearity, and homoscedasticity to guarantee the robustness of the regression model.

Multicollinearity Test

Table 12: Collinearity Statistics

Model	Tolerance	VIF
PRP - Procurement	.570	1.754
INM - Inventory Management	.635	1.575
STP – Storage	.791	1.265
INS – Information Sharing	.807	1.240
FOP – Forecasting	.555	1.801

Dependent Variable: MWER

As indicated in Table 12 which shows tolerance and Variance Inflation Factor (VIF) statistics of each independent variable. As can be seen, the VIF values are between 1.240 and 1.801, much below the standard maximum threshold value of 10 and even below 5. Likewise, the tolerance statistics lie between 0.555 and 0.807, which is significantly greater than the minimum tolerance required which is 0.2. Thus, no evidence of high multicollinearity among any of the independent variables like procurement, inventory management, storage, information sharing, and forecasting.

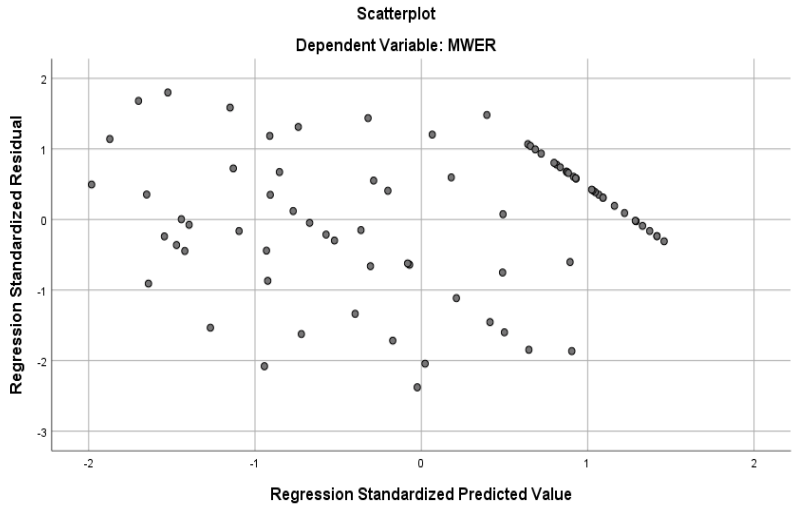
One can conclude that none of the predictor variables is collinear with other variables and therefore does not have redundant variance among them. It means that when using the predictor variables in the regression analysis, each variable will contribute uniquely to explaining variance in the dependent variable. For instance, while procurement and forecasting are logically correlated, their VIF statistics of 1.754 and 1.801 respectively show that their effects are independently estimated through the regression analysis.

In summary, the results show that there is no issue of multicollinearity among the predictor variables. Therefore, they are considered suitable for performing further regression analysis without problems of multicollinearity biasing the regression results. The results thus support the research goal of estimating the effect of supply chain practices on the medicine wastage rate in Ethiopian public hospitals using statistical techniques.

4.4.3 Linearity and Homoscedasticity Test

In order to verify the linearity assumption, the scatterplots of standardized residuals against standardized predicted values were examined. It was found that residuals were randomly scattered around zero without any visible pattern. As mentioned above, if the residuals were systematically scattered, it would have indicated a problem with the linear relationship between the independent variable and medicine wastage. Therefore, based on the obtained result, we can conclude that the assumption of linearity is met.

Figure 3 Scatterplot of standardized Residuals



To check the homoscedasticity assumption, the scatterplots of residuals against standardized predicted values were created as well as the results of the Breusch-Pagan test were analyzed. In terms of visual analysis, the graph shows that residuals are randomly scattered across the whole range of predicted values without any sign of increasing/decreasing variances.

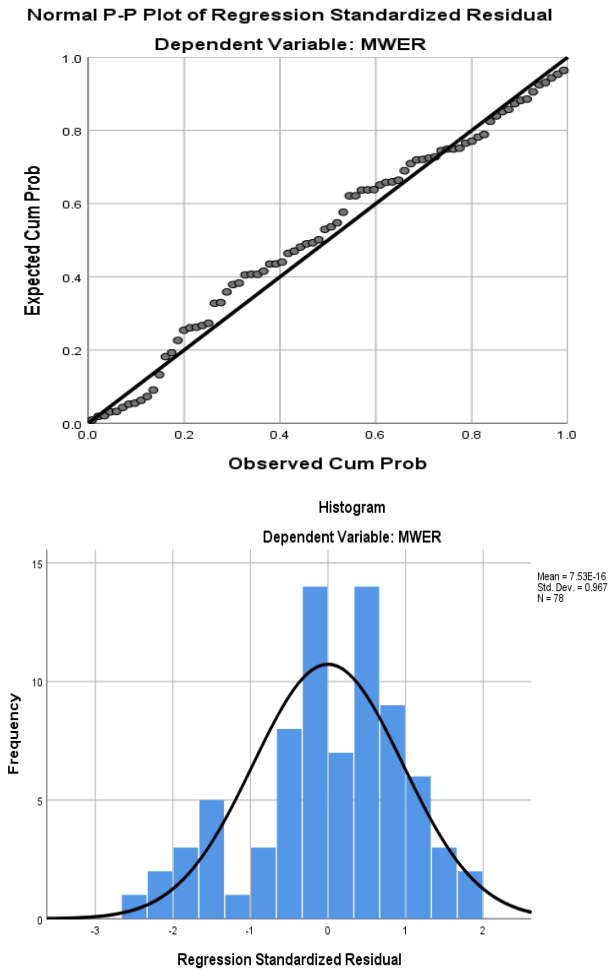
Fulfillment of linearity and homoscedasticity is crucial in regard to the research methodology and results interpretation since it allows claiming that coefficients are unbiased and efficient, while their standard errors are accurate and consistent. If one or both of the assumptions are violated, then the coefficients will be biased and standard errors will not accurately measure the level of sampling variance. Therefore, the estimates generated by the analysis may be unreliable. Therefore, from this perspective, linearity and homoscedasticity are critical assumptions that should be tested to ensure that the analysis produces valid results. According to the results obtained in this paper, it appears that the linearity and homoscedasticity assumptions are

fulfilled, which contributes to the credibility of the findings. Thus, the results of the analysis can be considered statistically accurate and valid.

4.4.4 Normality Test

Tests for normality of the residuals were performed via graphical tools and statistical techniques.

Figure 4 Normal P-P Plot and Histogram



First, based on the histogram plot of the standardized residuals, it is clear that there are no large differences between the frequencies and the normal curve. The mean value of the residuals is approximately equal to zero (7.53E-16), while the standard deviation of standardized residuals is close to one (0.967). Besides, the evidence supporting the normality of residuals is obtained using the Normal Q-Q Plot. The points in the plot tend to coincide with the reference line,

meaning that there is almost no difference between the observed and expected probabilities of data points.

Table12: Skewness and Kurtosis

Variable	N	Skewness	Std. Error	Kurtosis	Std. Error
Procurement	78	-.260	.272	-1.363	.538
Inventory Management	78	-1.006	.272	.258	.538
Storage	78	-.268	.272	-.897	.538
Information Sharing	78	-.112	.272	-1.130	.538
Forecasting	78	-.901	.272	.281	.538
Medicine Wastage/ Expiration	78	-.197	.272	-1.361	.538

Source: Own Survey, 2026

Table 13 shows that skewness values range from -1.006 to -0.112, all within ±2, and kurtosis values range from -1.363 to 0.281, all within ±7. These values indicate that the data are approximately normally distributed, satisfying the normality assumption for regression.

It should be mentioned that, according to the assumptions of regression analysis, normality is the basic condition for this technique. In other words, regression coefficients can be estimated accurately only if residuals are normally distributed. Thus, following the assumption of normality suggests that all regression tests are statistically sound. Furthermore, assuming normality means that skewness and kurtosis of residuals are not present, implying unbiased estimators of regression parameters. Thus, normality tests performed on residuals provide sufficient grounds to assert that this assumption holds, thereby ensuring that the conclusions drawn are based on credible information. The study aims to collect statistical evidence about the factors influencing medicine wastage in Ethiopian public hospitals.

4.4.5. Regression Analysis

To determine the degree of influence that the operational determinants exert on medicine wastage, multiple regression analysis was conducted. This method enables simultaneous investigation of multiple variables and the influence they have on wastage outcomes. Therefore,

this method allows for evaluation of procurement, inventory control, storage conditions, information systems, and forecasting as predictors of the dependent variable.

Table 13: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.867a	.751	.734	.48211

a. Predictors: (Constant), FOP, STP, INS, INM, PRP

As is shown in Table 14, the obtained multiple correlation coefficient (R) is equal to 0.867, meaning that the combination of all five predictors exhibits a strong positive correlation with the amount of medicine waste. Moreover, the coefficient of determination (R^2) amounts to 0.751, showing that these practices account for about 75.1% of variance in medicine wastage, i.e., play a critical role in determining the results. It should be noted that the other 24.9% of variance are associated with such factors as regulatory enforcement and others. The adjusted R^2 coefficient shows that 73.4% of variance are explained by operational determinants. In addition, there is a direct relation between predictors and medicine wastage, as determined by a p-value of 0.00000439.

The significance of the results can be assessed from several perspectives. First, the obtained results confirm the assumption made regarding the central role that operational determinants play in the issue. Second, the high coefficient of determination implies that the improvement of the identified practices can lead to significant reduction of wastage. Finally, the adjusted R^2 coefficient is quite high; hence, one may conclude that the model is appropriate for prediction of medicine wastage based on the discussed factors.

Table 14: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	50.498	5	10.100	43.452	.000b
	Residual	16.735	72	.232		
	Total	67.233	77			

a. Dependent Variable: MWER

b. Predictors: (Constant), FOP, STP, INS, INM, PRP

The ANOVA results (Table 15) show that the regression model is statistically significant ($F = 43.452$, $p < .001$). The regression sum of squares (50.498) constitutes a large portion of the total sum of squares (67.233), while the residual sum of squares (16.735) is relatively low. This confirms that the five supply chain practices jointly affect medicine wastage and that the model is reliable for interpretation.

5 Table : Coefficients

Model	Unstandardized Coeff.		Standardized Coeff.	t	Sig.
	B	Std. Error	Beta		
(Constant)	.508	.252		2.014	.048
Procurement	.150	.052	.224	2.870	.005
Inventory Management	.323	.064	.373	5.060	.000
Storage	.145	.051	.188	2.843	.006
Information Sharing	.105	.049	.142	2.164	.034
Forecasting	.205	.068	.237	3.000	.004

a. Dependent Variable: MWER

The coefficients presented in Table 16 reflect the degree to which each predictor influences the wastage of medicines. All five predictors, procurement practices (PRP), inventory management practices (INM), storage practices (STP), information sharing practices (INS) and forecasting practices (FOP), have statistically significant effects on wastage ($p < 0.05$). Thus, the findings indicate that an enhancement in practices in each category can result in a considerable decrease in wastage. In addition, the constant ($B = 0.508$, $p = 0.048$) reflects the baseline level of wastage in the case scenario when there are no robust practices.

Inventory management stands out as the strongest determinant ($\beta = 0.373$, $p < 0.001$). The finding highlights the key role that proper FEFO policy, ABC/VEN analysis and routine checking of stocks play in decreasing wastage. The deficiency in controlling the inventory

translates into expired medicines; therefore, this area appears to be the most vital one. Forecasting comes in second (β = 0.237, p = 0.004); it implies that an appropriate forecasting of demand helps prevent medicine surplus and subsequent loss of money. Consequently, the two predictors appear to be the foundation of supply chain management and possess the greatest power to mitigate wastage.

In turn, procurement practices (β = 0.224, p = 0.005) also influence the problem to a great extent. Timely ordering, proper coordination with suppliers and assuring the quality of medicines contribute to the delivery of products with enough shelf-life remaining. Besides, storage practices (β = 0.188, p = 0.006) and information practices (β = 0.142, p = 0.034) have a positive effect but with less pronounced power.

The findings indicate that although storage conditions and information flow are essential, their influence remains relatively weaker compared to inventory and forecasting practices. However, problems with storage and information sharing might lead to inefficient procurement and inventory practices, and, therefore, can serve as supporting pillars of supply chain management. With respect to the unstandardized coefficients, the following regression equation can be formed:

MWER = 0.508 + 0.150(PRP) + 0.323(INM) + 0.145(STP) + 0.105(INS) + 0.205(FOP).

This equation indicates the extent to which each predictor influences wastage in medicine. It provides a handy tool that can be used to guide managers and policymakers. For example, improving inventory management by one unit lowers the level of wastage by 0.323 units, being the greatest contribution among predictors. In other words, the equation gives a straightforward recommendation: priority should be given to inventory management and forecasting practices since these predictors have the greatest effect. On the other hand, it should be noted that procurement, storage and information sharing practices are equally important because they serve as supporting components of supply chain management. Based on the regression analyses, all study objectives were addressed. The test results of the hypotheses are summarized below:

Table 16: Summary of Hypotheses

Code - Alternative Hypothesis	Significance	Decision
H1: Procurement practices have a positive and significant effect on medicine wastage	β = .224, p = .005	Supported

H2: Inventory management practices have a positive and significant effect on medicine wastage	$\beta = .373$, $p < .001$	Supported
H3: Storage practices have a positive and significant effect on medicine wastage	$\beta = .188$, $p = .006$	Supported
H4: Information sharing practices have a positive and significant effect on medicine wastage	$\beta = .142$, $p = .034$	Supported
H5: Forecasting practices have a positive and significant effect on medicine wastage	$\beta = .237$, $p = .004$	Supported

4.5. Discussion of Findings

The findings of the regression analysis are discussed in the current section with regard to the overall aim of the research, which was to investigate the effect of supply chain management practices on the level of wastage and expiry of medicines in Zewditu Memorial Hospital. The statistical results are analyzed in relation to theoretical frameworks used to guide the study and previous empirical studies.

4.5.1. Inventory Management Practices

According to the results, the practice of inventory management had the greatest effect on reducing wastage among the five supply chain management practices under study. In particular, it is characterized by $\beta = .373$ and $p < 0.01$, implying a highly significant negative effect. Indeed, according to (Chopra & Meindl, 2007) the adoption of First-Expiry, First-Out (FEFO) practice in conjunction with regular cycle counting helps to reduce pharmaceutical obsolescence in health facilities. Moreover,(Alanazi et al., 2024) reports that the implementation of physical inventory checking and analysis of ABC/VEN reduces the rate of expiry to nearly 0.9 to 0.21. The current study shows a similarly high level of importance of conducting inventory, as indicated by the high mean ($M = 4.44$) and standard deviation ($SD = 1.254$). Therefore, it seems that even further strengthening of the practice will contribute to a reduction in the level of wastage and expiring medicines. This result is consistent with the conceptual framework that regards inventory management as the key determinant of efficiency of the supply chain process and agency theory, according to which information monitoring mitigates asymmetry of information.

4.5.2 Forecasting

In addition to inventory management, the practice of forecasting has been proven to be effective in reducing wastage. More specifically, β value of forecasting is equal to $\beta = .237$ and $p < 0.05$, meaning a moderate positive correlation. According to (Bilal et al., 2024), Poor demand forecasting is a key driver of stock outs and raises the risk of substandard medicines entering the health system. In particular good demand forecast prevents wastage since the forecasted consumption determines the amount of goods to be purchased from the supplier. Still, the average score of forecasting based on validation of the forecast with regard to past consumption patterns ($M = 3.71$ and $SD = 1.544$) shows that ZMH may rely on forecasting based on simple historical averages instead.

4.5.3 Procurement Practices

In the context of wastage reduction, procurement practices proved to have a moderate effect with the coefficient of $\beta = .224$ and $p < 0.05$. Low mean scores regarding the transparency of procedures ($M = 2.81$ and $SD = 1.613$) and budget ($M = 2.66$ and $SD = 1.588$) suggest that the hospital operates under various resource limitations. According to (Negera et al., 2021), public hospitals in Ethiopia often encounter the problem of budget constraints that make it difficult to purchase appropriate volumes and qualities of medicines. As a consequence, such problems as the purchase of near-expired drugs and over-ordering in order to use funds before they expire emerge. The correlation coefficient of 0.591 and $p < 0.01$ shows that procurement practices and forecasting negatively influence each other. Namely, poor procurement practices hinder the implementation of an accurate forecasting since hospital procurement specialists cannot receive necessary information. Stewardship theory, as mentioned in the literature review, implies that ineffective performance is not due to personal characteristics but the problem of structural factors.

4.5.4 Storage Practices

Moderate correlation has been detected between the practice of storage and medicine wastage ($\beta = .188$ and $p < 0.05$). While high levels of importance are assigned to temperature control ($M = 4.22$ and $SD = 1.568$) and proper labelling with visible expiry date ($M = 4.23$ and $SD = 1.528$), very low average scores of adequate storage budgets ($M = 2.31$ and $SD = 1.847$) and stacking practices ($M = 2.69$ and $SD = 1.936$) show important problems with storage practices. According

to the World Health Organization (2011), insufficient provision with shelving results in crushing of pharmaceutical packages. Consequently, injectable medicine can become contaminated, while the degradation of pills takes place because of moisture exposure despite proper temperature. The relatively low coefficient (β = .188) implies that the contribution of storage practice to the reduction in wastage is not considerable; however, its improvement can decrease the level of wastage.

4.5.5 Information Sharing

The effect of information sharing with regard to supply chains was relatively small, but it was still statistically significant (β = .142, $p < 0.05$). In particular, a very low average score of obtaining necessary information from the suppliers (M = 2.51 and SD = 1.723) and the answer that the lack of information leads to poor planning (M = 2.10 and SD = 1.672) point to severe informational asymmetry in Zewditu Memorial Hospital. It appears that information-sharing practices can be explained by the agency theory introduced by Jensen and Meckling (1976). Namely, the absence of supplier information regarding production, lead times, and available stock volume forces hospital procurement specialists to over order the drugs. On the contrary, sharing the information about inventories allows hospitals to adopt JIT orders or vendor managed inventories. Thus, the practice can be viewed as enabling in contrast to inventory management and forecasting.

In sum, the results prove the existence of the identified research gap, showing the relative effectiveness of individual practices in terms of wastage. Namely, the most impactful is inventory management (β = .373), followed by forecasting (β = .237), procurement (β = .224), storage (β = .188), and finally information sharing (β = .142). These results can be taken into account by hospitals in order to allocate available resources efficiently. It should be emphasized that very low means (2.66 and 2.31) indicate that a major resource-related barrier is the lack of budgets.

4.6 Extent of medicines wastage

The hospital received medications worth 347,471,150 Ethiopian Birr (ETB) during EFY 2016–2017, but the total financial value of wasted medicines in ZMH was 4,310,676 ETB. This

resulted in a 0.58% waste rate (due to time constraints and inaccurate documentation, I have only taken two years of data).

The average medication waste rate (0.58%) was less than the national target of less than 2%, according to the study's findings (FMOH, 2010). Table 17 shows the beginning balance of medications, the value of medications received, and the anticipated overall medication waste rate in ZMH. (EFY2016–2017), May 2026, Addis Ababa, Ethiopia.

Table 6 Extent of medicines wastage

	2016 EFY			2017 EFY		
	Received In ETB	Expired/wasted In ETB	Beginning balance In ETB	Received In ETB	Expired/wasted In ETB	beginning balance In ETB
FIRST	24804876	976587.33	48490238	67247963	1114617	45420592
2	16123000	171897	43660156	55065048	577813	26536289
3	42549713	271522	48120225	54840164	283974	54127078
4	22993561	385518	49092948	63936807	528748	76996217
Total Wastage	0.61%			0.58%		

Source: Researcher's Own (2026)

Types of wasted medicines

7 Table The most wasted pharmaceuticals in study hospital (EFY2015- 2016), Addis Ababa, April 2026

S.N	Product Name	Amount Wasted	Source For wastage	Value in Birr
1	Potassium Chloride - 150mg/ml in 10ml ampoule - Injection	80	Expired	833,721.00
2	Microbiology - Urea 40% Agar	52	Expired	303,922.50
3	Blood collecting tube - Serum Separator tube	10000	Expired	150,000.00
4	Amoxicillin + Clavulanic Acid - (200mg + 28mg)/5ml - Oral Suspension	660	Expired	128,700.00
5	Propofol - 10mg/ml in 20ml - Injection	1345	Expired	122,771.60
6	Neomycin Sulphate + Polymixin B Sulphate + Dexamethasone - (3.5mg + 6000IU + 0.1%) - Eye drop (Solution)	406	Expired	120,638.84
7	Adenosine 6mg/2ml - injection	10	Expired	98,000.00
8	Ciprofloxacin + Dexamethasone - 0.3% + 0.1% - Eye Drop	894	Expired	84,036.00
9	Urea /Bun (Linear) 100mlx2	19	Expired	79,755.00
10	Bupivacaine - 0.5% in 10ml ampoule - Injection	320	Expired	60,800.00

Source: Researcher's Own (2026)

Potassium chloride (150 mg/ml in a 10 ml ampoule) for injection, urea (40% Agar) for microbiology, and serum separator tubes for blood collection were the top three wasted medications in terms of value.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusion

The findings of this research prove that the application of supply chain processes is an integral part of health care delivery that defines waste rates and, therefore, affects both patient care and costs associated with providing this care. In the case of Zewditu Memorial Hospital, with its limited budgets and inefficient regulation and supply chain processes, it becomes obvious that supply chain efficiency and clinical outcomes are inherently connected, making the management of this process crucial for achieving good health care outcomes and controlling the financial risks associated with inefficiencies.

Operational performance achieved through reduced wastage is a product of several interrelated mechanisms and cannot result only from any individual process. Inventory management was identified as the most effective mechanism, as practices of FEFO compliance, the use of ABC/VEN analysis, and periodic inventory checks turned out to have the highest coefficient of determination. Secondly, forecasting became important for eliminating wastage, as it allows preventing orders that are excessive. Thirdly, procurement practices proved to influence medicine wastage significantly; however, their effect is dependent on budget decisions and the behavior of suppliers. Finally, although significant, the impact of storage and information sharing is smaller than the effect of other processes.

From a theoretical standpoint, the results obtained provide new evidence for validating contingency theory. Specifically, the role played by each practice will depend on the organizational environment in which they are applied. Contrary to the private sector where information sharing appears to be the key process, at Zewditu Hospital internal operational processes (inventory management and forecasting) become even more important compared to the external ones (like information sharing), as the information available in terms of both suppliers and budgets is inaccurate. Thus, there is a need for adjusting existing theories to the real conditions under which medical institutions operate.

From a practical point of view, hospitals should first develop inventory management practices, including the purchase of shelving equipment, FEFO training, and schedule of periodic checks. Next, forecasting should become a priority. Lastly, procurement procedures can become efficient

once all other issues related to medicine storage and inventory management are solved. Thus, by applying this approach, hospitals can reduce medicine wastage rates, save their budgets for purchasing other drugs, and, finally, provide better patient care.

5.2. Recommendations

The following suggestions are given for Zewditu Memorial Hospital based on the findings, along with the accountable parties.

- The first area where improvement is needed is the hospital inventory. It can be seen that the importance of efficient inventory is well understood by the hospital. Nonetheless, there are still some issues connected to the insufficient number of people and ignoring the principle of FEFO (first expiry first out). Hence, it is recommended that the hospital create an assigned position of inventory clerks who work per pharmacy shift, implement a color-coded labeling system to identify the principle of FEFO, and perform weekly cycle counts, paying attention to fast-moving medicines. These measures will enhance responsibility and considerably decrease the possibility of medicines' expiration. As can be noticed, these recommendations are directed toward the hospital's head and administration; thus, labeling can be implemented within a month, and other steps within three months.
- Forecasting is another area that requires some improvements as well. Forecasting is considered valuable by the hospital's personnel, yet it is not sufficiently validated. To improve the matter, the organization should organize monthly meetings where comparison of forecasts to the actual needs and calculation of errors in forecasts of vital medicines are performed. Furthermore, a simple moving average (based on recent data and not on the historic average) can be applied to make the process more precise. As can be noticed, responsibility lies on the head of the pharmacy and procurement committee; therefore, the design of the process can be developed during two months, and monthly review is required.
- The procurement process is also to be improved. The major issue in it now is connected with low budgeting and transparency. Thus, the hospital should obtain quarterly budget allocation from now on, implement a supplier scorecard where deliveries and expirations are measured, and enter into a contract with suppliers, ensuring sufficient shelf life of medicines. Implementation of such steps would considerably improve the process. Responsibility

includes the CEO of the hospital, the head of the pharmacy, and the procurement department; accordingly, budgeting should follow the cycle, which is six months long.

- Moreover, storing is an area where improvements should be made. Currently, there is a problem with shelving, as there are no restrictions on stack heights, and temperature and humidity changes are not recorded. Thus, to improve the situation, the hospital should finance new shelves and pallets, allowing for the storage of medicines off the floor, establish some limits on stack heights, and purchase temperature and humidity data loggers that are inexpensive and necessary. As can be noted, responsibility includes the hospital's administration, the head of the pharmacy, and the hospital's maintenance unit. Shelving can be done within three months, and monitoring equipment within one month.
- At last, improvements in information exchange can support the previous recommendations and help to make the matters better. The absence of relevant information about suppliers does not allow making right forecasts and performing proper procurement. To solve the problem, hospital's administration needs to design and fill a database, provide access to the information to forecasting specialists, and teach employees on how to work with it. In this case, institutional memory turns into something important. Responsibility includes the head of the pharmacy and an IT specialist, and process design is done in two months.

5.4 Directions for Future Research

In the future, this study could be conducted with the use of different approaches. First of all, the comparative analysis of the relationship between supply chain practices and medicine wastage should be performed for multiple hospitals, including both public and private hospitals and health centers. Secondly, the longitudinal approach could be used in order to investigate how implementing the recommendations from this paper impacts medicine wastage for 12-24 months. Thirdly, the use of qualitative methods could help identify possible barriers to introducing the best practices. Fourthly, in addition to the perceptual measures, objective indicators (for example, stockout rate and inventory turnover) should be considered. Lastly, the influence of emerging technologies on the issue in question, including blockchain-based supplier transparency, IoT temperature sensors, and machine learning-based demand forecasting, can become a good topic for future research.

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ANNEXES

Annex 1: Data Collection Sheet for Medicines Wastage Value

Section I: Data Abstraction Formats

No	**Question**	**year**			
		2014 EFY	2015 EFY	2016 EFY	2017 EFY
1	Total Value (in ETB) of Medicines Received				
2	Value of Medicines wasted (in ETB)				
	Expired				
	Damaged				
	Obsolete				
	Theft and pilferage				
	Others(Specify)				
	Total				

Data Collection Sheet for Medicines Wastage Records (2014 -2017 EFY**)**

S.N	Drug Name	Strength	Dosage Form	Amount Wasted	Source For wastage	Price

Addis Ababa University

School of Commerce

Department of Logistics and Supply Chain Management

Annexes 2 Verbal consent

Greetings! I'm Habtamu Firew, an MA candidate at Addis Ababa University's School of Commerce. I'm here to gather information regarding supply chain practices for the master's thesis, "Impact of Supply Chain Practices on Medicine Wastage and Expiration Rates in Zewditu Memorial Hospital."

The study's sole objective is academic. As a result, I can guarantee that it won't negatively impact either your company or you personally. Your honest and open response, which will be kept private, is essential to the study's success. As a result, I ask that you complete the form completely and truthfully. I want to express my gratitude in advance for your gracious cooperation.

My Contact address to provide Additional Information: Habtamu Firew, Mobile phone # 09-13-32-20-40 or email:

habtamuferaw@yahoo.com

General Instruction: When options are provided, please circle the letter of your choice. If a description response is needed, please fill it out in the designated field and indicate the appropriate areas with a checkmark.

_____ _____

Signature of the person administering consent Date

Annex 3:

Part 1: Demographic characteristics

Please circle the option that best describes your response to the following statement

1. **Gender**

1. Male.....
2. Female.....

2. **Professions**

1. Pharmacist.....
2. Nurse.....
3. Phisicians.....
4. HO.....
5. Other (Specify) .....

3. Education level

College/University Diploma level.....

Bachelor's Degree.....

Master's Degree.....

PhD Degree.....

Others ….....

4. How many years have you worked in this health facility?

1 – 5 years .....1 11 – 15 years 3

6 – 10 years .....2 Over 15 years 4

Part 2: Impact of Supply Chain Practices on Medicine Wastage and Expiration Rates in Zewditu Memorial Hospital

(Please rate the following statements on a scale of 1–5)

1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree

Categories			1	2	3	4	5
Procurement Practices	1	Availability of updated SOPs for procurement helps reduce medicine wastage and prevent expiration.					
	2	The selection of medicines based on ABC/VEN analysis helps reduce medicine wastage.					
	3	Near-expiry medicines (< 6months) are being delivered to the hospital, which causes medicine wastage					
	4	Adequate procurement budget supports effective planning and helps reduce medicine wastage.					
	5	Sufficient procurement budget enables effective planning and reduces medicine wastage					
	6	Effective procurement practices help reduce medicine expiration rates.					
Inventory Management	7	Conducting ABC/VEN analysis helps prevent overstocking and reduces the risk of expiry.					
	8	Adequate staffing in inventory management ensures effective stock control and helps reduce wastage.					
	9	The use of computerized inventory systems improves accurate stock tracking and helps reduce expiration.					

	10	Consistent ordering practices help prevent expiration and improve inventory management efficiency.					
	11	Failure to conduct regular physical inventory may delay the identification of medicines nearing expiry.					
	12	Proper separation of expired and damaged medicines helps reduce wastage and improve stock management.					
		Following the First Expiry First Out (FEFO) principle helps reduce medicine expiry and ensure proper stock utilization.					
Storage Practice	**13**	**Proper cleaning practices in storerooms help maintain medicine quality and reduce deterioration and wastage.**					
	14	Proper storage conditions, including adequate light control, ventilation, and temperature regulation, help reduce medicine expiry.					
	15	Proper protection from water and moisture helps maintain medicine quality and reduces wastage.					
	16	Proper stacking of medicines—such as keeping cartons at least 10 cm off the floor, 30 cm away from walls and other stacks, and not exceeding 2.5 m in height—helps prevent damage and reduces expiry.					
	17	Adequate storage budget supports proper medicine handling and helps reduce damage and expiry.					
	18	Proper arrangement of pharmaceuticals, particularly adherence to FEFO procedures, helps reduce medicine wastage in this facility.					
	19	Clear labelling and good visibility of expiry dates help reduce wastage and improve inventory management.					

Information Sharing and Technology	20	Availability of SOPs for information sharing helps improve stock management and reduce wastage.					
	21	An effective Logistics Management Information System (LMIS) helps ensure accurate stock records and improves overall inventory management Information and wastage.					
	22	Training on information systems enhances staff capacity, leading to improved stock control and reduced expiry.					
	23	Access to supplier information on stock availability helps improve planning and reduce medicine expiry.					
	24	An inadequate budget for information systems contributes to wastage					
	25	Lack of supplier information on stock availability leads to poor planning and expiry.					
	26	An inadequate budget for information systems contributes to wastage					
Forecasting	27	Validating forecasts by comparing previous estimated consumption with actual consumption helps reduce medicine wastage by improving procurement accuracy.					
	28	Accurate forecasting helps prevent medicine overstocking and reduces expiry.					
	29	Reliable forecasting helps minimize financial losses due to expired medicines.					
	30	Accurate records of stock movement support effective forecasting.					
	31	Proper forecasting improves efficient use of the hospital procurement budget.					
	32	Improved forecasting helps reduce medicine expiry rates.					

MEDICINE WASTAGE AND EXPIRATION	33	High medical expenses brought on by the cost of unused (expired) pharmaceuticals					
	34	Due to medication waste, patients are compelled to purchase pricey medications.					
	35	Medicine wastage negatively affects the availability of essential medicines for patients.					
	36	Medicine wastage reduces the efficiency of healthcare service delivery.					
	37	Medicine wastage negatively impacts patient treatment outcomes.					