DETERMINANTS OF MEDICINES WASTAGE ACROSS THE SUPPLY CHAIN IN HOSPITALS UNDER THE ADDIS ABABA CITY ADMINISTRATION HEALTH BUREAU

By

Bitwoded Baye Abate

A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY SCHOOL OF COMMERCE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ART IN LOGISTIC AND SUPPLY CHAIN MANAGEMENT

ADVISOR: Shiferaw Mitiku (PhD)

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Addis Ababa University School of Commerce, Logistics & Supply Chain Management Department

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Approved by Board of Examiners:

Advisor	**Signature**	**Date**
_____	_____	_____
Internal Examiner	**Signature**	**Date**
_____	_____	_____
External Examiner	**Signature**	**Date**
_____	_____	_____

DECLARATION

I do hereby declare that this study on "Determinants of Medicines Wastage across the Supply Chain in Hospitals under the Addis Ababa City Administration Health Bureau." is my original work, has not been submitted for credit at another university, and properly cites all sources utilized in the study.

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Name	**Signature**	**Date**

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LIST OF ACRONYMS AND ABBREVIATIONS

APTS	Auditable Pharmaceutical Transaction and Services
ART	Anti-Retroviral Therapy
DTC	Drug and Therapeutics Committee
EFMHCAA	Ethiopia Food, Medicine and Health Care Administration and Control Authority
EFY	Ethiopian Fiscal Year
EPSA	Ethiopia Pharmaceutical Supply Agency
ETB	Ethiopian Birr
FEFO	First Expired First Out
FIFO	First In First Out
FMOH	Federal Ministry of Health
GPC	Guideline Policy Change
HC	Health Care
HCMIS	Health Commodity Management Information System
HL	Hospital
HP	Hospital Practice
HSCM	Hospital Supply Chain Management
HSDP	Hospital Development plane
IPLS	Integrated Pharmaceutical Logistics Service
KPI	Key Performance Indicator
LMIS	Logistics Management Information System
NEDL	National Essential Drug List
PLMP	Pharmaceutical Logistics Master Plan
PSC	Pharmaceutical Supply Chain

PSCM	Pharmaceutical Supply Chain Management
SCM	Supply Chain Management
SOP	Standard Operating Procedure
Y12HMC	Yekatit 12 Hospital Medical College

Abstract

Medicines wastage happens when medicines are expired, damaged, or obsoleted and become unsafe for use. It burdens many health care institutions and increases the health care system costs. Despite studies indicating the existence of expired medicines in Ethiopia, there is limited objective evidences on its determinant factors as well as the extent and type of medicines wastage. Therefore the aim of this study was to identify the determinants of Medicines Wastage across the supply chain in hospitals under the Addis Ababa City Administration Health Bureau. The study employed a mixed of descriptive and explanatory study in the sampled hospitals from April 16 to May 15, 2022. In the study, both qualitative and quantitative data collection methods were used. The qualitative and quantitative data was collected using self-administered questionnaires and data abstraction formats and analyzed using SPSS version 26.0. The results of the analysis demonstrate a positive and strong association between supply chain determinants and medicine wastage, with a Pearson correlation coefficient of 0.545 (r=0.545) and significance at a p-value of 0.00. Poor coordination and communication between key stakeholders, delivery of near expiry date medicines, presence of overstocked medication due to improper forecasting of need in the hospitals, poor procurement practice, the presence of the warehousing storage space problem, weak or absence of fully functional drug and therapeutic committee (DTC) and lack of accountability for stock-outs and wastage of medicines in the hospitals were identified as major determinant factors for medicines wastage. *While all assessed health institutions received pharmaceuticals with a value of 193,279,074.17 Ethiopian Birr, there was a total of 9,339,542.58 Ethiopian Birr wasted medications, yielding a wastage rate of 4.83% within the time period in EFY 2012-2013. Knowing and adhering to the standard producer is critical to avoiding patient service interruptions, shortages and unavailability of essential medications, high healthcare costs and expensive medicine expiration. Therefore to reduce medicine wastage, hospitals should also improve information management, supply chain management and strengthening the Drug and Therapeutics Committee.*

Key Words: Determinant Factors, Medicine wastage, Essential Medicine, public hospitals, Wastage Rate

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Medicines are substances that are used to treat, prevent, diagnose, cure, or mitigate disease. (Mekuwanint Nega, 2017; Gebremariam *et al*, 2019).

Medicine wastage defined as all damaged, expired, counterfeit, substandard and adulterated, improperly sealed or stored or labeled, forbidden, or unauthorized pharmaceuticals (FMHACA, 2011; Gebremariam, 2017).

The Medicines Management cycle organizes medicine supply management around five core functions; selection, quantification, procurement, distribution, and usage. It has management support operations in addition, such as human resource management, quality assurance management and information management resulting in the availability of the right medicine in the right quantities, at affordable prices (Iqbal *et al*, 2017).

Despite the fact that the causes of drug wastage in healthcare environments are not well understood in low-income countries, a report finds that a poor supply chain management system is the leading cause. This includes practices that could lead to overstocking or under stocking of drugs, as well as the selection and quantification of pharmaceuticals without verified data/evidence. Poor storage conditions, like direct storage of medications on the floor, the presence of pests and dust, a lack of systematic stock arrangement, insufficient protection from direct sunlight, and the absence of temperature monitoring charts and facilities to monitor room temperature, can all contribute to the degradation of medicines. The system is vulnerable to theft and pilferage due to a lack of transparency and accountability in the management of pharmaceuticals and financial activities. (USAID, 2011; USAID and CDC, 2014; Kagashe *et al*, 2014).

Governments spend a significant amount of money on drug purchases, accounting for 40 to 60 percent of each country's total public health budget. Despite such high spending, one-third of the world's population lacks access to vital medicine, with Asia and Africa accounting for half of the total. One of the key causes of this precarious condition is the mismanagement of available resources; according to one study, up to

70% of a country's resources are lost owing to ineffective medication management systems. Pharmaceutical services in Ethiopia are still inadequate, although accounting for more than 70% of the country's health care costs (Iqbal *et al*, 2017; Fentie *et al*, 2015).

Medicine wastage is a worldwide problem with a variety of causes that has a significant influence on patients' finances, country economies, health-care costs, public health, and the environment. It affects the quality of health services by reducing the quality and quantity of medicines supplied to patients.(Josephine Katabaazi Nakyanzi *et al,* 2010, West *et al*, 2015).

The situation in Ethiopia is similar to that in the rest of the globe, with enormous amounts of medication wastage accumulating throughout the supply chain. Expired and unfit-for-use drugs occupy a significant percentage of the space at the medicines store in many public health facilities. (Tadeg *et al*, 2014).

1.2 Statement of the problem

A fragmented supplier base, unnecessary administrative costs, inadequate care, supply chain inefficiencies, poor management, and medicine wastage are all issues that can be mitigated with strong supply chain management. Pharmaceutical supply chain challenges include poor integration of problems with suppliers and health institutions, bad procurement practices, erroneous forecasts, and information gaps, which result in medicine wastage and stock outs (Gebremariam *et al*, 2019; Beyene *et al*, 2020).

Medicine wastage costs varying from 60 to over 770,000 euros and unused prescription costs 300 pounds per year in England. The situation is far worse in Ethiopia, where 80% of pharmaceuticals are imported.

A study conducted in industrialized countries like the United States, New Zealand, and England identifies the cause of medicine wastage; includes, changes in medication, patient condition resolution, patient death, and medicine expiration are all major causes of medicine wastage (L.M West, 2014; FMOH, 2015). Excess supply, pilferage, change of regimen, and patient death were identified as major contributors to medicine wastage in Tanzania, whereas quantification, procurement, and irrational use were reported as sources of pharmaceutical wastage in Uganda. Medicine wastage in Rwanda is caused by abrupt discontinuation of therapy due to policy changes,

expensive medicines, and rare diseases (Josephine Katabaazi Nakyanzi *et al*, 2010; Kagashe *et al*, 2014; Hakuzimana *et al*, 2021).

According to a study conducted in Ethiopia, Oromia Regional State's South West Shoa Zone, the average value of pharmaceuticals wastage was over 586,725.35 ETB. Unused pharmaceuticals costs 38228 and 60654 ETB in Ethiopia, Gondar town and Awi Zone, respectively. These losses are the result of ineffective pharmaceutical supply chain management. This showed that the financial cost of pharmaceutical wastage in the facilities would be huge. Pharmaceutical wastage is also a difficulty of health supply chain management in Ethiopia as well as the rest of Africa. Due to this improved supply chain management, wisely use of medicines and preventing wastage have paramount importance (Fentie *et al*, 2015; Gebremariam, 2017; Ebrahim *et al*, 2019).

‘‘There are several direct and indirect consequences of medication wastage, including economic implications for government, individuals, and society resulting from the costs of unused medications, expenses required to dispose of unused medications, costs associated with wasted time spent on supply-based activities such as prescribing and dispensing, and environmental implications associated with wastage disposal’’ (West *et al*, 2015).

Ineffective pharmaceutical supply chain management is straining the country's limited resources and generating disruptions in healthcare delivery. The pharmaceutical supply chain difficulties in public hospitals range from one health facility to another, therefore identifying the major challenges of the health facilities presenting these types of study is critical. Furthermore, to my knowledge, no published research addresses the issue of medicine wastage in hospitals under the Addis Ababa city administration's health bureau. As a result, the purpose of this study is to identify key Pharmaceutical Supply Chain determinants that contribute to medical wastage in hospitals under the Addis Ababa city administration health bureau.

1.3 Research questions

What are the determinant factors that causes medicines wastage across the supply chain in the selected hospitals?

What is the level of influence of determinant factors have on medicines wastage across the supply chain in the selected hospitals?

What is the relationship between determinant factors and medicines wastage across the supply chain in the selected hospitals?

What is the rate of medicines wastage in the selected hospitals?

1.4 Research objectives

1.4.1 General objectives

The general objective of this study is to identify the determinants of Medicines Wastage across the supply chain

1.4.2 Specific objectives

To assess the determinant factors that causes medicine wastage across the supply chain

To measure the level of influence of the determinant factors for medicines wastage across the supply chain

To examine the relationship between determinant factors and medicines wastage across the supply chain

To determine the medicines wastage rate of the hospitals under study

1.5 Operational definition of terms and concepts

Essential medicines: - Those that meet the population's most pressing healthcare needs. They are chosen based on public health significance, efficacy and safety evidence, and comparative cost effect-effectiveness. It should always be provided in the appropriate dosage forms, in adequate amounts, with adequate information, and at a price that individuals and communities can afford within the scope of functioning health systems (FMHACA, 2015).

Medicines wastage rate: - The percentage computed by dividing the wasted value into monetary terms by the total value of medications received during the same period is known as the medication wastage rate (Ebrahim *et al*, 2019).

Medication wastage: - Includes all expired, damaged, counterfeit, substandard and adulterated, improperly sealed or stored or labeled, forbidden, or unauthorized pharmaceuticals (FMHACA, 2013).

Hospitals under Addis Ababa City Administration Heath Bureau: - These are Yekatit 12 hospital medical college, Zewditu memorial hospital, Gandhi hospital, Menelik II referral hospital, Ras Desta Damtew memorial hospital, Triunes-Beijing hospital and Abebech Gobena mother and child hospital.

Expired medicine: - It's when an active ingredient of medicines loses its potency, quality, and purity after a certain amount of time, as mentioned on the labeling and packaging. (Farrugia, 2005).

Medicine management cycle: - It involves managing the selection, procurement, quantification, distribution, and use of medicines (Iqbal *et al*, 2017).

1.6 Significance of the study

By identifying supply chain obstacles that cause medicine wastage, this study assists hospital administration in addressing supply chain issues and thereby enhancing service delivery performance. The study also directs policymakers and other government bodies such as the MOH, in formulating pharmaceutical supply chain management policies and standard operating procedures. Finally, the findings of the study might be used as a resource for academics and researchers working in hospitals and other organizations that want to do additional studies on medicine wastage.

1.7 Limitation of the study

One of the study's limitations is that it only included wasted medicines with price lists; as a result, the study was unable to reveal the amount of wasted program and donation medicines. And the study's findings were based solely on the viewpoint of healthcare institutions; it excluded other stakeholders like the EPSA, the Addis Ababa regional health bureau, EFDA, the MOH's health offices, and partners. Time and finance are other limitations of the study.

1.8 Scope of the study

Due to a lack of resources, the research was limited to hospitals under the Addis Ababa city administration's health bureau, all of which are located in Addis Ababa. The study's conceptual framework also examined at the elements that influence pharmaceutical wastage across the supply chain. By using the hospital medicine supply chain key performance indicators (KPIs), the research was limited to measuring medicine wastage across the supply chain. Yekatit 12 hospital medical

college, Zewditu memorial hospital, Menelik II referral hospital, Ras Desta Damtew memorial hospital, and Triunes-Beijing hospital were among the hospitals under the Addis Ababa city administration's health bureau at which The study was undertaken.

The investigation was not including pharmaceuticals that are returned to pharmacies, inpatient wards, and households, wasted medicines that are recorded as the free price (listed at no cost), such as donation and program medicines, nor it look into equipment or medical supplies.

1.9 Organization of the study

This study has five chapters; Chapter one includes introduction about the study; chapter two includes review of relevant literature; chapter three deals with methodology of the study; chapter four includes results, discussion & interpretation of findings and, summary, recommendation and conclusion appears in chapter five.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Theoretical literature review

2.1.1 Pharmaceutical supply chain management

Pharmaceutical supply chain management includes everything from raw material procurement to active component manufacture, as well as formulation, packaging, and distribution to patients. It includes all related activities throughout the product lifecycle, such as clinical supply, outsourcing, scale-up and transfer, and product discontinuation (de Vries & Huijsman, 2011).

Many components of a medicine now often arrive at the place of manufacture from other nations, making the global supply chain for medical devices and pharmaceuticals complicated. Operating supply chains is difficult due to the heterogeneous system components, diversified commodity and material flow structure, trade-off scenarios, and opposing interests and ambitions of the participants (Mekuwanint Nega, 2017). Planning of pharmaceutical supply, request of the purchase order, reception of pharmaceutical, validation of delivery services, fitting and sorting of pharmaceutical packages, storage, preparation for distribution, allocation of pharmaceuticals to primary and secondary pharmacies and electronic equipment, and reverse logistics are the nine logistics tasks in the hospital pharmacy logistics system (Romero, 2013).

The Medicines Management cycle organizes medicine supply management around five core functions: selection, quantification, procurement, distribution, and usage. The above five basic management cycle functions of the medicine are ensured by efficient and robust pharmaceutical management in hospitals, resulting in the availability of the right medicine in the right quantities, at affordable prices, and to accepted quality standards throughout the year, with no stock-out periods in between. Competent medicines management is a multi-stakeholder collaborative process that is necessary to provide the health service with a road map for continuous quality improvement in the pharmaceutical supply chain, including cost containment with clear goals and performance metrics. There are significant gaps and deficiencies in existing hospital pharmaceuticals management and supply chain systems, including

insufficient resources and well-documented regulatory frameworks. (Iqbal *et al*., 2017).

According to the Ethiopian Ministry of Health's five-year plan, pharmaceutical supply chain management aimed to increase the availability of vital medicines while reducing wastage to less than 2%.

The Ethiopian hospital service transformation guideline (HSTG), which has been approved by the MOH, is a performance standard and guidelines aimed at promoting efficient and high-quality pharmaceutical service delivery. The Ethiopian Pharmaceutical Supply Agency (EPSA) is in charge of procuring and distributing high-quality medicines and medical equipment to government hospitals to meet the six Rs of medicine delivery: the right drug to the right particular patient, in the right quantity, and circumstance, at the right place and time (Mekuwanint Nega, 2017).

A collaborative approach that supports and fosters continuity in all sectors of the communities and health care sector is the key to safe and effective medication management (Iqbal *et al*, 2017).

2.1.2 Medicine wastage management

Any substance or element (solid, liquid, or gas) which has no direct usage and is disposed of permanently is considered waste. Hazardous waste has one or more of the following characteristics: it is combustible, explosive, reactive, corrosive, infectious, irritating, sensitizing, radioactive, or bio-accumulative. Medical waste management has been a major source of concern due to the potential for serious health and environmental consequences (M. Shareefdeen, 2012).

Out of the 43 studies carefully analyzed in 2010, just one study used the Delphi technique to identify pharmaceutical wastage or related keywords. Medication waste is defined as any medication that expires or stays unused along with the whole medication supply chain. Also, it includes unjustified consumption of the drugs by the patient or unjustified non-adherence to protocols by healthcare pro providers. Medication waste is costly to patients and the state's economy, and it requires sufficient education for all parties involved (West *et al*, 2015).

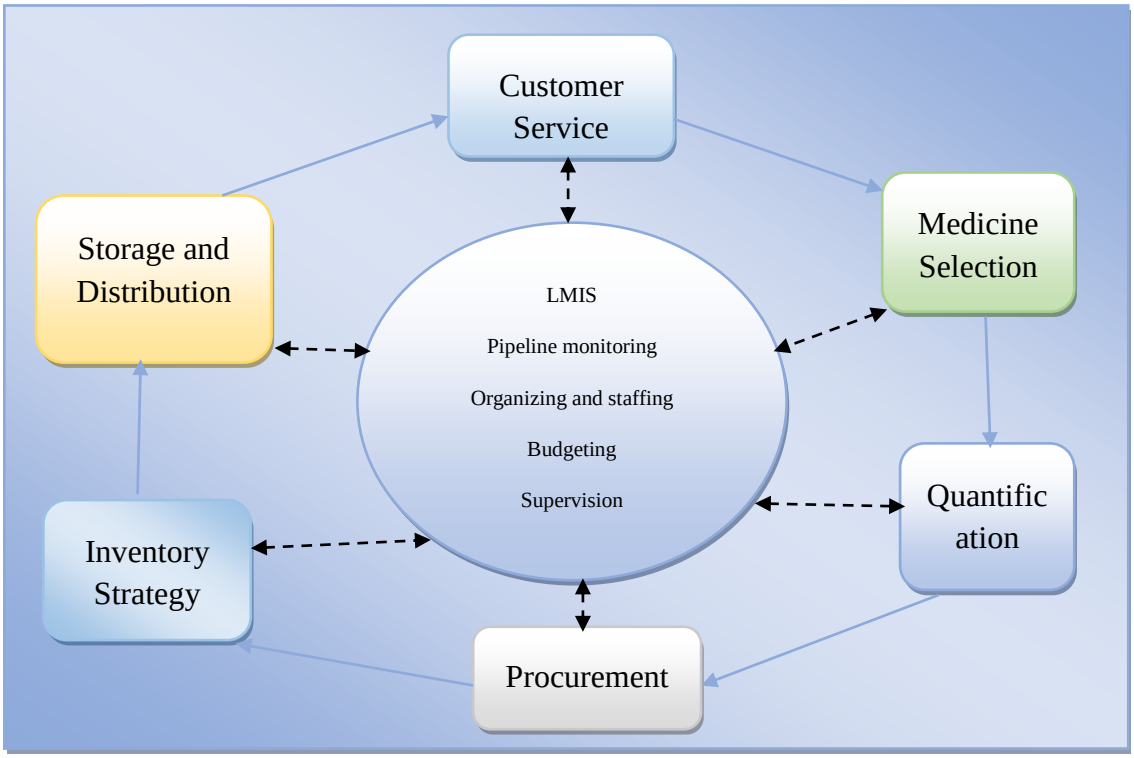
All expired, damaged, counterfeit, substandard and adulterated, improperly sealed or labeled and/or stored, illegal or unauthorized pharmaceuticals are included in the

Ethiopian Food, Medicine and Health Care Administration and Control Authority's (EFMHACA) disposal directive.(FMHACA, 2011; Gebremariam *et al*, 2019).

2.2 Theoretical framework of the study

Medicine is wasted when the logistics cycle's functions are not performed well. The cycle has five main functions, the heart of the cycle and the logistics environment, which includes policy and adaptability. To make sure that goals are met, quality monitoring tasks need to be carried out throughout the medication supply chain cycle.

Figure 2.1 the Medicine logistics cycle



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

2.3 Empirical literature review

2.3.1 Ethiopian medicine supply chain success: enablers

2.3.1.1 IPLS (Integrated pharmaceutical logistics system)

A single system for reporting and distributing pharmaceutical products is known as an integrated pharmaceutical logistic system. IPLS currently manages critical medicines such as those needed to treat Human Immunodeficiency Virus/Acquired Immune

Deficiency Syndrome (HIV/AIDS), malaria, tuberculosis (TB), and leprosy, as well as vaccines, family planning, and other necessary drugs (PFSA, 2015). By integrating pharmaceutical requisition, distribution, and reporting mechanisms, IPLS improves the pharmaceutical supply chain. Its goal is to ensure that patients have access to the medications they require at all times. To be effective, the system must ensure the six rights of supply chain management: the right items, in the right amount, of the right quality, at the right time, at the right place, and for the right price. It is the principal source of vital medications for all public health facilities. The IPLS is responsible for supplying and managing products on the National Pharmaceutical Procurement List (NPPL) (Mohammed *et al*, 2020).

2.3.1.2 Logistics management information system/health commodity management information system

It is an electronic record-keeping and reporting system that allows facilities to monitor daily pharmaceutical transactions. It aids in the tracking of issued goods, store stock levels, batch and expiry dates for medications, consumption statistics, and loss and adjustment calculations. It assists store managers in compiling and generating a requisition and report form (RRF) to submit to the Ethiopian Pharmaceutical Supply Agency (EPSA), the sole provider of medicines and medical supplies to government health facilities in Ethiopia. Logistics management and inventory management information systems are two of their components. (Tiye & Gudeta, 2018).

Supply chain information systems (SCISs) are used to integrate data between internal and external customers, providers, distributors, and other supply chain, partners. The most essential indicator of a supply chain information system's effectiveness is how successfully it has supported supply chain activities, such as reducing buffer inventory stocks, decreasing lead times, increasing revenues, and improving customer service. Supply chain strategies should be connected with information systems strategies to attain the best level of performance (Yousefi & Alibabaei, 2015).

2.3.1.3 APTS (Auditable pharmaceutical transaction and services)

APTS is a data-driven set of initiatives that track information about pharmaceutical transactions, making them transparent, quantifiable, and responsible. It facilitates effective budget management by facilitating transparent and accountable transactions

and creating trustworthy data. It also improves staff development and deployment by bringing innovative working environments and art that boosts customer and professional satisfaction. Implementing effective auditable pharmaceutical transactions and services can result in high-quality pharmacy service and reduced resource waste (Beyene *et al*, 2020).

2.3.1.4 Inventory management

Within the health sector, pharmacy inventory management is a challenging but crucial procedure. Inventory management is defined as the tasks involved in establishing and controlling inventory levels of raw martials, semi-completed (work-in-progress), and final product such that enough supplies are available and costs are minimized (Romero, 2013; Gurmu & Ibrahim, 2017)

Effective and transparent inventory monitoring systems that allow pharmacies to precisely record inventory components like pharmaceutical expiration dates and physical amounts have the potential to prevent negative patient outcomes (Iqbal *et al*, 2017).

Coordinating the activities of manufacturing, purchasing, distribution functions to satisfy marketing and organizational needs is the scope of inventory management; It also entails managing the lead time for replenishment, goods replenishment, defective goods returns, inventory carrying costs, physical inventory, asset management, available physical space, inventory visibility, inventory valuation, future inventory price forecasting, demand forecasting, and quality management (Iqbal *et al*, 2017).

2.3.1.5 Procurement management

The procurement process of pharmaceuticals is inherently complex because it requires the cooperation of the MOH agencies, financing sources, suppliers, and manufacturers. The distribution of health products to clients is disrupted by the poor capacity to select, quantify product specifications, and forecast to manage the purchasing process; therefore effective procurement is necessary to maintain pharmaceutical security.

Management goals and policy goals are two sets of contradictory goals that policymakers and public procurement officers must make tradeoffs between in a healthy procurement system. Quality, timeliness, and cost are among the procurement management criteria, as are minimizing business, financial, and technical risks,

maximizing competitiveness, and ensuring integrity. Economic goals, social aims, green procurement, and international trade agreements are included in procurement policy criteria (Mekuwanint Nega, 2017; Iqbal *et al*, 2017).

2.3.1.6 Medicine distribution and transportation

The interests of cheap distribution costs and excellent service quality are at odds. Transportation costs are higher when distribution frequency is high, but in a more predictable demand planning horizon with fewer tock-out scenarios. Last-mile distribution is frequently done on a collection basis, which means that HFs pick up orders at warehouses using bicycles, public transportation, or automobiles, some of which are used for multiple functions, and return the goods to the facility. Ad-hoc collections are common, and HFs requires funding for transportation. Furthermore, the collection of medicine by HFs may necessitate long-distance travel by health personnel, resulting in the closure of the HF owing to a lack of human resources (Allan, 2013).

2.3.1.7 Customer service

Several phrases are used to define suitable practices and processes leading to the most responsible use of medications, such as rational use of medicines, quality use of medicines, responsible use of medicines, improved use of medicines, and so on. One strategy to provide quality health care is to ensure the judicious use of medicine. Delivering medicines to patients that are appropriate for their illnesses, in the right dose, at the right time, and at the lowest cost possible is defined as rational use of medicines. It comprises functions such as providing medicines in accordance with regulations, drug monitoring, patient education, information flow, and performance improvement. ((Mohammed *et al*, 2020; Iqbal *et al*, 2017).

2.3.2 Determinants of medicine wastage across the supply chain

Medication wastage can be caused by patient noncompliance, excessive and inappropriate prescribing, or a lack of supervision over prescription drug sales in community pharmacies. The medication change, resolution of patient's condition, patient death, expired medication, and overstocking owing to fear of pharmaceutical unavailability, patient education and performance development functions have all been attributed as causative factors leading to medication wastage (West *et a*l, 2015).

According to a study done in Uganda, a variety of vital and essential drugs are wasted as a result of poor medicine selection, quantification, procurement, distribution, storage, and use, insufficient stock monitoring, non-participation of clinicians in medicine quantification in hospitals, poor knowledge of basic expiration dates prevention tools, third-party procurement by vertical programs, profit- and incentive-biased quantification, and overstocking. Another study in Uganda recommended the push system of procurement as a way to help with pharmaceutical expiration and stock out (Josephine Katabaazi Nakyanzi *et al*, 2010; Tumwine *et al*, 2010).

Quantification problem, ineffective drug and therapeutic committee, poor data quality, knowledge gap, communication problem, pilferage and obsolescence, different prescription pattern and substandard infrastructure for storage of pharmaceuticals are the main reasons identified for medicine expiry in the study conducted in Awi zone, Ethiopia (Ebrahim *et al*, 2019).

In a study conducted in south west shoa Ethiopia Supplier related and health institution related factors are among the major determinant factors contributing for medicine wastage across the supply chain; the major contributors to wastage, includes the provision of medications without need or requests, poor stock rotation/unable to use FEFO for issuing medications from stores to different retail pharmacy units, poor communication between health facilities and supplier, and between retail units within a health facility, inadequate pharmacy professionals, and a poor medicines wastage monitoring system. Issuing near-expired medicines (55 %), oversupply of medications (45 %) that is not based on health institutions' needs; inadequacy of store rooms (75 %), failure to follow the first-expire-first-out basic concept (25 %), poor protection from sunlight (40 %) and management attitude; lack of electronic stock control system and lack of trained practitioners and their poor practice. Poor inventory management was another major factor identified for medicine wastage and expiry; shortage of finance, lack of information and human power was the underlying factors for poor inventory management (Gurumu & Ibrahim, 2017; Gebremariam *et al*, 2019).

2.3.3 Extent of medicine wastage

The extent of medical waste has been investigated and documented in a number of nations, with quantities ranging from 65 wasted medication items to 20,304 medicine packages obtained from 100 community pharmacies. In 2009, the Department of Health in England assigned and supported a study to look at the scope and expense of drug waste. The study found that unused prescribed drugs cost the NHS £300 million per year and that the problem is exacerbated in countries like Ethiopia, where 80 % of pharmaceutical drugs are imported, due to management attitudes, a lack of electronic inventory control systems, and a shortage of qualified professionals and their poor practice (West *et al*, 2015; Tadeg *et al*, 2014).

The study conducted in Saudi Arabia and the gulf countries estimated $15 million medicines are wasted annually. More than $550,000 worth of anti-viral and 10 million antimalarial medicines were reported expired in a study conducted at Uganda National Medical Stores.(Josephine Katabaazi Nakyanzi *et al*, 2010).

According to a study conducted by Awol Jemal Ibrahim and Tadesse Gudeta Gurumu in the Awi zone and in east shore Oromia, a total of 606,545 ETB and 174,366.98 ETB worth of pharmaceuticals was wasted respectively. Ineffective pharmaceutical supply chain management is the primary cause of these losses (Gurmu & Ibrahim, 2017; Ebrahim *et al*, 2019).

2.3.4 Consequences of medicine wastage

There are many direct and indirect results of medication wastage, the most significant of which are the economic consequences for both individuals and societies rising from the costs of unused medications, expenses related to wasted time spent on the supply-based activities of prescribing and dispensing, costs required to dispose of unused medicines, and environmental consequences associated with wastage disposal. Self-poisoning can occur if drugs are left unattended at home (West *et al*, 2015).

Waste increases logistical operation expenses across the supply chain, which account for 20 % to 45% of health facility operating expenditures, including handling of materials, moving, and processing. As a result, good logistics practices in a hospital are critical (Moons *et a*l, 2018).

According to a study conducted at public health facilities in southwest Ethiopia, drug wastage is the main cause of crowded stores, a lack of budget, and a shortage of medicines (Gebremariam *et al*, 2019).

2.3.5 Summary of literature review

Table 2.1 Summary of literature review

Author/Authors and year of publication	Study topics	Determinants of medicine wastage (Dimensions)	Major findings	Remarks/Study limitation
(Mashishi, 2015)	Expiration of drugs in public hospital pharmacies of Sekhukhune district, Limpopo province, South Africa.	1.Inventory management	✓ Poor prescribing pattern	Doesn't included/investigate other determinant factors for drug expiry across the supply chain
		2. Medical Supply demand management and	✓ Over stocking	
		3.Expiry management	✓ Short half-life medicine supply	
			✓ Minimum and maximum order levels and	
			✓ Poor stock rotation.	
(Hakuzimana, 2019)	Assessment of factors contributing to medicines expiry in Rwanda: The case of central medical store; MPPD		✓ Excess drug supply	it can't be generalized to other areas, because the study is limited in only one hospital & The questions are not well customized
		1. Drug supply management	✓ Poor storage management	
		2. Storage condition	✓ Poor Supply chain management and other factors influence drug expir	
(Nakyanzi et al., 2010)	Expiry of medicines in supply	1. Quantification	✓ Profit- and incentive-biased quantification	Small sample size

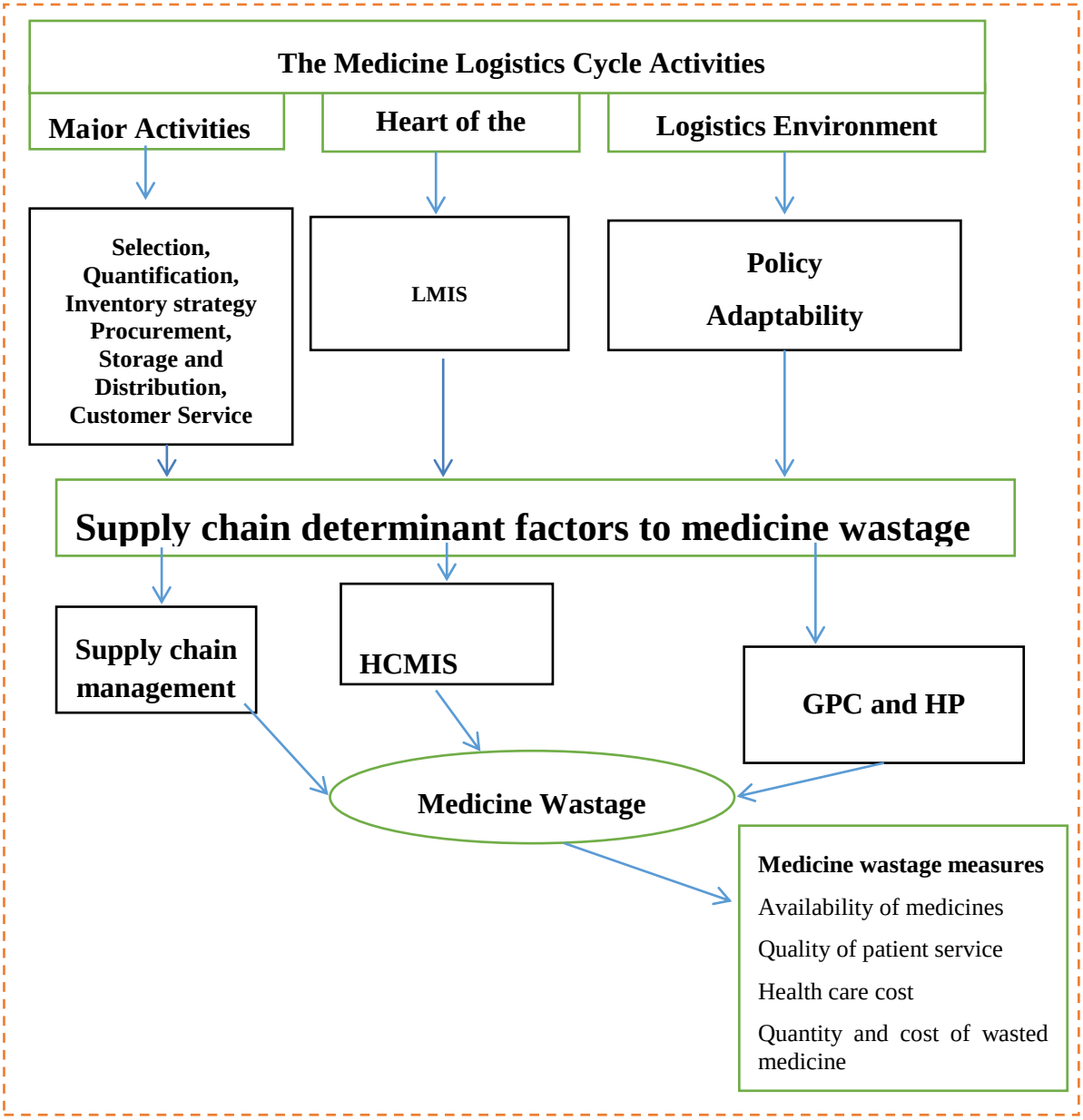
	outlets of Uganda	2. Procurement	✓ Lack of knowledge of basic expiry prevention tools	
		3. inventory management and usage	✓ Nonparticipation of clinicians in medicine quantification	
			✓ Poor stock monitoring	
			✓ Third party procurement by vertical programmers and overstocking.	
(Peltoniemi and Suomi, 2019)	Eliminating medicine waste in a Finnish university hospital a qualitative study	1. Communication and	✓ Lack of integration	The analysis excludes the hospital's senior management and IT vendors.
		Information system	✓ Inconsistent information system	
			✓ Poor usability of IT applications	
			✓ Inaccurate metrics	
			✓ In frequent ordering process	
(Kagashe et al., 2014)	Medicine wastage at tertiary hospital in Dare Salaam Tanzania	1. Medicine usage practice at inpatient wards	✓ Excess medicine usage	For the sake of reducing waste, there aren't enough patient opinions.
			✓ Pilferage of medicines	
			✓ Death of the patient and	
			✓ Discontinuation of the treatment are major sources of wastage	
(Gebremariam et al., 2019)	Factors contributing to medicines	1. HCMIS	✓ Lack of electronic stock management tools	Doesn't account for unused drugs at wards or the viewpoints of

	wastage in public health facilities of South West Shoa Zone	2. Medicine quantification	✓ Near expiry medicines (< 6 months) are being delivered to the health facilities by the supplier	other stakeholders.
		3. Inventory management and	✓ Poor stock management	
		4.Trained human resource key stake holders communication, warehousing condition	✓ Shortage of pharmacy professionals	

Conclusion: based on the objective of the above empirical evidence the major determinants of medicine wastage includes poor supply chain management, poor prescribing pattern, poor stock and storage management, over stocking, near expiry medicines (< 6 months) are being delivered to the health facilities by the supplier, excess drug supply, lack of knowledge of basic expiry prevention tools, inconsistent information system, poor usability of IT applications(lack of electronic stock management tools), inaccurate metrics, lack of integration, nonparticipation of clinicians in medicine quantification, shortage of pharmacy professionals, in frequent ordering process, excess medicine usage, pilferage of medicines, death of the patient and discontinuation of the treatment are major sources of wastage.

2.4 Conceptual framework of the study

Figure 2.2 Conceptual framework of the study



Source: ‘‘Adapted and modified from Gebremariam et al 2019; John Snow, Inc. 2017.’’

NB: - LMIS – Logistics management information system, HCMIS - Health commodity management information system, GPC and HP - Guideline policy change and Hospital practice

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Description of study area

Ethiopia's capital, Addis Ababa, is divided into 11 sub-cities and 116 woredas for administrative purposes. According to Ethiopian statistics, the population in 2009 EC/2017 GC/projected population was roughly 3.434 million. The city's health bureau administers 7 hospitals and 102 health centers, while the federal ministry of health administers the remaining 5 hospitals. Federal hospitals provide health services to the city's residents as well as those from outside the city who require more advanced medical care from a specialist physician. EPSA, which was given responsibility for obtaining supplies, is the principal source of supplies for the health facilities. Aside from that, health institutions purchase supplies from other suppliers.

3.2 Research approach

This study includes both qualitative and quantitative methods. Quantitative research is based on determining the quantity or amount of doing something. It can be used to describe phenomena that have a numerical value. The approach of the study takes a structured questionnaire of the health facilities' supply chain, with a focus on the hospital's drug store and retail pharmacies. The respondents answer was put on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).It allows for quantitative responses, as well as the collection of both opinion and emotion; it is also simple and inexpensive to analyze.

3.3 Research design

The study design was a mix of descriptive and explanatory, which was appropriate for studies that attempt to describe and analyze the cause-and-effect relationship of a specific problem. As a result, conclusions about the determinant factors that contribute to Medical waste across the supply chain was drawn.

3.4 Target population, unit of analysis and level of analysis, sample size and sampling technique

Hospitals under the Addis Ababa City Administration’s Health Bureau were the study's target populations. These are Yekatit 12 Hospital Medical College, Zewditu

Memorial Hospital, Menelik II Referral Hospital, Ras Desta Damtew Memorial Hospital, and Triunes-Beijing Hospital

3.4.1 Unit of analysis and level of analysis

The study's unit of analysis was Pharmaceutical supply chain determinants that contribute to pharmaceutical wastage. They were examined and observed, with data in the form of variables being collected. The investigation was focus on the hospital's pharmaceutical stores and retail pharmacies.

3.4.2 Sample size

Carballo's sample size determination was utilized to select 109 respondents from 283 (233 pharmacy professionals and 50 DTC members other than pharmacy professionals) populations due to the nature of the problem, time, and financial constraints. A sample size of pharmacists in positions of different pharmacy units, such as heads of the pharmacy directorate, drug supply chain (DSM) officers, pharmacists who engage in purchasing activities, store managers, retail managers, and participants in the DTC committee of each sampled hospital was used. This is because they are familiar with the problem and they can therefore provide creditworthy and valuable information.

Table 3.1 Carballo's sample size determination

Population size	**Sample size**		
	Small	Medium	Large
51-90	5	13	20
91-150	8	20	32
151-280	13	32	50
281-500	20	50	80
501-1200	32	80	125
1201-3200	50	125	200
3201-10,000	80	200	315
10,001-35,000	125	315	500
35,001-150,000	200	500	800

Table 3.2 Sample size of the study

Name of the Hospital	Yekatit 12 H/L	Zewditu H/L	Menelik H /L	Ras Desta H/L	Tirunesh-Beijing H/L	Sum

Total number of pharmacy professionals	62	47	53	37	34	233
DSM Officer	1	1	1	1	1	5
Pharmacist who engage in Purchasing activity	1	1	2	1	1	6
Pharmacy Director	1	1	1	1	1	5
Case team or Retail leaders	6	6	5	5	3	24
Store members	4	4	4	4	2	18
DTC members (Nurses, Physicians…)	13	15	8	7	7	50
Sample taken	26	28	21	19	15	109

Source: Researcher's Own (2022)

3.4.3 Sampling techniques

Because they are familiar with the nature of the problem, heads of the pharmacy directorate, all DSM officers, procurement officers, store managers and members of the DTC committee were included in the analysis.

3.5 Variables of the study

The study's independent variables include pharmaceutical supply chain determinants that causes to medicine wastage across the supply chain. Medicine wastage, on the other hand, was the study's dependent variable.

3.6 Data source and types

The study used both primary and secondary data because the information from various sources was acquired through constructed questionnaires as well as documents and reports. Data was collected from heads of pharmacy directorates, DSM officers, procurement officers, store managers, and pharmacy case team leaders at the selected hospitals by administering structured questionnaires with closed-ended questions, as well as evaluating electronic data systems, bin cards, stock cards, expiry registration forms, and other relevant data sheets.

3.7 Data collection procedure

Data was collected using a structured questionnaire with closed ended questions from April 16th to May 14th, 2022. The questionnaire includes a five-point Likert scale to determine the relative strength of determinant factors.

The questionnaire was divided into two sections. Part 1 was about data abstractions

from secondary data sources. Review and extract secondary data from the facility's pharmaceutical records, such as medicine waste registration, disposal registration (if wasted medicines are disposed), and Model 19 health documents whereas part 2 asks about the respondent's demographics and the research objectives. Questionnaires were directly administered to hospital staff to reduce response time and allow for immediate clarification of any doubts that respondents may have about any questions. However, for respondents who were short on time, the questionnaire was delivered through email and a drop-and-pick approach, allowing respondents to complete the questionnaire at their convenience time.

3.8 Methods of data analysis

The information gathered was examined in light of the goal and the variable of interest being discussed. The information gathered was coded and grouped into different categories and the participants' positions were determined. The statistical software for social science (SPSS) version 26.0 was used to examine the qualitative data acquired and correlation and regression analysis was done. The findings were provided using statistical analysis of mean, standard deviation, percentage, and frequency and the results was displayed in tables. The dependent variable is medicine wastage and the independent variables are determinants of medicine wastage across the supply chain.

3.9 Validity and reliability test

On 9 pharmacy professionals and 2 nurse professionals working outside of the chosen institutions, the validity of the standardized questionnaire was evaluated to ensure that they understood and responded as intended. This guaranteed the validity of the questionnaire that was developed. The questions utilized in this study were tested by prior researchers, which give the study more validity. The questionnaire was adopted from (Hakuzimana, 2019; Gebremariam *et al*, 2019).

The reliability of the questionnaires was evaluated using Cronbach's Alpha. Greater than 0.7 Cronbach's values are regarded as reliable. (Nunnally, 1978). Since the 31 questions used in the study had a Cronbach's Alpha score 0.94, indicating that the instrument is reliable.

Table 3.3: Reliability of supply chain determinants and medicine wastage

Reliability Statistics		
supply chain determinants and medicine wastage	**Cronbach's Alpha**	**N of Items**
Supply chain management (SCM)	0.827	9
Storage Condition	0.850	4
Guideline policy change and hospital practice (GPC & HP)	0.841	6
Health commodity management information system (HCMIS)	0.808	3
Health Care Cost	0.823	3
Essential Medicines Availability	0.845	3
Quality of Patient Care	0.807	3
Total (all variables)	0.940	31

3.10 Ethical consideration

Addis Ababa University's ethics review committee and the Addis Ababa Health Bureau's Public Health Research and Emergency Management Directorate provide ethical approval. Prior to data collection, participants' consent was obtained once they have been informed of the study's overall goal and benefits. Participants' personal information was kept anonymous, and protected from physical and psychological harm. Finally, without manipulating participant ideas, the findings were analyzed.

CHAPTER FOUR

RESULTS and DISCUSSION

4.1 Response rate

The study's goal was to collect data from 109 participants, and 99 of them provided valid responses that were used for analysis, resulting in a 90.8 % response rate.

4.2 Socio-demographic characteristics of participant

The total sample size is 99 people, with a ratio of male to female study participants 1.4. (57 versus 42 respectively). Because of the nature of the problem, the majority of the study participants were pharmacists working in various positions at the hospitals under investigation. Because they are DTC members who are familiar with the problem, the nurse, physician, and health officers are included. Participants in the study include 80 pharmacists, 9 nurses, 6 physicians, and 4 health officers. The majority of respondents (51%) have 6-10 years of experience, followed by 36 (36.4%) who have 1-5 years of experience, and the remaining 12 (12.1%) have more than 10 years of experience. Menelik referral hospital, Ras Desta Damtew hospital, Zewuditu memorial hospital, Yekatit 12 hospital, and Tirunesh Beijing hospital had respective percentages of 22.2%, 21.2%, 20.2%, 19.1%, and 17.2%. The respondents' educational levels in the Diploma Degree and Masters categories are 5, 84, and 10 respectively.

Table 4.1 Socio demographic table (N= 99)

Variables	Category	Frequency	Percent
Gender	Male	57	57.6
	Female	42	42.4
Age	20 to 30	43	43.4
	31 to 45	53	53.5
	>45	3	3.1
Professions	Physician	6	6.1
	Health Officer	4	4
	Pharmacist	75	75.7
	Druggists	5	5.1
	Nurse	9	9.1

Level of Education	Diploma	5	5.1
	Degree	84	84.8
	Masters	10	10.1
Work Experience	1 to 5 years	36	36.4
	6 to 10 years	51	51.5
	>10 years	12	12.1
Sampled Hospitals	RDDH	21	21.2
	Y12HMC	19	19.2
	MCH	22	22.2
	ZMH	20	20.2
	TBGH	17	17.2

Source: Researcher's Own (2022)

4.3 Supply chain determinant measures mean and SD of the hospitals under study

''To determine the minimum and the maximum length of the 5-point Likert type scale, the range is calculated by (5 − 1 = 4) then divided by five as it is the greatest value of the scale (4 ÷ 5 = 0.80). Afterwards, number one which is the least value in the scale was added in order to identify the maximum of this cell. The length of the cells is determined below:''

- ✓ "From 1 to 1.80 represents (strongly disagree)"
- ✓ "From 1.81 until 2.60 represents (do not agree)"
- ✓ "From 2.61 until 3.40 represents (true to some extent)"
- ✓ "From 3:41 until 4:20 represents (agree)"
- ✓ "From 4:21 until 5:00 represents (strongly agree)" (Alexander, 2009)

Table 4.2 Supply chain determinants and medicine wastage measures (N = 99)

Supply chain determinants and medicine wastage measures	Number of items	Grand Mean
Supply chain management	9	3.6
Guideline policy change and hospital practice	6	3.56
Storage Condition	4	3.53
Health commodity management information system	3	3.43
Health Care Cost	3	3.77

Essential Medicines Availability	3	3.49
Quality of Patient Care	3	3.19

Source: Researcher's Own (2022)

4.3.1 Supply chain management determinants of medicines wastage

The average mean of the Supply Chain Management Determinants construct is 3.60 (table 4.2). Nine questions were used to examine supply chain management determinants to medicine wastage, and the participant mean and SD distribution is shown in the table below (table 4.3). On average mean 3.77 of the participants agreed to on six questions that assess the problem of supply chain management. Poor communication and coordination with relevant parties were strongly agreed upon by (4.15 + 1.12) (mean + SD) of respondents; there is an oversupply of some medicines was agreed upon by (3.84 + 1.10) of respondents, near expiry medicines (in less than 6 months) are being delivered to the hospitals was agreed upon by (3.82 + 1.21) of the respondents, (3.79 + 1.19) of respondents agreed with the presence of excess inventory medicines in the hospital due to improper forecasting of need, (3.53 + 1.34) of respondents agreed that poor procurement practices are causing medicine waste and (3.51 + 1.11) of respondents agreed with medicines to treat rare diseases are procured in the hospital causing medicine waste(table 4.3).This findings are in line with the findings of (Gebremariam *et al*, 2019; Ebrahim *et al*, 2019; Mashishi, 2015; and Nakyanzi *et al*, 2010). Poor communication between the institution's internal and external stakeholders might lead to an oversupply of medicines, which can lead to medicines wastage. The availability of excess medicine results in inventory holding costs that tied up resources that could otherwise be used to purchase out-of-stock medicines, degradation, damage of the medications, and a crowded store; these results are in line with the findings of (Gebremariam *et al*, 2019; Ebrahim *et al*, 2019). Another supply chain management (SCM) construct that results and has a risk of storing expired medicines was receiving near expired medicines (< 6 months). Near expiry medications may be received due to variety of causes, such as excessive donations, the push system of procurement, and extended lead times; a study by (Ebrahim *et al*, 2019; Mashishi, 2015; Nakyanzi *et al*, 2010) also conclude that near expiry and over supply of medicines without need as causes to medicine wastage. According to a study by (Nakyanzi *et al*, 2010;Tumwine *et al*. 2010) poor procurement practices like

poor selection, poor need forecasting, and poor quantification are causes of medicine wastage.

Table 4.3 The perceived determinants of medicines wastage by study participants in selected hospitals under study Addis Ababa, Ethiopia, Aug 2022 (n=99).

Supply chain management	**Mean**	**SD**
Poor communication and coordination with key stake holders (MOH, suppliers, NGO's)	4.15	1.12
There is over supply of some medicines	3.84	1.1
Near expiry medicines (< 6months) are being delivered to the hospital	3.82	1.21
Presence of over stocked medicines due to improper forecasting of need in the hospital	3.79	1.19
Procurement practice is causing medicine wastage	3.53	1.34
Medicines to treat rare diseases are procured in the hospital	3.51	1.11
Weak physical security in the vehicle during transportation of medicines	3.4	1.14
There is discrepancy between physical count and stock cards	3.24	1.15
Selection of medicines are not based on ABC/VEN analysis(Vital, essential, None essential)	3.13	1.49
Storage conditions determinants	**Mean**	**SD**
There is not enough space for handling and moving products in the store	3.68	1.29
Medicines are stored on floor, and not arranged systematically on shelves in the hospital	3.61	1.28
Is adequate shelf life of products maintained	3.60	1.19
Medicines that need cold temperature are not stored in a functional refrigerator in the hospital	3.25	1.33
GPC and HP determinants	**Mean**	**SD**
Weak or absence of functional DTC in the hospital	3.81	1.28
Non-participation of other professionals (other than pharmacists)in medicine selection and quantification of the hospital facility	3.65	1.29
Lack of accountability for stock-outs and wastage of medicines in the hospital	3.64	1.32
Poor stock management like using neither FIFO nor FEFO in stock management	3.46	1.31
Weak or no mechanisms for medicine wastage monitoring and evaluation in the hospital	3.41	1.27
Treatment or policy changes has led to wastage of medicines	3.4	0.98
Health commodity management information system determinants	**Mean**	**SD**
No accurate data available in the hospital to facilitate quantification of medicines	3.58	1.32
There is lack of knowledge of basic expiry prevention tools	3.49	1.32
Lack of electronic stock management tools that automatically capture medicines wastage in the hospital	3.23	1.24
Essential medicines availability	**Mean**	**SD**
Some essential medicines are not available for longer period (> 15 days) due to medicine wastage	3.65	1.15
There is shortage of essential medicines by type and quantity due to medicine wastage	3.58	1.08
Patients are treated with less effective medicines due to medicine wastage (expiry, damage…)	3.25	1.24
Quality of patient care	**Mean**	**SD**
Patients receive substandard (compromised) service due to wastage of medicines	3.3	1.1
Procedures are postponed due to medicine wastage (expiry, damage)	3.24	1.17
Death and/ disability occurred due to medicine wastage	3.03	1.15
Health care cost	**Mean**	**SD**

High health care cost incurred due to costs related to wasted time spent on the supply based activities of purchasing, transporting and disposing (Logistics operation cost, disposal cost)	3.96	0.98
High health care cost incurred due to costs of unused (expired) medications	3.87	1.06
Patients are forced to buy expensive medicines due to medicines wastage	3.49	1.28

Source: Researcher's Own (2022)

4.3.2 Storage condition determinants

The average mean of the storage condition construct is 3.53 (table 4.2). The storage conditions at the study hospitals were evaluated using four qualitative questions, the results of which are provided in the table (Table 4.3). On average mean 3.63 of the participants agreed to three questions that assess the problem of Storage Condition determinants. The presence of the warehousing storage space problem are agreed by (3.68 + 1.29) (mean + SD) of the respondents, (3.61 + 1.28) of the respondents agreed on Medicines are stored on floor and not arranged systematically on shelves in the hospital which contribute to medicines wastage, maintenance of adequate shelf life of products were agreed by (3.60 + 1.19) and Medicines that need cold temperature are not stored in a functional refrigerator in the study hospital was to some extent agreed by (3.25 + 1.33) of the respondents (table 4.3). These results are in line with the findings of (Ebrahim *et al*, 2019; Gebremariam *et al*, 2019).

4.3.3 Guideline policy change and hospital practice determinants

The average mean of the Guideline policy change and hospital practice (GPC and HP) determinants construct is 3.56 (table 4.2). On average mean 3.59 of the participants were agreed on five of the six questions that evaluate GPC and HP determinants that causes medicine wastage. (3.81 +1.28) (mean + SD) of participants agree on the weak or absence of fully functional DTC, (3.65 + 1.29) of respondents were agreed that professionals other than pharmacists are not participate in medicine selection and quantification processes, lack of accountability for stock-outs and wastage of medicines in the hospital was agreeable with (3.64 + 1.32), poor stock management like using neither FIFO nor FEFO in stock management was agreed by (3.46 + 1.31) of participants, and weak or no mechanisms for medicine wastage monitoring and evaluation in the hospital was agreed by (3.41 + 1.27) (table 4.3). This is also founded in a study conducted by (Gebremariam *et al*, 2019; Hakuzimana T, 2019; Awol J, *et al*, 2019 and Nakyanzi *et al*, 2010). They observed that inadequate GPC &

HP has resulted in the buildup of excess medicine inside pharmacy warehouses and weak monitoring and evaluation lead to medicine wastage.

4.3.4 Health commodity management information system determinants

The average mean of the Health commodity management information system determinants (HCMIS) construct is 3.43 (table 4.2). Three questions were used to evaluate the HCMIS. On average mean 3.54 of the participants were agreed on two of the three questions that evaluate HCMIS. (3.58 + 1.32) (mean + SD) of participants agreed on No accurate data available in the hospital to facilitate quantification of medicines; lack of knowledge of basic expiry prevention tools was agreeable with (3.49 + 1.32) and shortage of electronic stock management tools that automatically capture medicines wastage in the hospital was to some extent agreeable by (3.23 + 1.24) of the respondents (table 4.3). This is in line with a study conducted by (Peltoniemi and Suomi, 2019; *Gebremariam et al*, 2019). They demonstrate how improper management of product information contributed to the wastage of medicines.

4.3.5 Medicine wastage operational measures

Pharmaceutical wastage was measured based on the basis of essential medicine shortages, patient care quality, and the quantity and cost of wasted medications. The average mean of essential medicine shortages is 3.49 (table 4.2). On average mean 3.62 of the participants were agreed on two of the three questions that evaluate shortage of essential medicines. Some essential medicines are not available for longer period (> 15 days) due to medicine wastage and shortages of essential medications by type and quantity related to medicine wastage was agreed by (3.65 + 1.15) and (3.58 + 1.08) (mean + SD) of respondents respectively and patient care is provided with less effective medicines due to medicine wastage was to some extent agreed by (3.25 + 1.24) of respondents (table 4.3). This finding is in line with the report of (Gebremariam *et al*, 2019 and Tumwine Y. *et al*, 2010). ‘‘A systematic review of the literature conducted by Phuong JM *et al*. in 2019 reveals that medicine is scarce in various settings and that patients are receiving alternative treatments that are not as effective as the first one’’. According to Tadeg H. *et al*, 2014.’S review of hospital pharmacies in Ethiopia, there is a shortage of essential medications as a result of poor

pharmaceutical supply chain management, which is in line with the results of this study.

The average mean of the patient care quality construct is 3.19 (table 4.2). Three questions were used to measure quality of patient care. It is true to some extent that all the respondents were agreed on all of the three questions (table 4.3). On the contrary to the previous findings on average mean 3.19 of the respondents were to some extent agreed on patients service compromised and postponing of procedures. Despite the results of this study, a systematic review of the literature done by (Phuong JM *et al*. 2019), medication wastage typically results in patient complaints, increase in the frequency of drug errors, adverse events, and mortality, in addition to patient service problems, and the delaying of operation procedures.

The average mean of the Health Care Cost constructs is 3.77 (table 4.2). Three questions were used to examine it and all participants were agreed on all of the three questions (table 4.3). The result of this study are in line with the findings of (Awol J. *et al*,2019; Gebremariam *et al*, 2019 and Lorna MW, 2015) that high value of medications are expired because of inadequate performance in pharmaceutical supply chain management.

Medication Wastage has direct and indirect outcomes; disposal cost, logistics operation cost, economic burden on society and government, and environmental impact are some of the medicine wastage costs. The direct consequence includes money lost as a result of expiry, pilferage and theft. These effects are observed in a study by (Awol J *etal*, 2019; Gebremariam *et al*, 2019 and K. Moons *et al*, 2018; Gurmu and Ibrahim, 2017; Lorna MW, 2015; Nakyanzi *et al*, 2010).

4.4 Correlation analysis between supply chain determinants and medicine wastage measures

4.4.1 Correlation analysis

The correlation analysis of supply chain determinants and medicine wastage measures was conducted. The relationship between two variables is described by correlation, which has a value range of -1 to +1; values of +1 indicate a strong relationship, 0 indicates no relationship, and values of -1 imply an opposite relationship. In correlation analysis, the correlation coefficient indicates the direction and strength of the relationship, while the p-value indicates the relationship's significance. “Pearson

correlation measures the existence (given by a p-value) and strength (given by the coefficient r between -1 and +1) of a linear relationship between two variables (Samuels, & Gilchrist, 2015). The significant outcome means that a correlation exists where an absolute value of r of 0.1 is classified as small, an absolute value of 0.3 is classified as medium, and of 0.5 is classified as large (Cohen, 1988)".

Correlation analysis between supply Chain determinants of health commodity management information system (HCMIS), supply chain management (SCM), guideline policy change and hospital practice (GPC and HP), and storage condition with medicine wastage measure is presented in the following table.

Table 4.4 Correlation between supply chain determinants and medicine wastage measures (N= 99)

		SCM	Storage Condition	GPC and HP	HCMIS	WM(Wastage Measures)
SCM	Pearson Correlation	1				
	Sig. (2-tailed)					
Storage Condition	Pearson Correlation	.667**	1			
	Sig. (2-tailed)	.000				
GPC and HP	Pearson Correlation	.672**	.710**	1		
	Sig. (2-tailed)	.000	.000			
HCMIS	Pearson Correlation	.584**	.595**	.745**	1	
	Sig. (2-tailed)	.000	.000	.000		
WM(Wastage Measures)	Pearson Correlation	.502**	.354**	.469**	.573**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
**. Correlation is significant at the 0.01 level (2-tailed).						

Source: Researcher's Own (2022)

With The Pearson coefficient of 0.573(r=0.573) and a significant value of 0.00 HCMIS has a strong relationship with the medicine wastage measures. SCM has a

strong relationship with pharmaceutical wastage measures, with a Pearson coefficient of 0.502 (r=0.502) and a significant value of 0.00. With a correlation coefficient of 0.354 (r = 0.354) and a significant value of 0.00, the storage conditions correlation with pharmaceutical wastage measures indicates that there is a moderate relationship. Medicine wastage measures have a moderate relationship with GPC and HP, with a Pearson correlation of 0.469(r=0.469) and a significant value of 0.00. This study suggests that supply chain management and health commodity management information system have a strong and positive relationship with medicine wastage.

Table 4.5 Correlation between supply chain determinants and medicine wastage (N= 99)

		SC determinant factors	Medicines wastage
SC Determinant factors	Pearson Correlation	1	
	Sig. (2-tailed)		
Medicines wastage	Pearson Correlation	.545**	1
	Sig. (2-tailed)	.000	
**. Correlation is significant at the 0.01 level (2-tailed).			

Source: Researcher's Own (2022)

The Correlation test between supply chain (SC) determinants and medicine wastage indicate that there is a strong and positive relationship with Pearson correlation coefficient of 0.545 and significant at p value of 0.00.

4.4.2 Regression analysis

Supply chain determinants and medicine wastage were studied using linear regression; a p-value of less than 0.05 indicates that supply chain determinants have a statistically significant effect on medicine wastage. The following is a representation of the model: Model of linear regression: $Y = \beta0 + \beta1\ X1 + \beta2\ X2 + \beta3\ X3 + \beta4\ X4 + \epsilon$ where Y = Medicine wastage; β0= the y intercept when x is zero; β1, β2, β3, β4, are regression coefficients of the following variables respectively; x1-HCMIS; x2-PSCM; x3-GPC& HP; x4- Storage condition; ϵ is the error term

4.4.2.1 Multi collinearity test

Table 4.6 Multi collinearity test of pharmaceutical supply chain determinants

Model	Tolerance	VIP
PSCM Practice	0.427	2.34
Storage Condition	0.468	2.14
GPC and HP	0.313	3.19
HCMIS	0.429	2.33

Source: Researcher's Own (2022)

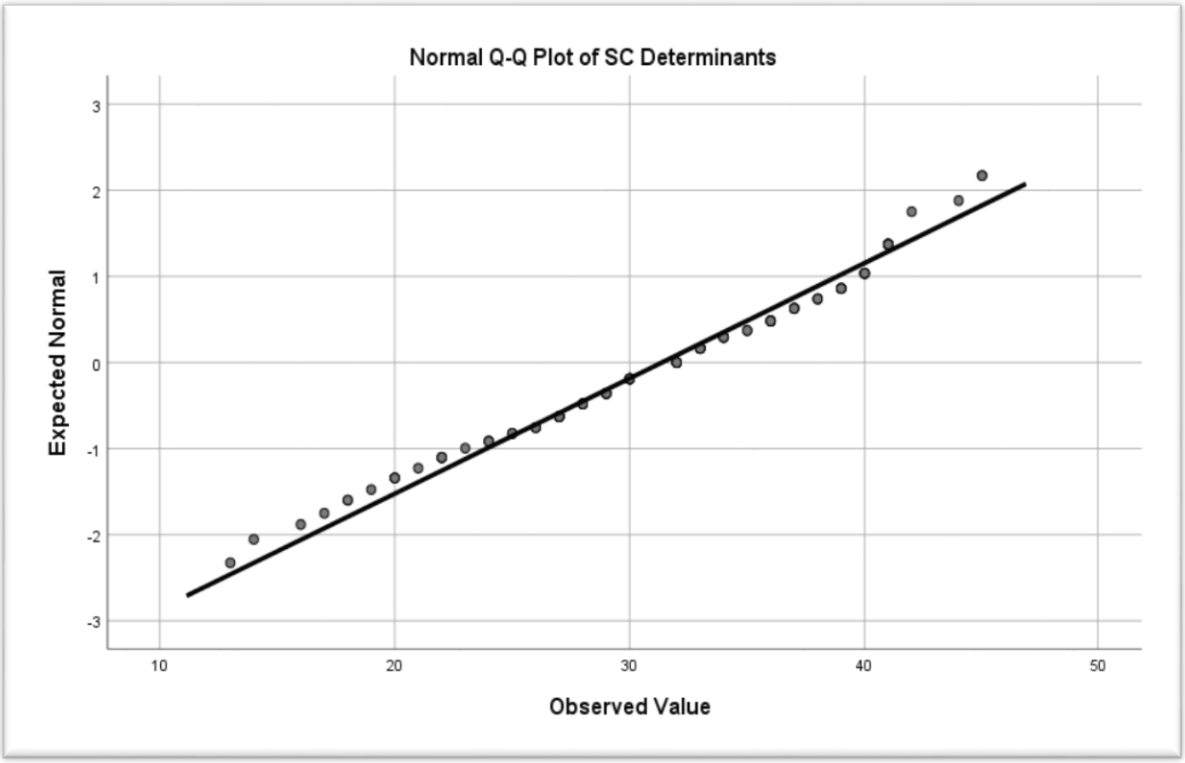
Dependent Variable: Medicine wastage

Because the tolerance value is more than 0.1 and the VIF is <10, there is no co-linearity problem of independent variables, as illustrated above (Table 4.12).

Table 4.7 Tests of normality of supply chain determinants

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SC determinants	.076	99	.184	.975	99	.053
a. Lilliefors Significance Correction						

Figure 4.1 Tests of normality of supply chain determinants



4.4.2.2 Coefficient of determination

Table 4.8 Coefficient of determination R square

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.617a	0.38	0.354	6.00203	1.947

Source: Researcher's Own (2022)

a. Predictors: (Constant), HCMIS, SCM, Storage Condition, Guideline & Policy changes and HP

The adjusted R2 0.354 coefficient of determination means that variation in SCM, storage conditions, HCMIS and GPC & HP, account for 35.4 % of the variation in pharmaceutical wastage. The adjusted R2 is relatively low ''…. In any social science settings, an R2 of 9% is considered respectable. That's about as good as it gets in most psychology studies where two distinct variables are correlated with each other. '' In this study there no multi-collinearity, therefore the model is considered to be fine even with relatively low R2 value. (Kenshi Itaoka, 2012)

4.4.2.3 ANOVA test

Table 4.9 ANOVA test

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2078.881	4	519.72	14.427	.000b
Residual	3386.29	94	36.024		
Total	5465.172	98			

Source: Researcher's Own (2022)

a. Dependent Variable: WM (Wastage measures)

b. Predictors: (Constant), HCMIS, SCM, Storage Condition, GPC and HP The regression model has a less than 0.001 chance of making a false prediction, according to the above ANOVA test results. As a result, the model is an appropriate predictor of the impact of supply chain determinants on medicine wastage (table 4.14).

4.4.2.4 Coefficients results

Table 4.10 Coefficients results

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
Constant	12.88	2.907	0	4.431	0	7.108	18.651
HCMIS	1.05	0.281	0.463	3.738	0	0.492	1.608
SCM	0.34	0.125	0.32	2.694	0.008	0.089	0.586
GPC and HP	0.01	0.194	0.01	0.069	0.945	-0.371	0.398
Storage Condition	-0.3	0.22	-0.142	-1.142	0.256	-0.687	0.185

Source: Researcher's Own (2022)

a. Dependent Variable: WM (Wastage Measures)

Beta values measure the magnitude of influence between variables, the higher the values indicate the strong the influence. The regression analysis formula with Beta coefficients is as follows:

$Y = 12.88 + 0.46\ HCMIS + 0.32\ SCM + 0.05\epsilon$

When all variables are set to zero (constant), the value of medicine wastage becomes 12.880, according to the above model (table 4.9). When other factors are held constant, a unit increase in HCMIS determinants results in a 0.46 increase in medicine wastage and a unit increase in SCM result in a 0.32 increase in medicine wastage, indicating that these two determinants have a significant impact on medicine wastage. But GPC & PH and Storage Condition have least impact on medicines wastage and they are excluded.

This study reveals that improper implementation of supply chain (SC) determinants has an impact on medicine wastage in the health care settings of hospitals under the Addis Ababa City Administration Health Bureau. Supply chain (SC) determinants generally have a positive and strong relationship with medicine wastage with Pearson correlation coefficients of 0.545 and significant at a p-value of 0.00. This study findings are in line with (Peltoniemi and Suomi, 2019; Hakuzimana, 2019; Gebremariam *et al*, 2019; Mashishi,2015;Nakyanzi *et al*,2010) studies.

4.5 Medicines wastage analysis

4.5.1 Extent of medicines wastage

In EFY 2012-2013(Jul,2019-Jun,2021), the total financial monetary value of wasted medicines in the surveyed hospitals was 9,339,542.58 Ethiopian birr (ETB), while all examined hospitals received medicines worth 193,279,074.17 ETB over the same period, resulting in a 4.83 % wastage rate(because of financial and time shortage I have taken only a two years data). A total of 3,108,471.10 ETB was wasted in EFY 2012, accounting for 3.6 % of the total value of medicines obtained by five hospitals in the same year. Wastage was estimated to be worth 6,231,071.48 ETB in the 2013 EFY, implying a 5.78 % annual wastage rate for five of the study institutions (table 4.16). This study indicated that the estimated rate of medicines wastage (in terms of monetary value) was found to be 4.83%, which is lower than the study found by Gebremariam *et al*, 2019 and Tadeg *et al*, 2014 (7.5% & 5.1%) Respectively. This might be due to strong implementation of IPLS and increased usage of electronic recording systems which enables to control of medicines inventory easily.

According to the result of this study, the average medicine wastage rate (4.83%) was higher than the national target of < 2% set on HSDP IV (FMOH, 2010). However, Auditable Pharmaceutical Transactions and Services (APTS) implementation studies in Ethiopia, found substantially lower wastage rates of 0.27 %. (FMOH, 2014b; Gedif *et al*, 2016).

Table 4.11 the estimated total medication wastage rate in hospitals and the value of medicines received. (EFY2012- 2013), Addis Ababa, Ethiopia, Aug 2022 (n=05)

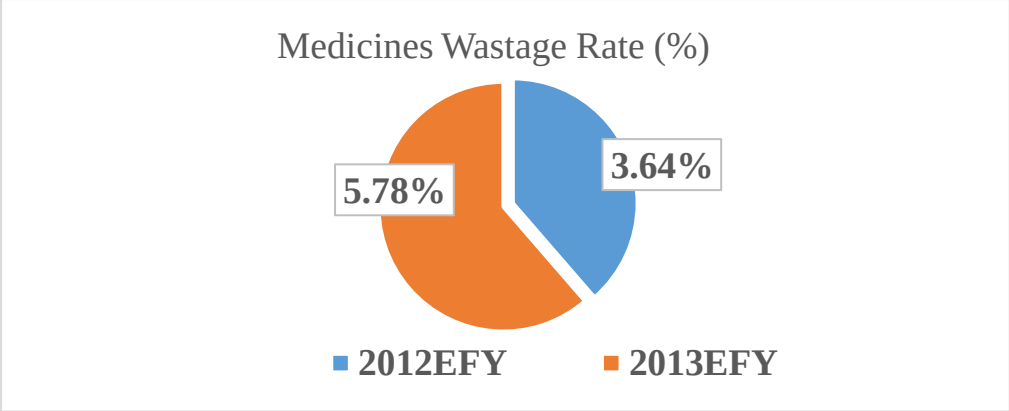
S.N	HF.CODE	2012 (Jul,2019-Jun,2020)			2013 (Jul,2020-Jun,2021)			**(EFY 2012- 2013)**		
		Received (Birr)	Wasted (Birr)	%	Received (Birr)	Wasted (Birr)	%	Received (Birr)	Wasted (Birr)	%
1	MCH	20,267,131.93	589,518.12	2.91	29,401,477.38	780,666.64	2.66	49,668,609.31	1,370,184.76	2.76
2	RD	27,067,0	408,547	1.51	18,099,20	1,765,95	9.76	45,166,27	2,174,	4.81

	DH	69.00	.95		3.17	2.87		2.17	500.82	
3	TBH	10,341,480.95	912,531.82	8.82	21,787,524.40	1,381,756.96	6.34	32,129,005.35	2,294,288.78	7.14
4	YHMC	15,517,413.07	1,030,800.76	6.64	18,169,294.80	1,362,570.18	7.50	33,686,707.87	2,393,370.94	7.10
5	ZMH	12,201,717.88	167,072.45	1.37	20,426,761.59	940,124.84	4.60	32,628,479.47	1,107,197.29	3.39
	Total Cost	**85,394,812.83**	**3,108,471.10**	**3.64**	**107,884,261.34**	**6,231,071.48**	**5.78**	**193,279,074.17**	**9,339,542.58**	**4.83**
	AVG	17,078,962.57	621,694.22	4.25	21,576,852.27	1,246,214.30	6.17	38,655,814.83	1,867,908.52	5.04

Source: Researcher's Own (2022)

For all selected hospitals, there was an overall increase in the wastage rate. It increased from 3.64 % in EFY 2012 to 5.78 % in EFY 2013. (Figure 4.1). This might be due to poor documentation practice of medicines wastage manually and because of most of the secondary data was collected from medicine electronic recording system called ''DAGU system'' and these system improves its capacity from time to time. This finding is in contrary to impact evaluation report revealed that IPLS is improving medicines wastage impact (PFSA, 2014). In the 2012 EFY and 2013 EFY, it was estimated that annual medicine wastage costs 3,108,471.10 ETB and 6,231,071.48 ETB, respectively. This indicated that the financial burden of costs of medication wastage in health facilities would be enormous. The stock of expired medications is a waste of resources that a country with limited resources cannot afford (Tumwine *et al*, 2010). To minimize any financial loss suffered by the health institutions, it is crucial that the health facilities must implement essential preventive measures.

Figure 4.2 Medicines wastage rate of all of sampled hospitals in Addis Ababa, Ethiopia (EFY 2012 - 2013), Aug 2022



Source: Researcher's Own (2022)

4.5.2 Types of wasted medicines

On the basis of their value, the types of wasted medicines were explored in terms of classes, dosage forms, and sources.

4.5.2.1 Classes of wasted medicines

Overall, 255 different types of wasted pharmaceuticals were identified in all hospitals assessed during the EFY2012-2013 period. Anesthesia medications (23.32%), cardiovascular medicines (19.85%), medicines acting on the central nervous system (16.38 %), and anti-infective medicines (16.21%) were the most common therapeutic categories of wasted drugs in terms of value (table 4.17). In contrary to the other findings anti invectives was much lower than what was found from the study in Ethiopia and Tanzania, (Gebremariam *et al*, 2019; Kagashe *et al*, 2014). Anesthesia medicines were the leading class of wasted medicines in this study. This is because of the presence of over stocked class of medicines due to push system without actual need by donor agencies and government institutions like EPSA (Kagashe *et al*, 2014; FMOH, 2010b).

Table 4.12 Estimated value of medicines wastage by classes in the study hospitals (EFY2012- 20213), Addis Ababa, Aug 2022

Classes of medicines	Value of wasted medicines (ETB)	
	N	% (From total wastage)
Anaesthesia medicine	2,177,697.21	23.32
Cardiovascular	1,853,449.75	19.85
Central nervous system	1,530,013.39	16.38
Anti-infective	1,513,993.95	16.21
Gastrointestinal	560,720.58	6

Ophthalmic agents	500,869.31	5.36
Immunological preparation	423,425.33	4.53
Blood products/ Anti anaemic	257,119.84	2.75
Water, electrolyte and acid-base balance correcting	175,594.04	1.88
Dermatological agents	147,081.99	1.57
Vitamins	115,790.98	1.24
Obstetric/ Gynaecological	41,086.49	0.44
Musculoskeletal	39,308.34	0.42
Ear-Nose- Throat preparations	3,371.38	0.04
Respiratory	20	0
Total	9,339,542.58	100

Source: Researcher's Own (2022)

The top three wasted pharmaceuticals in terms of value were ciprofloxacin 2mg/ml in 100ml Intravenous Infusion (10.50%), followed by halothane 250 ml inhalation (9.6%), and Nifedipine 20mg tablet (8.61%) (Table 4.18).

Table 4.13 Top ten pharmaceuticals wasted (value) in study hospitals (EFY2012-20213), Addis Ababa, Aug 2022

S No	Description of Wasted Medicines in Generic Name	Unit type	Value in ETB	% (From total wastage)
1	Ciprofloxacin - 2mg/ml in 100ml - Intravenous Infusion	Bag	938632	10.05
2	Halothane - 250 ml – Inhalation	Vial	938600	10.05
3	Nifedipine - 20mg - Tablet	Tab	803798	8.61
4	Vecronium Bromide -10 mg in vial -powder for injection	Vial	411617	4.41
5	Hydralazine - 20mg/ml in 1ml ampoule - Injection	Amp	392181	4.2
6	Aluminium Hydroxide + Magnesium Trisilicate - Tablet (Chewable) - (120mg + 250mg)	Tab	340918	3.65
7	Diclofenac Sodium - 25mg/ml in 3ml ampoule - Injection	Amp	340366	3.64
8	Thiopental Sodium - 0.5 g - Powder for injection	Vial	290252	3.11
9	Diclofenac Sodium - 50mg - Tablet	Tab	276110	2.96
10	Carbamazepine 200mg tab	Tab	250982	2.69

Source: Researcher's Own (2022)

4.5.2.2 Medicines wastage by dosage form

Medicine wastage in all dosage forms (solid, semisolid, liquid, and gaseous) was identified at the health institutions investigated. Solid dosage forms accounted for

65.86 % (6,150,456.16 ETB) of the total worth of wasted medicines (9,339,542.96 ETB), followed by liquid dosage forms 32.48 % (3,033,833.01 ETB) and semisolid dosage 1.66 % (154,959.79 ETB). 6.39 % (596,398.20 ETB) of the total value of wasted medicines were found in the form of ointments, 25.84 % (2,413,284.04 ETB) in the form of injection, 30.79 % (2,875,209.63 ETB) in the form of powders and 34.15 % (3,189,057.77 ETB) in the form of tablets (Table 4.19).

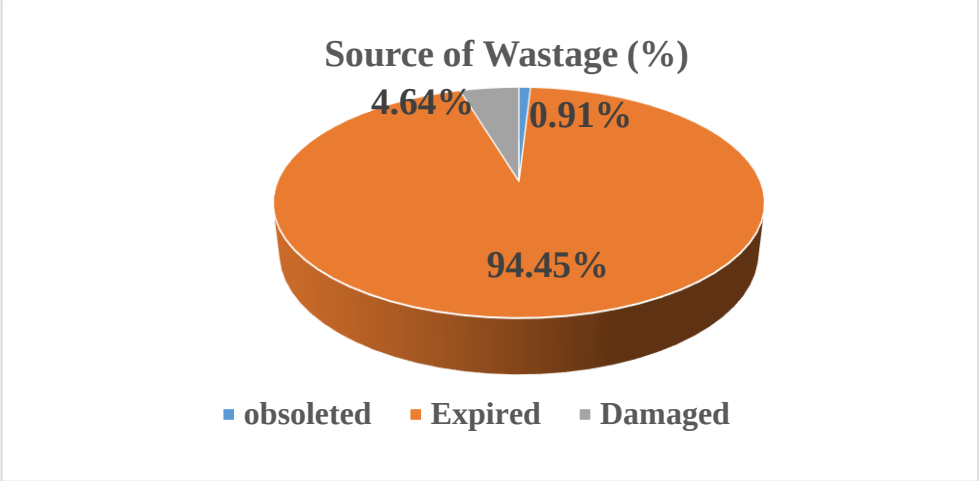
Table 4.14 Frequency and estimated value of medicines wastage by dosage forms in the study hospitals (EFY2012- 20213), Addis Ababa, Aug 2022

S.NO	Dosage Forms	Value	% (From total wastage)
1	Tablet	3,189,057.77	34.15
2	Powder	2,875,209.63	30.79
3	Injection	2,413,284.04	25.84
4	Ointment	596,398.20	6.39
5	Capsule	86,188.76	0.92
6	Suspension	81,761.84	0.88
7	Cream	40,689.88	0.44
8	Syrup	24,150.77	0.26
9	Gels	17,105.87	0.18
10	Lotions	9,204	0.10
11	Sachets	5,447.20	0.06
12	Elixir	751	0.01
Total Quantity		9,339,248.96	100

Source: Researcher's Own (2022)

4.5.2.3 Reasons of medicines wastage

Medicines were identified to be wasted due to expiration, deterioration, and obsolescence (out of the market before their expiry date). Nearly 94.45% of the total worth of wasted medicines in this study was due to expiration. In the EFY 2012-2013, it cost 8,820,947.41 ETB. Damaged / deteriorated medicines cost 433,776.98 ETB (4.64%) and obsoleted medicines cost 84,818.31 ETB (0.91 %) in the same period. Theft and pilferage were not documented as a source of pharmaceutical wastage in any of the sampled health institutions (Figure 4.2). This finding is in line with the study done by Gebremariam *et al*, 2019 & Kagashe *et al*, 2014.



Source: Researcher's Own (2022)

Figure 4.3 Percentage of medicines wastage by reason in the study hospitals (EFY2012- 20213), Addis Ababa, Aug 2022

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter summarizes the major data findings, draws conclusions from the findings that are highlighted, and offers suggestions for readers and future researchers on the area of medicines wastage across the supply chain. The analysis of the findings and recommended solutions focused on the problems of medicines wastage across the supply chain in hospitals and public health facilities.

Using SPSS version 26.0, this study analyzes participant responses both qualitatively and quantitatively. The study's findings were discussed in four different thematic areas and with operational medicine wastage measures.

5.2 Summary of the findings

5.2.1 Supply chain management determinants of medicine wastage

Poor coordination and communication between key stakeholders (4.15 + 1.12) (Mean + SD), oversupply of some medicines (3.84 +1.10), delivery of near expiry date medicines by EPSA (3.82 + 1.21), presence of overstocked medication due to improper forecasting of need in the hospitals, (3.79 + 1.19) and poor procurement practice causing medication wastage (3.53 + 1.34) were agreeable by the study participants and identified as major determinant factors for medicines wastage. Supply chain management (SCM) determinants have a strong relation with medicine wastage with Pearson correlation coefficients of 0.502 and significant with a p-value of 0.00.

5.2.2 Storage conditions determinants of medicine wastage

The presence of the warehousing storage space problems (3.68 + 1.29) (mean + SD), medicines are stored on floor and not arranged systematically on shelves in the hospitals which contribute to medicines wastage (3.61 + 1.28), and medicines that need cold temperature are not stored in a functional refrigerator in the study hospital (3.25 + 1.33) were agreeable by the study participants and identified as major determinant factors for medicines wastage. The association between the storage

condition and medication wastage is moderate, with a Pearson correlation coefficient of 0.35 which is significant at a p-value of 0.00.

5.2.3 Guideline policy change and hospital practice determinants

Weak or absence of fully functional drug and therapeutic committee (DTC) (3.81 +1.28) (mean + SD), lack of accountability for stock-outs and wastage of medicines in the hospitals (3.64 + 1.32), professionals other than pharmacists are not participate in medicine selection and quantification processes (3.65 + 1.29), poor stock management like using neither FIFO nor FEFO (3.46 + 1.31), and weak or no mechanisms for medicine wastage monitoring and evaluation in the hospital (3.41 + 1.27) were agreeable by the study participants and identified as major determinant factors for medicines wastage. GPC & HP has positive and moderate relationships with medicine wastage with a Pearson correlation coefficient of 0.47 and significant a p-value of 0.00.

5.2.4 Health commodity management information system determinants

No accurate data available in the hospital to facilitate quantification of medicines (3.58 + 1.32) (mean + SD); lack of knowledge of basic expiry prevention tools (3.49 + 1.32) and shortage of electronic stock management tools that automatically capture medicines wastage in the hospital (3.23 + 1.24) were agreeable by the study participants and identified as major determinant factors for medicines wastage. The relationship with medicine wastage is positive and strong with a Pearson correlation coefficient of 0.57 and significant a p-value of 0.00.

5.2.5 Medicine wastage measures

Hospital medicine wastage measures are investigated using metrics for patient service quality, healthcare cost and quantity of wasted medicine, and shortage of essential medicines. Patients are forced to purchase expensive medicines due to wastage. Some drugs are not available for longer periods of periods (> 15 days), there is a shortage of essential medicines by quantity and type, high health care costs incurred and the high value of medicines are expired due to wastage were important findings of the study that are agreeable by (3.49 + 1.20) (mean + SD), (3.65 + 1.15), (3.58 + 1.08), (3.96 + 0.98) of the respondents respectively. A high quantity of medicines (> 2 %) is wasted which is greater than the national recommended amount, with a wastage rate of 4.83 % and a monetary value of 9,339,542.58 Ethiopian birr.

5.3 Conclusion

After professional salaries, pharmaceuticals account for the second-largest portion of the health care economy. The country's health care economy and limited resources are greatly impacted by this pharmaceutical wastage in the hospitals. This problem is worse in a nation like Ethiopia, where 80% of pharmaceuticals are imported. Poor coordination and communication between key stakeholders, oversupply of some medicines, delivery of near expiry date medicines, presence of overstocked medication due to improper forecasting of need in the hospitals, poor procurement practice, the presence of the warehousing storage space problem, weak or absence of fully functional drug and therapeutic committee (DTC) and lack of accountability for stock-outs and wastage of medicines in the hospitals were identified as major determinant factors for medicines wastage. The study's findings indicate a direct relationship between the quantity and quality of patient care, the availability of essential medicines, health care cost and the degree of pharmaceutical wastage. Therefore, quick action should be taken by responsible bodies at each level in the health care system to enhance Health commodity management information system, supply chain management, procurement processes, guidelines, and policy implementation in hospitals to reduce medicine wastage and its impact.

5.4 Recommendation and Areas of future research

5.4.1 Recommendation

Wasted medicine increases the cost of logistics operations, disposal expenses, and environmental impacts. This study reveals a scarcity and stock out of essential medications, expensive and huge quantity of medicine wastage, as well as the high impact of medicine wastage on health care costs.

The first and second factors this study identified as determinants of pharmaceutical wastage were poor health commodity management information system (HCMIS) and weak supply chain management (SCM) practice. The primary stages in which medicine is wasted are during the selection, inventory management, and procurement, distribution, and usage phases of the SCM cycle for medicines. Poor coordination and communication between key stakeholders, delivery of near expiry date medicines, presence of overstocked medication due to improper forecasting of need in the hospitals, poor procurement practice, the presence of the warehousing

storage space problem, weak or absence of fully functional drug and therapeutic committee (DTC) and lack of accountability for stock-outs and wastage of medicines were identified as major determinant factors for medicines wastage in the hospitals under study. Due to this, concerned government organizations and hospital administrators should be aware of the various dimensions of the impact of medicine wastage. They should establish better methods for acquiring medicines and enhance inventory management processes, particularly in the areas of forecasting, stock management, demand management, and information management. They should then strengthen health commodity management information system, pharmaceutical supply chain management functions and undergo performance evaluations.

Key stakeholders (HFs, health bureau, FMOH, EFDA, EPSA, and partners) should form a solid partnership or common platform to have regular discussions on preventive measures against medicines wastage.

5.4.2 Implication for future research

The research's scope is restricted to five hospitals in Addis Ababa that are part of the Addis Ababa administration's regional health bureau, and it has a small sample size. However, interested researchers can analyze the problems in other ways, such as by increasing the sample size or by using a different design or methodology in different geographical areas.

References

Allan, W., (2013). Analysis of challenges of medical supply chains in sub-Saharan Africa regarding inventory management and transport and distribution. *International Journal Of Health Planning And Management*. http://www.transaid.org/medical-supply-chain-challenges-masterthesis

Alexander, R. (2009b). Towards a comparative pedagogy. In R. Cowen & A. M. Kasamias (Eds.), International Handbook of Comparative Education (pp. 923-942). New York, Springer.

Beyene, D, Abuye, H., & Tilahun, G. (2020). Effect of Auditable Pharmaceutical Services and Transaction System on Pharmaceutical Service Outcomes in Public Hospitals of SNNPR, Ethiopia. *Integrated Pharmacy Research and Practice*, *Volume 9*, 185–194. https://doi.org/10.2147/iprp.s277080

Cohen, J. (1988) Statistical Power Analysis for the Behavioral Sciences, 2nd ed. Hillsdale, NJ: Erlbaum.

De Vries, J., & Huijsman, R. (2011). Supply chain management in health services: An overview. *Supply Chain Management: An International Journal*, *16*(3), 159–165. https://doi.org/10.1108/13598541111127146

Ebrahim, A. J., Teni, F. S., & Yimenu, D. K. (2019). Unused and Expired Medications: Are They a Threat? A Facility-Based Cross-Sectional Study. *Journal of Primary Care and Community Health*, 1–11. https://doi.org/10.1177/2150132719847857

Farrugia, C. a. (2005). Controlled temperature storage of medicinals Good practice measures. *Journal of the Malta College of Pharmacy Practice*, *10*.

Fentie, M., Fenta, A., Moges, F., Oumer, H., Belay, S., & Sebhat, Y. (2015). Availability of Essential Medicines and Inventory Management Practice in Primary Public Health Facilities of Gondar Town , North West Ethiopia. *Journal of PharmaSciTech*, 2–4.

FMACA, 2013. List of Human Medicine and Medical Equipment/Supplies Exporter,

Importer and Wholesalers.

FMHACA. (2011b). *Medicines Waste Management and Disposal Directive Administration and Control Authority of Ethiopia*.

FMHACA. (2015). *National Essential Medicine List Fifth Edition Administration and Control authority of Ethiopia*. 1–37.

FMOH (2010). Federal Ministry of Health of Ethiopia plan and program directorate, Health Sector Development IV (HSDP IV /2010-2015) plan. Federal Ministry of Health, Addis Ababa, Ethiopia

FMOH (2014b). Health Sector Development Program IV: Annual Performance Report (2013/14). Federal Ministry of Health, Addis Ababa, Ethiopia

FMOH. (2015). Ethiopian Health Sector Transformation Plan.2015/16 - 2019/20. *Federal Democratic Republic of Ethiopia Ministry of Health*, *20*(May), 50.

Gebremariam, E. T., Gebregeorgise, D. T., & Fenta, T. G. (2019). Factors contributing to medicines wastage in public health facilities of South West Shoa Zone, Oromia Regional State, Ethiopia: A qualitative study. *Journal of Pharmaceutical Policy and Practice*, 1–7. https://doi.org/10.1186/s40545-019-0192-z

Gedif T, Teshome D, Sebsibie F, Assefa T, Gulelat B, Beedmariam G, Abdulber S, Bayissa R, Adinew A, Tadeg H (2016). Implementation of Auditable Pharmaceutical Transaction and Services in Ethiopia: Assessment Report. Special Bulletin 18th Annual Review meeting, Federal Ministry of Health, Addis Ababa, Ethiopia

Gurmu, T. G., & Ibrahim, A. J. (2017). Oromia Bölgesel Devleti Doğu Shewa, Etiyopya'daki sağlık tesislerinde en önemli temel ilaçların envanter yönetimi performansı. *Cukurova Medical Journal (Çukurova Üniversitesi Tıp Fakültesi Dergisi)*, *42*(2), 277–277. https://doi.org/10.17826/cutf.322908

Hakuzimana, T., Kayumba, P. C., Hahirwa, I., & Kabalisa, M. (2021). Assessment of Factors Contributing to Medicine Expiry in Rwanda: Case of the Medical

Procurement and Production Division. *Rwanda Journal of Medicine and Health Sciences*, *4*(2), 281–291. https://doi.org/10.4314/rjmhs.v4i2.7

Iqbal, M. J., Geer, M. I., & Dar, P. A. (2017). Medicines management in hospitals: A supply chain perspective. *Systematic Reviews in Pharmacy*, *8*(1), 80–85. https://doi.org/10.5530/srp.2017.1.14

John Snow, Inc. 2017. The Supply Chain Manager's Handbook, A Practical Guide to the Management of Health Commodities. Arlington, Va.: John Snow, Inc. - Bing [WWW Document], n.d. URL

Josephine Katabaazi Nakyanzi. (2010). Expiry of medicines in supply outlets in Uganda. *Bulletin of the World Health Organization*, *88*, 154–158. https://doi.org/10.2471/BLT.08.057471

Kagashe, G. A., Makenya, F. B., & Buma, D. (2014). Medicines wastage at a tertiary hospital in Dar es salaam Tanzania. *Journal of Applied Pharmaceutical Science*, *4*(6), 098–102. https://doi.org/10.7324/JAPS.2014.40615

Kenshi Itaoka, (2012). Regression and interpretation low R-squared. Social Research Network 3nd Meeting Noosa. Mizuho Information & Research Institute, Inc

L.M West. (2014). A systematic review of the literature on 'medication wastage': an exploration of causative factors and effect of interventions. *International Journal of Clinical Pharmacy*, *36*, 873–881. https://doi.org/10.1007/s11096-014-9981-2

Mashishi, K.A., 2015. Expiration of drugs in public hospital pharmacies of Sekhukhune District, Limpopo Province, South Africa (PhD Thesis).

M. Shareefdeen.(2012). Waste Management and Control. *Journal of Environmental Protection*, *3*, 1625–1628. https://doi.org/10.1080/21551278.1967.10114792

Mekuwanint Nega. (2017). *College of Business and Economics School of Commerce Department of Logistics and Supply Chain Management Graduate Program Assessment of Challenges of Pharmaceutical Supply Chain in Public*.

Mohammed, S. A., Mengesha, H. Y., & Hailu, A. D. (2020). Integrated pharmaceutical logistic system in Ethiopia: Systematic review of challenges and

prospects. *Journal of Biology and Medicine: Open Access Research Article* |, *1*(2), 113. www.gnoscience.com

Moons, K., Waeyenbergh, G., & Pintelon, L. (2018). Measuring the logistics performance of internal hospital supply chains – A literature study. *Omega (United Kingdom)*, 1–13. https://doi.org/10.1016/j.omega.2018.01.007

Nunnally, Jum C. (1967), Psychometric Theory, 1st ed., New York: McGraw-Hill. (1978), Psychometric Theory, 2d ed., New York: McGraw-Hill.

Peltoniemi, T., Suomi, R., 2019. Eliminating medicine waste in a Finnish university hospital a qualitative study. Journal of Pharmaceutical Policy and Practice https://doi.org/10.1186/s40545-019-0188-8

PFSA (2014).The Ethiopian Pharmaceuticals Supply Chain Management System Monitoring and Evaluation Training Manual. Pharmaceutical Fund and Supply Agency, Addis Ababa, Ethiopia

PFSA (2015). Standard operating Procedure Manual for The Pharmaceuticals Logistics System in Health facilities of Ethiopia. Pharmaceutical Fund and Supply Agency, Addis Ababa, Ethiopia

Phuong JM, Penm J, Chaar B, Oldfield LD, Moles R (2019) The impacts of medication shortages on patient outcomes: A scoping review. PLoS ONE 14(5): e0215837. https://doi.org/ 10.1371/journal.pone.0215837

Romero, A. (2013). Managing medicines in the hospital pharmacy: Logistics inefficiencies. *Lecture Notes in Engineering and Computer Science*, *2*, 1120–1125.

Samuels, & Gilchrist, 2015.Pearson Correlation. http://www.statstutor.ac.uk/resources/uploaded/pearsoncorrelation3.pdf.

Tadeg. (2014). *Auditable Pharmaceutical Transactions and Services (APTS): Findings of the Baseline Assessment at Federal, Addis Ababa, and Teaching Hospitals. Submitted to the US Agency for International Development by the Systems for Improved Access to Pharmaceuticals*. *July*, 1–50.

Tiye, K., & Gudeta, T. (2018). Logistics management information system performance for program drugs in public health facilities of East Wollega Zone, Oromia regional state, Ethiopia. *BMC Medical Informatics and Decision Making*, *18*(1), 1–13. https://doi.org/10.1186/s12911-018-0720-9

Tumwine, Y., Kutyabami, P., Odoi, R. A., & Kalyango, J. N. (2010). Availability and expiry of essential medicines and supplies during the "Pull" and "Push" drug acquisition systems in a Rural Ugandan Hospital. *Tropical Journal of Pharmaceutical Research*, *9*(6), 557–564. https://doi.org/10.4314/tjpr.v9i6.63555

USAID (2011). The Logistics Handbook: A Practical Guide for the Supply Chain Management of Health Commodities, 2nd edn, Arlington, USA.

USAID, CDC (2014). The president's malaria initiative (PMI): The eighth annual report to congress USA.

West, L. M., Diack, L., Cordina, M., & Stewart, D. (2015). Applying the Delphi technique to define "medication wastage." *European Journal of Hospital Pharmacy , 22*(5), 274–279. https://doi.org/10.1136/ejhpharm-2014-000593

Yousefi, N, & Alibabaei, A. (2015). Information flow in the pharmaceutical supply chain. *Iranian Journal of Pharmaceutical Research*, *14*(4), 1299–1303. https://doi.org/10.22037/ijpr.2015.1764

ANNEXES

Annex 1: Determinant of Medicines Wastage Tools

Background information for public hospitals

Facility Identification	Code Classification
1.1. Hospital Code:_____	
1.3. Types of the hospital: _____	
1.3. When the health facility was established (E.C)? _____	

Section I: Data Abstraction Formats

Instruction:

Inform the head pharmacist. Then, with the help of the store manager, review and extract secondary data from the facility's pharmaceutical records, such as medicine waste registration, disposal registration (if wasted medicines are disposed), and Model 19documents.

1. Data Collection Sheet for Medicines Wastage Value

No.	**Question**	**Year**			
		2020 (2012 EFY)	2021 (2013EFY)		
3.1	Total Value (in ETB) of Budget Medicines Received				
3.2	Value of Budget Medicines wasted (in ETB)				
	- Expired				
	- Damaged				
	- Obsolete				
	- Theft and pilferage				
	- Others(Specify)_____				
	- Total value				
3.3	Beginning stock				

1. Data Collection Sheet for Medicines wastage records (2020-2021)

S.N	Drug Name	Strength	Dosage Form	Amount Wasted	Source for wastage	Cost / sales value
1						
2						
3						
4						

Section II. Self-Administered Questionnaire for Data Collection on Determinants of Medicines Wastage across the Supply Chain

Addis Ababa University School of Commerce

Department of Logistics & Supply Chain Management

Information Sheet and Informed Consent

My name is Bitwoded Baye, I am a logistics and supply chain management Graduate class student at Addis Ababa University College of Business and Economics school of commerce. Currently I am conducting a research with the title "Determinant Factors for medicine Wastage across the supply in Hospitals under Addis Ababa City Administration Heath Bureau; Addis Ababa, Ethiopia". The purpose of the paper is to investigate the factors that are contributing for medicine wastage in your institution. The information you are giving will be used for the partial fulfillment for the master's thesis. I will assure you that the information you are given will be kept anonymous and confidential and also you are not asked to provide your address. I ask your frank response for the success of the study.

Please don't hesitate to contact me for any inquiry; I am available as per your need at

Kindly Regards: Bitwoded Baye

Mobile No: 0929- 317612 or

E-mail: bitwodedbaye@gmail.com

1.Socio-demographic Characteristics of Respondents

1.1 Sex Male ☐ Female ☐

1.2 Age in years:

20-30 years ☐ 31-45 years ☐ >45 years ☐

1.3 Total work experience in years:

1-5 years ☐ 6-10 years ☐ >11 years ☐

1.4 Level of education:

Diploma ☐ Degree ☐ Masters ☐ PHD ☐ Others-----

1.5 Professions:

a. Phisicians ☐ b. Health officer ☐

c. Pharmacist ☐ d. Nurse ☐

Others (Specify)_____

2: Questions on Determinants of Medicine Wastage across the supply chain at the public hospitals

In this section, we ask your feelings about determinant factors for Medicine Wastage (Expiry, Damage, Obsolete, Theft or others) in your facility. For each statement on the left, please encircle one number which best describes the level of your agreement (1=strongly Disagree (SD); 2=Disagree (D); 3=Neutral-N (Neither agree nor disagree); 4=Agree (A) and 5=strongly Agree (SA))

A	Poor Supply chain management	SD	D	N	A	SA
1	Selection of medicines are not based on ABC/VEN analysis(Vital, essential, Necessary) which results medicine wastage	1	2	3	4	5
2	Presence of over stocked medicines due to improper forecasting of need in the hospital results medicines wastage	1	2	3	4	5
3	Poor communication and coordination with key stake holders (MOH, suppliers, NGO's) causes for medicines wastage	1	2	3	4	5
4	Near expiry medicines (< 6months) are being delivered to the hospital which causes medicines wastage	1	2	3	4	5
5	Medicines to treat rare diseases are procured in the hospital which causes medicines wastage	1	2	3	4	5
6	There is over supply of some medicines which results medicines wastage	1	2	3	4	5
7	Weak physical security in the vehicle during transportation of medicines which results product theft	1	2	3	4	5
8	There is discrepancy between physical count and stock cards	1	2	3	4	5

9	Procurement practice is causing medicine wastage	1	2	3	4	5
B	**Poor Storage Condition**	**SD**	**D**	**N**	**A**	**SA**
1	Unable to maintain adequate shelf life of products results medicines wastage	1	2	3	4	5
2	Medicines are stored on floor, and not arranged systematically on shelves in the hospital which results spoilage and damage of medicines	1	2	3	4	5
3	There is not enough space for handling and moving products in the store which results medicines damage	1	2	3	4	5
4	Medicines that need cold temperature are not stored in a functional refrigerator in the hospital results spoilage of medicines	1	2	3	4	5
C	**Poor Guideline & Policy changes and Hospital practice**	**SD**	**D**	**N**	**A**	**SA**
1	Poor stock management like using neither FIFO nor FEFO in stock management which results medicines wastage	1	2	3	4	5
2	Weak or no mechanisms for medicine wastage monitoring and evaluation in the hospital	1	2	3	4	5
3	Weak or Absence of functional DTC in the hospital which results medicines wastage	1	2	3	4	5
4	Treatment or policy changes has led to wastage of medicines	1	2	3	4	5
5	Non-participation of other professionals (other than pharmacists)in medicine selection and quantification of the	1	2	3	4	5

	hospital facility contributes to medicines wastage					
6	Lack of accountability for stock-outs and wastage of medicines in the hospital	1	2	3	4	5
D	**Weak Health Commodity Management Information System**	**SD**	**D**	**N**	**A**	**SA**
1	No accurate data available in the hospital to facilitate quantification of medicines that results medicines wastage	1	2	3	4	5
2	Lack of electronic stock management tools that automatically capture medicines wastage in the hospital	1	2	3	4	5
3	There is lack of knowledge of basic expiry prevention tools which results medicines wastage	1	2	3	4	5
E	**Medicine Wastage Measures**					
	Quality of patient care	**SD**	**D**	**N**	**A**	**SA**
1	Patients receive substandard (compromised) service due to wastage of medicines	1	2	3	4	5
2	Procedures are postponed due to medicine wastage (expiry, damage)	1	2	3	4	5
3	Death and/ disability occurred due to medicine wastage	1	2	3	4	5
	Essential medicines availability	**SD**	**D**	**N**	**A**	**SA**
1	There is shortage of essential medicines by type and quantity due to medicine wastage	1	2	3	4	5
2	Some essential medicines are not available for longer period (>	1	2	3	4	5

	15 days) due to medicine wastage					
3	Patients are treated with less effective medicines due to medicine wastage (expiry, damage…)	1	2	3	4	5
	Health care cost	**SD**	**D**	**N**	**A**	**SA**
1	High health care costs incurred due to costs of unused (expired) medications	1	2	3	4	5
2	High health care costs incurred due to costs related to wasted time spent on the supply-based activities of purchasing, transporting, and disposing of (Logistics operation cost, disposal cost)	1	2	3	4	5
3	Patients are forced to buy expensive medicines due to medicines wastage	1	2	3	4	5