SUPPLY CHAIN PERFORMANCE OF ANTI-RETRO VIRAL THERAPY DRUGS MANAGEMENT PRACTICE IN SELECTED PUBLIC HEALTH HOSPITALS UNDER ADDISABABA CITY ADMINISTRATION GOVERNMENT HEALTH BUREAU.

By

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(ID.NO.GSE/8536/12)

JUNE, 2024

Addis Ababa

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A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY'S SCHOOL OF COMMERCE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER'S DEGREE IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

JUNE, 2024

Addis Ababa

Ethiopia

DECLARATION

I, ***Hibreteseb Tobiyaw***, hereby declare that this thesis, entitled "Supply Chain Performance of Anti-retroviral Therapy Drug Management Practice in Selected Public Health Hospitals under Addis Ababa City Administration Government Health Bureau, has been carried out by me under the guidance and supervision of ***Shiferaw Mitiku (Ph.D.).*** The thesis is original and has not been submitted for the award of any degree or diploma to any university or institution.

Declared by: -*Hibreteseb Tobiyaw (B.Pharm.)*

Signature----------

Date ----------

CERTIFICATE

This is to certify that the thesis, "Supply Chain Performance of Anti-retro viral Therapy Drug Management Practice in Selected Public Health Hospitals under Addis Ababa City Administration Government Health Bureau," submitted to Addis Ababa University's School of Commerce for the award of the Degree of Master of Arts in Logistics and Supply Chain Management, complies with Addis Ababa University's rules and standards.

Advisor, Shiferaw Mitiku (Ph.D.) **Sign. _____** Date_____

ADDIS ABABA UNIVERSITY

SCHOOL OF COMMERCE

DEPARTMENT OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Supply Chain Performance of Anti-retro viral therapy drugs Management Practice in Selected Public Health Hospitals under Addis Ababa city Administration Government Health Bureau.

Addis Ababa, Ethiopia

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Acknowledgement

First of all, I would like to thank my Almighty God for giving me the inspiration, courage, and patience to reach this stage of my proposal work. I would then like to extend my deepest gratitude to my instructor, ***Shiferaw Mitiku (Ph.D.),*** for his unreserved and invaluable advice, starting from title selection to reviewing my thesis progress work. To that end, my very special thanks go to ***Mr. Teshome Ayele*** for his generous support, critical comments, and provision of relevant materials. He spent his precious time correcting the whole thesis. I would also like to thank my sister ***Huluasebush Tobiyaw (MPH)*** and others for their critical comments and suggestions they gave me during the preparation of this thesis. Last but not least, I am pleased to acknowledge the staff of the Addis Ababa City Administration Health Bureau for their cooperation in providing me with all the relevant information that I used in preparing this document.

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Acronym and Abbreviation

AACAHB- Addis Ababa City Administration Health Bureau

ABC - Abacavir

AIDS- Acquired Immune-Deficiency Syndrome

ARV- Anti-Retro viral Drugs

ART- Anti-Retro Viral Treatment

DRV- Darunavir

DTG- Dolutegravir

EFV- Efavirenz

EFY- Ethiopian Fiscal Year

EPI- Expanded Program for Immunization

FMOH - Federal Ministry of Health

FP- Family Planning

HC- Health Centre

HAPCO - HIV/AIDS Prevention and Control Office

HIV - Human Immune Virus

IFRR- Internal Facility Requisition Report

IPLS- Integrated Pharmaceutical Logistics System

IT- Information Technology

3TC- Lamivudine

LIAT- Logistics Indicator Assessment Tool

LMICs- Low- & Middle-Income Countries

LMIS- Logistic Management Information System

MCH– Maternal and Child Health

MSH- Management Sciences for Health

NGOs- Non-Government Organizations

PFSA- Pharmaceutical Fund and Supply Agency

RDF- Revolving Drug Fund

RTV- Ritonavir

RHB- Regional Health Bureau

RRF- Report and Requisition Form

SCM- Supply Chain Management

SCMS - Supply Chain Management System

SDPs- Service Delivery Points

SKR- Stock Keeping Records

SKU- Stock Keeping Unit

SOPs- Standard Operating Procedures

TB- Tuberculosis

WHO- World Health Organization

Abstract

It was found that proper management of anti-retroviral medications and related products is essential to improving efficient product flow and avoiding frequent stockouts of essential items, which could reduce the program's impact on the general public. It was noted that HIV treatment involves lifelong therapy and that few or no substitutes may be made in the event of stockouts, treatment failure, or missed opportunities for diagnosis as a result of stockouts, presenting a particularly difficult problem. Ineffective logistics and supply chain management for these commodities were found to result in a large loss of resources.

The general objective of this study was to assess the supply chain of Anti-retroviral drugs for HIV/AIDS at public hospitals under the Addis Ababa City Government Health Bureau. Both qualitative and quantitative data analysis were used using a semi-structured questionnaire and an observation checklist, respectively. Data gathering for the project was completed within two months.

The data was used to determine the key performance indicators, and the system's current state was evaluated by comparing the data to the inventory management system that was chosen. Physical inventory was found to be a crucial step in figuring out how much ARV medication needs to be ordered and how much is actually in stock.

It was found that six hospitals had access to more than 80% of the ART medications: TDF+3TC+DTG (300+300+50mg) tab, TDF+3TC (300+300mg) tab, EFV 600mg, EFV 600mg, 3TC 150mg tab, AZT + 3TC (300mg + 150mg) tab, and ABC 300 tab were 100% available ART medications, while DTG 50mg tab and DRV 600mg tab were 2 (33.3%) available ART medications, but 4 (66.7%) were not available in public hospitals under AACAHB. AZT + 3TC (300 + 150 mg) tab, ATZ/r 300 mg/100 mg tab, Lopinavir 200mg/Ritonavir 50mg tablet, and ABC/3TC 120 mg/60 mg (pedi) tablet were 5 (83.7%) available ART medications, but 1 (16.7%) were not available in public hospitals under AACAHB. RTV 100mg tab and Lopinavir 100mg/Ritonavir 25mg Tablet (pedi) were 1 (16.7%) available ART medications, but 5 (83.7%) were not available. Lamivudine 30mg/Zidovudine 60mg pedi Tablets and Cotrimoxazole 240 mg/5 ml suspension for pediatric OI drugs were not available due to stock out and expiration

***Key words**: available ART medications, Supply Chain Performance, Logistics management.*

CHAPTER ONE

INTRODUCTION

1.1.Background of the study

The background of the study focuses on analyzing the performance of the ART drugs supply chain under the authority of the Addis Ababa Health Bureau Hospitals. ART drugs refer to antiretroviral therapy medications used in the treatment of HIV/AIDS. The supply chain refers to the system responsible for the procurement, storage, distribution, and utilization of these drugs within the health bureau's jurisdiction.

The goal of studying the ART drugs supply chain's performance is to assess its efficiency, effectiveness, and overall effectiveness in ensuring the availability and accessibility of ART drugs to patients in need. Such evaluations are crucial for identifying potential challenges, bottlenecks, or areas that require improvement within the supply chain.

By evaluating the performance of the ART drugs supply chain, policymakers, health officials, and stakeholders can identify specific issues or areas of concern. These may include stock outs, inaccurate forecasting of demand, delays or inefficiencies in procurement or distribution processes, inadequate storage facilities, or insufficient monitoring and evaluation mechanisms. Addressing these concerns can help ensure a smooth and uninterrupted supply of ART drugs, ultimately benefiting patients and improving the overall management of HIV/AIDS within the Addis Ababa Health Bureau.

AIDS is a severe condition caused by the human immune deficiency virus (HIV), which takes 10-15 years to develop. It attacks the immune system, affecting the body's natural defenses. Treatment involves active anti-retro viral therapy (HAART). Despite progress, access to care remains challenging, particularly in Sub-Saharan Africa, where nearly two-thirds of HIV/AIDS patients reside.

Ethiopia began providing free antiretroviral therapy (ART) in 2005, saving many lives. Since then, over 1230 venues have offered ART services, with 415,578 adults and 21,385 children under 15 using it. The national HIV prevalence was 1.16% in 2017, and the government has been involved in capacity-building initiatives to improve medical professionals' skills. As of 2015, 36.7 million people were HIV positive, with Sub-Saharan Africa being the most severely

impacted area. The Drug Fund and Supply Agency (PFSA) was established in 2007 to ensure continuous drug supply. Performance measurement is crucial for regulating supply chain activity and improving performance. Health information systems have not kept up with the rapid advancement of ART in resource-constrained economies. Berhanemeskel *et al*. (2016).

A study in Ethiopia reveals poor stock control and inventory accuracy in health facilities, with only 61.5% updating bin cards. This poses a risk to public health due to cutoffs in ARV medications, leading to drug resistance and disease progression. The Addis Ababa City Administration Health Beauru faces supply chain management challenges, including stock outs and wastage. The study aims to evaluate supply chain management effectiveness using indicators like order fill rate, lead time, emergency order frequency, and Logistic Management Information System data quality. Health professionals need on-the-job training to care for HIV positive patients. The global target for HIV/AIDS treatment is to place 15 million people on treatment by 2015.

The study aims to improve the performance of the ART drug supply chain in Addis Ababa Health Bureau by implementing stronger inventory management systems, improving coordination among stakeholders, store management, optimizing transportation and delivery mechanisms, establishing robust monitoring frameworks, and enhancing transparency and accountability. This research can contribute to informed decision-making, policy formulation, and strategies for strengthening HIV/AIDS treatment services.

There are six categories: nucleoside analogue reverse transcriptase inhibitors (NRTIs), non-nucleoside analogue reverse transcriptase inhibitors (NNRTIs), protease inhibitors (PIs), integrase inhibitors (IIs), chemokine receptor 5 (CCR5) inhibitors, and fusion inhibitors (FIs). These drugs suppress virus multiplication by interfering with its life cycle. The standard treatment guideline for General Hospital of Ethiopia: ART-nave patients initiate Triple Therapy, consisting of two NRTI plus one NNRTI as first-line drugs. If first-line regimen failure occurs, patients switch to a standard boosted protease inhibitor (PI)-based second-line regimen.

1.2.Statement of the problem

The Addis Ababa City Administration Health Bureau's ART drug supply chain management faces several challenges, including inadequate infrastructure, ineffective inventory management, and fragmented coordination among stakeholders. Insufficient storage capacity and transportation networks can lead to stockouts, delays in drug delivery, and compromised drug quality. Poor inventory management practices can result in frequent stockouts or excess stock, affecting patient care and increasing costs. Fragmented coordination among stakeholders, such as manufacturers, distributors, health facilities, and regulatory bodies, can also hinder the smooth flow of ART drugs.

Insufficient data visibility and monitoring can hinder decision-making processes and make it difficult to identify and address supply chain bottlenecks. Human resources and capacity constraints, such as limited training and high turnover rates, can also hinder efficient performance. Addressing these issues requires a comprehensive approach that strengthens infrastructure, implements robust inventory management systems, enhances supply chain coordination, improves data visibility and monitoring, and invests in human resources development.

Supply chain management (SCM) is crucial for high-value health goods like anti-retro viral medicines, ensuring continuous flow from manufacture to customers. The WHO's essential medicines plan aims to improve finance and supply systems, but unreliable networks hinder provision in developing nations. Ethiopia has implemented an integrated pharmaceutical logistics system to build a strong healthcare system.

The Ethiopian Government established the Pharmaceuticals Fund and Supply Agency (PFSA) in 2007 to ensure pharmaceutical supply. However, many Addis Ababa healthcare facilities lack adequate inventory management services, leading to drug shortages and delayed anti-retro viral treatment. A study found a positive correlation between ARV availability, bin card updating practices, inventory accuracy, and waste rate. (Berhanemeskel et al., 2016).

Ethiopia's medical facilities face challenges in storage and supply chain management, leading to stock-outs of ARV drugs and HIV test kits. The success of the free ARV treatment program depends on reliable medication supply, which can lead to viral suppression, drug resistance, increased morbidity, and low survival rates.

1.3. Objectives of the study

1.3.1 General objective

The general objective of this study is to assess the Supply Chain Performance of Anti-retro viral therapy drugs Management Practice under AACAHB Hospitals.

1.3.2 Specific objectives

- To assess the supply chain management practices of ARV drugs in public health hospitals of AACAHB in terms of Logistics management practices, LMIS practices, storage conditions, and inventory management practices.
- To determine the effect of supply chain practices (in terms of LMIS, storage conditions, and inventory management practices) on the performance of ARV drug availability in public health hospitals of the AACAHB.

1.4. Research Questions

- How the supply chain management of ARV drug is being practiced in public health hospitals of AACAHB in terms of Logistics management practice, LMIS practices, storage conditions and inventory management practice?
- What is the effect of the supply chain practices (in terms of LMIS, storage conditions and inventory management practice) on the performance of ARV drug availability in Public health hospitals of the AACAHB?

1.5. Scope of the study

The major subjects of this study were the assessment of the supply chain management effectiveness of ARV drug management procedures in public hospitals and the accessibility of ARV medications in those hospitals under AACAHB. The data were collected from the pharmacy departments of the aforementioned public hospitals in AACAHB. This study aims to assess the supply chain of anti-retroviral (ARV) pharmaceuticals in public hospitals under the AACAHB. The study evaluates logistic system performance, storage conditions, inventory management, and LMIS using a pharmaceutical supply chain management model. The study also assesses the efficiency of ARV supply chain management based on the number of days ARVs were out of stock over the previous six months, their availability, and the sum of those days.

1.6. Definition of the study

Availability of LMIS tool: -the accessibility of numerous instruments, such as the IRRF, IFFR, bin cards, and stock cards, which are essential for reporting and preserving data regarding drug supply and distribution. For the LMIS to be used effectively, these resources are essential.

Logistics Management Information System (LMIS):-is a system that produces fundamental logistical data necessary for making logistics decisions.

Proper use of LMIS tools: - correct and timely recording and reporting of drugs supply and distribution data use the LMIS tools.

Commodities: -are include reagents and test kits, laboratory equipment and supplies, condoms, and other medical supplies and equipment such as specimen collection tools.

Product Availability: -the amount of stock-on hand at the time of visit.

Stock out on the day of the visit: - was defined as not having any available stock on the day that the data collector arrived

Acceptable storage condition: -storage condition must comply with at least 80% of the seventeen's storage standards.

Bin card update: - An update was required to be made within 30 days. If a bin card had not been used for more than 30 days, had a balance of zero when last updated, and the facility had not yet received any of the products in question, it was not updated.

ARV Drugs: -HIV infections brought on by retroviruses are treated with anti-retro viral drugs. It stops other retroviruses or the human immunodeficiency virus (HIV) from multiplying inside the body.

LMIS: - It is a system that produces the fundamental logistical data required to make decisions in logistics.

Stock-Outs: - The WHO defines stock-outs as the total absence of a necessary medication for at least one day at a storage or delivery site.

Supply chain: - A supply chain is dynamic and entails the continuous movement of products, information, and funds between various ranges.

Supply Chain Management: - It is the incorporation of supply chain processes through established supply chain linkages in order to gain a long-term competitive advantage.

Lead time: - The time between when new stock is ordered and when it is received and available for use.

Safety stock: -Safety Stock is the additional quantities of goods stored as a safety net above the required amount to prevent going out of stock due to emergencies. An example of an emergency is when sold-off goods undergo damage to being delivered.

1.7. Limitation of the study

- The study primarily focused on supply chain components executed at the hospital level, such as inventory management, storage, and LMIS. It did not include all supply chain management components done at higher levels, such as selection, quantification, and procurement.
- The study left out supply chain participants including the PFSA, AACAHB, and funders. Only public hospitals that are under the AACAHB were used for the study.
- Absence of comparable studies, particularly in private hospitals and public health facilities funded by AACAHB, in the evaluation of the ART drug supply chain performance.

1.8. Significances of the study

The Addis Ababa City Administration Health Bureau's study on ART drug supply chain management offers numerous benefits, including identifying inefficiencies, optimizing resource allocation, and holding stakeholders accountable for timely medication delivery. Regular assessments help identify gaps and hold stakeholders accountable. The study evaluates the quality of the supply chain, identifying areas for improvement in storage conditions, transportation methods, and inventory management. This data-driven approach guides decision-making and evidence-based policies, contributing to improved healthcare outcomes for HIV/AIDS patients. The findings will be beneficial to academics and researchers, as they can

serve as a springboard for further investigation and expand knowledge in supply chain management from a public health system perspective.

1.9. Organization of the study

The thesis is organized into five major chapters. Chapter 1 provides a general introduction, including background information on the overall concept of supply chain, and outlines the key components of the chapter such as the statement of the problem, research question, objectives, significance, definitions, and limitations of the study. Chapter 2 presents a review of the relevant literature related to the supply chain of ARV drugs, pharmaceuticals, and related commodities, covering different theoretical and empirical literature, a theoretical and conceptual framework, and the identified literature gap. Chapter 3 details the methodology used in conducting the research. Chapter 4 presents the results and discussions of the research work based on the analysis. Finally, Chapter 5 summarizes the findings, provides a conclusion, and offers recommendations from the research work.

CHAPTER TWO

RELATED LITERATURE REVIEW

Introduction

This chapter reviews relevant literature on the key areas that the study covers. This chapter presents the theoretical underpinnings of the study. With a focus on the objectives and theoretical thresholds of this study, the chapter reviews related and contemporary literature on the assessment of supply chain Anti-Retro viral drugs and related commodities. The chapter examines various research studies and reports done locally (Ethiopia), regionally (Africa).

2.1. Theoretical Literature Review

2.1.1. Overview of supply chain

A dynamic supply chain involves the transfer of goods, data, and money across locations, involving people, organizations, resources, actions, and technical developments in the manufacturing and distribution of an item.

The supply chain involves the processes of delivering finished products or services to clients, including order fulfillment, sales, product delivery, customer assistance, and return services. It involves various parties, including producers, suppliers, transporters, warehouses, wholesalers, retailers, and customers. Lead time measures the total time it takes for these procedures to be completed. A supply chain involves all parties involved in fulfilling consumer requests, including product creation, marketing, operations, distribution, financing, and customer support, in organizations like manufacturers. Chopra and Meindl (2007).

"According to Chen and Paulraj (2004), a typical supply chain is a web of links for processing resources, information, and services that exhibits supply, transformation, and demand characteristics. A supply chain is a network of linked flows that process resources, data, and services while exhibiting characteristics of supply, transformation, and demand. It entails the acquisition of materials, their distribution, the exchange of electronic data, and the payment of money to suppliers and subcontractors. Clearly, physical distribution is a crucial component of supply networks, and in many supply chains, information and financial elements are equally crucial to the movement of goods. These definitions lead us to the conclusion that the supply

chain is made up of all the operations and procedures involved in the movement of materials and information from the raw material stage to the final user of the good or service.

2.1.2. Overview of Supply chain management

Supply chain management (SCM) integrates activities across the supply chain to create value for consumers and stakeholders. It involves sourcing, procurement, conversion, and logistics-related activities, regulating data flow across customers, companies, and partners. SCM connects supply and demand for a successful business model.

The Council of Supply Chain Management Professionals defines supply chain management as the organization and control of all sourcing, procurement, conversion, and logistics-related activities. The discipline of supply chain management (SCM) was developed to regulate the flow of data, products, and services across a network of customers, companies, and supply chain partners (Russel & Taylor, 2009).

Sweeney (2007) asserts that "Supply Chain Management is the systemic, strategic coordination of the traditional business function and across businesses inside the supply chain for the purpose of improving the long-term performance of the individual enterprises and the supply chain as a whole." "Supply chain management" is defined by Wisner et al. (2012) as "the integration of trading partners' key business processes from initial raw material extraction to the final or end customer, including all intermediate processing, transportation, and storage activities, and the final sale to the end product customer."

Many academics hold that SCM and logistics are interchangeable, and many give the historical growth of the logistics function credit for laying the groundwork for SCM. In accordance with Waters (2008), "logistics, or supply chain management, is the function responsible for the transit and storage of materials on their trip from originating suppliers, via intermediate businesses, and to end customers." Despite the fact that SCM covers logistics management tasks, the supply chain management concept and the traditional logistics concept differ. Logistics is the management function in charge of all material movement within the confines of a single organization, whereas SCM examines the movement of materials through the full network of associated businesses that makes up the supply chain more broadly. Marketing, the creation of new products, financing, and customer service are all included in supply chain management,

which also covers every facet of conventional logistics (Hugos, 2006). Four essential ideas were identified by Felea and Irina (2013) after reviewing the aforementioned definitions of SCM: management activities, logistical activities, objectives (such as value, customer requirements, trust, competitive advantage, and relationships), and components. Planning, organizing, implementing, inspiring, and controlling are all part of management activities. Transportation, processing, and storage activities include those done at suppliers, manufacturers, warehouses, and retail establishments.

2.1.3. Logistics Management Information Systems

A logistics management information system (LMIS) is employed to gather, analyze, and present data related to the supply chain. An effective LMIS has the ability to furnish decision-makers at different points in the supply chain with precise, prompt, and pertinent information (USAID, 2016). The LMIS can be either partially manual, utilizing paper-based methods, or entirely digital. Inventory levels, items consumed (distributed to users), losses, and adjustments are the three core LMIS data elements in any supply chain system. WHO (2016) reports that the majority of countries lack the resources and political will needed to implement an LMIS for the majority of life-saving drugs.

But because of the significant advantages, adopting an LMIS is viewed as a crucial step for setting up ART projects. Due to the substantial inflow of funding for the treatment, the expansion and risks connected with the erratic supply of ARV drugs, and the patchy delivery of treatment. Prior to providing ARV medications, it is ideal to construct and configure the LMIS.

This structure might not be useful given the emphasis on swiftly increasing access to therapy. The development of an LMIS with a focus on tracking ARV drugs should therefore rank among the most important interventions during the early phases of ART program deployment. Starting the LMIS as a separate system might be necessary in the short term, but in the medium to long term, as more PLWHA receive treatment and as the needs and capabilities of the healthcare system change over time, it's crucial to continually reevaluate how cost-effective this strategy is (Chris *et al.*, 2014).

Steps in the development of an LMIS are as follows (WHO, 2016):

1. Determine the list of other data elements that must be collected in addition to the essential supply chain data to facilitate the supply chain system's functioning. Ensure that this information is coordinated with the data requirements for patient and programme monitoring through a consultative process involving programme managers and ART service providers; also, define the types of feedback and output reports required by users.
2. Decide on the scope of the information systems that will be implemented for collecting all data related to ARVs (i.e., patient, clinical, supply chain, financing, etc.).
3. Explore cost, feasibility, and buy-in for different information system models: manual, semi-computerized, and fully automated or computerized. Include consideration of locally available technological innovations (e.g., bar coding, smart cards, palm pilots).
4. After the design of a system (including forms) has been determined, define procedures for information gathering, reporting, and analysis, and then document them in a procedures manual for each level of the distribution system and service site. Procedures should also be developed or refined for inventory management at all levels and should be aimed at ensuring minimum stock levels as well as secure storage and distribution throughout the supply chain.
5. Begin system implementation by pilot testing it in sites already providing ART. As part of the system roll out, develop job aids to enhance the daily workload of health workers in using and maintaining the system.
6. Ensure that the final LMIS is owned by and closely linked with all other Ministry of Health systems (HMIS, etc.)**.**

2.1.4. Inventory Management

Anti-retro viral medicine's cost and potential to save lives may encourage theft and poor management if inventory control methods aren't established. Supply of ARV drugs are initially rationed, but simplifying supply and implementing good inventory control systems can prevent shortages, overproduction, and expiration. (PFSA,2015)

Ineffective inventory management in public health facilities wastes resources, hinders pharmaceutical access, causes stock outs, and losses. To improve patient outcomes, programs should plan distribution systems with minimum levels, minimize storage locations, and

implement maximum-minimum inventory systems. Product managers should regularly monitor usage and stock levels to determine new orders.

The system's design, including the decision to employ the regular review period for placing routine orders, is focused on ensuring that logistics data and lead times are used to inform resupply choices, hence avoiding stock-outs. According to WHO (2016), the majority of ARV medications have a shelf life of 18 to 36 months. Contracts for ARV drug procurement should stipulate the minimum shelf life that the medications must have at the time of importation in order to limit the danger of expiration. National laws set minimum two-years or 75% of the whole shelf life for ARV medications, ensuring timely administration during expansion phases. Avoid shorter-lived medications unless an emergency exists and supply is certain.

Types of Inventory Management

Inventory management significantly impacts a corporation's health by ensuring proper stock levels and reducing erroneous records. Common methods include:

Stock review: - Small enterprises typically employ this manual technique. The stock review regularly examines the stock on hand and anticipated future requirements. The inventory management process can be controlled with this strategy, but it can also be labor-intensive and inaccurate.

Just-in-time (JIT): -is the procedure used to distribute things to customers when a demand has been made. One of JIT's main advantages is its capacity to satisfy customer demands without keeping a lot of inventory in a warehouse. However, there are some supply chain risks associated with employing this technology to manage stocks.

ABC analysis: This methodology creates three inventory levels: Layer A represents low-quantity, high-value items; Layer B represents moderate-value goods; and Layer C represents high-quantity, low-value products, requiring inventory management, safety stock, and supply management.

EOQ: It refers to just the right stock level to fulfill customer demands without running out of stock or stacking up low-moving inventory. EOQ reduces inventory to a minimum and makes sure the investment is as low as possible.

FIFO/LIFO: FIFO refers to first in, first out, where the oldest items are sold first. LIFO refers to last in, first out, where the newest items are sold first.

2.1.5. Procurement

WHO advises policymakers and program directors to collaborate with national drug regulatory authorities to prevent delays in ARV medication distribution. Manufacturers are responsible for registering new medications, but many delay until they are confident in their investment's success. Regular communication and cooperation between regulatory entities and procurement committees can reduce delays and improve access. Strengthening rules for registering and importing ARV medications, including engagement with national regulatory agencies, is crucial. As countries consider local ARV drug manufacturing, regulatory authorities must enhance post-market surveillance capacity and consistency in data collection for quality assurance.WHO,2017.

For example, a single country could have ARV drugs purchased by the following:

- The government's procurement office or agency, such as the central medical stores
- The local project office of the World Bank's Multi-country AIDS Programmed.

Procurement agents purchasing ARV drugs for the nongovernmental organization (NGO), mission, private voluntary organization (PVO), and faith-based organization (FBO) communities and facilities

Guidelines and coordinating procurement procedures for ARV drugs ensure effective funding use, regular ARV drug delivery, and minimize duplication. Pooling procurement exploits economies of scale, offering cost savings to cash-strapped programs. Examples include UNFPA, UNICEF, and Global Drug Facility for Tuberculosis. Standardized primary procedures, such as product specifications, should be implemented when a single procurement agent is not feasible.

Procurement guidelines should balance quality assurance mechanisms with flexibility for contracts, adapting to fluctuations in demand and commodity uptake. New drugs should have fewer side effects and benefit from technology advancements and price reductions. National procurement planning should coordinate funding, procurement, and shipments from multiple sources, aligning resources with estimated needs. A medium-term forecast aids coordination, provides clear estimates of costs, and allows new donors to invest in gaps. Aligning ARV drug

procurement with essential medicine procurement policies is crucial for improving overall health system performance.

Donor projects often create unique procurement arrangements in countries with poor standardized, transparent, and efficient procurement processes. This leads to supply imbalances, gaps in information, and weaker healthcare system performance. Long-term investments in enhancing local procurement capabilities, such as donor-appointed agents or centralized procedures, are crucial for improving healthcare system performance.

In order to speed up importation (customs clearance), reduce delays, and strengthen the capacity of the national regulatory authority for inspection, quality control, and registration, they should also encourage businesses that receive contract awards to submit importation documentation several weeks prior to the product's arrival at the port. This will help to minimize registration delays and improve the accessibility of data on drug quality. In particular, resources are needed for training and assessment of the inspection of ARV medications (USAID, 2017).

National rules governing the duty and tax status of ARV drugs should be revised, much like registration-related concerns, to improve access, maximize the use of resources for ARV drug procurement, and pay for the costs of their distribution (WHO, 2016). Taxes and levies on the supplies, medications, and equipment required for HIV/AIDS services may cause delays and obstructions in the supply chain, which may result in stock outs and irrational use of particular commodities. All goods will be distributed rapidly and with the least amount of delay if these barriers are reduced or eliminated.

In order to improve the quality of ARV drugs and lower the risks of obtaining substandard medications, governments and partners should, as advised by WHO (2016), strengthen quality assurance and human resource capacity of national drug regulatory authorities and national quality control laboratories. Also, consider standardizing the buying process or using various tactics, such as global, regional, or other pooled procurement structures that offer high-quality medications at more affordable prices. According to Chris *et al.* (2014), some of the major hurdles to the timely and reliable delivery of ARVs in the procurement and supply chain include supply risks, demand fragmentation, inaccurate forecasts, product registration, concerns with shelf-life requirements, and cost risks.

2.1.6. Storage and Distribution of ARV Drugs.

The health system or programme must transport the item to the level of service delivery where the client would get the supplies, according to USAID (2017). The products must be kept in storage throughout this process until either they are transferred to the following lower level or the consumer wants them.

Maintaining the proper temperature is vital since medicines need specific storage conditions. According to WHO recommendations, institutions in charge of ARV drug storage and distribution should be chosen or upgraded to ensure secure storage areas, storage conditions that support product quality, and the ability to maintain the frequency and mode of transportation that are based on the system design. Additionally, if the system involves any form of cost recovery for goods or services, there should be clearly defined mechanisms for issuing invoices and collecting payment, as well as clear procedures for responding to requests from implementing sites and for obtaining data and authorization for conducting distribution.

2.1.7. Supply chain management theories

Five alternative ideas or points of view have reportedly been put up to explain key aspects of supply chain management, according to Waters (2008). The resource-based view (RBV), stakeholder theory (ST), institutional theory (IT), transaction cost theory (TCT), and resource dependence theory (RDT) are a few of these. Numerous authors have suggested that these theories and points of view may help to explain certain facets of SCM.

A Resource-Based View (RBV): -According to the resource-based view (RBV) of the firm, firm conduct may be interpreted as an effort to outperform rivals. Supply chain participants try to exercise control over the production elements in the highly competitive market structure because doing so could provide them with an advantage over their close competitors (Ahuja, 2000; as cited in Bilkis et al., 2018). In the literature on strategic management, the RBV of the organization plays a significant role (Halawi et al., 2005; quoted in Bilkis et al., 2018). A company that employs a value-creating strategy has a competitive edge over its potential or existing competitors when those rivals do not do the same, claim Mitra et al. (2017). RBV is a widely used theory in supply chain management, focusing on the foundation of asset pooling to form relationships. It emphasizes value creation through immobility, inimitableness, and sustainability, while prioritizing accessing other companies' key skills for a competitive edge.

B. Stakeholder Theory (ST): -Firms are envisioned as the hub of an association of stakeholders in the supply chain formation process. Stakeholders are everyone who has an impact on or is negatively impacted by a company, including its investors, suppliers, employees, customers, competitors, local communities where it works, regulatory bodies, and so forth (Touboulic & Walker, 2015; as cited by Bilkis *et al.,* 2018). The idea that firms should coordinate stakeholder interests is regularly brought up in stakeholder literature (Busse et al., 2017; quoted by Bilkis et al., 2018). This viewpoint is wholly based on the notion that social organizations are by definition cooperative systems (Camilleri,2017). Because of their cooperative nature, organizations frequently form alliances with stakeholders to achieve common objectives. According to Jones et al. (1997), referenced by Bilkis et al. (2018), these alliances are also known as constellations, networks, and strategic networks. According to Kraatz (1998), as referenced by Bilkis et al. (2018), these cooperative links may be a powerful instrument for harmonizing stakeholder agendas and aiding a firm in reducing environmental uncertainty. Stakeholder literature frequently makes the point that corporations should coordinate stakeholder interests (Busse *et al*., 2017; cited by Bilkis *et al*., 2018). This perspective is entirely grounded in the idea that groups are, by their very nature, cooperative systems (Camilleri, 2017). Organizations have a tendency to create coalitions with stakeholders in order to accomplish shared goals because of their cooperative character. Such alliances go by several names, including constellations, networks, and strategic networks (Jones *et al.*, 1997; as cited by Bilkis *et al*., 2018). These collaborative connections may be a potent tool for coordinating stakeholder objectives and helping a business lessen environmental uncertainty (Kraatz, 1998; as cited by Bilkis *et al*., 2018)

The stakeholder theory is concerned with stakeholders in addition to shareholders. It emphasizes creating value for stakeholders. This idea is applied to a variety of business decisions, including the make-or-buy decision and supplier and outsourcing strategies. Decision-making in SCM and ST is closely intertwined.

C. Institutional Theory (IT): - According to institutional theory, institutional contexts provide pressure on firms to appear legitimate and adhere to established societal standards. By applying this concept to the corporate world, institutional pressures may drive organizations to pursue objectives that will increase their legitimacy and make them appear to be in line with the laws, regulations, and standards of their respective industries (Bilkis *et al*., 2018). The institutional

concept is potentially valuable in explaining how supply chain relationships are formed and why businesses behave in certain ways. Companies are encouraged to comply as a strategy of survival and attraction in addition to seeking legitimacy in order to increase their recognition or demonstrate their social worth (Oliver, 1991; as cited in Bilkis *et al*., 2018).

Institutional pressure and legitimacy can have a significant impact on how a corporate body's formal structure is formed and developed. A structured organization can guarantee technological effectiveness, giving it legitimacy in the market. This idea has ramifications for how SCM is conceptualized and other connected problems.

D. Transaction Cost Theory: -TCT focuses on employer-driven boundary-crossing activities to minimize manufacturing and transaction expenses (Bilkis et al., 2018). Manufacturing costs vary based on operations size, location, and private factors. Transaction costs include planning, managing, and tracking transactions, with opportunistic behavior increasing transaction costs (Halldorsson *et al*.,2015)**.** Despite its natural appeal, TCT was praised by several authors for its ability to explain how supply chain links are formed. TCT is limited to the justifications for coalitions that focus on efficiency and cost reduction (Ghozzi *et al*., 2016; as cited by Bilkis *et al.,* 2018). The goal of Transaction Cost Theory (TCT) is to justify the need for the firms it applies to. While determining whether to make or buy in the framework of SCM, TCT tries to lower transaction costs. According to TCT theory, various control and governance systems should be used to reduce the danger of supply chain enterprises acting opportunistically while outsourcing.

E. **Resource Dependence Theory (RDT): -** Building on a social alternate theoretical perspective, resource dependence theory (RDT) offers inter-firm governance as a strategic response to conditions of uncertainty and dependence between exchange partners. RDT focuses on how some corporations become dependent on others for needed resources along with goods and substances and how businesses can manage such relationships (Halldorsson *et al*., 2015). RDT complements RBV in that it sees the employer as seeking to exploit and recombine unique sources that may be found beyond the boundaries of the firm, and it considers how strategic relationship-building may wish to lead to the capture of these resources (Fynes*et al*. 2008; as cited by Bilkis *et al.,* 2018). A corporation needs resources with a variety of dimensions. A

company might not be able to use all of its resources evenly. It might establish relationships with others as a result. According to RDT, businesses should establish an exchange relationship with society so they can acquire complementary and heterogeneous resources in order to survive and prosper (Bilkis *et al.,* 2018).

This study looked at five different theories, namely the resource-based view (RBV), stakeholder theory (ST), institutional theory (IT), transaction cost theory (TCT), and resource dependence theory (RDT) - and ultimately decided to focus on the RBV theory. It is one of the most popular theories in the supply chain management literature, so it's perfect for examining public hospitals in the AACAHB. One of the most widely used theories in SCM literature is RBV (Bilkis *et al*., 2018).

2.1.8. Supply chain of ARV drugs

A management system helps programmers make informed decisions about ARV drug supply chains. However, limited funding and insufficient resources cause supply delays and shortages, affecting public sector employees.

The significance of effective supply chains is becoming more apparent to program planners. By more effectively ensuring the availability of the products they manage and by effectively leveraging the resources that are at their disposal, supply chain managers may improve the quality and reach of public health programs. This will reduce waste and improve accountability. A number of routinely executed tasks that must be coordinated make up supply chain management (USAID, 2006).According to USAID (2006), a few elements that have aided in the efficiency of the supply chain include the use of external procurement mechanisms, which are typically chosen and funded by donors, the commitment to maintaining a full supply of chosen products, a program of sustained and consistent financial and technical support for systems development and maintenance, and the small number of commodities with little change in technology or formulation over time.

Although technically possible, implementing integrated supply networks has proven to be challenging in many nations (Bates, *et al.,* 2008). According to USAID (2006), policymakers and program managers have realized that the implementation of effective supply chain strategies can play a significant role in minimizing some negative outcomes, including the risk of emerging

widespread drug resistance among patients as a result of supply interruptions or procurement of low-quality drugs, leakage of ARV drugs from the public sector into the private sector or to other countries, thus disrupting pricing patterns, and adverse effects such as affective supply chain management can also help reduce the risk of emerging widespread drug resistance among patients, as well as added costs to agencies that already do not have enough money to purchase and provide drugs for critical health issues.

2.1.9. Supply chain management

Supply chain management ensures continuous flow of high-value health commodities, including ARV drugs, by coordinating coordinated actions from manufacturing to customer usage. Quantity requirements for the short term (one to three years) and the medium term must be established once products for a programme have been chosen and registered for use (three years or more). The items must subsequently be purchased, cleared through customs, and put through quality control inspections. A multi-layer transport and storage strategy needs to be carefully planned after the products enter the program's supply chain so they can get to the service delivery locations where they can be utilized. Managers must receive supply chain data from all system levels in order to make better decisions.

2.1.10. Importance of effective supply chain in program success

The goal of a health logistics system is much larger than simply making sure a product gets where it needs to go. Ultimately, the goal of every public health logistics system is to help ensure that every customer has commodity security. Commodity security exists when every person is able to obtain and use quality essential health supplies whenever he or she needs them. A properly functioning supply chain is a critical part of ensuring commodity security. Effective supply chains not only help ensure commodity security, they also help determine the success or failure of any public health programme. Both in business and in the public sector, decision makers increasingly direct their attention to improving supply chains, because logistics improvements bring important, quantifiable benefits. Well-functioning supply chains benefit public health programmers in important ways by increasing programme impact enhancing quality of care and improving cost effectiveness and efficiency. So, Logistics systems boost programme impact by ensuring reliable commodity supply, increasing customer confidence, and motivating them to use health services.

2.2. Empirical literature review

2.2.1. Supply chain management of ARV drugs in Ethiopia

In Ethiopia, the number of new HIV infections and AIDS-related deaths is expected to rise from 11,715 in 2020 to 10,943 in 2021. The ART service began in 2003 and became free in 2005. VCT and ART services were first offered at Zewditu Memorial Hospital in 2002 and 2003, respectively. Since then, VCT, ART, and PMTCT services have been offered by public hospitals, health centers, private hospitals, and some NGO-owned facilities. Between 2005 and 2012, Ethiopia invested aggressively in the public health sector, establishing HIV units in government health centers. In 2010, there were 222,723 people receiving ART, a 26% increase from 2009 to 2010. Ethiopia's ARV coverage rose from 3% in 2005 to 56% in 2014 and 78% in 2020, while both HIV incidence and AIDS-related deaths declined.

The Global Fund to Fight AIDS, Tuberculosis, and Malaria provides funding for free ARV, with Ethiopia being one of its top recipients in the past decade. Between 2011 and 2012, 125 million USD was spent on HIV treatment and care programs, with 55% of that on ART medication. Self-help organizations for HIV-positive people have grown in Ethiopia, providing social and material assistance, peer counseling, HBC, food, and financial aid. Between 2004 and 2010, many of these organizations were established with foreign NGOs and funding agencies. (USAID,2017)

2.2.2. Supply chain of ARV drugs in Ethiopia

In order to solve the problems and guarantee a consistent supply of medications to the general population, the Federal Democratic Republic of Ethiopian Government established the Pharmaceuticals Fund and Supply Agency (PFSA) as a legal entity in September 2007 (Damtie *et al.*, 2020). Ethiopian EFDA ensures adequate, affordable, and quality medicines; adopted the HIV/AIDS National Policy in 1998 for anti-retro viral therapy. Then, the government launched a multi-sectorial initiative that was managed by the secretariats of the National and Regional HIV/AIDS Councils. The first anti-retro viral (ARV) guideline was established in 2003 by the ministry of health (MOH), drug administration and control authority (DACA), the current food medicine and health care administration and control office (FMHACA), and HIV/AIDS Prevention and Control Office (HAPCO). They developed the National Guidelines on ARV and

began providing ART training to teams of healthcare providers (MOH, 2005), which were revised in 2005 and 2008 to allow for a quick scale-up of ART. With continuing care and treatment updates, the Federal Ministry of Health changed national guidelines in order to scale up and improve service quality at all levels of care treatment (Federal Ministry of Health, 2017).

In Ethiopia, the supply chain management for goods related to HIV/AIDS is vertical and predominated by partners with little government ownership. The majority of the time, large-scale partnerships rather than the government were used to oversee centralized procurement, distribution, and LMIS activities. There are 11 PFSA hubs located throughout the nation, and seven more are currently being built (PFSA, 2017).

According to SCMS (2015), Ethiopia's health sector battled with a lack of pharmaceutical supplies, poor storage facilities, and ineffective stock management up until government-led changes started to be implemented in 200 5. High levels of waste and stock shortages were the outcomes. Each health program had its own logistics framework. With assistance from all parties involved, the Federal Ministry of Health (FMOH) and Pharmaceuticals Fund and Supply Agency (PFSA) worked to consolidate the supply chain spanning all levels and encompassing all health initiatives. A single health commodities distribution and reporting system, the new Integrated Pharmaceutical Logistics System (IPLS) was put into place by PFSA. At present, more than 90% of the facilities in the nation employ IPLS.

2.2.3. Supply Chain Management of ARV drugs under Ethiopian Context

In a study undertaken by Gemechu *et al*. (2020) on inventory management practice of ARV drugs in public health facilities in Addis Ababa, Ethiopia found that the availability of bin cards and reports and resupply forms was promising, but the data quality remains low. The study further stated that the majority of health facilities did not meet acceptable storage conditions and bad frequent stock-outs. A study conducted by Berhanemeskel *et al*. (2016) found that most of the health facilities in Addis Ababa have provided inadequate inventory management services, where nearly three quarters of the health facilities faced stock out of one or more drugs and could not start anti-retro viral treatment if patients were positive.

Insufficient data records, stock-outs, interrupted reports, inaccurate inventory, and wastage rates were all signs of poor supply chain management of HIV/AIDS commodities, according to a study by Damtie *et a*l. (2010) on the performance of the industry. To ensure commodities availability, they advised the corresponding entities to strengthen their responsible efforts. A study by Gemechu *et al*. (2021) in public health institutions in Addis Ababa found a strong positive correlation between the availability of ARV drugs and bin card updating practices, inventory correctness rate, and wastage rate. Additionally, waste rates and it had a very strong negative link.

The majority of healthcare facilities experienced frequent stock outs and inadequate storage conditions. In the same area, a study conducted by Berhanemeskel, *et al*. (2016) on the supply chain management of HIV/AIDS related commodities found that there were frequent stock-outs of ARV medicines and HIV test kits, which was an indicator of the weak supply chain management. According to a study conducted in Ethiopia's Oromia national regional state, first-line ARV medications were 100% and 95% available in hospitals and health centers, respectively. Standard Operating Procedures, guidelines, and inventory management tools were hardly ever employed at either level. On the day of the visit, hospitals and health centers had 12% and 11%, respectively, of OI medications in stock (Alemayehu, 2009).

An assessment conducted on ART sites of Ethiopia showed that, there were large quantities of ARV drugs which expire shortly. There were also some expired second line drugs. Expired ARV drugs were kept together with active drugs at one study site. There were inadequate storage facilities, management, capacity, and temperature monitoring, especially for the cold chain in the selected health facilities. It also showed that the ART pharmacy stores were managed by using stock cards, generally manual, but it was computerized in some places. (RPM, 2006). A study conducted by Berhanemesekel and Teferi (2014) on the supply chain management of HIV/AIDS commodities in selected Health facilities of Addis Ababa, Ethiopia, explored that, there were frequent stock outs of ARV drugs, which are an indicator of weak supply chain. Gabriel and Tadesse (2017) in their study of supply chain management of anti-retro viral drugs in public health facilities in Eastern Ethiopia found out that only thirty percent of the health facilities had received all the ordered quantities of ARV drugs. The health facilities will not receive all the quantities of ARV drugs that they have ordered (Ibid).

Araya (2018) found challenges in managing the supply chain for anti-retro viral drugs at St. Paul's Hospital, including proper logistics management, stock availability, professional knowledge, storage conditions, resupply periods, order fill rates, and emergency orders. Despite positive trends, gaps remain in the hospital's supply chain management.

2.2.4. Overview of logistic and supply chain management in health facilities of Ethiopia

Ethiopia's integrated pharmaceutical logistic system (IPLS) is delegated to PFSA, allowing hospitals to order medications every two months using RRF LMIS technology for usage reporting and refilling. PFSA promptly refills requested supplies after analyzing hospitals' RRF reports. Three crucial logistic data items, consumption, stock on hand, and loss or adjustment, must be reported through the system for resupply decisions. The facility determines the maximum stock level and quantity needed for the next period.

The calculation of the order quantity is significantly impacted by taking into account stock out days, if there are any, while determining the maximum stock amount. When the PFSA receives high-quality and timely LMIS data, this data will assist the PFSA in planning for future logistic management choices, including forecasting future demand and purchasing items, so it can have enough stock in the future to provide uninterrupted supply of program drugs to healthcare facilities like hospitals and health centers.PFSA(2015) All three logistic management components and functions must be in place for hospitals to have a successful supply chain for ARVand anti-TB medications, with all standards for quality, availability, and functioning clearly defined.

2.3. Theoretical framework of the study

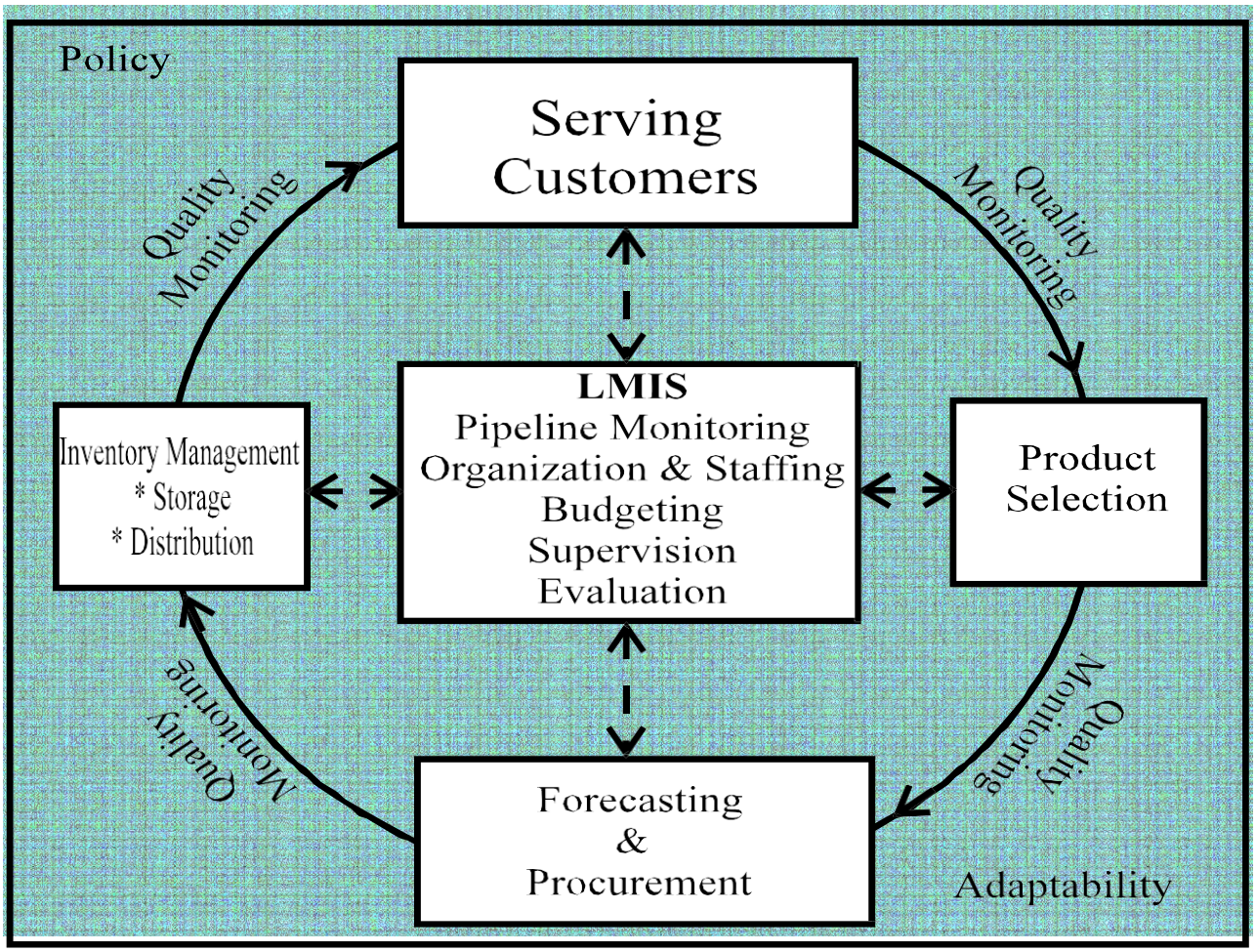

Figure 1 Theoretical framework of logistic cycle

2.3.1 Major activities in the logistics cycle

Let's briefly review the major activities in the logistics cycle:

Serving customers: -Logistics involves choosing, obtaining, storing, or distributing products to satisfy client needs. Storekeepers ensure commodity security, meeting the demands of immediate and end customers. Retailers and central medical stores provide customer service, while the logistics system upholds six rights to guarantee exceptional service and commodity security.

Product selection: - in health logistics systems involves a national committee, pharmaceutical board, or board of physicians, based on WHO Model Lists. Products' selection impacts logistics, requiring consideration of logistics requirements.

Quantification: estimating the quantity and cost of goods for a health program, ensuring continuous supply, and figuring out procurement and distribution dates are all parts of the quantification process.

Procurement: -. A supply plan is developed, and products must be procured from international, regional, or local sources or a procurement agent. Procurement should follow specific procedures for transparency and six rights support.

Inventory management, storage, and distribution: After an item has been procured and received by the health system or program, it must be transported to the service delivery level where the client will receive the products. During this process, the products must be stored until they are sent to the next lower level, or until the customer needs them. Almost all businesses store a quantity of stock for future customer needs.

2.3.2 Heart of the logistics system

Information is the engine that drives the logistics cycle; without information, the logistics system would not run smoothly.

Logistics management information system: Managers analyze data to plan and allocate resources in logistics management information systems (LMIS), which differ from HMISs in data gathering. LMIS collects commodity data for medical facility supply, while HMIS collects patient data for program impact assessment

2.3.3 Other activities at the heart of the logistics cycle

Other activities help drive or support the logistics cycle; they are the heart of a well-functioning logistics system. These activities include

Organization and staffing: - A logistics system relies on well-trained, efficient staff to monitor stock levels, place orders, and provide products. Health programs allocate resources, and national management units analyze data for efficient operations. Prioritizing six rights is crucial for a successful logistics system.

Budget: -Allocation and management of finances impact logistics cycle, affecting product quantities, storage, maintenance, and staff. Supply chain managers assess costs, determine cost-sharing with stakeholders, and scale up.

Supervision: - Supervising logistics staff ensures smooth operations, anticipates changes, and prevents supply problems and human resource constraints through routine supervision.

Monitoring and evaluation: -. Regular monitoring and evaluation assess pipeline and logistics system performance, areas for improvement, and impact on service provision.

2.4. Conceptual framework of the study

Supply chain management combines processes to match supply and demand. This study's conceptual framework, based on JSI (2017) and USAID (2006), focuses on logistic system performance, storage conditions, inventory management, and LMIS practices for assessing ARV medication accessibility in public hospitals.

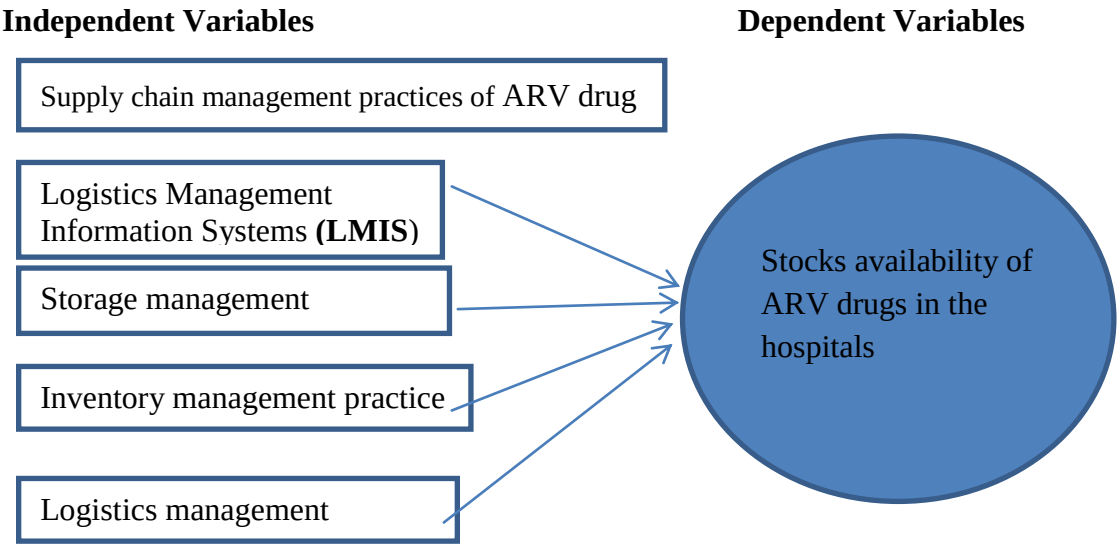

Figure 2 conceptual Framework of ARV Drugs and related commodities supply chain Management (DELIVER/JSI., 2017)

2.5. Identified Literature Gaps

In studying the performance of ART (Antiretroviral Therapy) drug supply chain management under the Addis Ababa City Administration Health Bureau and its hospitals, several literature gaps have been identified. These gaps represent areas where further research and analysis are needed to enhance our understanding of the subject matter. Some of these literature gaps include:

Limited research on ART drug supply chain management specifically in Addis Ababa: There is a scarcity of studies that focus specifically on the performance of ART drug supply chain management within the health institutions under the Addis Ababa City Administration Health Bureau. This gap highlights the need for more localized research to address specific challenges and opportunities related to this topic.

Impact of logistical challenges on ART drug supply chain: There is a lack of comprehensive studies examining the impact of logistical challenges, such as transportation, storage, and distribution, on the performance of ART drug supply chain management. Understanding these challenges and their implications is crucial for developing effective strategies to mitigate them and ensure timely delivery of medications to patients.

Health system factors affecting ART drug supply chain: There is a need for research that explores the broader health system factors influencing the performance of ART drug supply chain management. This includes factors such as governance, financing, human resources, information systems, and infrastructure. Understanding these factors' roles and interactions can inform policymakers and healthcare administrators in improving overall supply chain performance.

Research on patient-level outcomes of ART drug supply chain management is limited, but studies on its impact on key outcomes like medication adherence, treatment success rates, and patient satisfaction can provide valuable insights. The Addis Ababa City Administration Health Bureau needs to evaluate existing interventions and best practices, analyzing the effectiveness of different strategies, technologies, and management approaches. Addressing these gaps can help develop targeted interventions and strategies for improved performance in ensuring timely access to ART medications for individuals living with HIV/AIDS.

CHAPTER THREE

METHODS OF THE STUDY

In this chapter, the research approaches, design of the research, sampling design such as study population, sample size determination, and sampling method; variables of the study, types and sources of data, and method of data analysis is presented.

3.1. Research approach

A mixed research method of both quantitative and qualitative ones is used to conduct this study. These mixes of methods help to triangulate the responses from different sources to better improve the conclusion of the study.

The type of research approach will use a descriptive survey approach, whereby the LMIS, the inventory control system, and the storage system of the hospital will assess and examine the requirements and standards of supply chain management for ARV drugs and related commodities.

3.2. Research design

In order to evaluate the supply chain management practices of public hospitals in AACAHB and the effects of these practices on the performance of ARVs availability in public hospitals in AACAHB, the study chose a descriptive and explanatory design while employing a quantitative research approach. A descriptive research design, according to Musungu and Nasongo (2008), comprises interviewing the targeted population about a particular issue in order to acquire information on the phenomenon's actual status at the time of the study.

In order to understand the links between the variables in terms of a cause-and-effect relationship, the study used an explanatory approach. To study the causal link between the dependent variable (ARV availability in public hospitals in AACAHB) and the independent variables (logistic system performance, storage conditions, inventory management, and LMIS practice). Since the data was gathered from a sample chosen to reflect a larger population using a single questionnaire at one moment in time, the researcher employed a cross-sectional survey design for gathering the main data.

3.3. Research sample design

3.3.1. Targeted population of the study

The main objective of this study is to assess the supply chain management practices of public hospitals in AACAHB and the impact of this practice on the performance of ARVs availability in public hospitals in AACAHB. Among the stakeholders of the supply of ARV drugs are vast, due to time constraints, the research has focused on the major plays among the supply chain i.e., pharmacy department across each public hospital. As per the data collected from Human Resource department of the indicated public hospitals of AACAHB, as of May, 2023, there are a total of 263 employees working in each pharmacy department. The number of target population is presented as below.

Table 3.1: List of Population across each Public Hospitals

No.	List of Departments	Total Target Population
1	Zewditu Memorial Hospital	62
2	Menelik II Referral Hospital	53
3	Gandi Memorial Hospital	30
4	Yekatit 12 Hospital	47
5	Ras Desta Damtew Hospital	37
6	Tirunesh Beijing General Hospital	34
	Total Population	**263**

Source: Data from HR Department of Public Hospitals of AACAHB (as May 2023)

3.3.2. Sample size of the study

The study will be conducted in Addis Ababa city; the study of the population will be conducted in health facilities under the city government of Addis Ababa, which provide ART services to the public. The Addis Ababa City Administration Health Bureau's HR Department reported a total target population of 263 across six public hospitals in May 2023. Zewditu Memorial Hospital had the highest target population at 62 people, followed by Menelik II Referral Hospital at 53, Yekatit 12 Hospital at 47, Ras Desta Damtew Hospital at 37, Tirunesh Beijing General Hospital at 34, and Gandi Memorial Hospital at 30. These hospitals serve a significant number of patients, with larger teaching and referral hospitals like Zewditu Memorial, Yekatit 12 Hospital and Menelik II Referral having the highest target populations. A sample of 159 pharmacy store managers, purchasers, dispenser head pharmacists, and case team managers was used to gather data. Each pharmacy department employed 263 people as of May 2023, but investigating the

entire population due to time and financial constraints is challenging. Therefore, determining the appropriate sample size is crucial for the research.

To determine the sample size, the researcher used a statistical formula developed by Kothari (2004). The confidence level of the researcher will be set at 95% with a 5% error term. By using the Kothari (2004) formula, the following sampling was drawn:

$$\mathbf{n=N/\ [1+N\ (e^2)]}$$

Where n: Sample size, N: Population size i.e., 263, e: Level of precision or acceptable sampling error (0.05).

$$\mathbf{Sample\ size\ (n)\ =263/\ [1+263(0.05)^2]}$$

$$\mathbf{n=159}$$

159 employees were chosen as a sample from the population using the aforementioned formula. As a result, 159 pharmacy department staff under AACAHB's public hospitals was to be included in the data collection.

3.3.3 Sampling method of the study

To ensure that the conclusion drawn from the sample can be applied to the population of interest, it is crucial to select a sample that is accurately representative of the population. In this study, data were gathered using a variety of sampling techniques, including stratified sampling and simple random sample approaches. A stratified sample technique was used to choose among the employee groups found in each AACAHB public hospital. A sampling technique known as stratified sampling divides the entire population into smaller groups or strata in order to conduct the sample process (Kothari, 2004).

The strata were formed based on their common characteristics in the population data i.e., public hospital of AACAHB. After dividing the population into strata, the researcher randomly selected the sample proportionally across all stratum. While conducting a proportionate stratified sampling technique, the number of sampling unit drawn from each stratum was in proportion to the population size of that stratum.

A formula provided by Kothari (2004) to calculate the number of elements selected from each stratum was applied. The formula used is i = n. pi; pi= strata i/ N where i: number of items selected from stratum I, Pi: proportion of population included in stratum I, n: total sample size, and N: total population size.

Table 3.2: Proportionate Stratified Sample

No.	List of Stratum	Total Strata Size	I = M(Ni/P)	Proportionate Sample Size
1	Zewditu Memorial Hospital	62	159 (62) / 263	38
2	Menelik II Referral Hospital	53	159 (53) / 263	32
3	Gandi Memorial Hospital	30	159 (30) / 263	18
4	Yekatit 12 Hospital	47	159 (47) / 263	28
5	Ras Desta Damtew Hospital	37	159 (37) / 263	22
6	Tirunesh Beijing General Hospital	34	159 (34) / 263	21
	Total Population & Sample Size	**263**		**159**

Source: Data from HR (as of May, 2023) & Researchers' Computation

3.4. Data sources and type

The study uses two different types of data: primary and secondary data. The basic data is gathered through surveys and interviews. Primary data is information that the researcher independently discovers about a particular topic. This type of data is likely to have the advantage of being collected with the research's purpose in mind, ensuring that the information obtained is consistent with the research questions and purpose (Biggam, 2011).

Primary data sources

Questionnaires were being distributed to respondents to assess the performance of ART drug supply chain management at the Addis Ababa City Administration Health Bureau Hospital pharmacy. Likert-type questions measure performance, while structured interviews and observations provide insights into why and how questions are asked.

Secondary data sources

Data sources include physical and electronic documents and reports to cross-check primary data collected. The source population includes public hospitals receiving ARV, pharmaceuticals, and related commodities from Addis Ababa PFSA branch, including those providing HIV services, monitoring, and treatment. These hospitals are under the AACAHB and offer ART services.

3.5. Model specification of Data

As mentioned in the conceptual framework, multiple linear regression models were used to determine the best forecast for a dependent variable, focusing on tests like linearity, normality, and multi-co-linearity. Outliers, linearity, normality, and multi-co-linearity were crucial for successful implementation. *Almaquist et al. (2016).*

Before starting regression analysis, ensure large data collection and use a medium effect size of N>50+8m, where "m" represents the number of predictors. Tabachnick and Fiddell (2013). The conceptual framework specifies four predictors: inventory management practice, logistics management information system, logistics system performance, and storage condition. The study's sample size of 159 is sufficient for regression analysis, as 82 respondents are required. The minimum sample size is 159 respondents.

The proposed general linear regression model of this study is expressed as: -

$Yi = \beta 0 + \beta 1IMP + \beta 2LMIS + \beta 3LSP + \beta 4SC + \varepsilon$

Where Yi is ARV drugs availability, $\beta 0$, $\beta 1$, $\beta 2$, $\beta 3$, and $\beta 4$ are model parameters; ε is the error or noise term. IMP, LMIS, LSP, and SC denotes the independent variables inventory management practice, logistics management information system, logistics system performance, and storage condition respectively

3.6. Data collection procedure

Primary data was collected using a structured questionnaire from LIAT, modified by USAID/DELIVER, and standard indicators to measure ART drug supply chain performance. Data collectors were oriented, tested in facilities, and feedback collected. Modifications were made before data collection began for quality assurance and reliability. Interviews involve

physically meeting respondents and recording responses in questionnaires. Primary data collection involves observation and physical product counts. Secondary data is collected from literature, research papers, articles, journals, libraries, and health facility documents for a literature review. The principal investigator (PI) collected most study input, while a research assistant assisted in collecting data from hospitals pharmacy stores. The assistant received training on the survey tool before participating. Data collection will be completed over three weeks, with intensive supervision.

3.7. Data collection instruments

The researcher utilized a semi-structured questionnaire to gather primary data from pharmacy department staff at public hospitals under AACAHB. The questionnaire assessed independent variables like logistic system performance, inventory management, and logistics management information systems, adapted from previous studies by Araya (2018) and Berhanemeskel (2014).

The study evaluated storage conditions using a LIAT data collection instrument and a modified questionnaire to align with research goals. The dependent variable was evaluated using FMOH's 2017 standard treatment recommendations, which included 18 currently available ARV medications.

Each item in the dependent and independent variables was rated on a five-point scale. The Likert scale is expressed as 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, and 5: Strongly Agree to indicate how respondents agree or disagree regarding the statements prepared for measuring the independent and dependent variables.

The researcher designed an English questionnaire for self-administered research, containing 80 questions and six parts. Secondary data was collected from various sources, including literature, reports, journals, and academic publications, to encourage high responses and ensure information security. Table 3.3 indicates the structure of the questionnaire as below.

Table 3.3: Questionnaire Structure of the Study

S.No.	Statements	Total No. of Questions
1	Demographic Information	5
2	Inventory Management Practice	20
3	Logistics Management Information System	5
4	Logistic System Performance	10
5	Storage Condition	18
6	Availability of ARV Drugs	22
	Total Questions	**80**

3.8. Validity and Reliability

3.8.1. Validity Test

Validity refers to the precision and significance of conclusions drawn from research findings, ensuring that the findings accurately reflect the topic being studied. It is crucial for researchers to consider the ability and willingness of respondents to provide the desired information, as this plays a critical role in the quality of questionnaire results. Data analysis should be accurate and reliable to ensure the validity of the results. (*Creswell*, 2009).

Pilot research is conducted to refine a technique and test instrument, such as a questionnaire, before the final phase. Questionnaires are assessed on probable respondents to ensure impartiality, relevance, and reliability. Concerns raised by respondents are considered, and a consultant and subject-matter expert evaluate the instruments' content. Revised surveys are printed, copied, and distributed. *John Adams et al*. (2007),

3.8.2. Reliability Test

Internal consistency involves comparing each questionnaire item's response to the responses to the other questions, according to Kothari (2004), who also uses the term reliability to refer to consistency. One of the most widely utilized indicators of internal consistency is Cronbach's alpha. Scales with a coefficient above 0.95 are considered to have high reliability, whereas scales with a value between 0.80 and 0.95 are considered to have very good reliability, according to Almaquist *et al.* (2016). While values between 0.60 and 0.70 are regarded as having fair dependability, scales with coefficients between 0.70 and 0.80 are considered to have good reliability. When the coefficient is less than 0.6, the scale's reliability is weak. As a result, the researcher used Cronbach's alpha statistics to assess the questionnaire's reliability. All

Cronbach's alpha indexes are over 0.7, as shown in Table 3.1 below, indicating that the variables are consistent.

Table3.4. Reliability Test

Variables	No. of Item in the Scale	Cronbach's Alpha Result
Logistics Management Information System	5	.995
Logistic System Performance	10	.872
Inventory Management Practice	20	.716
Storage Condition	18	.882
Availability of ARV Drugs	19	.815
Overall Reliability	**72**	**.827**

Table 3.4 shows that the reliability of the independent variable "inventory management practice" is 0.716 (good reliability), the reliability of the "logistics management information system" is 0.995 (excellent reliability), the reliability of the "logistics system performance" is 0.872 (very good reliability), the reliability of the "storage condition" is 0.882 (very good reliability), and the reliability of the "availability of ARV drugs" is 0.815 (very good reliability). On the other hand, according to Almaquis*t et al*. (2016), the total Cronbach's Alpha values of the full questionnaire were 0.827 (82.7%), which suggests very strong reliability of the entire questionnaire.

As a result, the data analysis could move forward with confidence given the amount of alpha. As a result, it may be concluded that the researcher established the validity, reliability, and suitability of the questionnaire for dissemination to the population sample. In general, this served as a foundation for inferring credible conclusions from the research's dependable data.

3.9. Ethical Considerations

The proposal and study protocol submitted to Addis Ababa University School of Commerce and get the approval first; then the school issues a support letter to city government of Addis Ababa health bureau. Ethical clearance obtained from Addis Ababa Public Health Research and Emergency Management Core process after reviewing the proposal and the study protocol. Then city government of Addis Ababa health bureau issues a supporting letter to the selected health facilities before the beginning of the study. The consent of the respondent was asked and the name of respondent and the health facilities kept confidentially throughout the study.

CHAPTER FOUR

RESULT, DISCUSSION AND INTEREPRETATION

Introduction

This chapter includes the findings, discussion, and interpretation of the results from the survey that was done. These precise objectives are used to arrange this chapter. Reveals the demographics of the respondents, the response rate, the supply chain management techniques used for ARV medications, the stock levels of these medications, the storage conditions, and the connections between these supply chain management techniques used under AACAHB public hospitals. In addition, a document was reviewed to assess some of the ARV drug stock status of the hospitals. SPSS version 20 was used to perform the analysis. Of the entire 159 questionnaires administered, 130 were obtained, checked for completeness, and were valid for analysis, while 29 were not returned as a result of improper or incomplete responses. The response rate for this study was 82%.

4.1. Demographic characteristics of respondents

Table 4.1 Demographic characteristics of the respondents.

Characteristics	Description	Frequency	Percent	Cumulative Percent
Gender	**Female**	**49**	**37.5**	**37.5**
	Male	**81**	**62.5**	**100.0**
Age Group	**Below 20 years**	**3**	**2.1**	**2.1**
	21 – 30 years	**92**	**70.8**	**72.9**
	31 – 40 years	**31**	**24.0**	**96.9**
	41 – 50 years	**4**	**3.1**	**100.0**
Education Level	**Diploma**	**1**	**1.0**	**2.0**
	Degree	**104**	**79.2**	**81.2**
	Master's Degree	**23**	**17.7**	**98.9**
Years of Service	**Less than/equal to 1 year**	**20**	**15.6**	**15.6**
	1– 5years	**27**	**20.8**	**36.4**
	6 – 10years	**62**	**47.9**	**84.3**
	11 – 15 years	**17**	**12.5**	**96.8**
	16 – 20 years	**3**	**2.1**	**98.9**
	Above 20 years	**1**	**1.0**	**100.0**
Job Position	**Pharmacy Administration**	**15**	**11.5**	**11.5**
	ART Pharmacy	**31**	**24.0**	**35.5**
	Store	**28**	**21.9**	**57.4**
	Clinical Pharmacy (in-patient pharmacy)	**33**	**25.0**	**82.4**
	Out-patient Dispensary Pharmacy	**23**	**17.7**	**100.0**

Source: Survey of May, 2023

A. **Gender group Respondents**

Out of the 130 respondents in the study, 49 (37.5%) were female and 81 (62.5%) were male. This demonstrates that male employees make up the majority of the pharmacy staff at all AACAHB public hospitals.

B. Age Group of Respondents

The majority of respondents (n = 92, 70.8%) fell into the 21–30-year age group, followed by the 31–40-year age group (n = 31, 24%) and the 41–50-year age group (n = 4, 3.1%), in that order, according to the age distribution of respondents indicated in Table 4.1 above. Respondents above the age of 51, on the other hand, made up the least percentage of the sample, making up 0% and 2.1% (n = 3) of the sample, respectively. This implies that 97% of the pharmacy department staff members working in the AACAHB's public hospitals are under the age of 40.

C. Education Level of Respondents

The majority of respondents (n = 104, or 79.2% of the 130 total respondents) reported having a first degree, while 17.7% reported having a second degree (a master's degree) in terms of education. On the other side, only 1% of respondents had a diploma, which was the lowest percentage. Therefore, 99% of the respondents have a bachelor's degree or higher (a master's degree). This demonstrates that the vast majority of study participants are well-educated, able to comprehend the questionnaire with ease, and will significantly improve the calibre of the data gathered.

D. Demography of services in years

The respondents were questioned about how much time they had spent at each hospital. The findings show that the majority of respondents (i.e., n = 62, 47.9%) had worked for the company for 6 to 10 years. In addition, 20.8% of the respondents had worked there for one to five years, 15.6% had worked there for less than a year, 12.5% had worked there for eleven to fifteen years, 2.1% had worked there for sixteen to twenty years, and 1.0% had worked there for more than twenty years. This suggests that 84.3% of respondents have worked for their company for at least

a year and that about 63.5% have worked there for at least six years. Additionally, this will significantly aid in obtaining high-quality data.

E. Level of Occupation of Respondents: -

According to information acquired from the HR department of each public hospital, the pharmacy department is primarily organized into five occupational groups, including pharmacy administration, ART pharmacy, retail, in-patient, and out patient pharmacy. The respondents were asked to provide details about their level of employment. The majority of respondents were clinical pharmacists, according to the data in the table above, who were followed by ART pharmacies and stores, with percentage shares of 25%, 24%, and 21.9%, respectively. On the other side, pharmacy administrators and out-patient pharmacy had the lowest percentage of responses, with percentage shares of 11.5% and 17.7%, respectively.

4.2. Logistics System Performance of the SCM practice of ARV drugs in public hospitals under AACAHB

Logistics involves efficiently transporting supplies from origin to use, involving companies like manufacturing, retailing, and distribution. To ensure success, companies must evaluate their performance to ensure efficient transportation. This practice is crucial for various sectors, including armed forces, non-profits, civil defence, and public works departments.

The study evaluated the effectiveness of public hospitals in AACAHB's logistics systems for ARV medications, focusing on logistics knowledge, replenishment intervals, lead times, and emergency orders.

The results are shown in the table below

A. Logistic Knowledge Provision for the Staffs (Pharmacist)

Table4.2. Logistics System Performance (Logistic knowledge of Staffs, Length of Resupply, Lead-time, & Fill Rate, Emergency Orders.)

No.	Attributes of Logistics System Performance	Scale					Mean	St.dev.
A	**Logistic knowledge of Staffs**	SD	D	N	A	SA		
1	In our hospital, logistics management of ARV drugs training is periodically provided to the staffs of pharmacy	0% (0	8.3% (11)	4.2% (5)	75.0% (98)	12.5% (16)	3.9154	.7047
2	In our hospital, new HIV commodity awareness training is periodically provided to the staffs of pharmacy	27.1% (35)	42.7% (56)	11.5% (15)	17.7% (23)	1.0% (1)	2.2231	.1585
3	In our hospitals, pharmacy staffs are skilled to properly determine the quantities of ARV drugs order, forecasting the demand of ARVs, and determining the order resupply quantities.	28.1% (37)	29.2% (38)	6.3% (8)	30.2% (39)	6.3% (8)	2.5846	.3398
	Grand Mean of Logistic Knowledge of Staffs						2.9077	
B	**Lead-time and Fill Rate**	SD	D	N	A	SA	Mean	Std. dev.
1	In our hospital, the required amount of ARV drugs mostly ordered on its proper time (i.e., before ARVs are stocked-out) (length of sending order)	2.1% (3)	3.1% (4)	5.2% (7)	80.2% (104)	9.4% (12)	3.9077	.68705
2	In our hospital, we usually receive ARV medicines from EPSS exactly similar with the quantity we ordered (Order fill rate)	65.6% (85)	32.3% (42)	2.1% (3)	0% (0)	0% (0)	1.3692	.53030
3	EPSS is usually deliver the order ARV medicines in the expected delivery time (lead-time)	64.6% (84)	31.3% (41)	2.1% (3)	2.1% (3)	0% (0)	1.4154	.64441
	Grand mean of Lead-time and Fill Rate						2.2308	
C	**Emergency Orders**	SD	D	N	A	SA	Mean	Std dev.
1	In our hospital, we encountered no emergency orders for ARV in the last 6-months.	68.8% (89)	31.3% (41)	0% (0)	0% (0)	0% (0)	1.3154	.46647
2	In our hospital, we encountered one emergency orders for ARV in the last 6-months.	66.7% (87)	33.3% (43)	0% (0)	0% (0)	0% (0)	1.3308	.47231
3	In our hospital, we encountered two emergency orders for ARV in the last 6-months.	66.7% (87)	32.3% (42)	0% (0)	1.0% (1)	0% (0)	1.3462	.52402
4	In our hospital, we encountered three and more emergency orders for ARV in the last 6-months.	0% (0)	0% (0)	0% (0)	56.3% (73)	43.8% (57)	4.4385	.49812
	Grand mean of Emergency Orders						2.1077	
	Overall Grand Mean of Logistics System Performance						2.3846	

A weighted average of 1.00 to 1.79 is interpreted by Niftalem and Shiferaw (2021) as being very insignificant, 1.80 to 2.59 as being insignificant, 2.60 to 3.39 being neutral or unknowing, 3.40 to 4.19 being influential, and 4.20 to 5.00 being extremely influential. The degree of agreement for each factor is computed in accordance with an interpretation of the mean value of the weighted average categories.

As mentioned in Table 4.2 above, the majority of participants (mean = 3.9154) expressed their agreement regarding the provision of periodic logistics management training for ARV drugs to the pharmacy department staff in their respective hospitals. However, a small portion of respondents (mean = 2.5646) disagreed or strongly disagreed with the statement indicating that the pharmacy staff in their hospitals possess the necessary skills to accurately determine the quantities of ARV drug orders, forecast the demand for ARVs, and determine the appropriate resupply quantities. Additionally, respondents expressed disagreement (mean = 2.2231) regarding the periodic provision of new HIV commodity awareness training to the pharmacy staff in their respective hospitals.

The study indicates that pharmacy staffs in public hospitals of AACAHB are generally positive about regular training sessions on logistics management of ARV drugs. However, they have a negative perception of the training provided on new HIV commodities and their proficiency in determining ARV drug orders, forecasting demand, and determining order resupply quantities. The study suggests that authorities should prioritize training on new HIV commodities and necessary skills for accurate ARV drug order quantity, demand forecasting, and order resupply quantities.

B. Length of Resupply, Lead-time, & Fill Rate

The researcher added three new benchmarks to evaluate the logistic system's effectiveness: order submission time, order fill rate, and ARV medication delivery lead time.

The table indicates that a significant proportion of respondents (mean = 3.9077) agree that ARV drugs are ordered at the right time before they run out. However, none of them have a positive perception, and they strongly disagree with the statement that they receive ARV medicines from EPSS exactly in the quantity they ordered.

In the same manner, respondents disagreed that EPSS usually delivers the ordered ARV medicines within the expected delivery time. This suggests that the employees of the pharmacy department have a poor opinion about the lead time of EPSS's ARV and think there is a gap between the quantity ordered and the ARV medications actually received. Hence, EPSS has to maintain the resupply period of one month's period of request as recommended on the IPLS SOP. Regarding the negative perception of respondents about the lead-time of ARV supply, as per the recommendation of the Standard Operation Procedure (SOP) designed by EPSS, EPSS is responsible for resupplying health facilities with the requested quantity within one month of receiving a resupply request from a health facility (PFSA, 2015).

C. Emergency Orders

The frequency of emergency orders for ARV medications in public hospitals in AACAHB is crucial for evaluating the logistic system performance. Respondents requested a survey to determine the frequency of ARV orders, and the EPSS issued at least three such orders in the past six months.

The trend of emergency orders shown in this study is positive because, according to Araya (2018), receiving an emergency order three times in a six-month period is not seen as common.

Facilities must maintain a maximum-minimum inventory stock level to ensure sufficient products for clients and achieve targeted health outcomes. This prevents stock-outs and last-minute orders. If the stock falls below a set emergency order point, a mandatory emergency order must be placed before the reporting period ends. The logistic system's effectiveness depends on pharmacists' access to logistical expertise, resupply length, lead-time, fill rate, and emergency orders. (PFSA, 2015)

To ascertain which of the three characteristics of logistics system performance was most important, the study calculated the mean rank of each dimension. Table 4.3 shows the outcome.

T**able 4.3: Mean Rank of Logistics System Performance**

Dimensions of Levels of Employee Participation in Decision Making	Mean Rank
Logistic Knowledge Provision for the Staff (Pharmacist)	2.9077
Length of Resupply, Lead-time, & Fill rate	2.2308
Emergency Order	2.1077
Grand Mean Logistics System Performance	**2.4154**

Source: Using SPSS, survey questionnaire data was compiled in 2023.

From Table 4.3 above, the 2023 survey data reveals the logistics system's performance across key dimensions. The highest mean rank is 2.9077 for "Logistic Knowledge Provision for the Staff (Pharmacist)," indicating a strong emphasis on equipping pharmacists with the necessary logistical knowledge to manage the supply chain effectively. The second highest mean rank is 2.2308 for "Length of Resupply, Lead-time, & Fill rate", indicating the logistics system's proficiency in managing critical supply chain aspects like resupply times, lead times, and fill rates. The third highest mean rank is 2.1077 for "Emergency Order", indicating the system's ability to handle unexpected or urgent order requirements effectively. The grand mean logistics system performance across all dimensions is 2.4154, indicating a moderately strong level of overall performance. The Hospitals have established strengths in staff knowledge, supply chain management, and emergency response, but may have room for further optimization and improvement in certain logistics operations. Based on the mean value interpretation of Niftalem and Shiferaw (2021), this finding concludes that respondents have not neutral stand about the logistic knowledge provision of the staff. However, in order to check whether these observed differences are statistically significant or not, the researcher applies the Friedman procedure test.

Table 4.4: Friedman Test Statistics for Logistic System Performance

Test Statistics	
N	130
Chi-square	90.944
Df	2
Asymp. Sig.	0.000

a. Friedman Test

As reported in the Table 4.4 above, The Friedman test was used to compare the performance of a logistic system across three different conditions. The test resulted in a chi-square value of 90.944 with a small p-value of 0.000, suggesting that the system's performance was affected by the specific treatment or operational conditions it was subjected to during the 130 test runs. The study revealed that logistic knowledge provision for staff (Pharmacist) and length of resupply were the most significant attributes of logistics system performance in public hospitals in AACAHB. The findings suggest that public hospitals should prioritize logistic knowledge provision for staff and length of resupply to enhance logistics system performance across the hospitals. The chi-square statistic and p-value support the conclusion that the logistic system's performance was affected by specific treatment or operational conditions.

4.3. Inventory management practice

Effective inventory management is crucial to a company's success because it avoids the chance of having too much or too little product on hand and reduces the likelihood of inaccurate or out-of-stock data. Stock reviews, a manual procedure used by small businesses to examine existing inventory and expected future demand, are typical techniques. This method allows customers to have control over the inventory management process, but it can also be time and accuracy consuming. Inventory management involves tracking and monitoring a company's stock to ensure it's in the right location, quality, and quantity. It's crucial for business management as a shortage can hinder order fulfilment and customer satisfaction.

Every pharmacist who works in the ART drug distribution unit, as well as the store manager in the public hospitals covered by the AACAHB, is responsible for managing the ARV drug inventory. Inventory control models, order quantity estimating, stock keeping records and reporting, and safety stock rules were the four criteria that were utilized to examine the inventory management practices across all public hospitals under AACAHB. The responses from the responders are listed below.

Table.4.5. Inventory control models, order quantity estimation, stock keeping records and reporting, and safety stock regulations

No.	Attributes of Inventory Management Practices	Scale					Mean	Std.dev.
A)	Inventory Control Models	SD	D	N	A	SA		
1	Ordering ARV drugs in our hospital is usually conducted at the end of the reporting period (Forced Order System)	0% (0)	1.0% (1)	2.1% (3)	86.5% (112)	10.4% (14)	4.0692	.39744
2	Ordering ARV drugs in our hospital is usually conducted when minimum stock is reached (Continuous Review System)	52.1% (68)	38.5% (50)	1.0% (1)	8.3% (11)	0% (0)	1.6538	.86903
3	Ordering ARV drugs in our hospital is usually conducted at the end of reporting period for ARVs that have reached minimum stock level (Standard System)	51.0% (66)	43.8% (57)	1.0% (1)	4.2% (5)	0% (0)	1.5923	.73343
	Grand mean of Inventory Control Models						2.4385	
B	Determination of Order Quantities	SD	D	N	A	SA	Mean	Std.dev
1	In our hospitals, previous consumption data is usually used to forecast demand of ARVs (Projective Method)	1.0% (1)	0% (0)	2.1% (3)	94.8% (123)	2.1% (3)	3.9769	.34021
2	In our hospital, forecasts of the demand of ARV drugs are made based on external factors like epidemics, change in health system structure, and size (Causal Method)	41.7% (54)	32.3% (42)	14.6% (19)	11.5% (15)	0% (0)	1.9615	1.0146
3	In our hospital, forecasts of the demand of ARV drugs are made based on individual judgment of experienced staff (Judgment Method)	51.0% (66)	40.6% (53)	4.2% (5)	4.2% (5)	0% (0)	1.6154	.75107
4	In our hospital, forecasts of the demand of ARV drugs are made based on HIV prevalence, incidences, and expected number of attendances (Morbidity Method).	46.9% (61)	29.2% (38)	4.2% (5)	16.7% (22)	3.1% (4)	2.0000	1.21362
	Grand Mean of Determination of Order Quantities						2.3885	
C	Stock Keeping Record and Reporting	SD	D	N	A	SA	Mean	Std.dev
1	In our hospital, all ARV medicines have stock records	1.0% (1)	79.2% (103)	0% (0)	0% (0)	19.8% (26)	4.1769	.48967
2	Stock records for ARV medicines in our hospital are accurate and up to data.	2.1% (3)	0% (0)	0% (0)	85.4% (111)	12.5% (16)	4.0538	.57481
3	In our hospital, regular stock counts are done minimum once every reporting period of ARVs.	40.6% (53)	41.7% (54)	4.2% (5)	11.5% (15)	2.1% (3)	1.9308	1.05792

4	**In our hospital, entire inventory of ARV medicine is counted at one go in each stock take (full count)**	**21.9% (28)**	**22.9% (30)**	**6.3% (8)**	**45.8% (60)**	**3.1% (4)**	**2.8615**	**1.29252**
5	**Inventory of ARVs is divided into counting groups, with each group being counted per stock taking session (Cyclical count)**	**25.0% (33)**	**40.6% (53)**	**16.7% (22)**	**17.7% (23)**	**0% (0)**	**2.2615**	**1.03095**
6	**Reports of ARV medicines in our hospital are compiled at the end of each reporting period.**	**1.0% (1)**	**1.0% (1)**	**2.1% (3)**	**87.5% (114)**	**8.3% (11)**	**4.0231**	**.45691**
7	**Data on consumption is included in every report in our hospital**	**2.1% (3)**	**0% (0)**	**0% (0)**	**87.5% (114)**	**10.4% (14)**	**4.0308**	**.55599**
8	**Data on stock on hand is included in every report in our hospital**	**3.1% (4)**	**0% (0)**	**0% (0)**	**88.5% (115)**	**8.3% (11)**	**3.9923**	**.60356**
9	**Data on losses and adjustments is included in every report in our hospital**	**8.3% (11)**	**9.4% (12)**	**1.0% (1)**	**72.9% (95)**	**8.3% (11)**	**3.6385**	**1.04921**
10	**Data on commodities near expiry is included in every report in our hospital**	**36.5% (47)**	**45.8% (60)**	**7.3% (9)**	**6.3% (8)**	**4.2% (5)**	**1.9538**	**1.01814**
	Grand mean of Determination of Stock Keeping Record and Reporting						**3.2923**	
D	**Safety Stock Policy**	**SD**	**D**	**N**	**A**	**SA**	**Mean**	**Std.dev**
1	**A safety/buffer stock is kept for every ARV product in our hospital**	**6.3% (8)**	**4.2% (5)**	**2.1% (3)**	**80.2% (105)**	**7.3% (9)**	**3.7846**	**.87147**
2	**In our hospital, a standard formula is used in calculating safety stock**	**6.3% (8)**	**5.2% (7)**	**1.0% (1)**	**79.2% (103)**	**8.3% (11)**	**3.7846**	**.90635**
3	**In our hospital, a rough estimate is used as safety stock**	**4.2% (5)**	**0% (0)**	**4.2% (5)**	**79.2% (103)**	**12.5% (17)**	**4.0077**	**.60356**
	Grand Mean of Safety Stock Policy						**3.8590**	
	Over all grand mean of Inventory management practices						**3.0685**	

A. Inventory Control Models

Inventory control models are mathematical tools used by firms and institutions to determine the ideal stock level for their commodities. They guide supply chain managers on demand and issue to maintain a proper stock level and prevent overstocking or shortages**.**

Respondents were requested to show their perceptions about the availability of the forced order system, continuous review system, and standard system. As indicated in table 4.7, as per the

mean value categorization of Niftalem and Shiferaw (2021), respondents agree (Mean = 4.0692) that ordering ARV drugs in their respective hospitals is usually conducted at the end of the reporting period, i.e., a forced order system. On the contrary, only a few shares of the respondents agreed that ordering ARV drugs in their respective hospitals is usually conducted when minimum stock is reached (continuous review system) and at the end of the reporting period for ARVs that have reached minimum stock level (standard system) (Mean values of 1.6538 and 1.5923, respectively). This implies that the most predominantly used inventory control model in the public hospitals of AACAHB was the forced order system (Mean = 4.0692), while the standard system (ordering ARV drugs at the end of the reporting period of ARVs that have reached the minimum stock level) was the least preferred (Mean = 1.5923), as depicted in table 4.7 above.

B. Determination of Order Quantities

Determining order quantities requires considering various factors, including future demand. Forecasting methods include projective, causal, judgmental, and morbidity. Projective methods rely on past consumption, causal methods on external factors like epidemics and market structure, judgmental methods on staff estimates, and morbidity methods on disease incidence and treatment guidelines. Table 4.5 shows that most respondents use previous consumption data for ARV drug demand forecasting (projected method of forecasting) (Mean = 3.9769), while a small percentage use morbidity method (Mean = 2.0) based on HIV prevalence, incidences, and expected attendances. On the contrary, only 4% and 12% of the respondents stated that judgment and causal methods, respectively, are utilized in their hospitals for forecasts of the demand for ARV drugs. Hence, the study revealed that in the determination of order quantities, the projective method is mostly used in public hospitals of the AACAHB, followed by the morbidity method. On the contrary, judgment methods and causal methods are the least used methods for forecasting the demand for ARV drugs.

C. Stock Keeping Record and Reporting

In order to evaluate the stock keeping record and reporting, respondents were asked for their opinions on the following topics: the availability of ARV stock records, the accuracy of the stock records, the frequency of stock counts, the type of stock counts (full count, cyclical count), the

reporting of ARV medications, and the content of the data included in the report (consumption, stock on hand, losses and adjustments, and data on commodities).

As indicated in table 4.5, the majority of the respondents (Mean = 4.0538) stated that the stock records for ARV medicines in their hospital are accurate and up-to-date, and data on consumption is included in every report in their hospital. Besides this, respondents agreed that data on stock on hand is included in every report in their respective hospitals (Mean = 4.0308). Respondents also agreed that reports of ARV medicines in their respective hospitals are compiled at the end of each reporting period (Mean = 4.0231). Besides this, 81% of the respondents agreed or strongly agreed that data on losses and adjustments is included in every report in their respective hospitals. On the contrary, the least share of the respondents agreed that data on commodities near expiration is included in every report in their respective hospitals and that regular stock counts are done at least once every reporting period of ARVs (Mean = 1.9538 and 1.9308, respectively).

D. Safety Stock Policy

The hospital has a robust safety stock policy for ARV products, with a majority of respondents (80.2%) agreeing to keep a safety/buffer stock for every product. A standard formula is used to calculate safety stock levels, indicating a systematic approach. The mean scores for safety stock policy questions were around 3.8, indicating general agreement. The grand mean score was 3.07, indicating a generally favorable view of the hospital's inventory management practices. This structured, data-driven approach ensures consistent availability of critical ARV medications to patients in need.

4.4. Logistic Management Information System

The logistics management information system (LMIS) collects and provides data on healthcare commodities supplied to health facilities. Its primary purpose is to manage logistics, ensure a smooth supply chain, and monitor essential medicines as key indicators of health system performance. Electronic LMIS systems enhance medication accessibility and affordability by providing accurate information on pharmaceutical stocks and costs in pharmacies and healthcare facilities. These systems efficiently link medicine supply and demand with healthcare services, interacting with patient management systems.

Respondents were asked to evaluate the use of electronic and paper-based recording, reporting tools, patient records, HCMIS, RRF, and IFRR in public hospitals of AACAHB to assess the logistic management information system's effectiveness in managing stock movement between EPSS and hospitals.

Table 4.6: Frequency of Logistic Management Information System

No.	Attributes	Mean	Std.dev
1	Our hospital uses both computerized and paper-based recording and reporting tools	4.3615	.48230
2	In our hospital, computerized EDT is utilized to record patient information and for dispensary than paper-based format like daily ARV drug registers.	4.3538	.48001
3	In our hospital, Health commodity management information system (HCMIS) is mostly utilized in stores and stock movement.	4.3538	.48001
4	In our hospital, RRF (request and requisition form) are used to facilitate and control stock movement between EPSS and our hospital.	4.3538	.48001
5	In our hospital, Internal Facility Reporting and Requisition (IFRR) are used to facilitate and control stock movement within the hospital.	4.3769	.48649
	Grand Mean	4.359	

Source: generated using SPSS from survey questionnaires, 2023

The hospital's logistic management information system is highly utilized, with a grand mean of 4.359, indicating a combination of computerized and paper-based recording and reporting tools. The hospital favors computerized Electronic Drug Therapy (EDT) systems for patient information and dispensary management, with a mean of 4.3538 and a standard deviation of 0.48001. This shift towards computerized systems is a significant shift from paper-based formats like daily ARV drug registers.

The hospital also heavily utilizes the Health Commodity Management Information System (HCMIS) in its stores and for stock movement, with a mean of 4.3538 and a standard deviation of 0.48001. To facilitate and control stock movement, the hospital uses Request and Requisition Forms (RRF) between the (EPSA) and the hospital, with a mean of 4.3538 and a standard deviation of 0.48001. Additionally, the hospital employs Internal Facility Reporting and Requisition (IFRR) to manage stock movement within the hospital itself, with a mean of 4.3769 and a standard deviation of 0.48649.

Overall, the hospital has a well-established and extensively used logistic management information system, leveraging both computerized and paper-based tools to ensure efficient inventory management and stock control

4.5. Storage Management practice of ARV drugs

The hospital's storage condition was assessed using 18 LIAT (2006) standard criteria, using a checklist to evaluate compliance with ART stores. The survey results show compliance with these criteria.

Table 4.7. Storage condition of ARV drugs the hospitals under AACAHB.

No.	Description	No	Yes
1	Products are arranged on shelves with arrows pointing up, and with identification labels, expiry dates, and manufacturing dates clearly visible.	1(16.7%)	5(83.3%)
2	ARV drugs are stored and organized to FEFO (First-Expire-First-Out) procedures and are accessible for counting and general stock management.	1(16.7%)	5(83.3%)
3	Outer cartons are in good condition (not crushed, perforated, stained, or otherwise visibly damaged).	1(16.7%)	5(83.3%)
4	Damaged and expired products are separated from usable products in the storeroom, and procedures exist for removing them from inventory.	2(33.3%)	4(66.7%)
5	ARV drugs are stored in a dry, well-lit, well-ventilated storeroom. (Visually inspect roof, walls, and floor of storeroom.)	0(0%)	6(100%)
6	Cartons and products are protected from direct sunlight	0(0%)	6(100%)
7	There is no evidence of rodents or insects in the storage area. (Visually inspect the storage area for evidence of rodents [droppings] or insects that can damage or contaminate the products.)	0(0%)	6(100%)
8	Storage area is secured with a lock and key but is accessible during normal working hours; access is limited to authorized personnel.	1(16.7%)	5(83.3%)
9	Products are stored at the appropriate temperature according to product temperature specifications (8 °–30°C) and including cold chain storage (2°-8°C), as required for certain products.	1(16.7%)	5(83.3%)
10	Roof is maintained in good condition to avoid sunlight and water penetration.	1(16.7%)	5(83.3%)
11	Storeroom is clean, with all trash removed, no evidence of food and drinks, products stored on sturdy shelves/bins, and boxes organized neatly.	0(0%)	6(100%)
12	Current storage space is sufficient for existing products and planned program expansion.	3(50%)	3(50%)
13	ARV drugs are stored separately from insecticides, flammable products, and chemicals.	0(0.0%)	6(100%)
14	Food and drinks are not stored together in refrigerator used for storing ARV drugs that require cold storage.	2(33.3%)	4(66.7%)
15	Fire safety equipment is available and accessible. (Any item identified as being used to promote fire safety should be considered.)	0(0%)	6(100%)
16	Products are stacked at least 30 cm away from the walls and other rows or stacks of products (to prevent contact with outer walls and allow access to products).	3(50%)	3(50%)
17	Products are stacked no more than 2.5 m high.	1(16.7%)	5(83.3%)
18	Products are stacked at least 10 cm off the floor (on pallets or other materials that elevate the products off the floor).	2(33.3%)	4(66.7%)

***Source**: Survey of May, 2023*

As indicated in table 4.7 above, among the 18-store condition criterion. Most of the 18 storage recommendations that were examined were followed. At least 75% of the hospitals adhere to the 12 rules.

The majority of hospital ART stores 5(83.3%) adhere to the following standards: Products are arranged on shelves with arrows pointing up and with identification labels, expiration dates, and manufacturing dates clearly visible. ARV drugs are stored and organized according to FEFO (First-Expire-First-Out) procedures and are accessible for counting and general stock management. The outer cartons are in good condition (not crushed, perforated, stained, or otherwise visibly damaged). The storage area is secured with a lock and key but is accessible during normal working hours; access is limited to authorized personnel. Products are stored at the appropriate temperature according to product temperature specifications (8°–30°C) and including cold chain storage (2°–8°C), as required for certain products. The roof is maintained in good condition to avoid sunlight and water penetration, and Products are stacked no more than 2.5 m high.

4 (66.7%) of the hospital's damaged and expired products are separated from usable products in the storeroom. Food and drinks are not stored together in the refrigerator used for storing ARV drugs that require cold storage, and Products are stacked at least 10 cm off the floor (on pallets or other materials that elevate the products off the floor).

The hospitals store 100% of ARV drugs in a dry, well-lit, and well-ventilated room. Cartons and products are protected from sunlight, secured with a lock and key, and stored at the appropriate temperature. There is no evidence of rodents or insects, and ARV drugs are stored separately from insecticides, flammable products, and chemicals. Fire safety equipment is available and accessible, and any items used to promote fire safety should be considered.

3 (50%) of the hospitals Current storage space is sufficient for existing products, planned programme expansion, and Products are stacked at least 30 cm away from the walls and other rows or stacks of products (to prevent contact with outer walls and allow access to products).

4.6. Availability of ARV drugs public hospitals under AACAHB

Table 4.8. Availability of ARV drugs (stock out) on the day of visit

S/R No.	List of Drugs	Available Drug	
		Yes	No
1	TDF+3TC+DTG (300+300+50mg) tab	6(100%)	0(0%)
2	TDF+3TC (300+300mg) tab	6(100%)	0(0%)
3	EFV 600mg	6(100%)	0(0%)
4	DTG 50mg tab	2(33.3%)	4(66.7%)
5	AZT +3TC (300+150mg) tab	5(83.7%)	1(16.7%)
6	3TC 150mg tab	6(100.0%)	0(0%)
7	AZT + 3TC /300mg +150mg/ tab	6(100.0%)	0(0%)
8	RTV 100mg tab	1(16.7%)	5(83.7%)
9	DRV 600mg tab	2 (33.3%)	4(66.7%)
10	ABC 300 tab	6(100.0%)	0(0%)
11	ATZ/r 300mg/100mg tab	5(83.7%)	1(16.7%)
12	Lamivudine 30mg/Zidovudine 60mg Table	0(0%)	6(100%)
13	Lopinavir 200mg/Ritonavir 50mg Tablet	5(83.7%)	1(16.7%)
14	Lopinavir 100mg/Ritonavir 25mg Tablet (Pedi)	1(16.7%)	5(83.7%)
15	ABC/3TC 120mg/60mg (Pedi) tablets	5(83.7%)	1(16.7%)
16	DTG10mg tab Pedi	6(100%)	0%
17	Nevirapine 10mg/ml oral suspension.	6(100%)	0%
18	Zidovudine 50mg/5ml oral solution.	6(100%)	0%

Source: Survey of May, 2023

Based on the information provided in the table, the availability of antiretroviral (ARV) drugs on the day of the visit can be summarized as follows:

The majority of the ARV drugs are widely available, with 12 out of the 18 listed drugs having 100% availability. This includes important first-line regimens like TDF+3TC+DTG, TDF+3TC, and EFV 600mg, as well as other essential drugs like 3TC, AZT+3TC, ABC, and the paediatric formulations DTG 10mg and the oral suspensions of Nevirapine and Zidovudine.

However, there are a few gaps in the availability of certain ARV drugs. The drug DTG 50mg has a 66.7% stock-out rate, meaning it is not available for two-thirds of the patients. Similarly, the drugs RTV 100mg, DRV 600mg, and the paediatric formulation of Lopinavir/Ritonavir have stock-out rates ranging from 66.7% to 83.7%.

Additionally, the combination drug Lamivudine 30mg/Zidovudine 60mg is completely out of stock (100% stock-out rate), which could impact the availability of this important first-line regimen for some patients.

Overall, the majority of the essential ARV drugs appear to be readily available, but there are some gaps in the supply of specific drugs that may need to be addressed to ensure uninterrupted access to treatment for all patients.

4.2. Logistics System Performance of the SCM practice of ARV drugs

Logistics performance is evaluated by inventory availability, operational performance, and service reliability. Inventory availability focuses on meeting customer requirements, while operational performance involves speed and accuracy in the delivery process. Organizations aim for consistency in service and smooth operations to achieve these metrics.

4.2.1. Relationship between Supply Chain Management Practices in Public Hospitals of AACAHB and Availability of ARV Drugs

As stated in the methodology, both descriptive and explanatory designs were used in this study to achieve the stated aims. The availability of ARC drugs in public hospitals of the AACAHB is the dependent variable in this study. The independent variables are inventory management practice, logistics system performance, LMIS, and store condition. One of the explanatory designs used in this study is correlation analysis.

The range of a correlation coefficient's value is from -1 to 1. Values closer to the absolute value of 1 indicate that there is a significant relationship between the variables being correlated, while values closer to 0 indicate that there is little to no association. According to Creswell (2009), correlation coefficients of +0.9 to +0.7 are regarded as strong, +0.6 to +0.4 are regarded as moderate, and +0.3 to +0.1 are regarded as weak.

A correlation coefficient's sign tells us what kind of relationship there is between two variables. When the correlation coefficient is high, there is a positive linear link between the variables, which means that when one variable rises in value, so does the other. A negative linear relationship between the variables can be shown when one variable increase while the other

decreases (Almaquist *et al*., 2016). Based on these premises, the correlation analysis was conducted and presented as below:

Table 4.9: Results of Pearson Correlation Analysis

		IMP	LMIS	LSP	SC	ARV
Inventory Management Practice	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	127				
Logistic Management Information System	Pearson Correlation	.349	1			
	Sig. (2-tailed)	.051				
	N	127	127			
Logistic System Performance	Pearson Correlation	.349*	.014	1		
	Sig. (2-tailed)	.000	.890			
	N	127	127	127		
Store Condition	Pearson Correlation	-.249*	-.027	-.180	1	
	Sig. (2-tailed)	.014	.791	.080		
	N	127	127	127	29	
Availability of ARV	Pearson Correlation	. 679**	. 256*	. 685**	. 290**	1
	Sig. (2-tailed)	.000	.004	.000	.012	
	N	127	127	127	127	127

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: *Own Survey Result (2023), SPSS Output*

Table 4.9's coefficients show that every independent variable, including inventory management practices, logistic management information systems, logistic system performance, and store condition, is positively related to the dependent variable, which is the availability of ARV medications in AACAHB's public hospitals.

Regarding with the correlation between variables, Pearson correlation coefficient with the symbol "**" indicate that each of the variables are significantly correlated with each other at a significance level of $p<0.01$. Based on this, there is statistically significant and positive relationship between inventory management practice and availability of ARV drugs ($r = 0.679$, 0.000; $p<0.01$), between LMIS and availability of ARV drugs ($r = 0.256$, 0.004; $p<0.01$), and between store condition and availability of ARV drugs ($r = 0.290$, 0.000; $p<0.01$). On the other hand, Pearson correlation with the symbol "*" indicate that each of the variables are significantly correlated with each other at a significance level of $p<0.05$. Based on this, there is statistically

significant and positive relationship between logistics management information system and availability of ARV drugs ($r = 0.256, 0.012$; $p<0.05$).

Hence, the study revealed that there is statistically significant and positive relationship between all independent variables of the study (i.e., inventory management practice, logistic management information system, logistic system performance, and store condition) and the dependent variable i.e., availability of ARV drugs in the public hospitals of AACAHB.

As per the classification of relationship strength stated by Cress well (2009), there is statistically significant, positive, and moderate relationship between availability of ARV drugs and inventory management practice ($r = 0.679$) and between logistics system performance and availability of ARV drugs ($r = 0.685$) since their Pearson correlation coefficient is between 0.4 to 0.6. On the other hand, there is small/weak relationship between LMIS and availability of ARV drugs ($r = 0.256$) and between store condition and availability of ARV drugs ($r = 0.290$) since their Pearson correlation coefficient is between 0.10 – 0.30 (Creswell, 2009). This finding of the study opposes the previous work of Gemechu, *et al*. (2021) in public health facilities in Addis Ababa that found a very high positive correlation between storage condition and the availability of ARV drugs.

As a result, the study found that, among the identified drivers of ARV drug availability, there is a rather substantial correlation between the performance of the logistics system and the availability of ARV drugs, with inventory management practice, store condition, and store condition following closely behind. This suggests that public hospitals in AACAHB should place a strong emphasis on inventory management (particularly in ordering ARV drugs, forecasting the demand for ARV drugs, and performing routine stock counts) and logistics system performance (especially the order fill rate, delivery lead-time, and providing periodic awareness training for new HIV to the pharmacy staff).

4.2.2. The Effect of Supply Chain Management Practices on the Performance of ARV Drugs Availability in Public Hospitals of AACAHB

The effects of each independent variable on the dependent variable were examined using a multiple linear regression analysis by the researcher. Before performing the regression analysis, the assumptions of the classical model were verified, and the outcomes are as follows.

4.2.2.1. Diagnostic Test of Assumptions

To test multiple linear regressions, it is first necessary to test the classical assumption that includes linearity, normality test, auto-correlation test, and multi-co-linearity test. The results of each assumption are presented as follow.

I. Linearity Test

The goal of a linearity test is to determine whether the connection between the independent variables and the dependent variable is linear. The linearity test is required in correlation and linear regression analysis (Almquist *et al*., 2016). The relationships between the independent variables and the dependent variables are linearly dependent if the ANOVA test's sign deviation from linearity value is greater than 0.05; on the other hand, if the value is less than 0.05, the relationships are nonlinear.

Table 4.10: Linearity Test (ANOVA Table)

			Sum of Squares	Df	Mean Square	F	Sig.
Inventory Management Practice * ARV Availability	Between Groups	(Combined)	4.249	26	.163	4.593	.000
		Linearity	3.146	1	3.146	88.428	.000
		Deviation from Linearity	1.103	25	.044	1.240	.239
	Within Groups		2.455	69	.036		
	Total		6.703	126			
Logistic Management Information System * ARV Availability	Between Groups	(Combined)	.652	2	.326	5.007	.000
		Linearity	.565	1	.565	8.679	.000
		Deviation from Linearity	.087	1	.087	1.334	.251
	Within Groups		6.052	93	.065		
	Total		6.703	215			
Logistic System Performance * ARV Availability	Between Groups	(Combined)	3.848	17	.226	6.182	.000
		Linearity	3.092	1	3.092	84.448	.000
		Deviation from Linearity	.756	16	.047	1.290	.225
	Within Groups		2.856	78	.037		
	Total		6.703	126			
Store Condition * ARV Availability	Between Groups	(Combined)	1.068	3	.356	5.815	.000
		Linearity	.441	1	.441	7.194	.000
		Deviation from Linearity	.628	2	.314	5.125	.080
	Within Groups		5.635	92	.061		
	Total		6.703	126			

Source: Compiled from Survey Questionnaires using SPSS, 2023

Based on the ANOVA Output Table as indicated above, value sig. Deviation from Linearity of all independent variables is found greater than 0.05. Therefore, it can be concluded that there is a linear relationship between each dependent and independent variable.

II. Auto-correlation Test

Auto correlation prohibits the use of regression analysis. Fortunately, the Durban-Watson test makes it possible for us to recognize this problem. The findings of the auto-correlation test are revealed by the Durban-Watson test. According to Almquist *et al*. (2016), there is no auto correlation if the Durban-Watson values are between 1.5 and 2.5. A model with 130 observations and four independent variables has a Durban-Watson value of 1.582, as shown in Table 4.14. Since it is obvious that there is no auto correlation from this, we may move forward with the regression model.

III. Multi-co-linearity Test

According to Tustin *et al.* (2005), multi-co-linearity is the inability to disentangle the effects of the independent factors on the outcome variable due to the high correlation (r=0.8 or greater) between the independent variables. To put it another way, one of the predictor variables can be almost completely predicted by another one. When independent variables in a regression model are correlated, multi-co-linearity emerges. Because independent variables should be independent, this association is problematic. If the correlation between the variables is strong enough, it may be difficult to fit the model and interpret the findings. There are several methods for determining whether a dataset is multi-co-linear, including the bi-variant correlation matrix, the tolerance statistic (TOL), the variance inflation factor (VIF), the Eigenvalues, condition indices, the variance proportions, and zero-order vs. partial and part correlations. The researcher used the Variance Inflation Factor (VIF) and Tolerance Statistic to test for the presence of multi-co-linearity among these (TOL).

The variance inflation factor (VIF) identifies correlation between independent variables and the strength of that correlation. As stated by Almquist *et al*. (2016), a VIF value of 1 indicates that there is no correlation between this independent variable and any others. VIFs between 1 and 5 suggest that there is a moderate correlation, but it is not severe enough to warrant corrective measures. VIFs greater than 5 represent critical levels of multi-co-linearity where the coefficients

are poorly estimated, and the p-values are questionable. Besides this, a tolerance of less than 0.20 or 0.10 indicates a multi-co-linearity problem.

Based on these criteria, the tests were conducted on the independent variables and the result is shown as below.

Table 4.11: Multi-co-linearity Test

	Tolerance	VIF
Inventory Management Practice	.788	1.269
Logistic Management Information System	.935	1.070
Logistic System Performance	.864	1.157
Store Condition	.927	1.078

Source: Compiled from Survey Questionnaires using SPSS, 2023

The tolerance values for all the independent variables - Inventory Management Practice, Logistic Management Information System, Logistic System Performance, and Store Condition - are well above the recommended threshold of 0.1. The tolerance values range from 0.788 to 0.935, indicating that the variables are not highly correlated with one another.

Furthermore, the Variance Inflation Factor (VIF) values for these variables are all below the commonly used cutoff of 5. The VIF values range from 1.070 to 1.269, which is well within the acceptable limits. VIF measures how much the variance of a coefficient is inflated due to collinearity among the predictors. The model's independent variables show no concern for multicollinearity, as indicated by high tolerance levels and low VIF values. This indicates that the variables measure distinct concepts and are not redundant or overly correlated. This assumption is crucial for the reliability and validity of the statistical analysis, as it prevents biased or unstable estimates due to high correlations among predictors. This indicates the model can provide trustworthy insights about the relationships between independent and dependent variable.

Based on the coefficients output of co-linearity statistics obtained, VIF value of all independent variables is nearest to 1 or stated as between 1 to 5 (moderate correlation, but it is not severe enough to warrant corrective measures). Besides this, the value of tolerance for all independent variables is above 0.2. Hence, it can be concluded that there are no multi-co-linearity symptoms.

IV.Normality Test

The Normal P-P Plot of Regression Standardized Residual is a visual representation of the relationship between the dependent variable (Availability of ARV Drugs) and the observed cumulative probability. It shows a clear linear trend, indicating that the residuals follow a normal distribution. The data points follow the diagonal line, indicating that the underlying assumptions of the regression model, such as normality of residuals, are met. The linearity of the plot indicates a strong correlation between the dependent variable and the observed cumulative probability. The closer the data points are to the diagonal line, the better the fit of the regression model and the more accurate it can predict the dependent variable based on the independent variable(s). **Below is shown the normal probability plot of the SPSS output**.

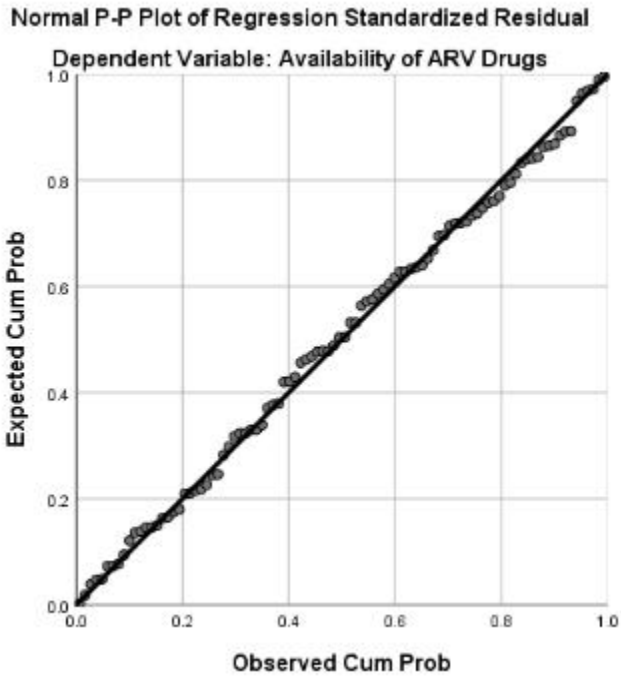

Figure 3: Normal P-P Plot

Source: Own Computations, 2023

The normal chart probability plot demonstrates how the existing points always approach and converge on the diagonal line. As a result, it may be claimed that the residual value has a normal distribution, demonstrating the effectiveness of the regression analysis method.

I. Residual Normality Test

Differences between the model's one-step anticipated output and the measured output from the validation data set are known as residuals. The portion of the validation data that the model is unable to account for is represented by residuals. The whiteness test and the independence test are the two tests that make up residual analysis**.** The graph shows the availability of Antiretroviral (ARV) drugs, with a bell-shaped curve indicating a normal distribution. The x-axis represents the regression standardized residual, while the y-axis represents the frequency of each residual value. The histogram suggests that ARV drug availability is influenced by multiple factors, including supply chain management, healthcare infrastructure, policy decisions, and socioeconomic conditions. The peak of the curve indicates the most commonly observed level of ARV drug availability. This information can inform policymakers, healthcare providers, and researchers in improving access to essential medicines and ensuring equitable distribution of ARV drugs. The histogram provides a visual representation of the distribution of ARV drugs, providing valuable insights into patterns and trends in this crucial healthcare variable.

The researcher used histogram to identify normal distribution of residuals and the result is presented as follow;

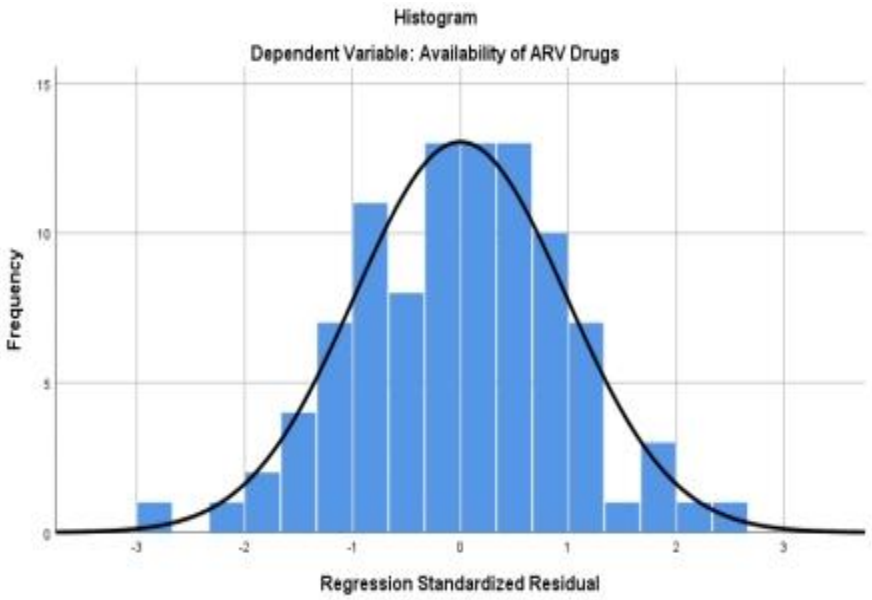

Figure 4: Regression Standardized Residual

Source: Own Computations, 2023

4.2.3. The Model Result.

The first table of the linear regression model is the Model Summary table. This table provides the R, R^2, adjusted R^2, and the standard error of the estimate, which can be used to determine how well a regression model fits the data. **R** is computed as the square root of R-squared and denotes the correlation between the observed and predicted values of the dependent variable. **R-Squared** (R^2 or the coefficient of determination) shows how well the data fit the regression model. **Adjusted R-square** is a modified version of R-squared that accounts for predictors that are not significant in a regression model. In other words, the adjusted R-squared shows whether adding additional predictors improve a regression model or not. The **standard error of the estimate** is the standard deviation of the error term and is the square root of the Mean Square Residual (or Error).

The Model summary is presented as follow below.

Table 4.12: Model Summary of Multiple Linear Regressions

Model Summary					
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Durbin-Watson**
1	.848[a]	.719	.706	.14391	1.582
a. Predictors: (Constant), Inventory management practice, LMIS, logistics system performance, store condition					
b. Dependent Variable: Availability of ARV drugs					

Source: Own computations, 2023

The R-value represents the simple correlation and the R-value of the regression model as indicated in table 4.12 is 0.848. As per the classification range of correlation stated by Cresswell (2009), the correlation coefficient ranging from 0.7 to 0.9 indicates strong relationship between the independent and dependent variables. Hence, as the R-value is 0.848, it indicates that there is strong association between the independent variables (i.e., Inventory management practice, LMIS, logistics system performance, and store condition) and dependent variable (i.e., availability of ARV drugs) in the hospitals.

The multiple linear regression model has an R-value of 0.848, indicating a strong positive correlation between the predictor variables (inventory management practice, LMIS, logistics system performance, and store condition) and the dependent variable (availability of ARV drugs). The R-squared value of 0.719 means that approximately 71.9% of the variation in ARV

drug availability can be explained by the combined effects of the four predictor variables in the model. The adjusted R-squared of 0.706 suggests that the model would account for about 70.6% of the variance in the dependent variable if the model was derived from the population instead of the sample. The standard error of the estimate is 0.14391, indicating the typical amount that the observed values deviate from the regression line. Finally, the Durbin-Watson statistic of 1.582 suggests there may be some positive autocorrelation present in the residuals, though the value is close to the ideal of 2 which would indicate no autocorrelation.

The second result of regression is ANOVA table as indicated in table 4.13 below. In this table, the p-value result is crucial to decide the reliability of the regression result. As indicated in Almaquist *et al*. (2016), if the p-value is less than 0.05, it indicates that the group of independent variables shows a statistically significant relationship with the dependent variable, or that the group of independent variables reliably predicts the dependent variable. If the p-value is greater than 0.05, the opposite will happen. Based on these premises, the result is presented as follow.

Table 4.13: ANOVA Result of Multiple Linear Regression Model

ANOVA[a]						
Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
1	Regression	4.818	4	1.205	58.163	.000[b]
	Residual	1.885	126	.021		
	Total	6.703	130			
a. Dependent Variable: Availability of ARV Drugs						
b. Predictors: (Constant), Inventory management practice, LMIS, logistics system performance, store condition						

Source: Own computations, 2023

As indicated in table 4.13 above, the p-value associated with the F value (58.163) is very small (0.000) or less than 0.05. This indicates that the group of independent variables (such as Inventory management practice, LMIS, logistics system performance, and store condition) reliably predicts the dependent variable (i.e., availability of ARV drugs).

However, this is an overall significance test assessing whether the group of independent variables when used together reliably predict the dependent variable and does not address the ability of any of the independent variables to predict the dependent variable. The ability of each individual independent variable to predict the dependent variable is addressed in the table 4.14 below, where each of the individual variable are listed.

Table 4.14: Multiple Linear Regression-Beta Coefficients of Independent Variables

Coefficients								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.979	.369		2.651	.009	.245	1.712
	Inventory management practice (IMP)	.363	.050	.454	7.243	.000	.264	.463
	LMIS	.095	.032	.172	2.984	.004	.032	.179
	Logistics System Performance (LSP)	.360	.042	.510	8.525	.000	.276	.544
	Store Condition (SC)	.023	.290	.374	.815	.017	.017	.888
a. Dependent Variable: Availability of ARV Drugs								

Source: Own Computations, 2023

The amount by which the dependent variable varies if we modify the independent variable by one unit while holding other independent variables constant, according to Almaquist *et al*. (2016), is represented by the Unstandardized coefficient. The availability of ARC medications in public hospitals in AACAHB is positively correlated with all independent factors, as demonstrated in the aforementioned table. According to Almaquist *et al*. (2016), coefficients with p-values less than alpha (0.05) are statistically significant, and coefficients higher than alpha (0.05) are not.

As indicated in table 4.14, the coefficient for inventory management practice (0.454) is statistically significant at the 0.05 level since the p-value is 0.000, which is less than 0.05. The coefficient for LMIS (0.172) is statistically significant because its p-value of 0.004 is less than 5. The coefficient for logistics system performance (0.510) is statistically significant because its p-value of 0.000 is less than 5. The coefficient for store condition (0.374) is statistically significant because its p-value of 0.017 is less than 0.5.

The study discloses that the average change in the dependent variable (Availability of ARV Drugs) is associated with a one-unit change in the independent variable. A constant term of 0.979 predicts the predicted value of Availability of ARV Drugs when all independent variables are equal to zero. An unstandardized coefficient for Inventory Management Practice (IMP) is 0.363, indicating that a one-unit increase in IMP is associated with a 0.363 increase in ARV Drugs availability. An unstandardized coefficient for Logistics System Performance (LSP) is

0.360, indicating that a one-unit increase in LSP is associated with a 0.360 increase in ARV Drugs availability. A one-unit increase in Store Condition (SC) is associated with a 0.023 increase in ARV Drug availability. All variables have p-values less than the significance level of 0.05, indicating their statistical significance.

From this, the study concludes that there is a positive and statistically significant association between all independent variables and dependent variable. Furthermore, in the above table, un-standardized coefficient B denotes the values for the regression equation for predicting the dependent variable from the independent variable. These estimates tell us about the relationship between the independent variables and the dependent variable (Almaquist *et al*., 2016). These estimates tell us the amount of increase in availability of ARV drugs that would be predicted by a 1-unit increase in the predictor (i.e., independent variables). For the independent variables, which are not significant, the coefficients are not significantly different from 0, which should be considered when interpreting the coefficients. With this, the results of association of independent variables with dependent variable are presented as below.

4.2.4. The Effect of Inventory Management Practice on the Performance of ARV Drug Availability in the Public Hospitals under AACAHB

Inventory Management Practice in Public Hospitals of AACAHB – the coefficient (parameter estimate) is 0.454 (sig. value 0.000). This indicates that for every unit increase in inventory management practice in public hospitals of AACAHB, there is a 0.454 unit increase in the predicted availability of ARV drugs in public hospitals of AACAHB, holding all other variables constant. The variable named inventory management practice in public hospitals of AACAHB is statistically significantly different from 0, because the p-value is .000, which is less than .05. As indicated in the descriptive analysis and mean rank computation, the study found out that determination or order quantities (especially conducting judgmental forecasts method) and stock keeping record and reporting practices in public hospitals of AACAHB (especially including data on commodities near expiry in every report in the hospitals) are the major determinant attributes of inventory management.

Therefore, it is advised that public hospitals in AACAHB use morbidity measures and prior consumption data (the projective method) to forecast the demand for ARV medications. In

addition, public hospitals in the AACAHB should forecast the demand for ARV medications using prior consumption data (the standard system) to improve the efficiency of their inventory management. A continual evaluation method should be used by hospitals to order ARV medications whenever the minimal supply is reached.

The results of this study support prior work by Mokheseng *et al*. (2017) carried out in the QwaQwa region, which discovered that inventory management had a statistically significant impact on the supply chain management of ARVs. With the exception of order lead time, Johnson *et al*.'s research in Kenya found that all areas of inventory management were deemed to be poor due to high stock out rates, subpar reporting rates, and high stock wastage rates as a result of observed expirations. The survey also showed that the biggest obstacles to ARV inventory management procedures are a lack of skilled workers and limited manpower. Furthermore, the finding of this study supported a study conducted by WHO (2016) that found that healthcare facilities are limited to making tactical decisions and run the risk of not being able to supply the most appropriate medication due to improper inventory management.

4.2.5. The Effect of LMIS Practice on the Performance of ARV Drug Availability in the Public Hospitals under AACAHB

LMIS in Public Hospitals of AACAHB – the coefficient (parameter estimate) is 0.172 (sig. value 0.004). This indicates that for every unit increase in LMIS in public hospitals of AACAHB, there is a 0.172 unit increase in the predicted availability of ARV drugs in public hospitals of AACAHB, holding all other variables constant. The variable named LMIS in public hospitals of AACAHB is statistically significantly different from 0, because the p-value is .004, which is less than .05. Among the attributes of LMIS, the use of internal facility reporting and requisition (IFRR) to facilitate and control stock movement within the hospitals is significant variable affecting the LMIS in the public hospitals of AACAHB. Hence, the hospitals are recommended to strengthen IFRR use for the facilitation and control of stock movement within the hospital. This study's conclusion confirms earlier research by Mokheseng *et a*l. (2017) conducted in the QwaQwa district, which found that LMIS has a statistically significant impact on how ARV supply chains are managed. According to the report, the biggest issue influencing the supply chain of ARVs is poor overall communication in the management of the supply chain.

4.2.6. The Effect of Logistics System Performance on the Performance of ARV Drug Availability in the Public Hospitals under AACAHB

Logistics System Performance in Public Hospitals of AACAHB – the coefficient (parameter estimate) is 0.510 (sig. value 0.000). This indicates that for every unit increase in logistics system performance in public hospitals of AACAHB, there is a 0.510 unit increase in the predicted availability of ARV drugs in public hospitals of AACAHB, holding all other variables constant. The variable named logistics system performance in public hospitals of AACAHB is statistically significantly different from 0, because the p-value is .000, which is less than .05. The study reveals that the logistics system performance, including knowledge provision for pharmacy department staff, length of resupply/lead-time/order fill rate, and emergency orders, significantly impacts the performance. The study recommends that public hospitals in AACAHB provide awareness training on new HIV commodities to pharmacy department staff and improve order fill rate, thereby enhancing the overall logistics system performance.

This finding of the study supports a study undertaken by Mori and Owenya (2014; as cited in Mokheseng *et al*., 2017) on ARV distribution in Tanzania which founds those stock-outs of ARVs is caused by a poor logistics system performance and due to inefficient supply systems.

As stated by Kapoor *et al*. (2018), strategies to improve order fill rate are minimizing the number of decisions that need to be made by warehouse staff for each order, establishing order picking plan, optimize the fulfillment process, regularly analyzing customer demand to determine the amount of inventory to hold, and establishing a clear path of communication.

4.2.7. The Effect of Store Condition on the Performance of ARV Drug Availability in the Public Hospitals under AACAHB

Store Condition in Public Hospitals of AACAHB – the coefficient (parameter estimate) is 0.374 (sig. value 0.017). This indicates that for every unit increase in store condition in public hospitals of AACAHB, there is a 0.374 unit increase in the predicted availability of ARV drugs in public hospitals of AACAHB, holding all other variables constant. The variable named store condition in public hospitals of AACAHB is statistically significantly different from 0, because the p-value is .017, which is less than .05. As indicated in descriptive analysis, the public hospitals of AACAHB have fulfilled 83% of the criterion of store condition stated in LIAT

(2006) to store ARV drugs. Hence, the study recommends the hospitals to properly establish their stores and fulfill all the 18 criteria specially to stack ARV products at least 30 cm away from the walls and other rows or stacks of products (to prevent contact with outer walls and allow access to products), stack the products no more than 2.5 m high, and stack products at least 10 cm off the floor (on pallets or other materials that elevate the products off the floor).

This finding of the study opposes a previous study conducted by Gemechu *et al*. (2020) on inventory management practice of ARV drugs in public health facilities in Addis Ababa, Ethiopia. Their study found that the majority of health facilities did not meet acceptable storage conditions.

From the above analysis, it can be concluded that the estimated regression equation was:

$$Yi\ \textbf{(Predicted)} = 0.979 + 0.454_{IMP} + 0.172_{LMIS} + 0.510_{LSP} + 0.374_{SC} + \varepsilon$$

Where, Y*i* denotes availability of ARV drugs, IMP denotes inventory management practice, LMIS denotes to logistics management information system, LSP denotes to logistics system performance, and SC denotes to store condition.

The result as indicated in table 4.14 above, among the identified independent variables, logistics system performance in public hospitals of AACAHB have the highest B coefficient value i.e., 0.510; followed by inventory management practice in public hospitals of AACAHB, store condition of public hospitals of AACAHB, and logistics management information system in public hospitals of AACAHB by having B coefficient value of 0.454, 0.374, and 0.172 respectively. This implies that, logistics system performance in public hospitals of AACAHB highly predicts (51.0%) the variation in the availability of ARV drugs public hospitals of AACAHB; followed by inventory management practice in public hospitals of AACAHB, store condition in public hospitals of AACAHB, and logistics management information system in public hospitals of AACAHB with a prediction of 45.4%, 37.4%, and 17.2% respectively.

CHAPTER FIVE

SUMMARY OF FINDING, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of major findings

This study's aim is to address the two clearly stated objectives and offer responses to the posed research questions. The initial objective of the study was to assess the supply chain management techniques, LMIS procedures, storage conditions, and inventory management techniques employed in the public hospitals covered by AACAHB. The study's objective was to gather feedback from the pharmacy department staff at all of the public hospitals under AACAHB. The SCM of ARV drugs aims to ensure sustainable availability at service delivery points, ensuring timely delivery of necessary drugs. Training for managing ARV drugs involves timely record-keeping, analysis, and reporting. The study found that logistic knowledge provision for staff (pharmacists) is the most significant attribute in public hospitals in AACAHB, followed by length of resupply.

Among the attributes of logistic knowledge of staffs, respondents have a negative perception about the provision of new HIV commodity awareness training to the staffs and about the skill of their staffs to determine the quantities of ARV drug orders, forecast the demand for ARV drugs, and determine the order resupply quantities. Among the attributes of lead-time and fill rate, the majority of the respondents agreed that the required amount of ARV drugs in their respective hospitals is usually ordered at the proper time, i.e., before ARV drugs are stocked out. However, almost all respondents (i.e., 98%) stated that in their hospital, they don’t receive ARV medicines from EPSA exactly in the quantity they ordered.

The Majority of bin cards were not updated with accurate information matching the physical count done at the time of the visit. And most of the hospitals didn’t use stock cards for stock recording. This caused wastage of medicines that expired without anyone noticing that the shelf-life date was approaching, which led to facilities stocking out of certain ARV drugs. Besides this, they stated that EPSS is not usually able to deliver the order of ARV medicines in the expected delivery time.

The study analyzed inventory management practices in public hospitals in AACAHB, revealing that the most common inventory control method is a forced order system, with 97% of

respondents using previous consumption data to forecast ARV demand. Stock keeping records and reporting trends are accurate and up-to-date, with 98% of respondents including data on consumption and stock in every report. However, data on commodities near expiry is not included in every report and regular stock counts are not done at least once every reporting period. All selected public hospitals used computerized and paper-based recording and reporting tools, including computerized EDT and HCMIS at the dispensary and store. RRF and Internal Facility Reporting and Requisition (IFRR) were used to facilitate and control stock movement between PFSA and the facility and within the hospital.

LMIS is crucial for public health commodity distribution systems, especially for HIV/AIDS commodities. It reduces resource waste through stockouts, overstocks, and losses. Inventory control systems help staff maintain stock levels and avoid shortages. These procedures are established at all ART monitoring pharmacies and are part of the national standard operating procedure manual for ARV drugs.

A well designed and well operated inventory control system helps to prevent shortages, oversupply, and expiry. The majority of the ARV drugs are widely available, with 12 out of the 18 listed drugs having 100% availability. This includes important first-line regimens like TDF+3TC+DTG, TDF+3TC, and EFV 600mg, as well as other essential drugs like 3TC, AZT+3TC, ABC, and the paediatric formulations DTG 10mg and the oral suspensions of Nevirapine and Zidovudine. However, there are a few gaps in the availability of certain ARV drugs. The drug DTG 50mg has a 66.7% stock-out rate, meaning it is not available for two-thirds of the patients. Similarly, the drugs RTV 100mg, DRV 600mg, and the paediatric formulation of Lopinavir/Ritonavir have stock-out rates ranging from 66.7% to 83.7%. Additionally, the combination drug Lamivudine 30mg/Zidovudine 60mg and Cotrimoxazole 240 mg/5 ml oral suspension for pediatric OI drugs were not available due to stock out and expiration is completely out of stock (100% stock-out rate), which could impact the availability of this important first-line regimen for some patients. Overall, the majority of the essential ARV drugs appear to be readily available, but there are some gaps in the supply of specific drugs that may need to be addressed to ensure uninterrupted access to treatment for all patients.

Storing is the safe keeping of pharmaceuticals to avoid damage, expiry, and theft. Proper storage procedures help to ensure that storage facilities protect the shelf life of products, that only high-quality products are issued, and that there is little or no waste due to damage or expiry of

products. If proper storage procedures are followed, customers can be assured that they have received a high-quality product. 5(83.3%) of the ART drugs are arranged on shelves with arrows pointing up, and with identification labels, expiry dates, and manufacturing dates clearly visible. One of the special characteristics of ARV drugs have short shelf life (expiry) due to this they need special attention.

When storing pharmaceutical there are two procedures that should be followed. First in first out (FIFO) and the other one is the FEFO procedure which is first expiry first out. 5(50%) of the ARV drugs are stored and organized to FEFO procedures and are accessible for counting and general stock management. Almost more than 80% of the hospitals have separate store for expired and damaged products, and procedures exist for removing them from inventory. 5(50%) of the hospitals Store room were clean, with all trash removed, no evidence of food and drinks, products stored on shelves/bins, and boxes organized during the time of visit. The majority of hospital ART stores 5(83.3%) adhere to the following standards: Products are arranged on shelves with arrows pointing up and with identification labels, expiration dates, and manufacturing dates clearly visible. ARV drugs are stored and organized according to FEFO (First-Expire-First-Out) procedures and are accessible for counting and general stock management. The outer cartons are in good condition (not crushed, perforated, stained, or otherwise visibly damaged). The storage area is secured with a lock and key but is accessible during normal working hours; access is limited to authorized personnel. Products are stored at the appropriate temperature according to product temperature specifications (8°–30°C) and including cold chain storage (2°–8°C), as required for certain products. The roof is maintained in good condition to avoid sunlight and water penetration, and Products are stacked no more than 2.5 m high.

4(66.7%) of the hospital's damaged and expired products are separated from usable products in the storeroom. Food and drinks are not stored together in the refrigerator used for storing ARV drugs that require cold storage, and Products are stacked at least 10 cm off the floor (on pallets or other materials that elevate the products off the floor).

The hospitals store 100% of ARV drugs in a dry, well-lit, and well-ventilated room. Cartons and products are protected from sunlight, secured with a lock and key, and stored at the appropriate

temperature. There is no evidence of rodents or insects, and ARV drugs are stored separately from insecticides, flammable products, and chemicals. Fire safety equipment is available and accessible, and any items used to promote fire safety should be considered.

3(50%) of the hospitals Current storage space is sufficient for existing products, planned programme expansion, and Products are stacked at least 30 cm away from the walls and other rows or stacks of products (to prevent contact with outer walls and allow access to products).

5.2. Conclusions

The study concludes that the practice of supply chain management of ARV drugs in the public hospitals of AACAHB in terms of logistics system performance indicates that logistic knowledge provision for the staff (Pharmacist) is the most significant attributes of logistics system performance in the public hospitals in AACAHB. The hospitals don't provide new HIV commodity awareness training to the staffs and there is skill gap to determine the quantities of ARV drugs order, forecasting the demand of ARVs, and determining the order resupply quantities. Besides this, the required amount of ARV drugs in the hospitals are usually ordered on its proper time i.e., before ARVs are stocked-out. However, the hospitals don't receive ARV medicines from EPSS exactly similar with the quantity they ordered. EPSS is not usually deliver the order of ARV medicines in the expected delivery time and there is an order fill rate gap while receiving ARV drugs as compared to the quantity ordered.

The inventory management practice in the public hospitals of AACAHB indicates that forced order system is the most predominantly used inventory control method across the hospitals. Besides this, previous consumption data is usually used to forecast the demand of ARVs in the hospitals while judgment and causal methods are the least used method for the forecasts of the demand of ARV drugs. Regarding with the use of LMIS, all of the selected public hospitals use both computerized and paper-based recording and reporting tools. Among the attributes of LMIS, the use of internal facility reporting and requisition (IFRR) to facilitate and control stock movement within the hospitals is significant variable affecting the LMIS in the public hospitals of AACAHB. The study also concludes that all public hospitals of AACAHB fulfill most of the store condition criterion of LIAT.

The study further concludes that all of the identified independent variables have statically significant effect on the availability of ARV drugs in the public hospitals of AACAHB. Furthermore, logistics system performance in public hospitals of AACAHB highly predicts the variation in the availability of ARV drugs in the public hospitals of AACAHB; followed by inventory management practice in public hospitals of AACAHB, store condition in public hospitals of AACAHB, and logistics management information system in public hospitals of AACAHB respectively.

5.3. Recommendations

From the aforementioned findings and conclusions of the study, the researcher forwarded the following recommendations.

In order to enhance the logistics system performance of public hospitals in AACAHB, the study provided the following recommendations.

- The concerned bodies across the aforementioned hospitals should give much emphasis for the provision of training on the new HIV commodities and the skill need for the determination of ARV drugs quantity order, forecasting the demand of ARVs, and determining the order resupply quantities.
- EPSS has to maintain the resupply period of one month's period of request as it is recommended on the IPLS SOP. As per the recommendation of the Standard Operation Procedure (SOP) designed by EPSS, EPSS is responsible to resupply health facilities with the requested quantity within one month of receiving resupply request from health facilities (PFSA, 2015).
- In order to improve the order fill rate, the public hospitals of AACAHB should minimize the decision-making time, establish order picking plan, optimize the fulfillment process, regularly analyze customer demand to determine the amount of inventory to hold, and establish a clear path of communication.

Regarding with the storage condition of public hospitals in AACAHB, the study provided the following recommendations.

- The hospitals have to properly establish their stores and fulfill all the 18 criteria specially to stack ARV products at least 30 cm away from the walls and other rows or stacks of products (to prevent contact with outer walls and allow access to products)
- The hospitals should stack the products no more than 2.5 m high, and stack products at least 10 cm off the floor (on pallets or other materials that elevate the products off the floor).

For enhancing the inventory management of public hospitals in AACAHB, the study provided the following recommendations.

- The hospitals should also use continuous review system (i.e., when minimum stock is reached) and standard system (i.e., ordering at the end of reporting period of ARVs) while ordering ARV drugs.
- The hospitals should include data on commodities near expiry in every report and a regular stock count has to be conducted minimum once every reporting period of ARVs.
- Public hospitals of AACAHB should use previous consumption data (standard system) to forecast the demand of ARV drugs to enhance their inventory management performances.

Regarding with LMIS, the study recommends:

- The hospitals are recommended to strengthen IFRR use for the facilitation and control of stock movement within the hospital.

- In order to ensure the availability of ARV drugs across the indicated hospitals, much emphasis has to be given to the following ARV drugs:

- Lamivudiner / Zidovudine (30/60) mg pedi Tablet
- Ritonavir100mg tab
- Darunavir 600mg tab
- Dolutegravir 50mg, and
- Lopinavir /Ritonavir (100/ 25mg) tablet. pedi.

Generally, the management of the supply chain for ART drugs has improved their availability, ensuring consistent access for HIV treatment. This has led to a reduction in stock outs, indicating better inventory management and distribution processes. The distribution system has been enhanced, allowing for more efficient delivery of ART drugs to health facilities and patients in

need. Monitoring and reporting of drug usage and stock levels have been improved, facilitating informed decision-making and resource allocation. However, challenges such as potential bottlenecks in the distribution process and issues with forecasting and procurement need to be addressed. Despite these challenges, the performance of ART drug supply chain management under the Addis Ababa City Administration Health Bureau has shown positive outcomes, indicating potential for further improvement.

5.4. Limitation and Further research recommendations

5.4.1. Limitation of the study

The study on ART drug supply chain management in Addis Ababa City Administration Health Bureau hospitals has limitations, including limited generalizability, small sample size, data accuracy, time constraints, dependence on self-reporting, and lack of a control group, external factors, and limited scope. The findings may only be applicable to Addis Ababa and may not be representative of other regions or countries. Small sample sizes, inaccurate or incomplete data, time constraints, and dependence on self-reporting can introduce bias. The study also lacks a control group or comparative data, making it difficult to isolate specific effects. External factors like economic conditions and government policy changes may also limit the study's generalizability.

5.4.2. Further research recommendation

The study focused on only public hospitals under the AACAHB, neglecting the Ethiopia Pharmaceutical Supply Service (EPSS) and ARV supply chain management from donor and customer perspectives. Further research is needed to compare hospital supply chain management with EPSS and assess patient satisfaction with ARV medication supply chain management. Future research should consider determinant aspects, larger sample sizes, and include other departments. The Addis Ababa City Administration Health Bureau should conduct further research on its antiretroviral therapy (ART) drug supply chain management, evaluating its efficiency, identifying challenges, and assessing patient outcomes. The use of technology and information systems should be evaluated for efficiency and transparency. Comparing the Addis Ababa system with other regions can help identify best practices for improvement. Recommendations include procurement strategies, capacity building, infrastructure investment, and stakeholder collaboration.

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Appendices

Appendix A: Questionnaire

Addis Ababa University

School of Commerce

Department of Logistics and Supply chain Management

Field of Study: Master of Arts Degree in Logistics and Supply Chain Management

Title of the Research: The Logistic Supply Chain Management Practice on the Performance of Anti-retroviral (ARV) Drugs public Hospitals under AACAHB. Ethiopia.

My name is ***Hibreteseb Tobiyaw***, and I am a graduate student in logistics and supply chain management at the School of Commerce at Addis Ababa University. This survey was created specifically to gather information on supply chain management procedures and how well they work with ART medications in government hospitals managed by the Addis Ababa City Administration Health Bureau.

The information gathered will be handled with the strictest confidentiality and will only be used for academic reasons. Your participation in this study has been highly beneficial and is greatly appreciated in resolving its issues. Please set aside some time to respond to these questions.

Address :-(hibrettobiyaw@gmail.com) Telephone No. 0913020995

Please Write the Name of the Hospital: _____

Part I – Personal Information

1. Sex
   A. Female ☐ B. Male ☐
2. Age
   A. Below 20 ☐ B. 21 – 30 ☐ C. 31 - 40 ☐ D. 41- 50 E. > 51 ☐
3. What is your highest level of Education?
   A. High school Graduate ☐ C. Diploma ☐ E. Master's Degree ☐
   B. Certification ☐ D. Degree F. PHD ☐
4. For how long you worked in this hospital?
   A. Less than one year ☐ C. 6-10 years ☐ E. 16-20 years ☐
   B. 1 – 5 years ☐ D. 11-15 years ☐ F. Above 20 years ☐
5. In which department are you currently working?
   A. Pharmacy administration ☐
   B. ART Pharmacy ☐
   C. Pharmacist ☐
   D. Clinical Pharmacy ☐
   E. Store ☐

Part -II: Inventory Management Practices of ARVs in your Hospital

Dear respondent, kindly indicate your level of agreement for the following statements by ticking on your appropriate level of agreement among the options.

No.	Attributes	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
A	***Inventory Control Models***					
1	Ordering ARV drugs in our hospital is usually conducted at the end of the reporting period (Forced Order System)					
2	Ordering ARV drugs in our hospital is usually conducted when minimum stock is reached (Continuous Review System)					
3	Ordering ARV drugs in our hospital is usually conducted at the end of reporting period for ARVs that have reached minimum stock level (Standard System)					
B	***Determination of Order Quantities***					
4	In our hospitals, previous consumption data is usually used to forecast demand of ARVs (Projective Method)					
5	In our hospital, forecasts of the demand of ARV drugs are made based on external factors like epidemics, change in health system structure, and size (Causal Method)					
6	In our hospital, forecasts of the demand of ARV drugs are made based on individual judgment of experienced staff (Judgment Method)					
7	In our hospital, forecasts of the demand of ARV drugs are made based on HIV prevalence, incidences, and expected number of attendances (Morbidity Method).					
C	***Stock Keeping Record and Reporting***					
8	In our hospital, all ARV medicines have stock records					
9	Stock records for ARV medicines in our hospital are accurate and up to data.					
10	In our hospital, regular stock counts are done minimum once every reporting period of ARVs.					
11	In our hospital, entire inventory of ARV medicine is counted at one go in each stock take (full count)					
12	Inventory of ARVs is divided into counting groups, with each group being counted per stock taking session (Cyclical count)					
13	Reports of ARV medicines in our hospital are compiled at the end of each reporting period.					
14	Data on consumption is included in every report in our hospital					

No.	Attributes	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
15	Data on stock on hand is included in every report in our hospital					
16	Data on losses and adjustments is included in every report in our hospital					
17	Data on commodities near expiry is included in every report in our hospital					
D	***Safety Stock Policy***					
18	A safety/buffer stock is kept for every ARV product in our hospital					
19	In our hospital, a standard formula is used in calculating safety stock					
20	In our hospital, a rough estimate is used as safety stock					

Part -III: Logistic Management Information System of ARVs in your Hospital

Dear respondent, kindly indicate your level of agreement for the following statements by ticking on your appropriate level of agreement among the options.

No.	Attributes of LMIS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Our hospital uses both computerized and paper-based recording and reporting tools					
2	In our hospital, computerized EDT is utilized to record patient information and for dispensary than paper-based format like daily ARV drug registers.					
3	In our hospital, Health commodity management information system (HCMIS) is mostly utilized in stores and stock movement.					
4	In our hospital, RRF (request and requisition form) are used to facilitate and control stock movement between EPSS and our hospital.					
5	In our hospital, Internal Facility Reporting and Requisition (IFRR) are used to facilitate and control stock movement within the hospital.					

Part -IV: Logistic System Performance of ARVs in your Hospital

Dear respondent, kindly indicate your level of agreement for the following statements by ticking on your appropriate level of agreement among the options.

No.	Attributes	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
A	***Logistic Knowledge Provision for the Staff (Pharmacist)***					
1	In our hospital, logistics management of ARV drugs training is periodically provided to the staffs of pharmacy					
2	In our hospital, new HIV commodity awareness training is periodically provided to the staffs of pharmacy					
3	In our hospitals, pharmacy staffs are skilled to properly determine the quantities of ARV drugs order, forecasting the demand of ARVs, and determining the order resupply quantities.					
B	***Length of Resupply, Lead-time, & Fill rate***					
4	In our hospital, the required amount of ARV drugs mostly ordered on its proper time (i.e., before ARVs are stocked-out) (length of sending order)					
5	In our hospital, we usually receive ARV medicines from EPSS exactly similar with the quantity we ordered (Order fill rate)					
6	EPSS is usually deliver the order ARV medicines in the expected delivery time (lead-time)					
C	***Emergency Orders***					
7	In our hospital, we encountered no emergency orders for ARV in the last 6-months.					
8	In our hospital, we encountered one emergency orders for ARV in the last 6-months.					
9	In our hospital, we encountered two emergency orders for ARV in the last 6-months.					
10	In our hospital, we encountered three and more emergency orders for ARV in the last 6-months.					

Part -V: Storage Condition of ARV Drug

Ask where the main storage area for ARV drugs is located. Ask for permission to visit the storage area. Assess storage conditions of main storage area only. Place a check (tick) mark in the appropriate column based on visual inspection of the storage area. To qualify for a Yes response, all products must meet the criteria for each item

No.	Description	Yes	No
1	Products are arranged on shelves with arrows pointing up, and with identification labels, expiry dates, and manufacturing dates clearly visible.		
2	ARV drugs are stored and organized to FEFO (First-Expire-First-Out) procedures and are accessible for counting and general stock management.		
3	Outer cartons are in good condition (not crushed, perforated, stained, or otherwise visibly damaged).		
4	Damaged and expired products are separated from usable products in the storeroom, and procedures exist for removing them from inventory.		
5	ARV drugs are stored in a dry, well-lit, well-ventilated storeroom. (Visually inspect roof, walls, and floor of storeroom.)		
6	Cartons and products are protected from direct sunlight		
7	There is no evidence of rodents or insects in the storage area. (Visually inspect the storage area for evidence of rodents [droppings] or insects that can damage or contaminate the products.)		
8	Storage area is secured with a lock and key but is accessible during normal working hours; access is limited to authorized personnel.		
9	Products are stored at the appropriate temperature according to product temperature specifications (8 ° −30° C) and including cold chain storage (2° -8° C), as required for certain products.		
10	Roof is maintained in good condition to avoid sunlight and water penetration.		
11	Storeroom is clean, with all trash removed, no evidence of food and drinks, products stored on sturdy shelves/bins, and boxes organized neatly.		
12	Current storage space is sufficient for existing products and planned program expansion.		
13	ARV drugs are stored separately from insecticides, flammable products, and chemicals.		
14	Food and drinks are not stored together in refrigerator used for storing ARV drugs that require cold storage.		
15	Fire safety equipment is available and accessible. (Any item identified as being used to promote fire safety should be considered.)		
16	Products are stacked at least 30 cm away from the walls and other rows or stacks of products (to prevent contact with outer walls and allow access to products).		
17	Products are stacked no more than 2.5 m high and at least 10 cm off the floor		
18	Products are stacked at least 10 cm off the floor (on pallets or other materials that elevate the products off the floor).		

Part-VI: Checklist to Assess the Availability of ARV Drugs in the Hospital at the time of visit.

S/R No.	List of Drugs	Available Drug	
		Yes	No
1	TDF+3TC+DTG (300+300+50mg) tab		
2	TDF+3TC (300+300mg) tab		
3	EFV 600mg		
4	DTG 50mg tab		
5	AZT +3TC(300+150mg)tab		
6	3TC 150mg tab		
7	AZT + 3TC /300mg +150mg/ tab		
8	RTV 100mg tab		
9	DRV 600mg tab		
10	ABC 300 tab		
11	ATZ/r 300mg/100mg tab		
12	Lamivudine 30mg/Zidovudine 60mg Table		
13	Lopinavir 200mg/Ritonavir 50mg Tablet		
14	Lopinavir 100mg/Ritonavir 25mg Tablet(pedi)		
15	ABC/3TC 120mg/60mg(pedi)		
16	DTG10mg tab Pedi		
17	Neverapine 10mg/ml of 100ml oral suspension.		
18	Zidovudine 50mg/5ml of 100ml oral solution.		

1. If there was any stock-out of ARV drugs, what was the reason for the stock-out?

   A. Didn't order on time ☐ E. Due to Stock-out at the central level ☐
   B. Transportation not available ☐ F. Don't know how to order ☐
   C. Didn't receive order ☐
   D. Didn't receive the quantity ordered ☐
   Others, _____
2. What do you think are the factors affecting the availability of ARG drugs in this hospital? _____
3. What do think are the major challenges in the supply management of ARV drugs in this hospital? _____
4. What are your suggestions for the above challenges? _____
   _____

Thank you for your time!