THE SUPPLY CHAIN MANAGEMENT PRACTICE AND ITS IMPACT ON THE PERFORMANCE OF ANTIRETROVIRAL DRUGS IN GOVERNMENTAL HOSPITALS IN ADDIS ABABA, ETHIOPIA

By

ANMUT ALAMREW
(ID No. GSD-2458/12)

March 2023

Addis Ababa, Ethiopia

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ANMUT ALAMREW

Advisor: Shiferaw Mitiku (Ph.D.)

A Thesis submitted to Addis Ababa University, School of Commerce, Department of Logistics and Supply Chain in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Arts in Logistics and Supply Chain Management

March 2023

Addis Ababa, Ethiopia

DECLARATION

I hereby declare that this thesis entitled *"**The Supply Chain Management Practice and Its Impact on the Performance of Antiretroviral Drugs (ARV) in Governmental Hospitals in Addis Ababa, Ethiopia**"* has been carried out by me under the guidance and supervision of Dr. Shiferaw Mitiku. The thesis is original and has not been submitted for the award of any degree or diploma to any university or institutions.

Researcher's Name	Date	Signature
Anmut Alamrew	_____	_____

CERTIFICATE

This is to certify that the thesis entitles ***"The Supply Chain Management Practice and Its Impact on the Performance of Antiretroviral Drugs (ARV) in Governmental Hospitals in Addis Ababa, Ethiopia"*** submitted to Addis Ababa University, School Commerce for the award of the Degree of Master of Arts in Logistics and Supply Chain Management complies with the regulations of the Addis Ababa University and meets the accepted standards with respect to originality and quality.

Adviser's Name	*Date*	*Signature*
Dr. Shiferaw Mitiku	_____	_____

ADDIS ABABA UNIVERSITY

SCHOOL OF COMMERCE

DEPARTMENT OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

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Approved by the Board of Examiners:

Shiferaw Mitiku (Ph.D.)	_____	_____
Advisor	**Signature**	**Date**
_____	_____	_____
Internal Examiner	**Signature**	**Date**
_____	_____	_____
External Examiner	**Signature**	**Date**

Acknowledgements

First and foremost, I would like to praise and thank God, the Almighty, who has granted countless blessing, knowledge, and opportunity, so that I have been finally able to accomplish my thesis. Apart from the efforts of me, the success of my thesis depends largely on the encouragement and guidelines of my friends. I take this opportunity to express my gratitude to the people who have been instrumental in the successful completion of this thesis. It would be impossible to list all names but several people deserve my thesis and special thanks.

I would like to show my greatest appreciation to my principal advisor, Dr. Shiferaw Mitiku, his guidance; support, encouragement, and invaluable professional advice have had an enormous impact on my thesis, to finalize my paper. I feel encouraged and motivated every time when I attend his discussion.

Next, I would like to extend my gratitude and special appreciation to my brother Mr. Zelalem Alamrew and Mr Wondosen my work would have been very difficult without them.

Finally, my special gratitude goes to all of the respondents and staff members at Addis Ababa district government hospital.

The Researcher

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ACRONYMS

AACAHB	Addis Ababa City Administration Health Bureau
AIDS	Acquire Immunodeficiency Syndrom
ART	Antiretroviral Therapy
ARV	Antiretroviral
DACA	Drug Administration and Control Authority
EFDA	Ethiopian Food and Drug Authority
EPHI	The Ethiopian Public Health Institute
EPSS	Ethiopia Pharmaceutical Supply Service
FEFO	Fist Expire First Out
FMOH	Federal Ministry of Health
HCMIS	Health Commodity Management Information System
HIV	Human Immunodeficiency Virus
IFRR	Internal Facility Reporting and Requisition
IPLS	Integrated Pharmaceuticals Logistics Systems
JSI	John Snow, Inc.
LIAT	Logistics Indicators Assessment Tool
LMIS	Logistic Management Information System
NEMLs	National Essential Medicines Lists
PFSA	Pharmaceuticals Fund and Supply Agency
PLHIV	People Living with the Human Immunodeficiency Virus
PLWHA	People Living with HIV/AIDS

RRF	Report and Requisition Form
SCM	Supply Chain Management
STGs	Standard Treatment Guidelines
WHO	World Health Organization

Abstract

This study titled "The supply chain management practice and its impact on the performance of antiretroviral drugs (ARV) in governmental hospitals in Addis Ababa, Ethiopia" aimed 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. The sample size of the study was 159, however, primary data were collected from 130 staffs of the pharmacy department across the hospitals. This makes the response rate 82%. The study followed a quantitative research approach and used explanatory and descriptive research designs. The study used a proportionate stratified sampling and simple random sampling techniques. The study utilized both primary and secondary sources of data. The study utilized cross-sectional survey method and semi-structured questionnaire as an instrument for data collection. The study utilized a statistical tool called SPSS V.26 for doing the analysis. Both descriptive and inferential statistics were used to analyze the data. Descriptive statistics such as frequencies, percentage, mean, and standard deviation were used for summarizing and presenting the data. With regard to inferential statistics, Pearson correlation coefficient and multiple linear regression analysis were used to test the relationship and association between independent and dependent variables. The analysis revealed that there is statistically significant and positive relationship between all identified independent variables of the study and the dependent variable i.e., availability of ARV drugs in the public hospitals of AACAHB. The result of regression analysis depicts that the identified independent variables used in this model explain 71.9% of the variation in availability of ARV drugs in public hospitals of AACAHB and there is a positive and statistically significant association between all independent variables and dependent variable. The study concludes that among the identified independent variables, inventory management practice in public hospitals of AACAHB highly predicts the variation in the availability of ARV drugs public hospitals of AACAHB; followed by logistics system performance, LMIS, and store condition in public hospitals of AACAHB respectively. The study recommended to the public hospitals under AACAHB across the variables i.e., inventory management practice, logistic management information system, logistic system performance, and store condition.

Keywords: *Availability of ARV drugs, Inventory Management Practice, Logistic Management Information System, Logistic System Performance, Store Condition.*

CHAPTER ONE

1. INTRODUCTION

This chapter contains background of the study, statement of the problem, research questions, objective of the study, significance of the study, scope of the study, limitation of the study definition of terms and the organization of the research report.

1.1 Background of the Study

Since the start of the HIV/AIDS epidemic 1981, an estimated 84.2 million people have been infected with HIV, and 40.1 million people have died of HIV/AIDS-related illnesses (UNAIDS, 2022). According to WHO (2016), those who have the acquired immunodeficiency syndrome (AIDS) or the human immunodeficiency virus (HIV) can live normal, healthy lives as long as they take their antiretroviral medications (ARVs) continuously and without interruption. Continuous antiretroviral therapy (ART) keeps the amount of HIV in an infected person's body at the lowest possible level, stops further immune system deterioration, allows the virus to become dormant, and lengthens the lives of people with HIV and AIDS (Schouten, 2011). However, HIV and AIDS treatment is lifelong, therefore once started, patients must get an ongoing monthly supply of their ARVs from medical facilities like hospitals and clinics in order to continue taking their medication every day for the rest of their lives (Mokheseng, *et al*., 2017). This shows that maintaining a steady supply of ARV medications is essential to safeguarding patients' health and wellbeing and lengthening the lives of those living with HIV/AIDS. However, maintaining continuous supplies of ARV drugs and preventing stock outs is a major challenge (Decroo, *et al*., 2011).

Since each point of dispensing ARV drugs (i.e., a clinic, hospital, and community outreach worker) must always have access to a customized and predictable supply of ARVs and other drugs, the rising demand for AIDS treatment globally presents supply chain management with unprecedented challenges (Xiong, *et al*., 2008). Unfortunately, due to unstable, ineffective (not at sufficient levels), and inefficient (too expensive) procurement and distribution channels, the supply of ARVs to hospitals and clinics is frequently interrupted, which leads to high rates of morbidity and mortality (Management Sciences for Health, 2006, as cited in Mokheseng, *et al*., 2017).

As stated by WHO (2016), unreliable supply systems have been identified as a major hindrance to sustainable provision of essential medicines across many developing countries. Successful implementation of public health programs requires an uninterrupted supply chain management of inventories (Amenyah, 2020). Globally, only 35.4% of the people living with HIV have received antiretroviral (ARV) treatment in 2019 and 28.7 million people were accessing antiretroviral (ARV) treatment in 2021, up from 7.8 million in 2010 (UNAIDS, 2022). Appropriate supply chain management of ARV drugs is needed in order leverage the benefits of the drugs. However, as stated by Berhanemeskel *et al*. (2016), the capacity of the pharmaceutical supply management system has always been challenging and weak in many low- and middle-income countries.

A study undertaken by Mori and Owenya (2014) in Tanzania found that inefficient supply systems, quantification problems and short expiry duration caused stock-outs of ARVs. Inadequate staffing and training, lack of adequate storage, lack of adequate resource and unreliable supplies are the main challenges of ARV inventory management practices (Johnson, *et al*., 2021). Similar to this, the revelation of pharmaceutical supply chain management practices, stock outs, and subpar storage conditions regarding the HIV program in general, and ARVs in particular occurred in Nigeria (Faruna & Folinas, 2018). A study in Tanzania and Côte d'Ivoire, also indicated the same result of improper supply chain management of ARV drugs (Mori & Owenya, 2014). Inadequate supply chain management practices are also prevalent in South Africa, district of QwaQwa (Mokheseng *et al*., 2017). An incorrect and inconsistent ordering procedure used by the hospitals and clinics, a lack of dependable, organized transportation from the depot to the hospitals, poor inventory management, and a general lack of communication was stated by the authors.

Different researches (though insignificant in number and scope) have been conducted on assessing the supply chain management practice and its impact on the availability of ARV drugs in Ethiopia in general and in public hospitals of AACAHB in particular. A study conducted by Gemechu *et al*. (2021) in public health facilities in Addis Ababa revealed that the majority of healthcare facilities experienced frequent stockouts and inadequate storage conditions. According to the Ethiopian Public Health Institute (2018) report, most important medications for infectious diseases including ARV drugs were > 80% available in Ethiopia's public health facilities, while a more recent study on service readiness assessment found that the majority of these treatments were only 50% available.

A study conducted by Berhanemeskel *et al.* (2016) revealed that the percentages of ARV products which were out of stock were 12.8% and 17% in health centers and hospitals, respectively. In another study of the 48 surveyed hospitals and health centers, 10 (21%) did not have ARV drug (Daniel, *et al*., 2012). A study conducted by Damtew *et al*. (2019) on their studies in public and private health facilities of Addis Ababa identified different factors that contribute to stock-outs/availability of ARV & ART drugs. They identified poor stakeholder coordination and communication, poor inventory management techniques, low stock managers' educational levels, poor ICT usage practices, a lack of transportation and road infrastructure, unforeseen changes or fluctuations in demand, low health budgets, issues with raw materials, frequently changing regulatory requirements, and the availability of drugs with short shelf lives from suppliers as the determinant factors.

The causes of drug stock-outs are complicated and rooted in every phase of a drug's life cycle. The main consequence of unavailability and stock outs of ARV medicines leads to ineffective viral suppression, resistance to medication, increased morbidity and low survival rates (Schaecher, 2013). Effective pharmaceutical supply management and inventory control avoid stock out, loss due to unnecessary expiry, theft and ensure that the desired pharmaceutical products are available at all times in adequate quantity (Barasa *et al*., 2018). As of the knowledge of the researcher, there is insufficient number of researches conducted on assessing the supply chain management practice of ARV drugs and its impacts on the availability of ARV drugs in public hospitals of AACAHB. Hence, this study aimed to assess the supply chain management practices of public hospitals under the Addis Ababa City Administration Health Bureau (AACAHB) and examine the impact of the existing pharmaceutical supply chain management on the performance of ARV drugs.

1.2 Statement of the Problem

According to the Council of Supply Chain Management Professionals, the term "Supply Chain Management" (SCM) was first used in 1982. It is characterized as an integrating function with the primary responsibility for connecting important business functions and business processes, both within and across companies, into a cohesive and high-performing business model (Bialas, 2014).

Antiretroviral (ARV) therapies are one example of a high-value health commodity that requires supply chain management to ensure the continuous flow of products from the place of manufacture to the point where customers use them (USAID, 2006). "To extend access to essential medicines by improving finance and supply systems" is one of the main goals of the WHO's essential medicines policy (WHO, 2016). Yet, a significant barrier to the sustainable provision of vital medicines in many developing nations has been highlighted as unreliable supply networks. In many low- and middle-income countries, the capability of the pharmaceutical supply management system has always been difficult and inadequate (Berhanemeskel *et al*., 2016). Ethiopia, one of the most afflicted nations in sub-Saharan Africa, has also put in place an integrated pharmaceutical logistics system to build a strong healthcare system, synthesize the massive amount of data, link all points in the supply chain, and make precise and fast decisions (Abiy, *et al*., 2015). In Ethiopia, the Federal Democratic Republic of Ethiopian Government established the Pharmaceuticals Fund and Supply Agency (PFSA) (now known as Ethiopia Pharmaceutical Supply Service) as a legal organization in September 2007 to address the issues and ensure a continuous supply of pharmaceuticals to the general public.

Despite this, the majority of Addis Ababa's healthcare facilities provide poor inventory management services; about three-quarters of them are plagued by drug shortages and are unable to start antiretroviral treatment if patients tested positive for the virus (Berhanemeskel *et al.*, 2016). A study by Gemechu *et al.* (2021) in public health institutions in Addis Ababa found a strong positive correlation between the availability of ARVs and bin card updating practices, inventory correctness rate, and wastage rate. Also, there was a very high negative association between it and waste rate. Most healthcare facilities frequently ran out of supplies and had poor storage conditions (Ibid). The same region had regular stock-outs of ARV medications and HIV test kits, which was a sign of poor supply chain management, according to a study by Berhanemeskel *et al*. (2016) on the management of HIV/AIDS-related commodities supply chain.

The start of the free ARV treatment program in Ethiopia was characterized by a significant influx of supplies that call for strong logistics capabilities. The ability to supply the necessary commodities regularly and reliably is crucial for the success of this extended HIV/AIDS program (Alemayehu, 2009). An efficient supply chain is necessary for HIV therapy in order to guarantee that ARV medications are always accessible and prevent treatment disruptions. Proper inventory control and pharmaceutical supply management prevent stock outs, losses from unneeded expiration, theft, and ensure that the requested pharmaceutical supplies are always available in sufficient quantities (Abiy, *et al*., 2015). The ability of domestic health care systems to deliver the appropriate product, in the right quantity, in the right condition, to the right place, at the right time, and for the right price is fundamental to maintaining access to treatment (Amenyah, 2020). Healthcare institutions are only able to make tactical judgments without efficient supply chain management, which increases the likelihood that they won't be able to provide the best medication (WHO, 2016).

The main consequences of the lack of accessibility and stock outs of ARV drugs caused by subpar supply chain management techniques are ineffective viral suppression, drug resistance, increased morbidity, and low survival rates (Schaecher, 2013). Hence, in order to increase access and consequently deliver high-quality services, it is essential to review the management of the ARV supply chain. In this sense, hardly much has been done. In order to determine whether the supply chain management of ARV medications is effective, this research tried to look into the supply chain management practices of ARVs being done in public hospitals in Addis Ababa under AACAHB and examine the impact of the supply chain management practice on the performance of ARV drugs in public hospitals in Addis Ababa under AACAHB.

1.3 Research Questions

The main research question of the study is “How is the supply chain management practiced in public hospitals in AACAHB and what is the impact of this practice on the performance of ARVs availability in public hospitals in AACAHB?” In the course of finding the answer to the main research question, the study seeks to address the following sub questions.

1. 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?
2. What is the effect of the supply chain practices of public health hospitals AACAHB (in terms of LMIS, storage conditions and inventory management practice) on the performance of ARV drug availability in the hospitals?

1.4 Objectives of the Study

1.4.1 General Objective

The main objective of this study is to assess the supply chain management practices of public hospitals in AACAHB and measure its effect on the performance of ARVs availability in public hospitals in AACAHB.

1.4.2 Specific Objectives

The study specifically seeks:

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

1.5 Significance of the Study

Public hospitals in AACAHB, stakeholders involved in HIV/AIDS management, different policy makers, and scholars and academicians will be benefited from this study.

The study's findings will help public hospital administrators in AACAHB address weaknesses in the supply chain management of ARV medications, address problems with the supply of ARVs, and provide guidance for expanding its operations in a way that would improve service delivery. The study's results will also assist other parties involved in HIV/AIDS management, such as the Ministry of Health, donors like USAID, PFSA, and others, in understanding how supply chains are now run so they may make the best recommendations on how to improve them. In order to promote best practices for ARVs supply chain management, the study's findings will also assist the stakeholders in identifying the areas that need resource mobilization and capacity building.

Furthermore, AACAHB will find the study invaluable in the execution of guidelines with a focus on ensuring public hospitals have effective supply chain management practices. Other than public hospitals and stakeholders, various policy makers will also find the study invaluable. The same experience will be expanded, if successful, to additional public and private hospitals in Addis Ababa and other regions of the country.

The study is helpful to academics and scholars as well. Future and current supply chain researchers will learn about how the supply chain is implemented in the healthcare industry in general and the pharmaceutical industry in particular. Those who want to do additional research might utilize the findings as a starting point. Additionally, the report will help researchers do additional research in the area of ARV drug supply chain management. In addition, the survey conducted for this study will probably be useful for future researchers in expanding the body of knowledge in supply chain management from the viewpoint of a public health system.

1.6 Scope of the Study

This study was focused on the assessment of supply chain management practices in public hospitals of AACAHB and the impact of this practices on the performance of ARVs availability in the public hospitals in AACAHB. The study was geographically delimited to public hospitals under the governance of AACAHB such as Yekatit 12 Hospital, Menelik II Referral Hospital, Gandi Memorial Hospital, Zewditu Memorial Hospital, Ras Desta Damtew Hospital, and Tirunesh Beijing General Hospital. The data was collected from the pharmacy departments of the aforementioned public hospitals in AACAHB.

Antiretroviral (ARV) drugs are one example of a high-value health commodity that requires supply chain management to ensure the continuous flow of products from the place of manufacture to the point where customers use them (USAID, 2006). Based on the pharmaceutical supply chain management model, the practices of supply chain management in ARVs are evaluated in the areas of logistic system performance, storage condition, inventory management, and LMIS. In addition, the supply chain management effectiveness of ARV medications in the public hospitals of the AACAHB is assessed based on the ARVs' availability in stock over the past six months, their stock-outs over that same period, and the sum of those days over that same period. Thus, these aspects of supply chain management and supply chain performances are the conceptual limits of the study.

Regarding with the methodology, this study followed a mixed research approach (both quantitative and qualitative approach). The study employed a descriptive design to determine the what, where, and how of a phenomenon, as well as to determine, characterize, and explain the identified variables and focus the research on key topics associated with the study. The study also employed explanatory research design in order to link ideas raised in the study to realize the associations of variables in terms of cause and result relationship. In another word, in order to examine the impact of dimensions of supply chain management on the performance of ARVs availability. The collected data is analyzed by the statistical tool named SPSS v.26.

1.7 Operational Definition of Key Terms

Table 1.1: Definition of Key Terms

Key Terms	Definition	Authors
Acceptable Storage Condition	Storage facilities must comply with at least 80% of the set requirements.	FMOH (2019)
ARV Drugs	Antiretroviral medications are prescribed to treat HIV infection caused by retroviruses. It prevents the human immunodeficiency virus (HIV) or other retroviruses from proliferating in the body.	WHO (2016)
Bin Card Update	Within 30 days, an update had to be made. The bin card was not updated if it had not been used in more than 30 days and had a balance of zero when it was last updated and the facility had not yet received any of the product in question.	Shewarega *et al*. (2015)
LMIS	It is a system that produces the fundamental logistical data required to make decisions in logistics.	Mori & Owenya (2014)
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.	Hwang *et al.*, (2019)
Supply Chain	A supply chain is dynamic and entails the continuous movement of products, information, and funds between various ranges.	Handfield & Nichols (2015)
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.	Handfield & Nichols (2015)
Supply Chain of Pharmaceuticals	It is a set of operations that ensures a constant flow of goods from the manufacturing site to the consumer usage site. The supply chain or its components operate inside a management framework that gives program managers access to data to assist them decide what kinds of items are required, as well as where, when, and in what quantities.	USAID (2006)

1.8 Organization of the Paper

The research report organized in five chapters: Chapter one: Introduction – this chapter contains background of the study, statement of the problem, research questions, objective of the study, definition of terms, significance of the study and scope of the study. Chapter two contains review of related literature. Chapter three contains method of the study. Chapter four contains results and discussions. Finally, the last chapter contains summary, conclusions and recommendations.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

This Chapter discusses related literatures that are pertinent to the topic. The supply chain of pharmaceuticals in Ethiopia, the empirical literature review, the conceptual framework, and the theoretical literature review are the four primary elements that make up this chapter. The notion of supply chain management and pharmaceutical supply chain management are explored in the section on theoretical literature reviews. The researcher has identified four supply chain management for ARVs dimensions after carefully examining various literature sources. They include inventory management, storage conditions, logistic system performance, and LMIS. The management of the ARV supply chain in Ethiopia is covered in the next section. The results of various literatures connected to the research issue are reported in the empirical literature review section. The conceptual framework for the study is offered at the conclusion of the chapter.

2.1 Theoretical Literature review

2.1.1 The Concept of Supply Chain Management

2.1.1.1 Overview of Supply Chain

A supply chain is dynamic and entails the consistent movement of items, information, and funds between various regions (Handfield & Nichols, 2015). The network of all the people, businesses, resources, activities, and technological advancements involved in the production and distribution of a good is known as a supply chain (Habib, 2010). A supply chain includes every step of the process, from the transfer of raw materials from the supplier to the producer to the final distribution to the customer. A supply chain is made up of all the steps used to deliver a finished good or service to the customer. According to Chopra and Meindl (2007), the basic steps of a supply chain include order fulfillment/sales, product delivery, customer support, and return services. Raw materials are sourced, refined into basic parts, combined to produce a product, and then ordered. Lead time is the length of time it takes for any one of these processes to complete from beginning to end. Manufacturers, suppliers, transporters, warehouses, wholesalers, retailers, various intermediaries, and even customers themselves are among the entities involved in the supply chain.

"A supply chain comprises of all parties involved, directly or indirectly, in fulfilling a consumer request," according to Chopra and Meindl (2007). The supply chain in every organization, such as a manufacturer, entails all activities involved in receiving and completing a client request. New product creation, marketing, operations, distribution, financing, and customer support are just a few of these duties. 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. The three interrelated flows that make up an integrated supply chain model are typically purchasing, transformation, and distribution of materials, electronic data exchange for information, and financial flows, which cover payments made to suppliers and subcontractors for the goods and services as well as payments made by customers to retailers for the finished product (Waller, 2003). 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.

2.1.1.2 Overview of Supply Chain Management

The integration of supply chain activities through established supply chain partnerships, in order to gain a long-term competitive advantage, is known as supply chain management (SCM) (Handfield and Nichols, 2015). The definition of supply chain management is the integration of critical business operations throughout the supply chain with the goal of creating value for customers and stakeholders. Supply chain management does, in fact, combine supply and demand within and among businesses in a successful business model (Shah, 2004).

Supply chain management is described by the Council of Supply Chain Management Professionals as the planning and management of all sourcing, procurement, conversion, and logistics-related operations. To control the flow of information, goods, and services across a network of clients, businesses, and supply chain partners, the field of supply chain management (SCM) was established (Russel & Taylor, 2009). According to Sweeney (2007), "Supply Chain Management is the systemic, strategic coordination of the traditional business function and across business inside the supply chain, for the purpose of improving the long-term performance of the individual enterprises and the supply chain as a whole."

According to Wisner *et al*. (2012), "Supply chain management is 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 final sale to the end product customer."

Several scholars believe that SCM and logistics are synonymous, and many credit the historical development of the logistics function for laying the foundations of SCM. "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," according to Waters (2008). Even though SCM includes logistics management tasks, there are differences between the supply chain management idea and the conventional logistics concept. While SCM takes a broader view of movement through all associated organizations that make up the supply chain, logistics is the management function responsible for all material movement inside the limits of a single organization. The activities of marketing, new product development, financing, and customer service are also a part of supply chain management, which embraces all aspects of traditional logistics (Hugos, 2006).

Felea and Irina (2013) looked at the aforementioned definitions of SCM and came up with four key concepts: management activities, logistics activities, objective (such as value, customer requirements, trust, competitive advantage, and relationships), and components. Management activities include planning, organizing, implementing, motivating, and controlling. Logistics activities include transportation, processing, and storage (such as suppliers, manufacturers, warehouses, and stores).

2.1.1.3 Supply Chain Management Theories

Waters (2008) stated that there are five theories or views of supply chain management. These five theories or views are: resource-based view (RBV), stakeholder theory (ST), institutional theory (IT), transaction cost theory (TCT), and resource dependence theory (RDT). These theories and views are proposed by several authors to have the potential for explaining various aspects of SCM.

A. Resource-Based View (RBV)

The resource-based view (RBV) of the firm suggests that firm action might be seen as an attempt to acquire an advantage over competitors. In the highly competitive market structure, supply chain participants strive to exert control over the production factors because those can give them a competitive edge over their immediate rivals (Ahuja, 2000; as cited in Bilkis *et al.*, 2018). The RBV of the company has a dominant role in the literature on strategic management (Halawi *et al*., 2005; as cited in Bilkis *et al.*, 2018).

According to Mitra *et al*. (2017), a firm that implements a value-creating strategy gains a competitive advantage over its capacity or current competitors when those competitors do not do the same. The RBV denotes that the foundation of assets pooling to form supply chain relationships is made as a result of the introduction of accept as genuine with based absolutely collaborative value. Among the characteristics of resources that highlight value creation and help to promote supply chain alliance are immobility, inimitable, and sustainability. Accessing another company's key skills in order to acquire a competitive edge is RBV's main priority. The most valuable assets of a company, according to RBV, are its resources and competencies. One of the most widely used theories in SCM literature is RBV (Bilkis *et al*., 2018).

B. Stakeholder Theory (ST)

Firms are envisioned as the hub of an association of stakeholders in the supply chain formation reasoning. 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).

Stakeholder literature frequently makes the point that corporations should coordinate stakeholder interests (Busse *et al*., 2017; as 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 are 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)

TCT focuses on how an employer should set up its boundary-crossing activities to minimize the sum of its manufacturing and transaction expenses (Bilkis *et al*., 2018). The manufacturing expenses of corporations vary depending on the size of their operations, how well they know and enjoy the results, the advantages of their geographic location, and private factors like patents, trade secrets, and procedures. Other transaction costs include those for planning, managing, and keeping track of transactions between markets (Halldorsson *et al*., 2015). Transaction costs increase when a trading partner exhibits opportunistic behavior, which is characterized as self-absorbed or deceptive behavior. 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).

Following an analysis of the five theories, namely the resource-based view (RBV), stakeholder theory (ST), institutional theory (IT), transaction cost theory (TCT), and resource dependence theory (RDT), this study is founded on the RBV theory and places a lot of emphasis on the resources and capabilities of public hospitals in the AACAHB. One of the most widely used theories in SCM literature is RBV (Bilkis *et al*., 2018).

2.1.2 Supply Chain Management of Pharmaceuticals

2.1.2.1 An Overview of Pharmaceutical Supply Chain

Manufacturers, wholesale distributors, pharmacies, and Pharmacy Benefit Managers are the main elements of Pharmaceutical Supply, according to Kapoor *et al*. (2018). Generic medicine producers often do not invest as much money in the research and development of new drug therapies as brand name drug manufacturers do. Once the relevant patent has expired,

manufacturers of generic drug products concentrate on creating generic substances that directly compete with the drug product that was originally patented.

From the source of production to the drug wholesalers and, in some cases, directly to hospital chains, chain pharmacies, specialty pharmacies, and some health plans, pharmaceutical manufacturers oversee the distribution of drug products. While wholesale distributors are the biggest customers of medication makers, in some situations, these companies also sell their goods directly to government agencies including the Veterans Administration, AIDS Drug Assistance Program (ADaPs), and the Vaccines for Children (VFC) program. Drugs are rarely provided directly to patients or to a self-insured employer with a pharmacy on-site. The biggest impact on prescription medicine pricing comes from prescription drug manufacturers. To determine the wholesale acquisition cost, they project marketing expenditures based on an analysis of the anticipated demand and future competition (WAC).

The main problems with the pharmaceutical supply chain, according to Mokheseng *et al*. (2017) and Kapoor *et al.* (2018), are those related to counterfeiting, adverse drug reactions in patients, problems that arose from supply chain operations' entities, manufacturing problems (such as mixing incorrect input raw materials, cross contamination from manufacturing multiple drugs in the same facility, or improper labeling of the final product), and retailer's problems in the market. Along with these, there are transportation problems brought on by improper handling, poor temperature control, and use of the wrong shipping method, storage and warehouse problems brought on by using poor temperature control, improper handling in the warehouse, and mixing products with raw materials; and problems with raw material suppliers such as improperly prepared raw materials, raw materials with high impurity levels, and incorrect labeling of raw material shipments.

2.1.2.2 Benefits of Pharmaceutical Supply Chain Management

In the pharmaceutical sector, supply chain management can modernize the company to more effectively utilize its assets and resources, generate profits, raise shareholder value, and respond proactively to customer demand. Almost all company operations, including data integrity, reducing operational complexity, supplier selection, purchasing, warehousing, and distribution, can benefit from and evolve as a result of effective supply chain management. Additional advantages (Deisingh, 2005; quoted in Kapoor, 2018) include faster customer response and fulfillment rates, shorter lead times, increased productivity and cheaper costs, decreased inventory supply throughout the chain, enhanced forecasting accuracy, fewer suppliers, and

shorter planning cycles. In addition, efficient and cooperative supply chain management in the pharmaceutical industry improves the accuracy of demand forecasts, inventory visibility, and delivery predictability. Improved prevention of drug theft and counterfeiting, as well as on-time, complete performance. increased capacity to react to and bounce back from interruption (Mokheseng, *et al*., 2017).

2.1.3 Supply Chain Management of ARV Drugs

2.1.3.1 Supply Chain of ARV Drugs

A management system that gives program administrators with data to help them decide what kinds of items are needed, where and when they are needed, and in what amounts. This management system includes the supply chain or its functions for ARV medications (USAID, 2006). To develop and strengthen those supply chains, however, there are frequently not enough financial, human, and technical resources due to competing priorities for the little funds allocated to public health programs. As a result, important health commodities frequently experience supply disruptions and shortages in many public-sector programs.

The significance of effective supply chains is becoming more and 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 factors that have contributed to the efficiency of the supply chain are a small number of commodities with little change in technology or formulation over time, a commitment to maintaining a full supply of chosen products, a program of sustained and consistent financial and technical support for systems development and maintenance, or the use of external procurement mechanisms, which are typically chosen and funded by donors, or the extensive use of electronic procurement mechanisms. Although technically possible, implementing integrated supply networks has proven to be challenging in many nations (Bates, *et al.*, 2008).

2.1.3.2 The Need for Effective Supply Chains in the Provision of ARVs

Governments and donors had been hesitant to widely provide ARV medications in situations with low resources prior to 2003. This caution was motivated by a variety of causes, including the high expense of the pharmaceuticals, the scarcity of human resources, and worry about possible unfavorable effects from administering these pricey, extremely effective, life-saving drugs. Despite the decrease in anxiety, actual worries continue (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.

2.1.3.3 Supply Chain Management Functions of ARV Drugs

To ensure the constant flow of goods from the site of manufacture to the point where customers utilize them, supply chain management of important health commodities, particularly high-value medications like antiretroviral (ARV) pharmaceuticals, entails a number of operations (USAID, 2006). A number of coordinated tasks must be consistently carried out as part of supply chain management. Quantity requirements for the short term (one to three years) and the medium term must be established once products for a program 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 multilayer 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. The cycle then continues. The supply chain cycle in figure 2.1 illustrates these functions and their interdependencies (USAID, 2006).

Figure 2.1: Supply Chain Cycle of ARVs
Source: USAID (2006) and JSI (2017)

The supply chain cycle, which is depicted in the above image, lists the tasks and materials needed to run a successful supply chain system. Each of the supply chain cycle's actions depends on the others, as the cycle illustrates. If one of the activities breaks down, customers won't be served. The following details each supply chain management function of ARVs.

2.1.3.3.1 Servicing Customers

Regardless of the goods that flow through it, the main goal of any supply chain is to satisfy its clients. In the context of antiretroviral programs, this goal entails making sure that qualified persons with HIV/AIDS (PLWHA) always have access to high-quality antiretroviral (ARV) medications whenever they need them (WHO, 2016). In particular, patients need ARV medications to be available more than 95% of the time when they come for resupplies because long-term efficacy of treatment regimens depends on more than 95% adherence to ARV. Achieving this effectiveness requires less than one missed dosage every two weeks in a twice-daily program. The national ARV programs must therefore develop and prioritize initiatives around the idea of continuous availability of the ARV drugs in order to create and sustain a supply chain that is focused on the final consumer (USAID, 2006).

Service providers need clear and comprehensive guidelines for ART eligibility and enrollment, and standardizing prescribing and dispensing practices for ARV drugs is critical for supply chain planning as well as for promoting patient adherence and rational drug use. These and other key considerations were provided by WHO for better serving people with HIV/AIDS (PLWHA). In addition, the WHO recommends that ARV drug supplies be closely correlated with ART service capacity at both the national and facility levels, and that programs should establish minimum standards for facilities and conduct ART site selection and accreditation

based on those standards in order to guarantee uninterrupted, safe, and effective ART service provision. The supply chain management criteria for ARVs should cover topics including training, storage, inventory control, record keeping, and reporting, in addition to actions to reevaluate locations to make sure that standards are upheld over time (WHO, 2016).

2.1.3.3.2 Product Selection

According to JSI Deliver (2005), one of the first steps in product selection would be to produce standard treatment guidelines or necessary drug lists that contain HIV drugs and supplies. In the recommendations, WHO suggests a public health strategy focused on ensuring that antiretroviral (ARV) drug regimens are accessible to everyone, standardized, and made simple in order to support the implementation of treatment programs in settings with limited resources and guarantee that ARV drug treatment regimens are supported by scientific research (WHO, 2016). In addition to preventing the spread of a virus that is resistant to treatment, the aim is to avoid using subpar treatment techniques. The WHO's recommendations should be consulted as a starting point by national committees responsible for updating national essential medicines lists (NEMLs) and creating standard treatment guidelines (STGs) when deciding which ARV treatment regimens are suitable for the environment of their particular nation.

The selection of ARV medications, regimens, formulations, and packaging, for example, will have an impact on procurement, forecasting, and distribution; therefore, these pertinent supply chain issues should be taken into account when choosing ARV medications. USAID emphasized these important factors for product selection. As treatment is extended in numerous resource-poor countries, ART program managers and product selection committees may require periodic revisions to review ARV pharmaceuticals on national essential medicines lists and to be in line with evolving data and experience. To ensure the availability of ARV medications at the time of implementation, policymakers contemplating revisions to STGs and NEMLs for ART regimens should take procurement lead times into account (USAID, 2006).

For programs, ordering ARV medications typically requires a three-to-eight-month lead time. Program managers should account for procurement lead times when planning revisions and updates to STGs and significant changes to the ARV medications chosen so that the formalization of a new STG policy coincides with the availability of the new pharmaceuticals (WHO, 2016).

2.1.3.3.3 Quantification and Forecasting

Decisions about which products to choose, how to finance them, where to buy them, and how to deliver them should be informed by quantification (PFSA, 2015). Family Health International (2008) states that while accurate quantification is essential for all health commodities, it is particularly crucial for those connected to HIV/AIDS due to the difficulty of quantifying the drug and health commodity requirements for HIV/AIDS programs and the requirement to ensure patients' unhindered access.

In order to conduct the initial quantification, it is necessary, according to USAID (2006), to have knowledge of the standard treatment regimens for ART that have been recommended and approved, as well as local and global pricing information for all ARV drugs included in those regimens. It is also necessary to estimate the percentage of patients who will start taking first- and second-line medications, as well as alternate first- and second-line medications for both adults and children. In addition, it is necessary to estimate the percentages of patients (adults and children) who will experience changes in treatment regimens and of patients (adults and children) who will receive varying doses of ARV medications according to weight bands (adults and children) and surface area measurements (children only). According to Chris *et al*. (2014), it is difficult to produce an accurate national demand estimate, which might lead to orders that could not accurately reflect the country's needs. On the one hand, inadequate planning can lead to product shortages, which raises the possibility of stockouts and necessitates expensive last-minute orders.

Developing countries now lack the resources to purchase enough antiretroviral (ARV) medications to treat all clinically qualified HIV/AIDS patients (PLWHA). Also, despite the fact that national ARV programs are relatively new and expanding, there is a lack of information that can be used to predict the demand for and usage of ARV medications (USAID, 2006). It is imperative to create a medium-term projection before coordinating funding and procurement because it will help programs better understand their long-term needs, gauge their success toward attaining their therapeutic goals, and set new objectives. The desired number of patients selected for treatment in national policies over a certain time period can be used to produce medium-term predictions, which can then be complemented with knowledgeable assumptions from key stakeholders and implementers. As more knowledge about the acceptability, tolerability, and effectiveness of ART is learned and as supply chain and services data become more accessible, those predictions and procurement strategies will need to be

routinely altered. According to WHO (2016), program managers should seek advice from seasoned pediatric ART service providers when creating projections for pediatric ARV drug needs in order to make up for the lack of information and experience in this area of service delivery.

2.1.3.3.4 Logistics Management Information Systems

Supply chain data is gathered, processed, and reported via a logistics management information system (LMIS). Decision-makers across a supply chain may access accurate, timely, and pertinent data thanks to a well-functioning LMIS (USAID, 2016). The LMIS may be entirely computerized or partially (paper-based) manual. The three crucial LMIS data elements for every supply chain system are quantity of stock on hand, quantity of stock consumed (dispensed to users), and losses and adjustments. According to WHO (2016), the lack of funding and political will in the majority of nations has precluded the deployment of an LMIS for the majority of life-saving medications. Nonetheless, the adoption of an LMIS is thought to be a crucial intervention when setting up ART programs due to the significant influx of money for the treatment, the expansion and hazards associated with interrupted supply of ARV medications, and the intermittent provision of treatment.

Prior to the distribution of ARV medications, the LMIS should ideally be created and set up. With the emphasis on quickly expanding access to therapy, this structure might not be practical. Therefore, one of the top interventions during the early stages of ART program deployment should be the creation of an LMIS that is designed for tracking ARV medications. In the short term, it may be necessary to start the LMIS as a parallel system; but, in the medium to long term, as more PLWHA receive treatment and as the needs and capabilities of the health system evolve over time, it is important to continuously reevaluate how cost-effective this strategy is (Chris, *et al.*, 2014).

In addition to an LMIS, functioning systems for individual patient's medical record keeping, reporting, and monitoring are critical for providing routine feedback from clinical and pharmacy records. This set of systems allows toxicity, resistance, dropouts, and stock status to be detected and reported regularly; it allows the forecast of needs to be adjusted and for the shipment quantities and product formulations to be changed as needed. Similarly, given highly mobile populations in many resource-limited settings, the ability to track ARV supply needs as patients move through the system is critical to maintaining as many patients on uninterrupted

treatment as possible. Such a system must take into consideration issues of patient confidentiality so that inadvertent disclosure is not made.

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 supply chain system functioning. Ensure that this information is coordinated with the data requirements for patient and program monitoring through a consultative process involving program 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 system rollout, 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).

When thinking about putting in place computerized systems, it is more effective to start by automating supply chain information management at a central point before extending outward to peripheral locations (Chris, *et al*., 2014). Central medication procurement and distribution centers are typically already computerized; however, the level of complexity varies greatly; those centers have better hardware availability and more computer aware staff. In the event that the centers are partially privatized, there will probably be less worker turnover than in the public sector at the regional or district levels (Ibid).

According to WHO (2016), the LMIS should be created and put into place prior to the delivery of ARV pharmaceuticals in order to respond promptly and accurately to changes in demand, to supply the right amount of high-quality medications, and to reduce theft and abuse of these medications. Program managers should come up with methods to compare patient and clinical data with supply chain data without sacrificing the timeliness of supply chain data collection and utilization in order to improve clinical monitoring and accountability and make knowledgeable predictions about ARV medications (Ibid).

2.1.3.3.5 Inventory Management

If proper inventory control methods and systems are not implemented, the value of antiretroviral (ARV) drugs in terms of cost and the possibility that they may save lives might serve as an incentive for theft and poor management. Additionally, because governments lack the resources to treat all HIV/AIDS patients who require antiretroviral therapy, supplies of ARV medications will initially be rationed (ART). The supply can therefore be streamlined in order to increase the number of patients that programs can enroll for ART. In addition to careful forecasting, stringent inventory level monitoring and safe transportation and storage facilities can play a vital role in this process (USAID, 2006).

It is possible to avoid pharmaceutical shortages, overproduction, and expiration by using an effective inventory control system. (PFSA, 2015). According to Chris *et al*. (2014), inefficient inventory management in public health facilities results in the waste of financial resources, the inability to acquire some essential pharmaceuticals, stock outs, stock losses, and ultimately, a failure to enhance patient outcomes. The distribution system may be designed by programs to have a minimum number of tiers. A shorter pipeline will mean fewer points at which ARV drugs will be stored, reducing the number of sites to be monitored and facilitating timely submission of reports and training of staff members in the supply chain for ARV drugs. It will also mean fewer locations at which security needs to be upgraded, streamlining transportation and lowering costs. It will also mean fewer points at which buffer stocks of all drugs are required, maximizing the use of available resources. It will also mean more ability for central levels to regulate the supply chain (USAID, 2006).

Maximum-minimum inventory systems or systems that make sure stock levels are maintained within a given range are the most effective inventory control strategies. Product managers regularly track usage and stock levels at facilities to determine the size of 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 stockouts. 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. This threshold is often set by national laws in many nations at a minimum of two years or 75% of the whole shelf life. ARV medications might not be administered as quickly as anticipated, especially during the first phase of expansion when ART demand and adoption are uncertain (especially at new sites). So, it is wise to refrain from accepting medications with shelf life that are shorter than those needed unless an emergency exists and the supply is certain to be used.

2.1.3.3.6 Procurement

According to WHO (2016), policymakers and program directors should collaborate closely with national drug regulatory agencies to make sure that the absence of ARV drug registration does not pose a barrier to the provision of the medication. Manufacturers are responsible for registering new medications; however, many do not do so right once, waiting until they are certain that there will be a financial return on their investment. Following the completion of the procurement process, frequent contact and cooperation between the regulatory bodies and the procurement committee or agent are easy actions that can reduce delays and ease access.

Countries should also tighten up the processes for registering and importing ARV medications. To reduce potential delays linked to registration and importation, they should specifically include engagement with the national regulatory body as part of the procurement evaluation and contract process for ARV medications. In addition, they should encourage businesses that receive contract awards to submit importation documentation several weeks prior to the product's arrival at the port, speed up the importation process (customs clearance), reduce delays, and strengthen the capacity of the national regulatory authority for inspection, quality control, and registration, with a general objective of minimizing registration delays and improving the accessibility of data on drug quality. Specifically, capacity is required for training and evaluation in inspection of ARV drugs (USAID, 2006).

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 stockouts 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.

2.1.3.3.7 Storage and Distribution of ARV Drugs

According to USAID, the health system or program must transmit the item to the level of service delivery where the client would get the supplies (2010). Throughout this procedure, the goods must be kept in storage until either they are moved to the next lower level or the customer requests 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 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. The last point is especially pertinent in the case of national medical shops, which serve as parastatal organizations and keep and distribute medications on behalf of the Ministry of Health.

2.2. Empirical Literature Reviews

2.2.1. Supply Chain Management of ARVs in Ethiopia

Antiretroviral therapy (ART) has played a crucial role in the therapeutic management of HIV-infected people, despite the fact that there is no cure for HIV/AIDS. Only 35.4% of HIV-positive individuals received antiretroviral (ARV) treatment globally in 2019, and 28.7 million people had access to it by 2021, up from 7.8 million in 2010. (UNAIDS, 2022). According to estimates from the Ethiopian Public Health Institute (EPHI), there would be 622,326 HIV-positive individuals living in Ethiopia in 2020 and 617,921 in 2021. (EPHI, 2020). In addition, EPHI predicted that in 2020 there will be 11,715 new HIV infections and 11,546 yearly AIDS deaths, while in 2021 there will be 10,943 new HIV infections and 6,988 annual AIDS deaths. In Ethiopia, ART service started in 2003 with a fee and went free in 2005. (Shimelis, *et al*., 2015). At Zewditu Memorial Hospital, VCT and ART services were introduced for the first time in 2002 and 2003, respectively. Thereafter, in 2004 and 2005, respectively, St. Peter's and ALERT's ART services were launched. Since then, VCT, ART, and PMTCT services have been offered jointly or independently by all public hospitals and health centers, several private hospitals, and some NGO-owned facilities (Berhanemeskel, 2014).

The rollout of ART in Ethiopia coincided with a period of aggressive investment in the public health sector between 2005 and 2012. HIV units were established in renovated and newly established government health centers throughout the country, with staff members conducting screenings, consulting patients, disseminating ARVs, and maintaining patient records (Nishi, 2022). In Ethiopia, there were 222, 723 people receiving ART in 2010 and there was a 26% increment between 2009 and 2010. In 2011 there were 237,400 individuals receiving ART with a total budget of $293 million dollars in Ethiopia (PEPFAR, 2012; WHO, 2012; as cited in Berhanemeskel, 2014).

In 2014, ARV was provided at 1,047 health facilities, of which 849 were public health centers (HAPCO, 2014). ARV coverage in Ethiopia increased from 3% in 2005 to 56% in 2014 and to 78% in 2020. AIDS-related deaths and HIV incidence decreased during the same period. The free ARV is largely financed by the Global Fund to Fight AIDS, Tuberculosis and Malaria (hereafter, the Global Fund). Ethiopia has been among the largest recipients of the fund in the last decade (Nishi, 2022). Between July 2011 and June 2012, 125 million USD were spent on HIV treatment and care programs, of which 69 million (55%) were spent on ART, according to data compiled by the Ethiopian government (HAPCO, 2014).

Alongside the ART scale-up, self-help associations among HIV-positive people have proliferated in Ethiopia. Some began operations during the 1990s, representing crucial aspects of HIV care work and relationships in Ethiopia while providing social and material support, including peer counseling, HBC, and food and monetary assistance for their members. Between 2004 and 2010, many such associations were established countrywide and encouraged via moral and financial support from transnational NGOs and funding agencies.

2.2.2. Supply Chain of ARVs in Ethiopia

In Ethiopia, the Federal Democratic Republic of Ethiopian Government formed the Pharmaceuticals Fund and Supply Agency (PFSA) as a legal organization in September 2007 to address the issues and ensure a continuous supply of drugs to the general people (Damtie, *et al.,* 2020). According to the Ethiopian Food and Drug Administration (EFDA), there should always be sufficient supplies of safe, efficient, and inexpensive medications that are of the necessary and guaranteed quality (Sintayehu, *et al.,* 2022).

The Ethiopian government recognized the need for antiretroviral treatment and adopted HIV/AIDS National Policy in 1998. Then, the government has established a multi-sectoral program coordinated by National and Regional HIV/AIDS Council Secretariats. The first antiretroviral (ARV) guideline is 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) 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 (Alemayehu, 2009). 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 2005. 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. Factors Affecting ARV Drugs Supply Chain

Related studies have been conducted by different researchers on ARV drugs supply chain management, some of the studies are briefly reviewed as below.

The results of an assessment of the Central Medical Store in four West African nations (Ghana, Nigeria, Cote d'Ivoire, and Burkina Faso) revealed that the forecasting of ARV medications suffers from the absence of data on drug consumption. In most countries, quantification committees are set up to advise medicine selections in accordance with standard treatment recommendations. The quantification procedure may not necessarily include validating the data that was used for it. The danger of medicine stockouts or expiration is increased as a result of all of these contributing to the lack of accuracy in estimating demands (Samuel & Gerard 2013; as cited in Araya, 2018).

According to a study by Mokheseng *et al*. (2017) in the QwaQwa district, the main issues affecting the supply chain management of ARVs are identified as incorrect and inconsistent ordering practices by the hospital and clinics, a lack of dependable, structured transportation from the depot to the hospital, poor inventory management, and poor overall communication. In a study on the distribution of ARVs in Tanzania, Mori and Owenya (2014; cited in Mokheseng *et al.,* 2017) discovered that patients were forced to switch ART regimens as a result of stock-outs of ARVs due to ineffective supply systems, quantification issues, and short expiry durations, raising the risk of the emergence of drug-resistant HIV strains.

According to research by Johnson *et al.* (2021) in Kenya, all supply chain performance metrics—aside from order lead time—were found to be subpar due to high stock out rates, subpar reporting rates, and high stock wastage rates as a result of identified expiries. The survey also showed that the biggest obstacles to ARV inventory management techniques include a lack of proper staffing and training, poor storage, inadequate resources, and unreliable supplies.

Similar to this, the Nigerian HIV program had insufficient reporting of practice, little supplies, and poor storage conditions (Faruna & Folinas, 2018). According to WHO (2016), healthcare facilities are only able to make tactical judgments and incur the danger of not being able to provide the most appropriate medication due to improper inventory management.

According to a study by David *et al*. (2014) on antiretroviral procurement and supply chain management, it is challenging to accurately forecast and order at the ART center level for each product in hundreds of ART centers operating in numerous countries, often with little data training and support. Furthermore, it can take many months to resupply inventories from a central warehouse to an ART center. Despite there being inventory at the central warehouse, these circumstances frequently result in stock-outs or expired products at ART sites. At the central level, it is likewise difficult to estimate demand accurately given low site-level visibility and frequent switches between regimens and unpredictable scale-up rates. This results in lack of storage space, sub-optimal storage, risk of expiry as well risk of stock-outs. Some countries compensate poor forecasting accuracy with large safety stock levels. Although this works well to prevent stock-outs, it can contribute to product expirations or the costly efforts to relocate stocks from one center or country to another. (David *et al*., 2014).

When ordering the quantities of ARV drugs required for adults, pediatric ART, and ARV prophylaxis during pregnancy, post-partum, and for post-exposure prophylaxis, a supply chain assessment for ARVs conducted in Sierra Leone revealed that estimates did not take into account monthly consumption, lead time, safety stock, re-order levels, stock on hand, and the procurement period – the ordering process did not clearly describe the sources of data, the basis for the assumptions, or how the estimates (Allers *et al*., 2007; as cited in Araya, 2018). An investigation carried out in three East African nations—Tanzania, Uganda, and Rwanda—showed that, despite efforts to expand access to and availability of ARVs, the pharmaceutical supply management in those nations was determined to be inadequate. The inability to properly quantify needs, place orders, and retain records was highlighted as a shortcoming (Matowe *et al.,* 2008; as cited in Araya, 2018). According to a research by Muyingo *et al*. (2000) in Uganda, inadequate space, shelves, ventilation, and sanitation were the most problems with store management at PHC clinics. One PHC did not have a dedicated area for the storage of medications, and in certain locations, medications may be discovered strewn around the storeroom table.

2.2.4. Supply Chain Management Practice of ARVs in 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 antiretroviral treatment if patients were positive.

A study conducted by Damtie *et al*. (2010) on supply chain management performance of HIV/AIDS commodities revealed that unsatisfactory data records, stock-outs, interrupted reports, inaccurate inventory and wastage rates were indicators for defective supply chain management of HIV/AIDS commodities. They recommended respective organizations to improve their responsible activities to secure commodities availability.

The availability of ARVs showed a very high positive correlation with bin card updating practice, inventory accuracy rate, and wastage rate, according to a study by Gemechu, *et al*. (2021) in public health facilities in Addis Ababa. It also had a very strong negative correlation with waste rate. The majority of healthcare facilities experienced frequent stockouts 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 antiretroviral 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).

According to a study by Araya (2018) on the inbound logistics operation for ARVs in the case of St. Paul's Hospital, there are major challenges in managing the supply chain for antiretroviral drugs as well as the availability and proper use of logistics management and information systems, stock availability, logistics knowledge of professionals, fulfillment of acceptable storage conditions for antiretroviral drugs store rooms, resupply period, order fill rate, and trends in emergency orders. Even if some positive trends are being shown in some measurements, there are some gaps in the hospital's supply chain management of antiretroviral medications.

2.3. Conceptual Framework of the Study

Supply chain management is a system that integrates activities to closely align supply and demand. Alternatively, it can be considered as logistics activities as the operational component of supply chain management. The conceptual model of this study is adopted from USAID (2006) and JSI (2017). USAID (2006) and JSI (2017) have identified logistic system performance, storage conditions, inventory management, and LMIS practices as a determinant variable for the supply chain management of health commodities. Hence, these variables are identified as a determinant variable for examining the availability of ARV drugs in the public hospitals in AACAHB. Figure 2.2 shows the conceptual framework of this study.

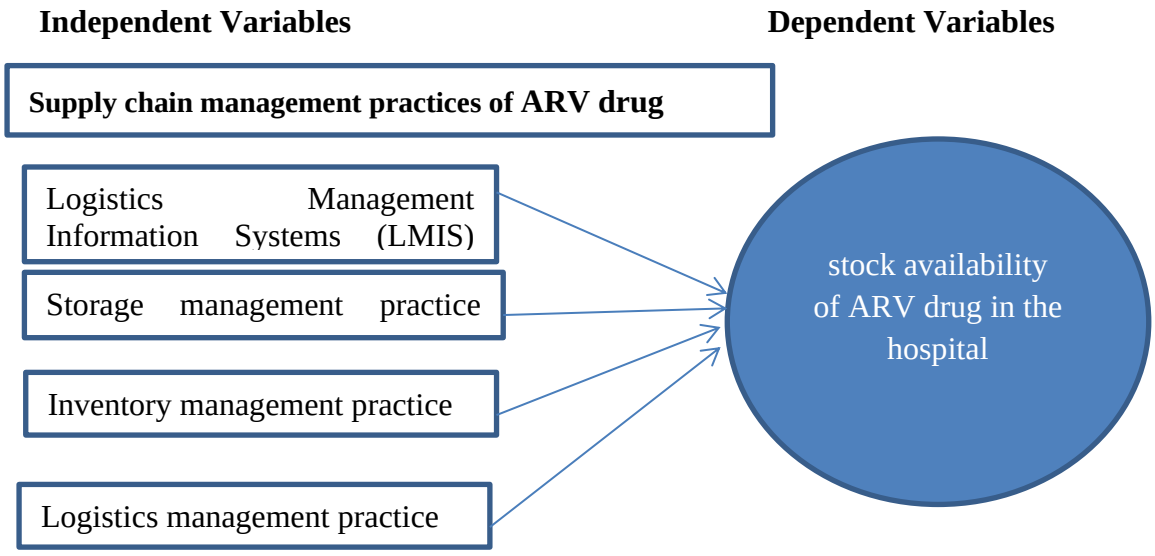

Figure 2.2: Conceptual Framework
Source: Adopted from USAID (2006) and JSI (2017)

CHAPTER THREE

3. METHODOLOGY 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

The study used quantitative research approach complimented by qualitative approach. This is because the research question and specific objectives of the study seeks to deal with deep understanding as well as facts on the study population. Data was collected by structured questionnaire to examine the supply chain management practice of ARV drugs and examine its impact on performance of the availability of ARV drugs in public hospitals of AACAHB. A quantitative approach, according to Cresswell (2003), is one in which the researcher predominantly uses post positivist claims for knowledge development (i.e., cause and effect reasoning), reduction of specific variables, and query.

3.2 Research Design

The study adopted a descriptive and explanatory design while using a quantitative research approach 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. According to Musungu and Nasongo (2008), a descriptive research design entails asking the chosen population about a certain topic in order to gather data on the phenomenon's real status at the time of the study.

The study employed an explanatory approach with the goal of realizing the relationships between the variables in terms of a cause-and-effect relationship. In another word, to examine the causal relationship between the independent variables (i.e., logistic system performance, storage conditions, inventory management, and LMIS practice) and the dependent variable (i.e., ARVs availability in public hospitals in AACAHB). While collecting the primary data, the researcher used cross-sectional survey design since data was collected at one point in time from sample selected to represent a larger population by a single questionnaire.

According to Saunders *et al.* (2009), cross-sectional research design entails conducting a study only once, with the data then being utilized to represent a particular time. In this study, a cross-sectional survey methodology is appropriate because the research is time-constrained and is being done for a 3-month academic course. A questionnaire using the survey method is the data collection tool employed in the study. A survey, according to Cooper and Schindler (2008), is a method for gathering data through standardized questionnaires during a highly structured interview.

3.3 Sampling Design

3.3.1 Target 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 November 2022, 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	Yekatit 12 Hospital	62
2	Menelik II Referral Hospital	53
3	Gandi Memorial Hospital	30
4	Zewditu Memorial 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 of November 2022)

3.3.2 Sample Size

According to Tustin *et al.* (2005), the sample size is a lower portion of the whole population. A researcher can save time and money by using a sample, resulting in more detailed information for their respondents. As per the data collected from Human Resource department of the indicated public hospitals of AACAHB, as of November 2022, there are a total of 263 employees working in each pharmacy department. However, due to time and resource constraints, it would be difficult to study all the population of the study (i.e., all employees of

the pharmacy department) and defining a sample size is necessary. To determine the sample size, the researcher used a statistical formula developed by (Kothari., 2004). The confidence level of the researcher will set as 95% with a 5% error term. By using the Kothari (2004) formula the following sampling was drawn.

$n=N/[1+N(e^2)]$ Where n: Sample size, N: Population size i.e.,263, e: Level of precision or acceptable sampling error (0.05).

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

n=159

Based on the above formula, a sample of 159 employees were targeted from the population. Therefore, the data was designed to be collected from 159 employees of the pharmacy department across the public hospitals of AACAHB.

3.3.3 Sampling Method

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 were 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.

Accordingly, after applying the above formula the number of respondents, which were selected from each stratum, was illustrated in the following Table 3.2.

Table 3.2: Proportionate Stratified Sample

No.	List of Stratum	Total Strata Size	I = M(Ni/P)	Proportionate Sample Size
1	Yekatit 12 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	Zewditu Memorial 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 November, 2022) & Researchers' Computation

Based on the size of each stratum the respondents were selected using a simple random sampling technique. With the use of simple random sampling, every participant in the population being studied has an equal chance of being chosen (Dawson, 2002). The questionnaires were distributed & collected randomly across each stratum in the hospitals.

3.4 Sources of Data and Data Collection Techniques

3.4.1 Data Type and Source

In order to achieve the general & specific objectives of the study, both primary and secondary sources of data were utilized. As Malhotra (2005) stated, even if obtaining them can be expensive and time consuming, the researcher originates primary data for the specific purpose of addressing the problem at hand, the primary data were collected through structured questionnaires. Primary sources of data were distributed to the employees of the hospitals found in pharmacy departments. The secondary sources of data are different documents from recent year's records, internet, articles, magazines, research papers and different reference books related with the study topics. The secondary data helps the researcher to improve the understanding of the problem and it provides a basis for comparison for the data that is collected by the researcher. With this, the researcher leverages secondary data analysis to examine an alternative perspective on the research questions in this study. As a general rule stated by Malhotra (2005), examination of available secondary data is a pre requisite to the collection of the primary data.

3.4.2 Data Collecting Instruments

For collecting the primary data, the researcher used semi-structured questionnaire as the main instrument for data gathering from the employees of pharmacy department across the public hospitals of AACAHB.

The independent variable namely storage condition was assessed by a data collection instrument adopted from LIAT (2006) and the questionnaire for examining the remaining independent variables such as logistic system performance, inventory management, and logistics management information system are adopted from the previous works of Araya (2018) and Berhanemeskel (2014). The researcher modified the questionnaire to relate it with the general and specific objectives of the research. For evaluating the dependent variable, the list of ARV drugs is adopted from the standard treatment guidelines developed by FMOH (2017). The guideline listed eighteen lists of ARV drugs.

Each item of the dependent and independent variables was rated using a five points Likert Scale 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 the questionnaire in English language as indicated in Appendix A. Since the questionnaires are self-administered, the researcher provided the questionnaire to the target population with a covering letter which explains the purpose of the study, the way of responding, the aim of the research, and the security of the information to encourage high response. The questionnaire has six parts and has a total of eighty (80) question. 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**

The questionnaire was prepared by English language as indicated in appendix A herewith this document. Regarding the collection of secondary data, the researcher referred several literatures, reports, journals, academic magazines, published papers, books, essays, researches, dissertations, websites, reports, and documents related to the research topics.

3.4.3 Data Collection Methods

The systematic and methodical gathering of information based on research factors/variables is known as data collection (Cooper & Schindler, 2008). For collecting the primary data from the employees of pharmacy department across the public hospitals of AACAHB, the researcher utilized survey data collection method. Cooper and Schindler (2008) defined a survey as an instrument process used to collect information during a highly structured interview through use of structured closed-ended questionnaires. In survey method structured questionnaire was used in order to collect the data. The questionnaires were given out and gathered in person as well as electronically via email and telegram. Reviewing the chosen textual materials from the aforementioned sources served as the primary method of gathering secondary data.

3.5 Data Analysis Techniques

Before conducting the analysis, data cleaning activities such as the detection of errors and omissions as well as the checking of data completeness and consistency were carried out through scrutiny of the completed questionnaires after the time allotted for the questionnaires to be filled out had passed. Anomaly-containing entries were removed, and outliers were corrected, in addition. According to Cooper and Schindler (2008), this procedure is essential to statistical data analysis since anomalous items may alter the direction of expected results. The data was then categorized and coded.

Statistical Package for Social Sciences (SPSS V.26), a statistical analysis tool, was employed in the study to carry out the analysis. SPSS is recommended because of its ability to handle a wide range of statistical and graphical data analysis. The goals of the research were in line with the appropriate statistical tools. Tables, percentages, averages, and standard deviation were employed in the descriptive analysis. In addition, the link between the dependent and independent variables was examined using inferential statistical methods such mean rank and multiple linear regression models.

3.6 Model Specification

As stated in the conceptual framework, a multiple linear regression model was utilized to determine the best prediction of a dependent variable from the identified independent factors. The absence of outliers, linearity, normality, and multicollinearity are among the main tests for running multiple linear regression models, according to Almaquist *et al*. (2016).

Prior to starting regression analysis, it is essential to make sure the data set is large enough. Tabachnick and Fiddell (2013) suggested that N> 50+8m is required, where "m" is equal to the number of predictors, when examining the connections between variables using a medium effect size. The minimum sample size for this study, using this method, would be 82 respondents (the number of predictors (m) specified in the conceptual framework is four i.e., inventory management practice, logistics management information system, logistics system performance, and storage condition) and the sample size of this study is 159 and hence this pre-requisite is fulfilled. The sample size is considered adequate for doing the regression analysis because this study planned to utilize a sample size of 159 for the analysis.

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.

3.7 Description of Study Variables

In research, variables are things that can be measured, controlled, or changed. Independent and dependent variables were the two main types of variables employed in this investigation. The availability of ARV medications and the eighteen medications that go along with it were used as the dependent variable in this study. The independent variables are inventory management practice with its dimensions such as inventory control models, determination of order quantities, stock keeping record and reporting, and safety stock policy; logistics management information system, logistic system performance with its dimensions such as logistic knowledge of staff, length of re-supply, lead-time, and fill rate, emergency orders; and storage condition.

3.8 Validity and Reliability

3.8.1 Validity

Validity is the degree to which differences between test subjects that are discovered using a measuring tool actually reflect those differences (Cooper & Schindler, 2008). The goal of the study's validity has been to find pertinent evidence that supports the solutions obtained using the measuring tool, which is the nature of the issue. Validity can be established in a number of methods, including content validity, concurrent convergent validity, predictive validity, construct validity, and convergent validity.

As stated in the literature review part, the questionnaire has been developed based on previous studies such as LIAT (2006), USAID (2006) and JSI (2017), Araya (2018), Berhanemeskel (2014), FMOH (2017) and review of related literatures to increase its validity. Besides that, the researcher discussed with the advisor about the questionnaires before it was distributed and to ensure the validity of the instrument a pilot test 20 questionnaire was distributed to the staffs of pharmacy department across the indicated public hospitals in Addis Ababa. Therefore, this study addressed content validity through the review of literature and adapting instruments used in previous studies. In addition to that, the correlation coefficient for the independent and dependent variables were calculated.

3.8.2 Reliability

According to Kothari (2004), consistency is referred to as reliability, and internal consistency entails comparing the answers to each questionnaire item with those of the other questions. Cronbach's alpha coefficient is one of the most commonly used measures of internal consistency. According to Almaquist *et al*. (2016), scales with a coefficient above 0.95 are regarded as having excellent reliability, while scales with a coefficient between 0.80 and 0.95 are regarded as having very good reliability. Scales with coefficients between 0.70 and 0.80 are regarded as having good reliability, whereas values between 0.60 and 0.70 are considered to have fair dependability. The scale's dependability is poor when the coefficient is less than 0.6.

Therefore, the researcher has analyzed the reliability of the questionnaire by using Cronbach’s alpha statistics. As indicated in the table 3.4 below, all Cronbach’s alpha indexes are above 0.7 suggesting that the variables are consistent.

Table 3.4: Reliability Test

Variables	No. of Item in the Scale	Cronbach's Alpha Result
Inventory Management Practice	20	.716
Logistics Management Information System	5	.905
Logistic System Performance	10	.872
Storage Condition	18	.882
Availability of ARV Drugs	22	.795
Overall Reliability	**75**	**.801**

As indicated in table 3.4, the reliability of independent variable named as inventory management practice is 0.716 (good reliability), logistics management information system is 0.905 (very good reliability), logistics system performance is 0.872 (very good reliability), storage condition is 0.882 (very good reliability), and availability of ARV drugs is 0.795 (good reliability).

On the other hand, the overall Cronbach's Alpha values of the entire questions were equals 0.801 (80.1%) and as per the classification of Almaquist *et al*. (2016), this indicates very good reliability of the entire questionnaire. This means that there is very good internal consistency and reliability in the questionnaire. Therefore, the level of alpha was reliable enough to proceed with the data analysis. Thereby, it can be said that the researcher proved that the questionnaire was valid, reliable, and ready for distribution to the population sample. Generally, this constituted a basis for making valid conclusions through the reliable data in this research.

3.9 Ethical Consideration

The researcher identified four main ethical concerns that might have an impact on this research project among other important ethical issues, and put plans in place to deal with them. They include the following: informed consent, confidentiality, a detrimental effect on employment, and data security. First, approval to conduct the research was acquired from the hospitals. Informed consent was obtained since the respondents were made aware of the study's history and purpose, as well as the significance of the data that would be gathered from them. The researcher also gave the respondents the assurance that none of the respondents' answers would be disclosed to anybody and that the data would only be utilized for academic research, maintaining the researcher's secrecy. Maintaining the confidentiality of responses prevents adverse effects on employability. By keeping all responses in the researcher's possession, data security was lastly maintained.

CHAPTER FOUR

4. RESULT, DISCUSSION AND INTERPRETATION

This chapter presents the findings, interpretation of the responses from the survey conducted, discussion, and interpretation of the results. This chapter is organized accordingly with the specific objectives. The first section presents the response rate and demographic information of the respondents. The second section presents the supply chain management practices of ARV drugs in public hospitals of AACAHB. The third section presents the stock availability of ARV drugs in public hospitals of AACAHB and the fourth section presents the relationship between supply chain management practices in public hospitals of AACAHB. The last section presents the effect of supply chain management practices on the performance of ARV drugs availability in public hospitals of AACAHB. While conducting the analysis, a statistical software SPSS version 26 is utilized.

4.1 Response Rate and Demographic Information

4.1.1 Response Rate

As indicated in the methodology, the staffs of pharmacy department across the public hospitals of AACAHB was the target population of the study. Self-administered semi-structured questionnaires were designed to collect data from the target population. The researcher issued a total of 159 questionnaires in person, email, and telegram to the identified respondents. The response rate of the respondents is presented in table 4.1 below.

Table 4.1: Response Rate of the Respondents

No.	Description	Respondents
1	Total sample size	159
2	Questionnaire distributed	159
3	Questionnaire returned	130
4	Response rate (%)	82%

Source: - Computed by the researcher, 2022

As indicated in the above table, out of the issued 159 questionnaires (having 80 questions) in person, email, and telegram, 130 were filled and returned giving a response rate of 82%. Therefore, the response rate considered adequate for the study.

4.1.2 Demographic Information of Respondents

As indicated in the previous section, out of 159 questionnaires distributed, 130 were filled and retrieved representing a response rate of 82%. Additionally, all of these interviewees recruited agreed to participate. The Sociodemographic characteristics of respondents i.e., name of hospitals, sex, age, education, years of service, and occupation of the respondents is presented in table 4.2 below.

Table 4.2: Demographic Information of Respondents

Characteristics	Description	Frequency	Percent	Cumulative Percent
Public Hospitals	Yekatit 12 Hospital	33	25.4	25.4
	Menelik II Referral Hospital	27	20.8	46.2
	Gandi Memorial Hospital	14	10.8	56.9
	Zewditu Memorial Hospital	22	16.9	73.8
	Ras Desta Damtew Hospital	19	14.6	88.5
	Tirunesh Beijing General Hospital	15	11.5	100.0
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
	Adult Pharmacy	23	17.7	100.0

Source: *Own Survey Result (2022), SPSS Output*

A. Respondents across Public Hospitals of AACAHB

As it indicated in the previous section, proportionate stratified sampling design was utilized in this study. The sample was designed based accordingly with the existing public hospitals of AACAHB. As indicated in the methodology section, the sample size across each hospital were 38 from Yekatit-12 hospital, 32 from Menelik II referral hospital, 18 from Gandi memorial hospital, 28 from Zewditu memorial hospital, 28 from Ras Desta Damtew hospital, and 21 from Tirunesh Bejing general hospital. However, as indicated in the above table, the responses

collected from Yekatit-12 hospital is 33 (response rate 87%), 27 from Menelik II referral hospital (response rate 84%), 14 from Gandi memorial hospital (78%), 22 from Zewditu memorial hospital (79%), 19 from Ras Desta Damtew hospital (86%), and 15 from Tirunesh Bejing general hospital (71%).

B. Gender of Respondents

Out of the 130 respondents for the study, 81 (62.5%) were male whilst 49 (37.5%) were female. This shows that the majority of the staff of pharmacy department across each public hospital of AACAHB are male.

C. Age Group of Respondents

The age distribution of respondents reported in Table 4.2 above shows that majority of the respondents fell within the age group of 21 – 30 years (n=92, 70.8%) followed by age groups 31 – 40 years (n=31, 24%), and 41 – 50 years (n=4, 3.1%) respectively. In contrary, respondents who fell within above 51 years group constituted the least share followed by age groups of below 20 years, which represents 0% and 2.1% (n=3) of the sample respectively. This implies that age groups below 40 years occupy 97% of the staffs of pharmacy department across the public hospitals of AACAHB.

D. Education Level of Respondents

With the educational background, majority of the respondents (n=104, 79.2% out of the total respondents 130) have said that they possessed the first degree; and 17.7% possessed second-degree (master's degree) educational level. On the other hand, least share of respondents possessed in diploma by having a percentage share of 1%. Hence, 99% of the respondents have possessed first-degree and above first-degree (Master degree) educational level. This shows that, the majorities of respondents, which are participating in the study, were well educated and have the ability to understand the questionnaire easily and will have a great contribution for the quality of the collected data.

E. Year of Service

The respondents were asked to indicate the length of years they had spent in their respective hospitals. The results indicate that majority of the respondents (i.e., n=62, 47.9%) had spent 6 up to 10 years in the organization. Besides this, 20.8% of the respondents had spent 1 up to 5 years in the organization whilst 15.6% of the respondents had spent less than a year and 12.5% of the respondents spent 11 up to 15 years as well as 2.1% of the respondents had spent 16 up to 20 years, and 1.0% of the respondents spent above 20 years in their organization. This implies that 84.3% of the respondents have worked in their organization for above 1 year and around 63.5% of the respondents have worked in their organization for above 6 years. This also will have a great contribution to get quality of data.

F. Occupation Level of Respondents

As per the data collected from the HR department of each public hospitals, the pharmacy department is basically designed into five occupational levels such as pharmacy administration, ART pharmacy, Store, in-patient, and adult pharmacy. The respondents were requested to indicate their occupational level. As indicated in the above table, majority of the respondents were clinical pharmacist followed by ART pharmacy and store by having a percentage share of 25%, 24%, and 21.9% respectively. In contrary, least share of respondents were pharmacy administration and druggist by having a percentage share of 11.5% and 17.7% respectively.

4.2 Supply Chain Management practices of ARV Drugs in Public Hospitals of AACAHB

The main objective of this study was 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. With this, the first specific objective of the study is to assess the supply chain management of ARV drugs with respect to the logistic system performance, storage conditions, inventory management, and LMIS practices of public hospitals in AACAHB. The study sought to seek the response of the staffs of pharmacy department across the public hospitals of AACAHB about their perception on the identified variables of supply chain management of ARV drugs. Descriptive analysis across all independent and dependent variables were under taken and the following section presents the result of the collected data.

4.2.1 Logistics System Performance

The logistics system performance of public hospitals of AACAHB for ARV drugs was assessed with respect to the provision of logistics knowledge for the personnel involved in the ARV drugs supply chain management, resupply period/lead-time and emergency order. The findings are depicted below.

A. Logistic Knowledge Provision for the Staffs (Pharmacist)

Respondents were asked to provide their opinions on the three questions in order to assess the logistics information provided by the public hospitals of AACAHB to the people involved in the ARV medications supply chain. The analysis's findings are shown in the table below.

Table 4.3: 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		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	.7886
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**	**.44865**
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**	**.40099**
	Overall Grand Mean of Logistics System Performance						**2.3846**	**.44346**

Source: *Own Survey Result (2022), SPSS Output*

The weighted average categories (mean value) are interpreted with the degree of agreement for each factor calculated accordingly and its interpretation was made on the basis of Niftalem and Shiferaw (2021) suggestion as weighted average between 1.00-1.79 interpreted as very uninfluential, 1.80-2.59 as un influential, 2.60-3.39 as neutral/do not know, 3.40-4.19 as influential and 4.20-5.00 as very influential.

As indicated in table 4.3 above, majority of respondents (Mean = 3.9154) were agreed that in their respective hospitals, logistics management of ARV drugs training is periodically provided to the staffs of pharmacy department. However, un influential share of respondents (Mean= 2.5646) were disagreed or strongly disagreed about the statement stating that pharmacy staffs in their respective hospitals are skilled to properly determine the quantities of ARV drugs order, forecasting the demand of ARVs, and determining the order resupply quantities. Furthermore, respondents were disagreed (Mean=2.2231) that new HIV commodity awareness training is periodically provided to the staffs of pharmacy in their respective hospitals.

This descriptive implies that the staffs of pharmacy department across the public hospitals of AACAHB have positive perception about the periodical provision of trainings on the logistics management of ARV drugs to the staffs of pharmacy. In contrary, respondents have a negative perception about the provision of new HIV commodity awareness training to the staffs. Respondents have also negative perception about the skill of their staffs to determine the quantities of ARV drugs order, forecasting the demand of ARVs, and determining the order resupply quantities. Hence, 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.

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

Three more criteria have been created by the researcher to evaluate the effectiveness of the logistic system. Answers to questions about the length of sending orders in their particular hospitals, the order fill rate, and the lead-time of ARV medicine supply were solicited from respondents. As indicated in the above table, influential share of respondents (Mean = 3.9077) showed agreed that the required amount of ARV drugs in their respective hospitals are usually ordered on its proper time i.e., before ARVs are stocked-out.

However, none of the respondents showed a positive perception instead respondents showed negative perception (disagreed and strongly disagreed) about the statement stating that in their hospital they receive ARV medicines from EPSS exactly similar with the quantity they ordered. In the same manner, respondents disagreed that EPSS is usually deliver the order ARV medicines in the expected delivery time. This suggests that the employees of the pharmacy department has a poor opinion about the lead-time of EPSS's ARV and thinks 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 it is recommended on the IPLS SOP. Regarding with 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 to resupply health facilities with the requested quantity within one month of receiving resupply request from health facilities (PFSA, 2015).

C. Emergency Orders

The other attribute to examining the logistic system performance of public hospitals of AACAHB is the frequency of emergency order. The respondents were requested to indicate the frequency of emergency order for ARV in the last 6 months. As per the result obtained from the survey, all respondents stated that public hospitals of AACAHB have placed places emergency orders for ARV drugs about three and more times from the EPSS in the last 6 months. As stated by Araya (2018), having an emergency order of three times within six months period is not considered frequent and hence the trend of emergency order indicated in this study is encouraging.

Facilities should always be able to maintain the maximum-minimum inventory stock level, per the IPLS SOP guideline, in order to always have adequate stock on hand in order to serve their customers and produce the intended health outcome. This maximum-minimum inventory stock assists in preventing stock outs and urgent orders. Before the conclusion of the reporting period, an emergency order needs to be placed if the facility's stock of any product falls below a predetermined emergency order point (PFSA, 2015). As indicated in above, logistic system performance has three attributes i.e., logistic knowledge provision for the Staff (Pharmacist), length of Resupply, lead-time, & fill rate; and emergency orders.

The study analyzed the mean rank of each dimension of logistics system performance to determine which of the three dimensions was the most important. Table 4.4 shows the outcome.

Table 4.4: 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: Compiled from Survey Questionnaires using SPSS, 2022

From the above Table 4.4, it can be seen that logistic knowledge provision for the staff (Pharmacist) ranked (Mean = 2.9077) as the first significant dimension of logistic system performance followed by length of resupply (Mean = 2.2308) and emergency order (Mean = 2.1077) respectively.

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 4.5 presents the SPSS output of the Friedman Test Statistics for the identified dimensions of logistic system performance.

Table 4.5: Friedman Test Statistics for Logistic System Performance

Test Statistics[a]	
N	130
Chi-Square	90.944
df	2
Asymp. Sig.	.000
a. Friedman Test	

As reported in the Table 4.5 above, the computed Friedman Chi-square statistics is 90.944 with two degree of freedom and the Asymptotic p-value is 0.000, which is less than 0.05. Hence, we conclude that the observed differences in the rankings among the three dimensions of logistics system performance across the public hospitals in AACAHB are not simply by chance. Therefore, the logistics system performance across each dimension in the public hospitals in AACAHB are statistically different and not simply by chance.

In conclusion, the study revealed that among the three dimensions of logistics system performance in the public hospitals in AACAHB, logistic knowledge provision for the staff (Pharmacist) is the most significant attributes followed by length of resupply. Hence, the public hospitals of AACAHB should give much emphasis for the logistic knowledge provision for the

staff (Pharmacist) and length of resupply (lead-time) in order to enhance the logistics system performance across the hospitals.

4.2.2. Storage Management Practices

In order to assess the storage condition of the hospital, 18 standard criteria designed by LIAT (2006) as indicated in appendix A was considered and the respondents of pharmacy department staff were requested to evaluate compliance of their respective hospital store to these criteria. The result of the survey is presented as follow.

Table 4.6: Frequency of Store Condition

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.	100%	130
2	ARV drugs are stored and organized to FEFO (First-Expire-First-Out) procedures and are accessible for counting and general stock management.	100%	130
3	Outer cartons are in good condition (not crushed, perforated, stained, or otherwise visibly damaged).	100%	130
4	Damaged and expired products are separated from usable products in the storeroom, and procedures exist for removing them from inventory.	100%	130
5	ARV drugs are stored in a dry, well-lit, well-ventilated storeroom. (Visually inspect roof, walls, and floor of storeroom.)	100%	130
6	Cartons and products are protected from direct sunlight	100%	130
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.)	100%	130
8	Storage area is secured with a lock and key but is accessible during normal working hours; access is limited to authorized personnel.	100%	130
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.	100%	130
10	Roof is maintained in good condition to avoid sunlight and water penetration.	100%	130
11	Storeroom is clean, with all trash removed, no evidence of food and drinks, products stored on sturdy shelves/bins, and boxes organized neatly.	100%	130
12	Current storage space is sufficient for existing products and planned program expansion.	100%	130
13	ARV drugs are stored separately from insecticides, flammable products, and chemicals.	100%	130
14	Food and drinks are not stored together in refrigerator used for storing ARV drugs that require cold storage.	100%	130
15	Fire safety equipment is available and accessible. (Any item identified as being used to promote fire safety should be considered.)	100%	130
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).	89.60%	116
17	Products are stacked no more than 2.5 m high.	87.50%	114
18	Products are stacked at least 10 cm off the floor (on pallets or other materials that elevate the products off the floor).	86.50%	112

Source: Compiled from Survey Questionnaires using SPSS, 2022

As indicated in table 4.6 above, among the 18-store condition criterion of LIAT (2006), all respondents stated their respective hospitals have fulfilled 83% (n=15) of the criterion. All of the respondents agreed that in their pharmaceutical store's products are arranged on shelves with arrows pointing up, ARV drugs are stored and organized to FEFO (First-Expire-First-Out) procedures, cartons and products are protected from direct sunlight and outer cartons are in

good condition, damaged and expired products are separated from usable products in the storeroom, ARV drugs are stored in a dry, well-lit, well-ventilated storeroom, storage area is secured with a lock and key, products are stored at the appropriate temperature, roof is maintained in good condition, storeroom is clean, current storage space is sufficient for existing products and planned program expansion, ARV drugs are stored separately from insecticides, flammable products, and chemicals, food and drinks are not stored together in refrigerator used for storing ARV drugs, and fire safety equipment is available and accessible.

However, only 89.6% of the respondents agreed that 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) in their respective hospital. Specifically, 4 respondents from Yekatit 12 hospital, 4 from Zewditu memorial hospital, 3 from Gandi memorial hospital stated that products are not stacked at least 30 cm away from the walls and other rows or stacks of products. Besides this, 87.5% agreed that products in their respective hospitals are stacked no more than 2.5 m high. Majority of respondents disagreed with this statement are from Yekatit 12 hospital and Zewditu memorial hospital. Furthermore, 86.5% agreed that products in their respective hospital are stacked at least 10 cm off the floor.

4.2.3. Inventory Management Practices

For examining the inventory management practice across the public hospitals of AACAHB, four dimensions were utilized and these are inventory control models, determination of order quantities, stock keeping record and reporting, as well as safety stock policy. The response of the respondents is presented as below.

Table 4.7: Inventory Management Practices

No.	Attributes of Inventory Management Practices	Scale					Mean	S.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**	**.53481**
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

No.	Attributes of Inventory Management Practices	Scale					Mean	S.dev
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 (Judgement 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**	**.66038**
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**	**.49535**
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**	**.63743**
	Over all grand mean of Inventory management practices						**3.0685**	**.43510**

Source: Compiled from Survey Questionnaires using SPSS, 2022

A. Inventory Control Models

A firm or institution dealing with commodities can determine the ideal level of stock to be retained by using inventory control models, which are mathematical tools (Araya, 2018). The goal of an inventory model is to provide the supply chain manager with guidance on when and how much to demand or issue in order to maintain the proper stock level and avoid running out of inventory or overstocking (Nishi, 2022).

Respondents were requested to show their perception about the availability of 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 are agreed (Mean = 4.0692) that ordering ARV drugs in their respective hospital is usually conducted as the end of the reporting period i.e., forced order system. In contrary, only few shares of the respondents agreed that ordering ARV drugs in their respective hospital is usually conducted when minimum stock is reached (continuous review system) and conducted at the end of reporting period of ARVs that have reached minimum stock level (standard system) (Mean value 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 reporting period of ARVs that have reached 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 taking into account a number of things. Considering future demands while setting order numbers is a crucial factor (Nishi, 2022). The projective method, which is based on past consumption, the causal method, which is based on external factors like epidemics and market structure, the judgmental method, which is based on estimates from experienced staff, and the morbidity method, which is based on data on disease incidence and accepted treatment guidelines, are the methods used for forecasting demand, according to Nishi (2022).

As indicated in table 4.7, majority of the respondents stated agreed that previous consumption data is usually used to forecast the demand of ARVs in their respective hospitals (i.e., projected method of forecasting) (Mean = 3.9769) while insignificant share of respondents stated that the demand of ARV drugs are made based on HIV prevalence, incidences, and expected number of attendances (i.e., morbidity method) (Mean = 2.0). In contrary, only 4% and 12% of the respondents stated that the judgement and causal methods respectively are utilized in their hospitals for the forecasts of the demand of ARV drugs. Hence, the study revealed that in the determination of order quantities, projective method is mostly used in public hospitals of AACAHB followed morbidity method. In contrary, judgement method and causal method are the least used method for the forecasts of the demand of ARV drugs.

C. Stock Keeping Record and Reporting

Respondents were asked to provide their perceptions regarding the availability of ARV stock records and the accuracy of the stock records, the frequency of stock counts, the method of stock counts (full count, cyclical count), reporting of ARV medicines, and the content of the data included in the report (consumption, stock on hand, losses and adjustments, and data on commodities) in order to assess the stock keeping record and reporting.

As indicated in table 4.7, majority of the respondents (Mean = 4.0538) stated that the stock records for ARV medicines in their hospital are accurate and up to data; 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 hospital (Mean = 4.0308). Respondents also agreed that reports of ARV medicines in their respective hospital are compiled at the end of each reporting period (Mean = 4.0231). Besides this, 81% of the respondents agreed/strongly agreed that data on losses and adjustments is included in every report in their respective hospital. In contrary, least share of the respondents agreed that data on commodities near expiry is included in every report in their respective hospital and regular stock counts are done minimum once every reporting period of ARVs (Mean = 1.9538 and 1.9308 respectively).

D. Safety Stock Policy

In order to assess the safety stock policy across the public hospitals in AACAHB, respondents were requested to indicate their level of agreement for the following three questions. As indicated in table 4.7, most respondents have showed a positive perception for the three attributes of safety stock policy. However, majority of the Pharmacists when asked about their safety stock policy indicated that a rough estimate is used as safety stock in their respective hospitals (Mean = 4.0077). Whereas, large share of the respondents stated that a safety/buffer stock is kept for every ARV product and a standard formula is used in calculating safety stock in their respective hospitals (Mean = 3.78).

4.2.4. Logistic Management Information System

For examining the logistic management information system utilization across the public hospitals of AACAHB, respondents were requested to indicate their perceptions about the utilization of computerized and paper-based recording and reporting tools, computerized EDT

to record patient information, HCMIS in stores and stock movement, RRF to facilitate and control stock movement between EPSS and hospitals, and IFRR to facilitate and control stock movement within the public hospitals of AACAHB. The following table 4.8 presents the result.

Table 4.8: Frequency of Logistic Management Information System

No.	Attributes	SD	D	N	A	SA	Mean	Std.deviation
1	Our hospital uses both computerized and paper-based recording and reporting tools	0% (0)	0% (0)	0% (0)	63.5% (83)	36.5% (47)	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 register.	0% (0)	0% (0)	0% (0)	64.6% (84)	35.4% (46)	4.3538	.48001
3	In our hospital, Health commodity management information system (HCMIS) is mostly utilized in stores and stock movement.	0% (0)	0% (0)	0% (0)	64.60% (84)	35.40% (46)	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.	0% (0)	0% (0)	0% (0)	64.60% (84)	35.40% (46)	4.3538	.48001
5	In our hospital, Internal Facility Reporting and Requisition (IFRR) are used to facilitate and control stock movement within the hospital.	0% (0)	0% (0)	0% (0)	62.50% (81)	37.50% (49)	4.3769	.48649

Source: Compiled from Survey Questionnaires using SPSS, 2022

As indicated in the above table, all of the selected public hospitals used both computerized and paper-based recording and reporting tools. They also used computerized EDT and HCMIS at dispensary and store respectively. In addition to these RRF and Internal Facility Reporting and Requisition (IFRR) were used to facilitate and control stock movement between PFSA and facility and within the hospitals itself. RRF and IFRR are paper based format used to report, order and control stock movement. The study of Berhanemeskel (2014), showed that EDT reduces the work load of the pharmacists and the data clerk at ARV dispensary. This computerized software eases the work of the health professionals.

4.3. Stock Availability of ARV Drugs in Addis Ababa Public Hospitals

In Ethiopia, the Federal Democratic Republic of Ethiopian Government created the Pharmaceuticals Fund and Supply Agency (PFSA) as a legal organization in September 2007 to address issues and ensure the people received uninterrupted access to drugs (Damtie *et al*., 2020). According to the Ethiopian Food and Drug Authority (EFDA), safe, effective, and reasonably priced medications of the necessary and guaranteed quality, in sufficient quantities, should always be accessible for the delivery of appropriate healthcare services (Sintayehu *et al*., 2022).

In Ethiopia, the number of health facilities providing ART services, mainly public facilities, has expanded, enabling the enrolment of hundreds of thousands of people living with HIV AIDS from time to time as the drugs are provided free of charge. In order to examine the stock availability of ARV drugs in the public hospitals of AACAHB, the respondents were requested to examine the stock status based on the bin-cards of the last 6 month (May – Oct/2022). The result is presented in table 4.9 below.

Table 4.9: Frequency of Stock Availability of ARV Drugs

No.	List of ART drugs	Was the item available in the period of May – Oct/2022 (Yes/No)	If stock-out, for how many times within this period?	Total days of stock-out (During May-Oct/2022)
1	Abacavir 300mg Tablet	97% (126)	1.0	10
2	Efavirenz 600mg Tablet	97% (126)	1.0	9
3	Lamivudine 150mg Tablet	99% (129)	1.0	7
4	Lamivudine 300mg/Tenofovir 300mg Tablet	88% (114)	1.0	8
5	Lamivudine 300mg/Tenofovir 300mg/Efavirenz 600mg Tablet	100% (130)	1.0	6
6	Zidovudine 300mg/Lamivudine 150mg Tablet	88% (114)	1.0	6
7	Zidovudine 300mg/Lamivudine 150mg/Nevirapine 200mg Tablet	90% (117)	1.0	7
8	Atazanavir + Ritonavir (300+100) mg Tablet	0% (0)	1.0	6
9	Lopinavir 200mg/Ritonavir 50mg Tablet	24% (31)	1.0	7
10	Abacavir 60mg + Lamivudine 30mg Tablet	42% (55)	1.0	7
11	Efavirenz 200mg Capsule	20% (26)	1.0	7
12	Efavirenz 50mg Capsule	10% (13)	1.0	7
13	Lamivudine 30mg/Zidovudine 60mg/Nevirapine 50mg Tablet	92% (120)	2.0	7
14	Lamivudine 30mg/Zidovudine 60mg Tablet	100% (130)	1.0	7
15	Lopinavir/Ritonavir 80/20mg/ml Solution	36% (47)	1.0	6
16	Nevirapine 10mg/ml Suspension	21% (27)	1.0	7
17	Lamivudine 300mg/Tenofovir 300mg/Dolutegravir 50mg Tablet	100% (130)	1.0	6
18	Dolutegrvir 50mg	22% (29)	1.0	5

Source: Compiled from Survey Questionnaires using SPSS, 2022

4.3.2. Stock Availability of ARV Drugs During the last 6 Months

As indicated in table 4.9 above, among 18 products of ARV drugs, all of the respondents stated that Lamivudine 30mg/Zidovudine 60mg Tablet, Lamivudine 300mg/Tenofovir 300mg/Efavirenz 600mg Tablet, and Lamivudine 300mg/Tenofovir 300mg/Dolutegravir 50mg Tablet were available across the identified public hospitals of AACAHB during the last 6 months. This implies that 17% of ARV drugs were available in the identified hospitals during the last 6 months. Besides this, 99% of the respondents stated that Lamivudine 150mg Tablet was available in the stock while 97% of respondents stated that Abacavir 300mg Tablet and Efavirenz 600mg Tablet were available in the stock during the last 6 months. In contrary, 100%

of the respondents stated that Atazanavir + Ritonavir (300+100) mg Tablet was stocked out during the last 6 months across all public hospitals of AACAHB while 90% of the respondents stated that Efavirenz 50mg Capsule was stocked out during the last 6 months. The study also revealed that all products of ARV drugs have been stocked out at least once in the last 6 months.

Hence, the study revealed that among the 18 products of ARV drugs, 56% of the drugs were available in the last 6 months in the public hospitals of AACAHB as stated by more than 88% of the respondents. These ARV drugs are Lamivudine 30mg/Zidovudine 60mg Tablet, Lamivudine 300mg/Tenofovir 300mg/Efavirenz 600mg Tablet, Lamivudine 300mg/Tenofovir 300mg/Dolutegravir 50mg Tablet, Lamivudine 150mg Tablet, Abacavir 300mg Tablet, Efavirenz 600mg Tablet, Lamivudine 30mg/Zidovudine 60mg/Nevirapine 50mg Tablet, Zidovudine 300mg/Lamivudine 150mg/Nevirapine 200mg Tablet, Lamivudine 300mg/Tenofovir 300mg Tablet, and Zidovudine 300mg/Lamivudine 150mg Tablet. The primary reason for holding stock in a pharmaceutical supply system is to ensure availability of essential items almost all the time (MSH, 2012 as cited in Araya, 2018).

The study further revealed that, among the 18 products of ARV drugs, all respondents were stated that Atazanavir + Ritonavir (300+100) mg Tablet were stocked out during the last 6 months and 28% of the drugs were stocked out in the last 6 months in the public hospitals of AACAHB as stated by more than 75% of the respondents. These ARV drugs were Efavirenz 50mg Capsule, Efavirenz 200mg Capsule, Nevirapine 10mg/ml Suspension, Dolutegrvir 50mg, and Lopinavir 200mg/Ritonavir 50mg Tablet. The study further revealed that on average each drug of ARV was stocked out at least once in the last 6 month. Stock outs and overstocks in any health system are important indicators of the logistics system lack of effectiveness and efficiency (MSH, 2012 as cited in Araya, 2018). Stock outs may result into unavailability of life saving medicines, disrupt course of treatment and ultimately patients and health workers may lose trust to the health system (Araya, 2018). Different studies showed a record of stock out for certain items during an assessment. For example, in an assessment of pharmaceutical sector in Ethiopia in 2010, it was observed that the national average for availability of essential drugs in public health facilities was 70% (30 % stock outs) and the average duration for stock out is 99.2 % days which are higher figures when compared with the result of this study as discussed above (WHO, 2010). A study conducted in SNNPRS of Ethiopia by Damtie *et al*. (2020) also found that 53.3% commodities of ARV drugs were stocked out at least once within the last six months.

4.3.3. Duration of ARV Drugs Stocked Out During the Last 6 Months

The average days of stock out during the last 6 months (May – Oct/2022) ranges from 5 – 10 days and total average duration of the 18 ARV drugs is computed as 7 days. The mean duration of stock out longer (days) for Abacavir 300mg Tablet followed by Efavirenz 600mg Tablet (9 days) and Lamivudine 300mg/Tenofovir 300mg Tablet (8 days) respectively. In the contrary, the mean duration of stock out was least for Dolutegrvir 50mg (5 days) followed by a 6 days of stock duration in Lamivudine 300mg/Tenofovir 300mg/Efavirenz 600mg Tablet, Zidovudine 300mg/Lamivudine 150mg Tablet, Atazanavir + Ritonavir (300+100) mg Tablet, Lopinavir/Ritonavir 80/20mg/ml Solution, and Lamivudine 300mg/Tenofovir 300mg/Dolutegravir 50mg Tablet.

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

As indicated in the methodology, this study used both descriptive and explanatory designs to reach at the identified objectives of the study. Correlation analysis is one of explanatory design utilized in this study to examine the significant relations between the independent variables i.e., inventory management practice, logistics system performance, LMIS, and store condition and dependent variable i.e., availability of ARC drugs in public hospitals of AACAHB.

A correlation coefficient's value can be anywhere between -1 and 1. While values closer to 0 suggest that there is little to no linear relationship between the variables being correlated, values closer to the absolute value of 1 show that there is a strong relationship between the variables being correlated. Cresswell (2009) noted that correlation coefficients between +0.9 and +0.7 are considered strong, +0.6 to +0.4 are considered moderate, and +0.3 to +0.1 are considered weak.

The direction of a correlation coefficient indicates the kind of connection that exists between the two variables. If the correlation coefficient is positive, the variables have a positive linear relationship, meaning that when one variable rises in value, the other also does. When a variable's value grows, the other variable's value falls, indicating a negative linear relationship between the variables (Almaquist *et al*., 2016).

Based on this premises, the correlation analysis was conducted and presented as below;

Table 4.10: Results of Pearson Correlation Analysis

		IMP	LMIS	LSP	SC	ARV
Inventory Management Practice	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	130				
Logistic Management Information System	Pearson Correlation	.349	1			
	Sig. (2-tailed)	.051				
	N	130	130			
Logistic System Performance	Pearson Correlation	.349*	.014	1		
	Sig. (2-tailed)	.000	.890			
	N	130	130	130		
Store Condition	Pearson Correlation	-.249*	-.027	-.180	1	
	Sig. (2-tailed)	.014	.791	.080		
	N	130	130	130	130	
Availability of ARV	Pearson Correlation	. 679**	. 256*	. 685**	. 290**	1
	Sig. (2-tailed)	.000	.004	.000	.012	
	N	130	130	130	130	130

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Source: *Own Survey Result (2022), SPSS Output*

According to Table 4.10, the coefficients indicated that all independent variables such as inventory management practice, logistic management information system, logistic system performance, and store condition are positively related to the dependent variable i.e., availability of ARV drugs in public hospitals of AACAHB.

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 Cresswell (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 (Cresswell, 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 ARVs.

Hence, the study revealed that among the identified determinants of ARV drugs availability, there is relatively strongest relationship between logistics system performance and availability of ARV drugs followed by inventory management practice, store condition, and store condition respectively. This implies that, public hospitals of AACAHB should give much emphasis for the attributes of logistics system performance (especially for the order fill rate, delivery lead-time, and providing awareness training for new HIV periodically to the staffs of pharmacy) and for inventory management (especially in ordering ARV drugs, forecasts of the demand of ARV drugs, and conducting a regular stock counts).

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

The researcher used a multiple linear regression analysis to examine the impact of each independent variables on the dependent variable. Classical model assumptions were validated before running the regression analysis, and the results are as follows.

4.5.2. Diagnostic Test of Assumptions

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

I. Linearity Test

A linearity test attempts to ascertain whether or not there is a linear relationship between the independent factors and the dependent variable. In the correlation and linear regression analysis, the linearity test is necessary (Almquist *et al*., 2016). If the ANOVA test's sign. deviation from linearity value is greater than 0.05, the independent variables' relationships with the dependent variables are linearly dependent; conversely, if the value is less than 0.05, the relationships between the independent variables and the dependent variables are nonlinear. Table 4.11 presents the result of linearity test.

Table 4.11: 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
			5.635	92	.061		
			6.703	126			

Source: Compiled from Survey Questionnaires using SPSS, 2022

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. Autocorrelation Test

Autocorrelation cannot be present when performing a regression analysis. The Durbin-Watson test, fortunately, allows us to pinpoint this problem. The results of the autocorrelation test are indicated by the Durbin-Watson test. Hence, according to Almquist *et al.* (2016), we can conclude that there is no autocorrelation if the Durbin-Watson values are between 1.5 and 2.5.

As indicated in table 4.14, we can see that the value of Durbin-Watson of a model with four independent variables and 130 observations is 1.582. From this, we can conclude that there is no autocorrelation, and we can proceed with the regression model.

III. Multicollinearity Test

According to Tustin *et al.* (2005), multicollinearity 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, multicollinearity 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 multicollinear, including the bivariate 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 multicollinearity 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 multicollinearity 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 multicollinearity problem.

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

Table 4.12: Multicollinearity 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, 2022

Based on the coefficients output of collinearity 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 multicollinearity symptoms.

IV. Normality Test

The researcher utilized a normal probability plot test with SPSS to check for normality. According to Almquist *et al*. (2016), the decision-making standard is that if the points follow the diagonal line, the value is likely to be normally distributed. On the other hand, if the points deviate from the diagonal line, it can be said that the residual value has an irregular distribution. The normal probability plot of the SPSS output is presented as below.

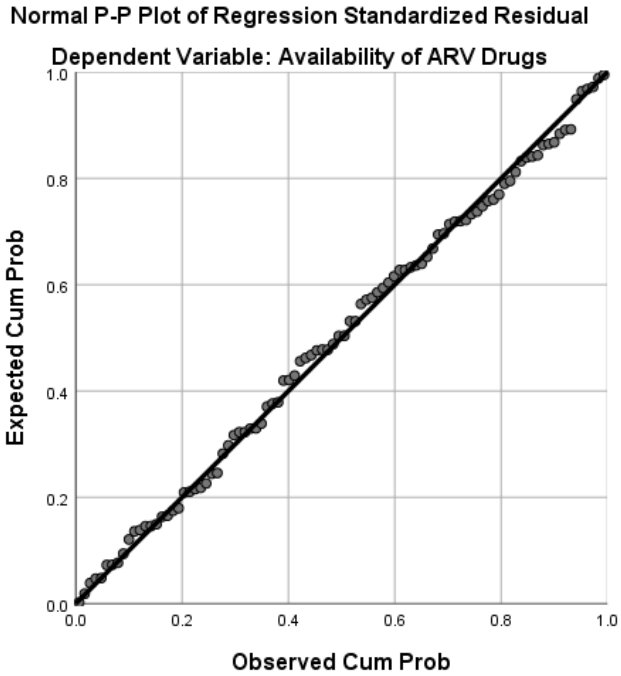

Figure 4.1: Normal P-P Plot
Source: Own Computations, 2022

The existing points always approach and follow the diagonal line, as shown by the normal chart probability plot. As a result, it may be said that the residual value has a normal distribution, meaning that the regression analysis technique has been successful.

V. Residual Normality Test

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

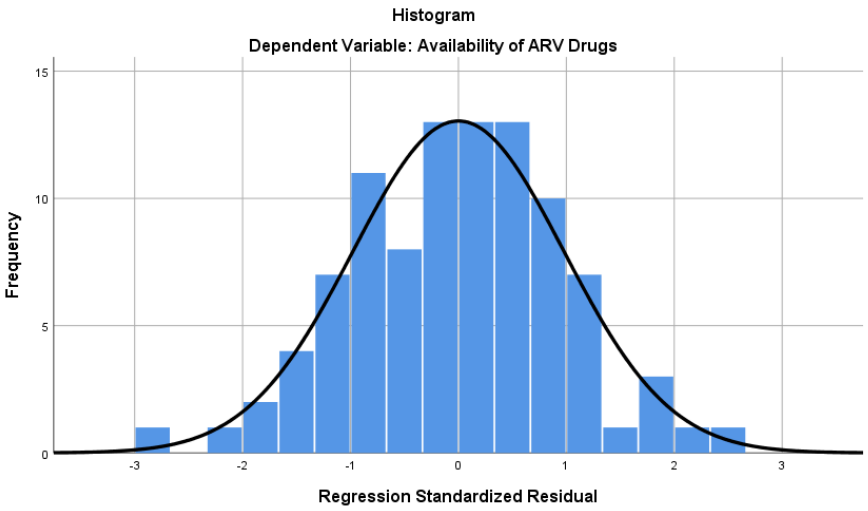

Figure 4.2: Regression Standardized Residual
Source: Own Computations, 2022

This shows that the histogram is bell-shaped, standard residuals are at the center of the curve, and many residuals are reasonably close to the curve. Thus, the greatest bars on the histogram are all centered around the central value, indicating that the majority of scores are distributed about the distribution's center. This suggests that the residuals are distributed normally.

4.5.3. 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.

Table 4.13: Model Summary of Multiple Linear Regressions

Model Summary[b]					
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, 2022

The R-value represents the simple correlation and the R-value of the regression model as indicated in table 4.13 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.

Table 4.13 also indicates that R square and adjusted R square value is 0.719 and 0.706 respectively. As indicated in Almaquist *et al*. (2016), adjusted R square is used for interpretation when the study is worked with samples. Hence, since the researcher used a sample, we consider the value of adjusted R square value (0.706). This indicates that 70.6% of the data fit the regression model. In another word, the value of R square indicates that, the identified independent variables used in this model explain 70.6% of the variation in availability of ARV drugs in public hospitals of AACAHB. From this figure, one can conclude that the explanatory variable, which is the aforementioned four independent variables (i.e., Inventory management practice, LMIS, logistics system performance, and store condition) jointly, explained 70.6% of the variation in availability of ARV drugs in public hospitals of AACAHB. The remaining 29.4% variation in the availability of ARV drugs in public hospitals of AACAHB is caused by other factors or variables, which are not included in this study.

The second result of regression is ANOVA table as indicated in table 4.14 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 4.14: 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, 2022

As indicated in table 4.14 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 4.15 below, where each of the individual variable are listed.

Table 4.15: Multiple Linear Regression-Beta Coefficients of Independent Variables

Coefficients[a]								
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, 2022

As stated by Almaquist *et al.*, (2016), unstandardized coefficient represents the amount by which dependent variable changes if we change independent variable by one unit keeping other independent variables constant. As shown in the above table, there is a positive association between all independent variables and availability of ARC drugs in public hospitals of AACAHB. As a rule of thumb, coefficients having p-values less than alpha (0.05) are statistically significant; and greater than alpha (0.05) are not statistically significant (Almaquist *et al.*, 2016). As indicated in table 4.15, 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 .05. The coefficient for logistics system performance (0.510) is statistically significant because its p-value of 0.000 is less than .05. The coefficient for store condition (0.374) is statistically significant because its p-value of 0.017 is less than .05.

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, unstandardized 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 is presented as below.

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

Hence, it is recommended that public hospitals of AACAHB should conduct previous consumption data (projective method) and morbidity method to forecast the demand of ARV drugs. Besides this, public hospitals of AACAHB should use previous consumption data (standard system) to forecast the demand of ARV drugs to enhance their inventory management performances. Furthermore, the hospitals should order ARV drugs when minimum stock is reached (continuous review system).

This study's conclusion confirms earlier research by Mokheseng *et al*. (2017) conducted in the QwaQwa district, which found that inventory management has a statistically significant impact on the supply chain management of ARVs. A research by Johnson *et al*. (2021) in Kenya indicated that all aspects of inventory management, with the exception of order lead time, were judged to be unsatisfactory because of high stock out rates, below-par reporting rates, and high stock wastage rates as a result of discovered expiries. The study further revealed that inadequate

staffing and lack of provision of skill gap training are the main challenges of ARV inventory management practices. 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 unproper inventory management.

4.5.3.2.The Effect of LMIS Practice on the Performance of ARV Drug Availability in the Public Hospitals of 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 al*. (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.

4.5.3.3.The Effect of Logistics System Performance on the Performance of ARV Drug Availability in the Public Hospitals of 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. As indicated in the descriptive analysis, among the three attributes of logistics system performance i.e., logistics knowledge provision for the staffs of pharmacy department, length of resupply/lead-time/order fill rate, and emergency orders; length of resupply/lead-

time/order fill rate have a significant impact on the logistics performance followed by logistics knowledge provision for the staffs of pharmacy department. From the descriptive analysis, the study recommends for the public hospitals of AACAHB to periodically provide awareness training on the new HIV commodities to the staffs of pharmacy department and should improve order fill rate. 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 that 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.

4.5.3.4.The Effect of Store Condition on the Performance of ARV Drug Availability in the Public Hospitals of 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 criterions 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:

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

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 4.15 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

5. SUMMARY OF MAJOR FINDINGS, CONCLUSION AND RECOMMENDATION

This study aimed 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. In conducting this study, the required data was obtained through self-administered semi-structured questionnaires. Validity and reliability tests were carried out for the adopted data collecting instruments. This chapter provides the summary of major findings, conclusions, and recommendations from the study. The major findings and conclusions are derived from the data analysis and interpretation, which are presented in chapter four. The recommendations are provided accordingly with the major findings of the study.

5.1 Summary of Major Findings

This study intended to provide answers for the identified research questions and address the identified two specific objectives. The first objective of the study was to assess the supply chain management practices of ARV drug in public health hospitals of AACAHB in terms of Logistics management practice, LMIS practices, storage conditions and inventory management practice in the public hospitals of AACAHB. In doing so, the study sought to seek response on the perceptions of the staffs of pharmacy department across the public hospitals in AACAHB.

Regarding with the logistics system performance, the study revealed that among the three dimensions of logistics system performance in the public hospitals in AACAHB, logistic knowledge provision for the staff (Pharmacist) is the most significant attributes 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 drugs order, forecasting the demand of ARVs, and determining the order resupply quantities. Among the attributes of lead-time and fill rate, majority of the respondents agreed that the required amount of ARV drugs in their respective hospitals are usually ordered on its proper time i.e., before ARVs are stocked-out. However, almost all respondents (i.e., 98%) stated that in their hospital, they don't receive ARV medicines from EPSS exactly similar with the quantity they ordered. Besides this, they stated that EPSS is not usually deliver the order of ARV medicines in the expected delivery

time. The respondents also revealed that there is an order fill rate gap while receiving ARV drugs as compared to the quantity ordered. As per the result obtained from the survey, all respondents stated that public hospitals of AACAHB have placed emergency orders for ARV drugs about three and more times from the EPSS in the last 6 months. The study further assessed the store condition of the hospitals and found that among the 18-store condition criterion of LIAT, all respondents stated their respective hospitals have fulfilled 83% (n=15) of the criterion. While the remaining 17% of the criterion are not fully implemented in the hospitals.

The study further assessed the inventory management practice of public hospitals of AACAHB and found that ordering ARV drugs in the hospitals is usually conducted as the end of the reporting period i.e., forced order system. This implies that forced order system is the most predominantly used inventory control method across the hospitals. Regarding with the determination of order quantity, majority (97%) of the respondents stated that previous consumption data is usually used to forecast the demand of ARVs in their respective hospitals (i.e., projected method of forecasting). In contrary, judgement and causal methods are the least used method for the forecasts of the demand of ARV drugs. Regarding with stock keeping record and reporting trends of the hospitals, majority of the respondents i.e., 98% stated that the stock records for ARV medicines in their hospital are accurate and up to data; and data on consumption and on stock are included in every report in their hospital. Besides this, respondents stated that reports of ARV medicines in their respective hospital are compiled at the end of each reporting period. However, data on commodities near expiry is not included in every report in their respective hospital and regular stock counts are not done minimum once every reporting period of ARVs. Regarding with the use of LMIS, all of the selected public hospitals used both computerized and paper-based recording and reporting tools. They also used computerized EDT and HCMIS at dispensary and store respectively. In addition to these RRF and Internal Facility Reporting and Requisition (IFRR) were used to facilitate and control stock movement between PFSA and facility and within the hospitals itself. 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 examined the availability of ARV drugs in the public hospitals of AACAHB and found that among the 18 products of ARV drugs, 17% of ARV drugs were available in the

identified hospitals during the last 6 months (May – Oct/2022) as stated by all respondents while 56% of the drugs were available in the last 6 months in the public hospitals of AACAHB as stated by more than 88% of the respondents. In contrary, Atazanavir + Ritonavir (300+100) mg Tablet was stocked out across the public hospitals of AACAHB during the last 6 months. Besides this, 90% of the respondents stated that Efavirenz 50mg Capsule was stocked out during the last 6 months. The study also revealed that all products of ARV drugs have been stocked out at least once in the last 6 months. The study further revealed that, among the 18 products of ARV drugs, all respondents were stated that Atazanavir + Ritonavir (300+100) mg Tablet were stocked out during the last 6 months and 28% of the drugs were stocked out in the last 6 months in the public hospitals of AACAHB as stated by more than 75% of the respondents. The average days of stock out during the last 6 months (May – Oct/2022) ranges from 5 – 10 days and total average duration of the 18 ARV drugs is computed as 7 days. The mean duration of stock out longer (days) for Abacavir 300mg Tablet followed by Efavirenz 600mg Tablet (9 days) and Lamivudine 300mg/Tenofovir 300mg Tablet (8 days) respectively.

The researcher has conducted correlation and regression analysis in order to address the second specific objective of the study i.e., to determine the effect of the supply chain management practices of public health hospitals AACAHB (in terms of Logistics management practice, LMIS, storage management and inventory management practice) on the performance of ARV drug availability in the public hospitals of AACAHB. The analysis 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. The study further revealed that the relationship between availability of ARV drugs and inventory management practice as well as logistics system performance is moderate while the relationship between the remaining two independent variables (LMIS and store condition) with availability of ARV drugs is found as weak. The result of regression analysis depicts that the identified independent variables used in this model explain 70.6% of the variation in availability of ARV drugs in public hospitals of AACAHB. Besides this, the analysis revealed that there is a positive and statistically significant association between all independent variables and dependent variable.

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 judgement 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 criterions 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:

- Atazanavir + Ritonavir (300+100) mg Tablet
- Efavirenz 50mg Capsule
- Efavirenz 200mg Capsule
- Nevirapine 10mg/ml Suspension
- Dolutegrvir 50mg, and
- Lopinavir 200mg/Ritonavir 50mg Tablet

5.4 Limitations and Future Research Direction

5.4.1 Limitation of the Study

Although this study may provide several useful contributions, like all other researches, it has some limitations. The sample size is relatively small and the research only focuses on pharmacy department assuming that this department is core among others in the supply chain. However, within the hospitals, other departments were supposed to be included in the target group. Besides this, the study only focused on the identified public hospitals and didn't get the direct opinions of ARV suppliers i.e., Ethiopia Pharmaceutical Supply Service (EPSS). If any researcher wishes to replicate this study, they should be firstly aware of these limitations.

5.4.2 Further Research Direction

This study only limited to ARV drugs supply chain management of public hospitals under AACAHB, did not include Ethiopia Pharmaceutical Supply Service (EPSS) and also didn't include the ARV supply chain management with client's perspective. Hence further research should be conducted on the supply chain management of ARV drugs to triangulate the hospital supply chain management with EPSS and to see the patient's satisfaction on the supply chain management of ARV drugs from customer service perception. Besides this, the study focused on limited variables of supply chain management of pharmaceuticals and hence next researches needs to consider other determinant variables and enlarge the sample size through including different departments other than the pharmacy department.

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Appendices

Appendix A: Questionnaire

ADDIS ABABA UNIVERSITY
SCHOOL 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 Supply Chain Management Practice and its Impact on the Performance of Antiretroviral Drugs (ARV) in Governmental Hospitals in Addis Ababa, Ethiopia

Dear Respondent,
My name is Anmut Alamrew, a student of Addis Ababa University, School of Commerce pursuing a Master of Arts Degree in Logistics and Supply Chain Management. This questionnaire has been designed for the sole purpose of collecting data on the supply chain management practice and its impact on the performance of ARG drugs in governmental hospitals in Addis Ababa city administration health bureau. The data collected will be treated with a very high degree of confidentiality and it is meant for academic purposes only. Your involvement in this study is extremely valuable and greatly appreciated to address the study's concerns. Kindly spare some minutes to answer these questions.

Thank You for Your Cooperation

Anmut Alamrew
Email: anmutalamrew@gmail.com
Cellphone: +251910840865

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 (Judgement 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					
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 register.					
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.		
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

Fill in the following table based on the inspection on inventory or Bin or stock cards.

No.	List of ART drugs	Was the item Stock-out in the period of May – Oct/2022 (Yes/No)					If stock-out, for how many times within this period?	Total days of stock-out (During May-Oct/2022)
		SD	D	N	A	SA		
1	Abacavir 300mg Tablet was sufficiently available in the last 6 months							
2	Efavirenz 600mg Tablet was sufficiently available in the last 6 months							
3	Lamivudine 150mg Tablet was sufficiently available in the last 6 months							
4	Lamivudine 300mg/Tenofovir 300mg Tablet was sufficiently available in the last 6 months							
5	Lamivudine 300mg/Tenofovir 300mg/Efavirenz 600mg Tablet was sufficiently available in the last 6 months							
6	Zidovudine 300mg/Lamivudine 150mg Tablet was sufficiently available in the last 6 months							
7	Zidovudine 300mg/Lamivudine 150mg/Nevirapine 200mg Tablet was sufficiently available in the last 6 months							
8	Atazanavir + Ritonavir (300+100) mg Tablet was sufficiently available in the last 6 months							
9	Lopinavir 200mg/Ritonavir 50mg Tablet was sufficiently available in the last 6 months							
10	Abacavir 60mg + Lamivudine 30mg Tablet was sufficiently available in the last 6 months							
11	Efavirenz 200mg Capsule was sufficiently available in the last 6 months							
12	Efavirenz 50mg Capsule was sufficiently available in the last 6 months							
13	Lamivudine 30mg/Zidovudine 60mg/Nevirapine 50mg Tablet was sufficiently available in the last 6 months							
14	Lamivudine 30mg/Zidovudine 60mg Tablet was sufficiently available in the last 6 months							
15	Lopinavir/Ritonavir 80/20mg/ml Solution was sufficiently available in the last 6 months							
16	Nevirapine 10mg/ml Suspension was sufficiently available in the last 6 months							
17	Lamivudine 300mg/Tenofovir 300mg/Dolutegravir 50mg Tablet was sufficiently available in the last 6 months							
18	Dolutegrvir 50mg was sufficiently available in the last 6 months							

1. If there was any stock-out of ARV drugs, what was the reason for the stock-out?
   - A. Didn't receive order ☐
   - B. Didn't order on time ☐
   - C. Transportation not available ☐
   - D. Didn't receive the quantity ordered ☐
   - E. Due to Stock-out at the central level ☐
   - F. Don't know how to order ☐

   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!