ADDIS ABABA UNIVERSITY

SCHOOL OF COMMERCE

DEPARTMENT OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Determinants of Stock-Out of First Line Antiretroviral Therapy (ART) Drugs: The Case of Hospitals of Addis Ababa City Administration Health Bureau, Addis Ababa, Ethiopia

By

Tewodros Zewde

February, 2023

Addis Ababa, Ethiopia

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Addis Ababa, Ethiopia

Statement of Declaration

I, Tewodros Zewde, declares that this thesis work entitled "Determinants of Stock-Outs of First Line ART Drugs: The Case of Hospitals of Addis Ababa City Administration Health Bureau, Addis Ababa, Ethiopia" is my original work in partial fulfillment of the requirement for the award of Degree of Master of Arts in Logistics and Supply Chain Management. I also declare that it has never been presented in other university and that all resources and materials used in the thesis have been duly acknowledged.

Author: **Tewodros Zewde** _____ _____

Signature Date

Statement of Certification

This is to certify that research under taken by Tewodros Zewde under my advising entitled with: “Determinants of Stock-Outs of First Line ART Drugs: The Case of Hospitals of Addis Ababa City Administration Health Bureau, Addis Ababa, Ethiopia” submitted to the AAU in partial fulfillment of the requirements for 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.

Tariku Jebena (Ph.D.)	_____	_____
Advisor Name	**Signature**	**Date**

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BY:

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Acronyms

AACAHB	Addis Ababa City Administration Health Bureau
AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral Therapy
DACA	Drug Administration and Control Authority
EFDA	Ethiopian Food and Drug Authority
EFDA	Ethiopian Food and Drug Authority
EPHI	Ethiopian Public Health Institute
HCMIS	Health Center Management Information System
HIV	Human Immunodeficiency Virus
IPLS	Integrated Pharmaceuticals Logistics Systems
LMIS	Logistics Management Information System
PFSA	Pharmaceuticals Fund and Supply Agency
PLHIV	People Living with the Human Immunodeficiency Virus
WHO	World Health Organization

Abstract

This study was aimed to examine the determinants of stock-out of first line antiretroviral (ART) therapy drugs in the case of hospitals of AACAHB. ART supplier performance, inventory management of the public hospitals, human resource, ICT use, and health system support were identified as an independent variable in this study. A quantitative research approach, cross-sectional survey strategy, and structured questionnaire for the primary data collection were used in this study. The research used descriptive and explanatory research design. The data was collected from the employees of pharmacy department across the public hospitals of AACAHB. Proportionate stratified sampling method along with random sampling techniques was applied to identify respondents proportionately across the hospitals. Both primary and secondary data sources were used to gather data. The study has utilized a statistical tool called SPSS V.26 for doing the analysis. Descriptive statistics were used for summarizing and presenting the results of demographic information of the respondents, and presenting the responses on the independent and dependent variables. In addition to this, inferential statistical tools such as correlation, and logistics regression analysis were utilized for examining the relationship between dependent and independent variables. The study revealed that there is statistically significant and negative relationship between all independent variables (such as performance of ART supplier, health system support, ICT, human resource factor, and inventory management) and dependent variables (i.e., stock out of first line ART drugs) in the public hospitals of AACAHB. The study further concluded that all of the identified independent variables have statistically significant effect on the first line ART drugs stock out in public hospitals of AACAHB. Among the identified independent variables, inventory management has the greatest impact on the stock out of first line ART drugs in the public hospitals followed by health system support, ICT, ART supplier performance, and human resource factors respectively. The study has forwarded recommendations across each independent variables to be carried out by the concerned bodies.

Keywords: *ART, Inventory Management, Supply Chain Management.*

CHAPTER ONE: INTRODUCTION

This chapter presents the background of the study, statement of the problem, objective of the study, research questions, significance of the study, operational definition, delimitations of the study and limitation of the study and organization of the study.

1.1 Background of the Study

Since the inception of the first case reported in 1981, Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) epidemic continues to be a major global public health problems and development challenges (WHO, 2016). Since the start of the epidemic, an estimated 84.2 million people have been infected with HIV, and 40.1 million people have died of HIV/AIDS-related illnesses and around 40% of all people living with HIV/AIDS do not know that they have the virus (UNAIDS, 2022). According to UNAIDS (2022), 38.4 million people globally were living with HIV, 1.5 million people became newly infected with HIV, and 650,000 people died from AIDS-related illness in 2021.

Although there is no curative therapy for HIV/AIDS, the advent of antiretroviral therapy (ART) played a critical role in the clinical management of HIV infected individuals by restoring the immune function, preventing morbidity and mortality, improving quality of life, and preventing the transmission of the virus to other uninfected individuals (Madec *et al*., 2013). The primary goal of ART is to achieve long-term durable suppression of HIV replication, which gives immunologic and clinical benefits, and in turn leads to a reduction in morbidity and mortality and improved quality of life (Ibid). The ART treatment goals are suppression of HIV replication, restoration and preservation of immune function, reduction in HIV-related morbidity and mortality that improves the quality-of-life people living with HIV/AIDS (PLWHA) (WHO, 2016). On the other hand, when first-line antiretroviral treatment failure develops, all benefits of ART are affected (Ibid). As stated by UNAIDS (2022), globally, 28.7 million people were accessing antiretroviral therapy in 2021, up from 7.8 million in 2010. The report also revealed that in 2021, 75% of all people living with HIV were accessing treatment. In Ethiopia, ART service began in August 2003 with payment and free ART was launched in January 2005 (Shimelis *et al*., 2015).

Uninterrupted supply of ART is critical to controlling the HIV. However, stock-outs were reported to be widespread in Sub-Saharan Africa with proportion of months, with ART stock-

outs higher in Africa than other continents. Data from WHO showed that in 1,703 clinics in 35 countries, 35.7% had an ART stock-out over a one-year period (Hwang., *et al*., 2019). The study further revealed that stock-outs of HIV commodities were common especially due to downstream problems in the last part of the chain.

In a context of increasing strain on a fragile health system with limited resources, the risk associated with stock-outs is significant and requires enhanced attention, monitoring and strengthening of the supply chain (Hwang *et al*., 2019). Stock-outs are defined by the WHO as the complete absence of a required medicine for at least one day at a storage or delivery point. Health-care worker coping strategies such as shortening of the refill period, borrowing medicine or referring patients to other facilities increase patient-borne costs and can lead to unplanned treatment interruptions (Ibid). Such unplanned interruptions are associated with an increased risk for opportunistic infections, virologic failure and drug resistance (Mori *et al*., 2014). Patients may also experience a significant financial burden due to additional transport costs and experience an increase in time to access treatment, potentially discouraging patients from optimal adherence (Ibid).

A 2015 study from Kinshasa found that stock-outs of HIV commodities were common especially due to downstream problems in the last part of the chain (Hwang *et al*., 2019). Studies determined different reasons for Stock-outs such as poor communication and coordination among stakeholders, poor inventory management practice, educational level of stock managers, poor practice of use of ICT by stock managers, poor availability of transportation and road infrastructure, unexpected demand changes or fluctuations, limited health budgets, raw material problems, frequently changing regulatory requirements and, supply of short expiry drugs from a supplying warehouse ((Mungu, 2013, & Damtew *et al*., 2019). The causes of drug stock-outs are complicated and rooted in every phase of a drug's life cycle. Hence, this study aimed to examine determinants of stock-out of first line antiretroviral therapy drugs in the case of hospitals of Addis Ababa city administration health bureau, Addis Ababa, Ethiopia.

1.2 Statement of the Problem

Sub-Saharan Africa is the world's severely affected region. It constitutes about two thirds of the total number of people living with HIV/AIDS globally. Ethiopia, Kenya, Malawi, Mozambique, Nigeria, South Africa, Uganda, United Republic of Tanzania, Zambia and Zimbabwe account for 81% of people living with HIV in the region. Nigeria and South Africa account for half of this figure (Damtie *et al*., 2020). The Ethiopian Public Health Institute (EPHI) has estimated that people living with HIV in Ethiopia is 622,326 in 2020 and 617,921 in 2021 (EPHI, 2020). EPHI further estimated that new HIV infections is 11,715 and annual AIDS deaths is 11,546 in 2020; and in 2021, new HIV infections is 10,943 and annual AIDS deaths is 6,988.

Although there is no curative therapy for HIV/AIDS, the advent of antiretroviral therapy (ART) played a critical role in the clinical management of HIV infected individuals. In Ethiopia, ART service began in 2003 with payment and free ART was launched in 2005 (Shimelis *et al*., 2015). The Ethiopian government recognized the need for antiretroviral treatment and established the first antiretroviral (ARV) guidelines in 2003, 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, Pharmaceuticals Fund and Supply Agency (PFSA) is a legal entity established under the law of Federal Democratic Republic of Ethiopian Government to overcome the problems and assure uninterrupted supply of pharmaceuticals to the public in September 2007 (Damtie *et al*., 2020). As per the Ethiopian Food and Drug Authority (EFDA), safe, effective, and affordable medicines of the required and assured quality, in adequate quantity should always be available for the provision of proper healthcare service (Sintayehu *et al*., 2022).

However, previous study in 2016 showed > 80% availability of key medicine for infectious diseases in Ethiopia's public health facilities and recently conducted study on service readiness assessment shows < 50% availability of most essential drugs. According to the research conducted in Addis Ababa, 84.2% of the health centers (HCs) have one or more emergency order in the past six months which indicates supply chain management performance unmet (Berhanemeskel *et al*., 2016 cited in Damtie *et al.,* 2020). Another study conducted in Addis Ababa revealed that, 60.5% of health facilities reported that they usually run out of at least one ART monitoring product before resupply and 37.2% have stock out at the time of visit for at

least one laboratory commodity (Adino *et al*., 2013 cited in Damtie *et al.,* 2020). A study conducted by Berhanemeskel, *et al.* (2016) revealed that the percentages of ART 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 ART drug (Daniel, *et al*., 2012).

Frequent conversations with the warehouses that supply these health facilities reveal that adequate stocks are already available at their warehouses and that the health facilities can easily collect during drug shortages due to the fact that the supply warehouses and the health facilities are both located in the same city and are only a short distance apart. The extent of these stock-outs and the determinants are not well investigated, and evidences, particularly on the determinants, are not documented so far. Despite the fact that these issues are frequently brought up during program implementation review meetings and other gatherings related to the HIV/AIDS program of the Addis Ababa City Administration, they have not yet been adequately supported by evidence. Besides this, as of the knowledge of the researcher, there were no studies done before on determinants of the stock-out of ART drugs in hospitals of AACAHB. Hence, this study aimed to examine the determinants of stock-out of first line antiretroviral therapy (ART) drugs in the case of hospitals of AACAHB.

1.3 Research Questions

The main research is “what are the determinants of stock-out of first line antiretroviral (ART) therapy drugs in the case of hospitals of AACAHB?”. Besides this, the study seeks to address the following sub questions.

1. To what extent does the performance of first line ART supplier affect the stock-out of ART in in public hospitals in Addis Ababa?
2. To what extent does health system support affect the stock-out of first line ART in in public hospitals in Addis Ababa?
3. To what extent does information and communication technology (ICT) use affect the stock-out of first line ART in in public hospitals in Addis Ababa?
4. To what extent does the human resource factor affect the stock-out of first line ART in in public hospitals in Addis Ababa?
5. To what extent does inventory management affect the stock-out of first line ART in in public hospitals in Addis Ababa?

1.4 Objectives of the Study

1.4.1 General Objective

The study aimed to examine the determinants of stock-out of first line antiretroviral (ART) therapy drugs in the case of public hospitals of AACAHB.

1.4.2 Specific Objectives

Despite the aforementioned general objective of the study, the study specifically seeks:

1. To assess the stock level of first line ART drugs in public hospitals in Addis Ababa
2. To analyze the effect of the performance of ART supplier on the stock-out of first line ART in in public hospitals in Addis Ababa
3. To examine the effect of health system support on the stock-out of first line ART in in public hospitals in Addis Ababa
4. To determine the impact of information and communication technology (ICT) use on the stock-out of first line ART in in public hospitals in Addis Ababa
5. To examine the effect of the human resource factor on the stock-out of first line ART in in public hospitals in Addis Ababa
6. To examine the impact of inventory management on the stock-out of first line ART in in public hospitals in Addis Ababa

1.5 Hypotheses

To achieve the above listed objectives, the study attempts to test the following non-directional hypotheses that were developed based on the reviewed literatures and research model or conceptual framework.

Hypotheses

H_{01}: The performance of ART supplier has no significant impact on the stock-out of first line ART in in public hospitals in Addis Ababa

H_{02}: Health system support has no significant effect on the stock-out of first line ART in in public hospitals in Addis Ababa

H_{03}: The use of information and communication technology (ICT) has no significant impact on the stock-out of first line ART in in public hospitals in Addis Ababa

H_{04}: The human resource factor has no significant impact on the stock-out of first line ART in in public hospitals in Addis Ababa

H_{05}: Inventory management has no significant effect on the stock-out of first line ART in in public hospitals in Addis Ababa

1.6 Significance of the Study

The study would have significances for the public hospitals in AACAHB, policy makes, researchers and academia, different stakeholders, and government.

- **For the Hospitals:** the findings and recommendations of the study may help guide the identified public hospitals, in view of identifying the main causes for stock-out of ART drugs, tackling the identified key variables affecting the availability of ART drugs, managing and utilization of ART drugs. The outcomes of this study will help to meet the demand of health facilities and patients in the future, resulting in increased public trust in health systems.
- **For Government & Policy makers:** through identifying underlying causes of determinant of stock-out of first line ART drugs, the study recommends the factors to prioritize and undergo intervention on them to reduce stock-out and plan for future course of action to improve the availability of and strengthen the overall drug supply management system with lessons learned from findings.
- **For the researchers**: the study will make a significant contribution to the body of knowledge related to the drugs supply management and fill the gaps of availability of insufficient studies on the topic in the country. The results of the study may confirm the findings of the previous research efforts or it may end against the previous research findings.
- **For academic purpose**: besides filling availability of insufficient studies on the topic in the country, the study serves as a stepping-stone for other researchers who aspire to make depth study about the issue under the study. Besides, the study will have a significant role in attracting potential researchers to continue conducting studies on the topic with a wider scope and advanced methodology to know the subject matter as well as to identify the existing challenges in the sector. In addition, the study will help as a source document for those who want to make a further study on the area afterward.

1.7 Scope of the Study

This research is delimited geographically, conceptually, and methodologically. The primary focus of this research is to examine the determinants of stock-out of ART drugs in the public hospitals of AACAHB.

Hence, this study is **geographically** delimited to Addis Ababa, Ethiopia. These public hospitals are named as Yekatit 12 Hospital, Menelik II Referral Hospital, Gandi Memorial Hospital, Zewditu Memorial Hospital, Ras Desta Damtew Hospital, and Tirunesh Beijing General Hospital. The results of the study are all about these hospitals answering the research question stated previously and testing the hypotheses listed above. However, since the determining factors of the stock-out of ART drug is situation-specific, this may reduce the generalizability of the findings.

Among the underlying theoretical basis of efficient supply chains used in medical healthcare; this study is **conceptually** delimited to pharmaceutical supply chain management. Pharmaceutical supply chain management involves a number of activities, beginning with the choice of products, registration for use, and estimation of quantity required for the short-term (one to three years) and the medium-term (three years or more); that must be routinely performed in a synchronized fashion. Based on this, five determining factors that affect the stock-out of ART drugs in public hospitals in AACAHB are identified. These are information and communication technology (ICT) use, health system support, performance of the ART suppler, human resource factor, and inventory management.

Methodologically, this study is delimited to a quantitative research approach. The participants are majorly from staffs of pharmacy department. After collecting, cleaning, and entering the data in to the analytical system (SPSS), the data analysis is conducted in descriptive statistics and inferential statistics such as Logistic regression model.

1.8 Limitations of the Study

This study has provided deep insight of the determinants of stock-out of first line antiretroviral (ART) therapy drugs in the case of hospitals of AACAHB and examined the effect of each determinant variables on the stock out of first line ART drugs in public hospitals of AACAHB. However, it has some limitations. Methodologically, only quantitative data has been used in this study. Besides this, the study has only identified limited number of determinant variables and didn't include all components of supply chain management. The study also didn't collect primary data from the suppliers; instead tried to address the issues as perceived by the pharmacists working the hospitals, and only pharmacy departments among the existing departments in the hospitals were targeted. Besides this, the study didn't include major stakeholders in the supply chain of first line ART drugs. This has significantly reduced the scope and applicability of the research. If any researcher wishes to replicate this study, they should be firstly aware of these limitations.

1.9 Operational Definition of Key Terms

Table 1.1: Definition of Key Terms

Key Terms	Definition	Authors
Stock-out	Stock-outs are defined by the WHO as the complete absence of a required medicine for at least one day at a storage or delivery point.	Hwang *et al*., (2019)
Human Immunodeficiency Virus (HIV)	It is a virus that attacks the body's immune system.	WHO (2016)
Acquired immunodeficiency syndrome (AIDS)	It is the late stage of HIV infection that occurs when the body's immune system is badly damaged because of the virus	WHO (2016)
Supply Chain	It is a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. Supply chain activities involve the transformation of natural resources, raw materials, and components into a finished product that is delivered to the end customer.	Lelisa (2017)
Supply Chain Management	Supply chain management encompasses the planning, coordination and collaboration of staffs for all logistics management activities such as quantification, procurement, inventory management, transportation, data collection, and reporting.	USAID (2022)
Antiretroviral therapy	Refers to the use of a combination of three or more ARV drugs for treating HIV infection. ART involves lifelong treatment.	WHO (2016)
Addis Ababa City Administration Health Bureau Hospitals	These are hospitals under 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	

Source: Authors computation

1.10 Organization of the Study

The report is structured in five chapters. The first chapter presents the background of the study, background of the study area, statement of the problem, the research question, and objectives, as well as the scope of the study. The second chapter provides the reader both empirical and theoretical background about the study area. Theoretical Background provides insight into the concepts related to the study area. Empirical Background provides the findings of different studies conducted in related study areas. The third chapter presents the entire research process including its research design, approach, sampling design, & data collection methods. The fourth chapter i.e., Data analysis & Discussion. The last chapter i.e., Summary of Findings, Conclusion & Recommendation, presents the summary of the findings, conclusion, and recommendations as well as limitations and further research direction.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

This chapter reviews literatures relevant to the study. This chapter is structured in four main sections such as theoretical literature review, empirical literature review, research gap, and conceptual framework. The theoretical literature review section presents the concept of ART drugs, fundamentals of pharmaceutical supply chain, and pharmaceutical logistics system in Ethiopia. The empirical literature review section presents the result of different literatures related with the research topic. Under this section literatures and hypotheses are presented. At the end of the chapter, the conceptual framework of the study is presented.

2.1Theoretical Literature Review

2.1.1 Overview of ART Drugs

There's no cure for HIV, but treatment options are much better than they were a few decades ago. Because of medical advancements, people can now live long, active lives with HIV. The medicines that treat HIV are called antiretroviral drugs. The treatment for HIV is called antiretroviral therapy (ART) (WHO, 2016). ART involves taking a combination of HIV medicines (called an HIV treatment regimen) every day. ART is recommended for everyone who has HIV. People with HIV should start taking HIV medicines as soon as possible. ART cannot cure HIV, but HIV medicines help people with HIV live longer, healthier lives. ART also reduces the risk of HIV transmission.

The standard treatment consists of a combination of drugs that suppress HIV replication. The combination of drugs is used in order to increase potency and reduce the likelihood of the virus developing resistance. Each drug fights the virus in the patient's body in a slightly different way. The use of three or more antiretroviral medicines—sometimes referred to as an anti-HIV "cocktail"—is currently the standard treatment for HIV infection and lowers the chances that the virus will become resistant to treatment (USAID, 2011). Antiretroviral therapy (ART) is the combination of several antiretroviral medicines used to slow the rate at which HIV makes copies of itself (multiplies) in the body. A combination of three or more antiretroviral medicines is more effective than using just one medicine (monotherapy) to treat HIV (WHO, 2016).

Antiretroviral medicines that are often used to treat HIV include:

- Nucleoside/nucleotide reverse transcriptase inhibitors, also called nucleoside analogs, such as abacavir, emtricitabine, and tenofovir. These medicines are often combined for best results.
- Non-nucleoside reverse transcriptase inhibitors (NNRTIs), such as efavirenz, etravirine, and nevirapine.
- Protease inhibitors (PIs), such as atazanavir, darunavir, and ritonavir.
- Entry inhibitors, such as enfuvirtide and maraviroc.
- Integrase inhibitors, such as Doltugravir, Raltegravir

Some medicines are available combined together in one pill. This reduces the number of pills to be taken each day. As stated by the Federal Ministry of Health (2017), the lists of ART drugs are presented in table below.

Table 2.1: Lists of ART Drugs in Ethiopia

No.	List of ART drugs
1	TDF/3TC, 300/300mg
2	AZT/3TC, 300/150mg
3	DTG 50mg
4	EFV, 50mg
5	EFV, 200mg
6	EFV, 600mg
7	3TC, 150mg
8	ABC, 300mg
9	ABC/3TC, 120/60mg
10	TDF/3TC/DTG, 300/300/50mg
11	TDF/3TC/EFV, 300/300/400mg
12	AZT/3TC, 60/30mg
13	AZT, 10mg/ml solution

Source: FMoH (2017)

2.1.2 Significance of ART Drugs

As stated by WHO (2016), the ART treatment goals are suppression of HIV replication, restoration and preservation of immune function, reduction in HIV related morbidity and mortality that improves the quality of life of People Living With HIV/AIDS (PLWHA). Virological suppression, clinical recovery and immunological improvement are expected from PLWHA after initiation of ART. ART has dramatically reduced HIV related morbidity and mortality and has transformed HIV infection into a manageable chronic condition. The treatment is also highly effective at reducing sexual transmission of HIV in patients who have adequately suppressed viral loads (USAIDS, 2022).

Global scale-up of antiretroviral therapy has been the primary contributor to a 48% decline in deaths from AIDS-related causes, from a peak of 1.9 million (1.7 million-2.2 million) in 2005 to 1.0 million (830 000-1 2 million) in 2016. At the end of December 2021, 28.7 million people were accessing ART, up from 7.8 million in 2010. In 2021, 75% (66 – 85%) of all people living with HIV were accessing treatment. 76% [67–87%] of adults aged 15 years and older living with HIV had access to treatment, as did 52% [42–65%] of children aged 0–14 years. Besides this, 80% [72–91%] of female adults aged 15 years and older had access to treatment; however, just 70% [61–82%] of male adults aged 15 years and older had access. 81% [63–97%] of pregnant women living with HIV had access to antiretroviral medicines to prevent transmission of HIV to their child in 2021 (USAID, 2022).

2.1.3 The Concept of Stock-Out Events

The Business Dictionary defines stock-out as "a situation in which the demand or requirement for an item cannot be fulfilled from the current inventory" (Adusei & Awunyo-Vitor, 2014). This means, stock-out is a situation in which the current inventory cannot meet the demand for an item. Emmelhainz, *et al*. (1991) simply puts the definition of stock-out as "the situation where the demand for an inventory item outpaces your supply and the need for the item cannot be fulfilled". Further, they also explain a stock-out as the situation when inventory gets depleted and the organization cannot immediately obtain it from its suppliers. One of the characteristics of a stock-out is "an inefficient process of refilling shelves" (Vasconcellos & Sampaio, 2009). According to Vasconcellos and Sampaio (2009), "a stock-out rate is the percentage of all the items commercialized that should be for sale, but are not found on the shelves". For example, "a 10% rate of stockouts as referring to 500 out of 5000 items catalogued and commercialized by a supermarket that would not be available on the shelves for immediate purchase by the final consumer". At a public health facility, stock out refers to the complete absence of a specific medicine formulation and/or dosage (WHO, 2016).

The attributes of the stock-out condition refer to aspects of the stock-out event(s) that can be measured and that can be calculated as stock-out rate (Adusei & Awunyo-Vitor, 2014). There are multiple attributes that describe stock-out events, and thus there are multiple stock-out rates that are calculated and reported.

Each attribute can be expressed as a rate over a given measurement period. Stock-out attributes include:

- **Number of occurrences over time**: "Item Out-of-stock event rate." This is typically measured as the simple number of Out-of-stock events for an item over a given unit of time, for example, "six times per month." This measurement useful when comparing the rate against bench marks or among items in a category (Gruen & Corsten, 2008).
- **Number of simultaneous occurrences**: "Category Out-of-stock event rate." For this measure, the number of items in the category that are Out-of-stock at the time the measurement is taken are summed and expressed as a percentage of the total number of items intended for sale (Gruen & Corsten, 2008). For example, if the category has 50 items intended for sale, and at a given time there are five items that are Out-of-stock, then the Category Out-of-stock event rate is 10 percent. This is the most commonly reported rate because it is easy to calculate when taking a manual audit of the category.
- **Duration**: "Out-of-stock duration rate." Over a given period of measurement, the Out-of-stock duration rate is calculated as the total time that the item is Out-of-stock divided by the total selling time available of the measurement period (Vasconcellos & Sampaio, 2009). For example, if a store is open 24/7, and if during a given week of measurement an item was Out-of-stock for 20hours, then the Out-of-stock duration rate would be 12 percent (20 Out-of-stock hours/168 possible selling hours). It is important to note that the Out-of-stock duration over a given period may (and typically does) consist of multiple Out-of-stock events and duration of each event is summed over the measurement period. The Out-of-stock duration rate measures the lost selling time for the item.
- **Shelf Availability**: "Shelf Availability Rate." This is directly related to the Out-of-stock Duration Rate, which refers to the probability that shoppers will find the item when they enter the store (Gruen & Corsten, 2008). This is calculated as 100 percent - Out-of-stock Duration Rate. Thus, for the previous example, the shelf availability rate for the item would be 88 percent, meaning that the item was available for sale during 88 percent of the time the store was open.

2.1.4 Effects of Stock-Outs of ART Drugs

Stock-outs are defined by the WHO as the complete absence of a required medicine for at least one day at a storage or delivery point (WHO, 2016). A stock-out of any ARV routinely used, is an early warning indicator for the development of ART resistance (Ibid). Patients were retrospectively considered to be affected by a drug stock-out if: (i) it led to ART regimen

modification, defined as at least one drug substitution, or an discontinuation of at least one month (i.e., = prolonged discontinuation); (ii) the medical record stated that the ART modification or discontinuation had occurred due to a drug stock-out; and (iii) the ART modification or prolonged discontinuation occurred when there was a shortage of one of the patient's drugs, as reported by the study center pharmacy (Pasquet *et al*., 2010).

As stated in the previous section, the primary goal of ART is to achieve long-term durable suppression of HIV replication, which gives immunologic and clinical benefits, and in turn leads to a reduction in morbidity and mortality and improved quality of life. Unable to suppress HIV viral replication results in treatment failure and development of antiretroviral (ARV) drug resistance (WHO, 2016). On the other hand, when first-line antiretroviral treatment failure develops, all benefits of ART are affected. Unplanned interruptions of ART are associated with an increased risk for opportunistic infections, virologic failure and drug resistance (Mori *et al*., 2014). Patients may also experience a significant financial burden due to additional transport costs and experience an increase in time to access treatment, potentially discouraging patients from optimal adherence. In addition, ARV stock-outs have a negative impact on retention in care and patient survival (Ibid). A study in South Africa concluded that patients who claimed less than 80% of their prescription refills were three times more likely to die than those who claimed 80% or more (Hwang et al., 2019). Clinics with more stock-outs also had worse on-time appointment keeping, on time pill pick-up and retention in care (Ibid). In an analysis of the determinants of adherence to ART among HIV-infected patients in Coˆte d'Ivoire, Diabate´ et al. reported that 10% of interruptions were related to drug stock-outs (Diabate *et al*., 2007).

2.1.5 Factors Affecting Medicine Stock-Out

Stock outs are influenced by a variety of factors known as causes for stock outs, which are divided into two categories: downstream supply chain practices and upstream supply chain practices. Stock outs are thought to be caused by problems in downstream procedures such as listing, store ordering, inventory management, placement, and replenishment, as well as upstream supply chain practices such as warehouse operations, forecasting mistakes, communication issues, and transportation delays (Ehrenthal & Hofstetter, 2014).

The causes of stock out, according to Gruen and Corsten (2008), are process-based, and there are three in general: ordering, replenishing, and planning. Ordering practices may result in stock outs if the order is too small, placed too recently, or forecasted incorrectly; replenishment

practices may result in stock outs due to insufficient shelf space, a lack of adequate signal to retail management, or a poor back-room inventory handling procedure; and replenishment issues may arise at the upstream level of the store when warehouse inventory fails to meet retailer orders. When there is a misalignment between shelf capacity and replenishment frequencies, as well as when purchase frequencies are not carefully considered, planning methods may result in stock outs (Gruen & Corsten, 2008).

Stock out causes can also be divided into two categories: pre-store and in-store. The pre-store causes are linked to direct suppliers or the retailer's distribution center, and they arise as a result of fulfillment or delivery issues such as general planning, communication, and unreliable transportation. Listing issues, physical shipment issues, incoming goods cover shortfalls, store inventory problems, and replenishment issues are all in-store causes for stock outs. Data inaccuracy, forecast and ordering inaccuracy, infrequent replenishment, limited shelf capacity, a poorly maintained perpetual inventory system, and inefficient product transfer from backroom to store shelves are all identified to be in-store practices that cause stock out (Ehrenthal & Hofstetter, 2014).

As stated by Mekonen (2017), failure to deliver products on time and in the requested quantity, poor selection, quantification, and procurement practices, unreliable data and late submission of reports and requests from health facilities, poor information exchange, and a poor fleet management system at the distribution point are all factors that contribute to stock outs of medicine.

Multiple factors associated with stock-outs of essential medicines at the facility level have been cited, including manufacturing shortages, errors in ordering or requesting products, difficulties in transport, sudden increases in demand, inadequate funding and staffing, and lack of incentives to maintain stocks (Penfold *et al*. 2013).

2.1.6 Fundamentals of Pharmaceutical Supply Chain

2.1.6.1 Overview of Supply Chain

Formally, a supply chain is an integrated process wherein raw materials are manufactured into final products, then delivered to customers (via distribution, retail, or both) (Benita, 1999). A typical supply chain is depicted in Figure 2.1.

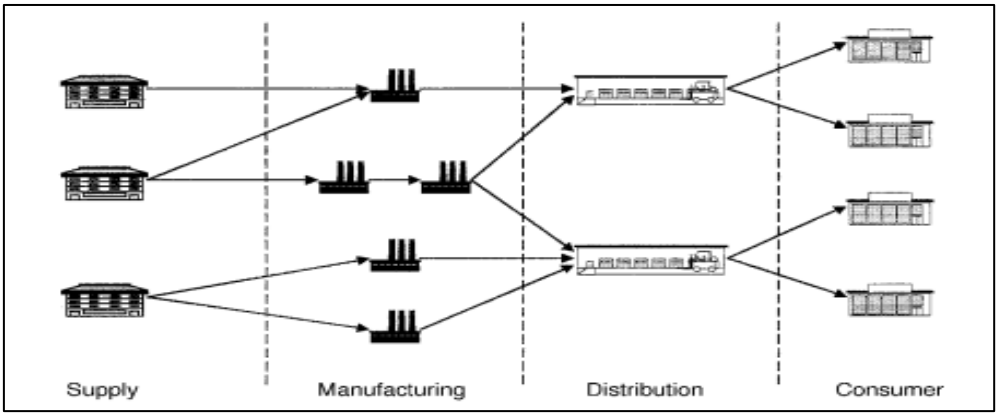

Figure 2.1: Supply Chain Process
Source: Benita (1999).

The supply chain depicted in Figure 2.1 contains four echelons (supply, manufacturing, distribution, and consumers), where each level (or echelon) of the chain may comprise numerous facilities. Thus, the complexity of the supply chain arises from the number of echelons in the chain and the number of facilities in each echelon. Given the inherent complexity of the typical supply chain, selecting appropriate performance measures for supply chain analysis is particularly critical, since the system of interest is generally large and complex. The objective of every supply chain should be to maximize the overall value generated. The value a supply chain generates is the difference between what the final product is worth to the customer and the costs the supply chain incurs in filling the customer's request (Bialas, 2014).

2.1.6.2 Overview of Supply Chain Management

The term “Supply Chain Management” (SCM) was introduced in 1982, and according to the Council of Supply Chain Management Professionals, it is described as an integrating function with primary responsibility for linking major business functions and business processes, within and across companies, into a cohesive and high-performing business model. It includes the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities as well as manufacturing operations and it drives

coordination of processes and activities with and across marketing, sales, product design, and finance and information technology.

SCM also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers (Bialas, 2014). Supply chains (SCs) are involved in the entire product life cycle, from material procurement to manufacturing to distribution, customer service and eventually the recycling and disposal of the product (Ibid). As stated by Rossetti, et al. (2011), supply chain management is defined as the amalgamation of key business processes across the supply chain for the rationale of generating value for customers and stakeholders. Indeed, supply chain management integrates supply and demand within and across companies in an efficient business model (Rossetti, *et al*., 2011). Hence, successful supply chain management requires many decisions relating to the flow of information, product, and funds (Sunil, 2007).

2.1.6.3 Pharmaceutical Supply Chain Management

The pharmaceutical supply chain is an important element of a health system that involves manufacturers, suppliers, third-party service providers, middlemen, patients, activities such as logistics and includes aspects like information systems and finance (Rossetti, *et al*., 2022), all with the aim of delivering medicines and medical products in the right quantity and right quality, at the right time and at the right cost to a customer (USAID, 2011), so as to add value to all stakeholders. The pharmaceutical supply chain process includes purchasing, transporting, storing, and then delivering medications to both in-patients and out-patients (Croxton *et al*., 2001). As stated by Hokey (2014), the process used to manufacture and deliver prescription medications to patients is known as the pharmaceutical supply chain. However, the network's supply chain is actually highly intricate, necessitating a lot of actions to guarantee that patients have access to and may obtain pharmaceuticals. The key stakeholders in this supply chain include multiple government agencies, hospitals, clinics, drug manufacturers, drug distributors, pharmacy chains, retailers, research organizations, and regulatory bodies (Rossetti, *et al*., 2011).

A pharmaceutical manufacturer supplies a quantity of its products that is ideally equal to the demand for its products from consumers/patients. These manufacturers then manage the actual distribution of drugs from facilities to drug wholesalers or directly to retail pharmacy chains, mail-order and specialty pharmacies, hospital chains, and some health plans (Chaar, 2014). Next in the network are wholesale distributors who purchase pharmaceutical products from

manufacturers and distribute them to a variety of customers, including pharmacies. Pharmacies are the final step before drugs reach the patient, and arguably the most vital step because they serve as the information link between pharmacy benefit managers, drug manufacturers, and wholesale distributors. Pharmacies purchase drugs from wholesalers or directly from manufacturers. After purchasing products, pharmacies must maintain an ample stock of drug products and provide information to consumers about the safe and effective use of prescription drugs (Ibid).

2.1.6.4 The Logistics Management Information System (LMIS)

According to Rushton, Croucher, & Baker (2014; as cited Daniel, *et al*., 2012), LMIS refers to system of records and reports, either paper-based or electronic, which are used to aggregate, analyze, validate, and display logistics data. The primary goal of Logistics Management Information System is to ensure availability of quality health commodities at health facilities and community at large. There are various types of Information Management Systems used by different organizations across the world.

Christiansen (2015) explains that the main types of Information Management Systems are Management Information System (MIS), Executive Information System (EIS), Decision Support Systems (DSS) and Enterprise Systems. Other Information Management System include office automation system, communication system and transaction processing system. Health care organizations are required to use standardized ways of exchanging logistic information with other systems and with specific authorizations hence the need for use of the Logistic Management Information Systems, which mostly depends on external information and standards to comply with medical regulations.

2.1.7 Supply Chain Management of ART Drugs in Ethiopia

The Ethiopian pharmaceutical Fund and Supply Agency (PFSA) was founded in 2007 by Proclamation No. 553/2007 with the goal of considerably enhancing the public's access to high-quality pharmaceuticals at a reasonable price. The Agency is responsible for ensuring that all public health facilities have access to inexpensive, high-quality medications and that they are used appropriately. Since its inception in 2010, the integrated pharmaceuticals logistics systems (IPLS) have been created and implemented with the goal of efficiently and effectively carrying out its mandate in the pharmaceuticals supply chain (PFSA, 2017). The IPLS is the primary mechanism through which all public health facilities in Ethiopia get critical and crucial

medications, including those utilized by HIV/AIDS, Malaria, TB and Leprosy, EPI, family health programs, and purchased necessary drugs. The IPLS is responsible for supplying and managing products on the National Pharmaceuticals Procurement List (NPPL) (PFSA, 2017).

ART and VCT services in Ethiopia have been available for almost a decade. In 2002 and 2003, VCT and ART services were first offered at Zewditu Memorial Hospital. After then, ART services were established at the St. Peter (2004) and Alert (2005) hospitals. Since then, all governmental hospitals and health centers, as well as certain private hospitals and NGO-run institutions, have begun to offer VCT, ART, and PMTCT services, either together or independently (Berhanemeskel *et al*., 2016).

Ethiopia's government launched a multi-sectoral program that was overseen by the National and Regional HIV/AIDS Council Secretariats. The National Guidelines on ARV were developed in 2003 by the Ministry of Health (MOH), the Drug Administration and Control Authority (DACA), the current Food Medicine and Health Care Administration and Control Office (FMHACA), and the HIV/AIDS Prevention and Control Office (HAPCO), and began providing ART training to teams of healthcare providers in 2004 (MOH, 2005).

In Ethiopia, the supply chain management of HIV/AIDS-related commodities is vertical, dominated by partners with limited government ownership. Most centralized procurement, distribution, and LMIS activities were controlled by a large number of partners other than the government in the majority of situations (Berhanemeskel *et al*., 2016). PFSA has 11 hubs around the country, with seven more under construction in various parts of the country (PFSA, 2017).

2.2Empirical Literature Review

Stock-outs are reported to be widespread in sub-Saharan Africa, with proportion of months with ART stock-outs higher in Africa than other continents. Data from WHO show that in 1,703 clinics in 35 countries, 35.7% had an ART stock-out over a one-year period between 2005 and 2014 (WHO, 2016). A study conducted in South Africa also revealed that stock-outs have been reported throughout the years and the National Department of Health (NDoH) has identified medicine stock-outs in general and ARTs drugs in particular as a major health systems concern (Hwang et al., 2019). A study from Kinshasa also found that stock-outs of HIV commodities (ART drugs) were common and the study found that over half of ART stock-out cases resulted in patients leaving the facility without ART (Gils, *et al*., 2018). A study

conducted in Ethiopia by Berhanemeskel *et al*. (2016) also revealed that 73.7% of the hospitals under the study had a stock-out of one or more ARV medicines (such as ART drugs) on the day of visit. Their study also found that 84.2% of the health centers (HCs) in Addis Ababa have one or more emergency order whereas all hospitals have emergency order of ARV drugs (including ART drugs) more than three times in the past six months which indicates supply chain management performance unmet (Ibid). Another study conducted in Addis Ababa by Adino, *et al*. (2013) also revealed that, 60.5% of HFs reported that they usually run out of at least one ART monitoring product before resupply and 37.2% have stock out at the time of visit for at least one laboratory commodity.

The aforementioned studies and other literatures have found in their studies that there are different contributing factors that affect the stock-outs of ART drugs. The findings of different researches are presented along with supporting the identified hypotheses in this study.

2.2.1 ART Drugs Supplier Performance and Stock-Outs of ART drugs

According to a study by De Palencia *et al*. (2016) on the factors that contribute to the stock-out of medicine in general and ART drug shortages in particular in small automated dispensing systems, drug supplier performance or supply shortage is a major factor in stock-out of medicines. The study went on to detail how the performance of drug suppliers affected drug stock-outs, including when they encountered a supply deficit and when they were unable to fulfill a customer requested order. A similar study in Lesotho conducted by Harries, *et al*. (2007) found that poor performance of suppliers has a significant role for the stock-out of ART drugs. They specified the main contributing factors are the delivery and transport system of the supplier. A study conducted in South Africa by Hwang *et al*. (2019) also revealed that supplier performance affects the stock-out of ART drugs. They justified that supply crises due to international shortages affects the shortage of the drugs. Interruption of supplies by the concerned suppliers have affected the stock-outs of ART drugs in Addis Ababa (Adino, *et al*., 2013). A study conducted by Damtie, *et al*. (2020) also revealed that the main contributing factors for the stock-outs of ART drugs in SNNPR health facilities is the poor performance of drug suppliers, specifically the long lead time of ordered items. Based on the empirical evidence, it can be hypothesized that:

H01: The performance of ART supplier has no significant impact on the stock-out of first line ART in in public hospitals in Addis Ababa

2.2.2 Health System Support (Organizational Support) and Stock-Outs of ART drugs

A study identified health system support or organizational support as a determinant factor for the stock-outs of ART drugs in hospitals under the AACAHB. Health system supports are described as a supportive supervision to the pharmacy department from the organization (i.e., top level management), the delivery of reliable logistics data to the supplier (i.e., PFSA), and the submission of appropriate report and request form (RRF) to the supplier (i.e., PFSA). Regarding with this, different researches support this. A study conducted in Kinshasa by Gils, *et al.* (2018) revealed that stock-outs of HIV commodities are common especially due to the downstream problems in the last part of the chain. Their study also indicates that insufficient support, inappropriate request order, and predication mistakes along with insufficient health system support played a significant role. A study in Lesotho by Harries, *et al*. (2007) founds that insufficient health system support has a significant impact on the stock-out of ART drugs. They elaborated that a lack of supervisory visits led to erratic stock levels. Hwang *et al.* (2019) also supported that organizational support and periodical monitoring the health system has a significant impact on the availability of ART drugs. They further recommended that end-user monitoring of the supply chain by patients and civil society has the potential to increase transparency and complement public sector monitoring systems. Based on the empirical evidence, it can be hypothesized that:

H_{02}: Health system support has no significant effect on the stock-out of first line ART in in public hospitals in Addis Ababa

2.2.3 Information and Communication Technology (ICT) and Stock-Outs of ART drugs

A study has identified ICT as a determinant factor for the stock-outs of ART drugs in hospitals found in AACAHB. Electronic logistics management system (LMIS) and technology-based communication (such as communication via social media group and the use of SMS messages) within the hospitals are the attributes of this variable. A study in Lesotho by Harries, *et al*. (2007) founds that in information technology system has a significant impact on the stock-out of ART drugs. They elaborated that stock management information systems may lead to identification of root causes and solutions (Harries, *et al.,* 2007). Mabirizi *et al*. (2014) found that health information systems have a significant impact on the availability and stock-outs of medicines in general and ART drugs in particular. They stated that although, it has been over a decade since ART became accessible in resource-limited countries, most health information

systems are still lagging, making it difficult to produce useful forecasts and this affected the stock-outs of ART drugs. The study conducted by Damtie, *et al*. (2020) on SNNP concluded that, the main contributing factors for the stock-outs of ART drugs were related with information system i.e., improper use of health center management information system (HCMIS). A study conducted by De Palencia *et al*. (2016) on the causes of stock-out of ART drugs in small automated dispensing system revealed that, ICT usage has a significant impact. They elaborated that inadequate maintenance of the database i.e., formulary and/or stock of drugs not being correctly updated in the database has an impact for stock-out. Based on the empirical evidence, it can be hypothesized that:

H03: The use of information and communication technology (ICT) has no significant impact on the stock-out of first line ART in in public hospitals in Addis Ababa

2.2.4 Human Resource and Stock-Outs of ART drugs

A study has identified human resource as a determinant factor for the stock-outs of ART drugs in hospitals found in AACAHB. Availability of appropriate trainings to the staff, availability of adequately qualified staff, ability of staffs in making timely requests and medicines orders, skill of record keeping and planning. And ability of anticipating the demand of ART drugs are the attributes of human resource. A study of 20 health centers in Ethiopia revealed that the contributing factors for the stock-outs of ART drugs are related with the human resources of health facilities such as inappropriate patient data collection and limited supply planning capacity of the staffs (Berhanemeskel, *et al*., 2016). A study in Lesotho by Harries, *et al*. (2007) founds that human resource factors have a significant impact on the stock-out of ART drugs. They elaborated that human resource capacity affects the stock-outs of the health facilities. The study conducted by Damtie, *et al*. (2020) on SNNP concluded that, the main contributing factors were related with human resources such as job dissatisfaction of the staffs. Based on the empirical evidence, it can be hypothesized that:

H04: The human resource factor has no significant impact on the stock-out of first line ART in in public hospitals in Addis Ababa

2.2.5 Inventory Management and Stock-Outs of ART drugs

A study has identified inventory management as a determinant factor for the stock-outs of ART drugs in hospitals found in AACAHB. Arrangement of ART drugs on the shelves with arrows pointing up and with identification labels, store management, conducting periodical inventory, availability and utilization of rules, procedures, and guidelines are the attributes. A study of 20

health centers in Ethiopia revealed that the contributing factors for the stock-outs of ART drugs are related inventory management i.e., inaccurate use of the stock management software (Berhanemeskel, *et al.*, 2016). A study in Lesotho by Harries, *et al*. (2007) founds that in appropriate inventory management system has a significant impact on the stock-out of ART drugs. They elaborated that storage space and buffer stocks may lead to identification of root causes and solutions (Harries, *et al*., 2007). Gurmu and Ibrahim (2017) concluded that stock control and record-keeping have a significant role in the stock-outs of ART drugs in East Sshewa zones in Ethiopia. According to their study conducted in East Shewa zone, average updating practice and inventory accuracy are 59.5% and 28.5% respectively; and this affects the availability of drugs (Gurmu & Ibrahim, 2017). A study conducted by Tilahun *et al.* (2016) and Shewarega, *et al.* (2015) revealed that poor inventory system such as regular updating of bin cards and filling appropriate quantity order played a significant impact on the stock-outs of ART drugs. Almost similar findings in Addis Ababa shows that only 61.5% of health facilities (HFs) update their bin cards regularly (Tilahun *et al*., 2016). Ethiopia national survey also revealed that the percentage of facilities filled with the quantities ordered are about 60% with correct product 37% at both the hospitals and HCs level (Shewarega, et al., 2015). The study conducted by Damtie, *et al.* (2020) on SNNP concluded that, the main contributing factors for the stock-outs of ART drugs were related with inventory management of the health facilities such as order fill rate and refill of near expiry. A study conducted by De Palencia *et al*. (2016) on the causes of stock-out of ART drugs in small automated dispensing system revealed that, inventory management has a great impact on the stock-outs of ART drugs. They explained further that insufficient stock and inadequate pharmacy management such as when an order was not sent to the supplier, or the order was sent to late to avoid the stock-out; pharmaceutical dosage forms which require packaging delayed the distribution process, and other such as expired drugs, broken containers, inventory discrepancies, etc. are identified as the main causes for stock-out.

Based on the empirical evidence, it can be hypothesized that:

H_{05}: Inventory management has no significant effect on the stock-out of first line ART in in public hospitals in Addis Ababa

2.3Conceptual Model

As stated by Creswell (2009), the conceptual framework provides the study of a structure that represents the systematic approach of researching and finding out fundamental relationships between variables. Besides this, it shows the crucial process, which is useful to show the direction of the study. The conceptual framework is represented in the diagram below which shows the relationship between the study variables. It is developed from the above literature review and empirical findings. The independent variables are performance of ART drugs supplier, health system support, human resource, ICT use, and inventory management. When manipulated through interventions, the independent variables will have an effect on the dependent variable (stock-outs of ART drugs).

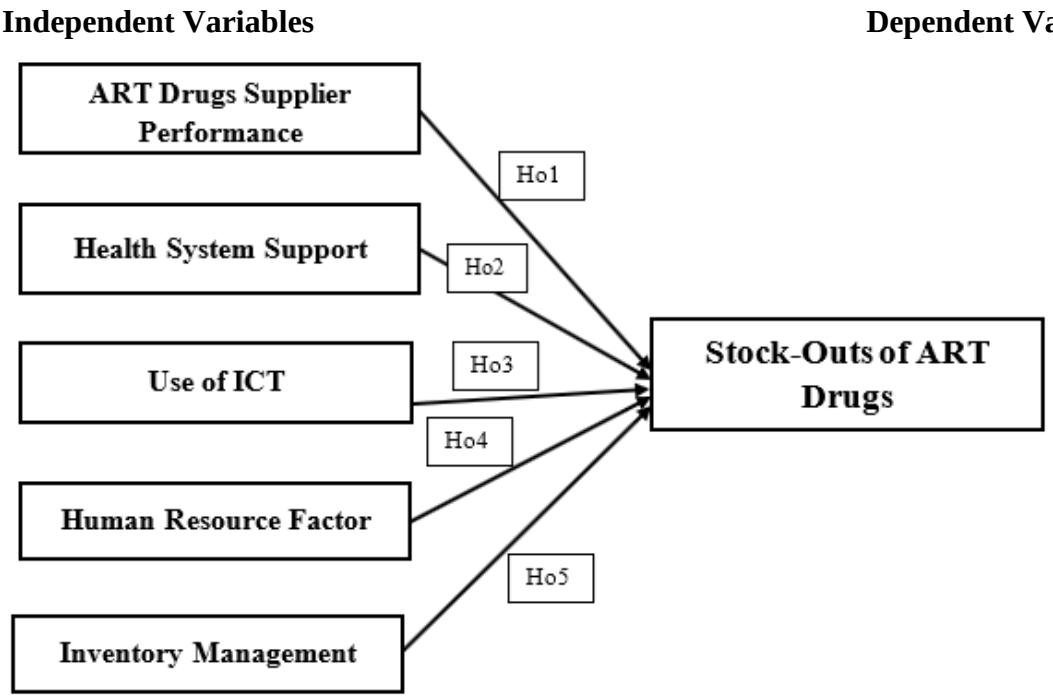

Figure 2.2: Conceptual Framework
Source: Own Computation (2022)

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter explains the methodology used for conducting the research as well as the practical approaches that were used to address the study's objectives. This covers the research approach and design, sampling design, tool and process for collecting data along with the validation of the measuring tool, and analytic method are included in this section.

3.1 Research Approach

Among the three research approaches (Jonker & Pennink, 2010) i.e., qualitative research, quantitative research, and mixed research approach. This research followed quantitative research approach. Quantitative research seeks to quantify the collected data for analyzing and finding a final course of the action. The reason for quantitative approach is that the research questions deal with issues that require both deep understanding as well as facts on the study population. Besides this, a quantitative approach is one in which the investigator primarily uses post positivist claim for developing knowledge, reduction of specific variables, and question (Cresswell, 2003).

3.2 Research Design

Based on the purposes they serve, Robson (2002) has categorized research design into three types: explorative, descriptive, and explanative. To achieve the identified objectives and address the research questions, the researcher used both descriptive and explanatory research designs. The study used descriptive design in order to have a clear view of the problem from other related sources, ascertain, and describe the identified variables and narrow the research around important issues related to the study. The study also employed explanatory research design to realize the associations of variables in terms of cause and result relationship. In another word, in order to examine the causal relationship between the independent variables and the dependent variable.

For collecting primary data, the study followed a cross-sectional data collection design. A cross-sectional study is a type of research design in which the researcher collect data from many different individuals at a single point in time (Cresswell, 2003). In cross-sectional research, the researcher observes variables without influencing them.

3.3 Sources of Data and Data Collection Techniques

3.3.1 Data Type and Source

Both primary and secondary sources were used in the research. Structured questionnaires were used to acquire the primary data from the identified hospitals of AACAHB especially from pharmacy department. Different documents from recent year's records, the internet, articles, periodicals, research papers, and various reference books that state about the study topic were used as secondary sources of data. Secondary data aided the researcher in better understanding the problem and provided a comparison point for the data gathered by the researcher. The researcher used secondary data source to investigate an alternative viewpoint on the study's research topics. Malhotra and Peterson (2005) states that the assessment of accessible secondary data is a requirement for the collecting of primary data.

3.3.2 Data Collecting Instruments

For collecting the primary data, the researcher used a pre-tested structured questionnaire as the main instrument for data gathering from the public hospitals of AACAHB. Structured questionnaire is a document that consists of a set of standardized questions with a fixed scheme, which specifies the exact wording and order of the questions, for gathering information from respondents (Cooper & Schindler, 2008). The questionnaire used in this research is adopted from the previous studies and the researcher modified the questionnaire in order to relate it with the general & specific objectives of the research.

The questionnaire is composed of five parts to accomplish the aim of the research. The first section is about the demography of the respondents, the second section is about factors affecting the stock-out of ART drugs, and the third section of the questionnaire is about the stock-out status of ART drugs. A total of forty-four (44) question was prepared. Each item of the 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. Table 3.1 indicates the structure of the questionnaire as below;

Table 3.1: Questionnaire Structure of the Study

S.No.	Sections	Questions	No. of Questions
1	**Demographic Information**	**Question No. 1 – 5**	**5**
2	**Factors Affecting Stock-out of ART Drugs**	**Question No. 6 – 30**	**25**
2.1	*ART Drugs Supplier Performance*	*Question No. 6 – 11*	*6*
2.2	*Inventory Management*	*Question No. 12 – 17*	*6*
2.3	*Human Resource Factors*	*Question No. 18 – 23*	*6*
2.4	*Health System Support*	*Question No. 24 – 26*	*3*
2.5	*ICT use*	*Question No. 27 – 30*	*4*
3	**Stock-out Status of ART Drugs**	**Question No. 31 – 44**	**14**
	Total Questions		**44**

The questionnaire was prepared by English language as indicated in appendix B herewith this document. Regarding the collection of secondary data, the researcher referred the aforementioned secondary sources.

3.3.3 Data Collection Procedure

For collecting the primary data from the targeted group across the target population, the researcher utilized a cross-sectional survey 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. A structured questionnaire was utilized to collect data in the survey approach. Secondary data was gathered by looking at the written materials from the aforementioned sources. The researcher has acknowledged the HR of each hospital and received their permission to distribute the questionnaire, collect the filled questionnaire, and fill the check-list of ART drugs in the dispensary bin card. The researcher has distributed and collected the questionnaire to the identified respondents in person and via different electronic platforms such as telegram and email.

3.4 Sampling Design

Kothari (2004) has defined a sample design as a plan for obtaining a sample from a given population. In this section the population, target population, sampling frame, sample size, and the sampling techniques are described as follow.

3.4.1 Population of the Study

According to Kothari (2004), the aggregation of elements from which the sample is actually selected is called population. The total population of this study is those public hospitals governed under 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.

3.4.2 Target Population

Target population as stated by Hair *et al.* (2010) is a specified group of people or object for which questions can be asked to develop required data structures and information. Since target population constitutes the totality of units about which the research intends to study, the population for this study comprises all staffs of pharmacy department who directly involved in predicting, ordering, receiving, and dispensing of ART drugs in the identified public hospitals of AACAHB such as pharmacy administration, senior pharmacist, pharmacist, clinical pharmacy, and druggist as indicated in the hierarchy of the department. As per the data collected from the HR of the hospitals, there are 263 staffs of pharmacy department across the identified hospitals. The number of pharmacy staffs across each hospital is presented in table 3.2 below.

Table 3.2: List of Population across Public Hospitals of AACAHB

S.N	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: Human Resource Department of Public Hospitals of AACAHB (as of Nov 2022)

3.4.3 Sample Size

Use of a sample enables a researcher to save time and money hence get more detained information for its respondents (Tustin, *et al.*, 2005). Though the total number of target population of the study was 263, due to time and resource constraints, since it is difficult to study all the population of the study (i.e., all employees of the hospitals). Hence, the researcher determined the appropriate sample size by using a formula of Kothari (2004) which is used by most researchers. This calculation is based on a desired level of precision of 5% and a desired level of confidence of 95%. The following is a description of the formula.

$n=N/[1+N(e^2)]$ Where; n = Sample size, N = Population size i.e.,263, e = Level of precision or acceptable sampling error (0.05). Therefore, **Sample size (n) =263/ $[1+263(0.05)^2]$, n=159**

Based on the above formula, a sample of 159 were targeted from the population.

3.4.4 Sampling Techniques

This study followed different types of sampling techniques at different stages. First the proportionate stratified sampling was followed to know the sample size across each public hospital of AACAHB. Based on their common characteristics in the population, the population was stratified into six stratums i.e., the total number of public hospitals of AACAHB. The targeted sample size across each public hospital is presented in table 3.3 below.

Table 3.3: Proportionate Stratified Sample Distribution

S.N	Stratum by Occupation	Staff Size (N)	Sampling Fraction (I) = M(Ni/P)	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	**263**		**159**

Source: Own Computation (2022)

In order to identify the respondents across the pharmacy departments of the public hospitals of AACAHB based on the sample size of each stratum, the researcher followed the other sampling technique called simple random sampling method. As stated by Kothari (2004), a simple random sample is one of the probability sampling methods and it is a randomly selected subset of a population. In this sampling method, each member of the population has an exactly equal chance of being selected.

3.5 Test of Data Collecting Tools

3.5.1 Validity

As stated by Kothari (2004), validity is the degree to which the results are truthful. So that it requires research instrument (questionnaire) to correctly measure the concepts under the study. Validity can also be thought of as utility. In other words, validity is the extent to which differences found with a measuring instrument reflect true differences among those being tested (Cooper & Schindler, 2008). As stated above, the researcher utilized a pre-tested structured questionnaire adopted from previous studies to collect the primary data. Therefore, to assure validity of the instrument the researcher has given a chance for professionals on the area to review the questionnaire and it was finally validated by the advisor.

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. As per the result of the correlation analysis, the independent variables can be considered as a good measure of determinants of ART stock-out.

3.5.2 Reliability

The reliability refers to a measurement that supplies consistent results with equal values (Blumberg *et al*., 2005). According to Kothari (2004), reliability measures consistency, precision, repeatability, and trustworthiness of a research and it indicates the extent to which it is without bias (error free), and hence insures consistent measurement cross time and across the various items in the instruments (the observed scores). One of the most used indicators of internal consistency is Cronbach's alpha coefficient (denoted as α).

Based on the following rule of thumb of (Almaquist *et al.,* 2016), if "α > 0.95 – 'Excellent', α 0.8 – 0.95 – 'Very good', α = 0.7 – 0.8 – 'Acceptable', α >0.6 – 'Questionable', α >0.5 – 'Poor', and α <5 – 'Unacceptable'. Hence, for conducting the analysis, the Cronbach's alpha coefficient has to be greater than 0.7. In order to check the consistency of the data collection tool, the researcher has computed a reliability test by using Cronbach's alpha statistics and presented as below.

Table 3.4: Reliability Test

Variables	Cronbach's Alpha	N of Items
Overall Reliability	**.835**	**39**

Source: Own Computation (2022)

As indicated in table 3.4 above, the Cronbach's Alpha test is computed as 0.835 which implies that reliability test of the study is located on "Very good" range. This means that there is a very good internal consistency and reliability in the questionnaire. Therefore, the level of alpha was reliable enough to proceed with the data analysis. Thereby, this constituted a basis for making valid conclusions through the reliable data in this research.

3.6 Data Analysis Techniques

Data was gathered primarily by means of structured questionnaires. Data collected was cleaned and entered into SPSS version 26 for further analysis. It was encrypted, tabled and evaluated from the properly ordered questionnaires. The proper statistical tools were aligned with the objectives of the research. The descriptive statistics of research variables and inferential statistics were used to evaluate the relationship between dependent and independent variable. The descriptive statistics included mean and standard deviation and inferential statistics such as logistics regression. A logistic regression model was used to test the hypotheses. Logistic regression describes the relationship between a dichotomous response variable and a set of explanatory variables. Assumptions were checked before regression analysis.

3.7 Model Specification

Logistic regression model is a statistical technique for predicting the probability of an event, given a set of predictor variables (Kothari, 2004). The dependent variable of this study is a dichotomous variable and hence binary logistic regression model is preferred. As indicated by Kothari (2004), the binary logistic regression procedure empowers one to select the predictive model for dichotomous dependent variables.

It is necessary to ensure that the data set is of sufficient size before performing regression analysis. When investigating the associations between variables, Tabachnick and Fiddell (2013) proposed that $N \geq 50+8m$ is necessary, where "m" is equal to the number of predictors. The minimum sample size for this study, using this method, would be 90 respondents (the number of predictors (m) specified in the conceptual framework is five i.e., supplier performance, inventory management, human resource, health system support, and information and communication technology). However, 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 model states the logistic regression equation thus:

$$SOT = \log\left(\frac{p(y=1)}{1-(p=1)}\right) = \beta 0 + \beta 1SP + \beta 2IM + \beta 3HR + \beta 4HS + \beta 5ICT + \varepsilon$$

Where: SOT is Stock out of ART drugs, β_0 is the intercept, $\beta_1 - \beta_5$ are model parameters and; SP, IM, HR, HS, and ICT are independent variables denoted to supplier performance, inventory management, human resource, health system support, and information and communication technology respectively.

The logit (of the number p), p/1 – p, is the outcome being modelled. Therefore, the logit function provides the logarithm of the odds, or log-odds, when the functions variable represents p, which is the probability (Almaquist *et al*., 2016).

3.8 Description of Study Variables

As indicated in the conceptual framework, majorly two kinds of variables were used in this study: independent and dependent variables. The independent variables are ART drugs supplier performance, inventory management, human resource factors affecting ART drugs stockout, health system support (management support), and information and communication technology (ICT) use. The dependent variable is stockout status of ART drugs at public hospitals of AACAHB.

3.9 Ethical Consideration

Throughout the research procedure, the researcher addressed ethical concerns about confidentiality and privacy. The respondents were provided a written guarantee that their names would not be exposed in the questionnaire or the research report. Before the survey, the participants were given a verbal and written description of the study, as well as informed consent. They were promised that their replies would be kept anonymous and only utilized for the purpose of this study if they agreed to participate in the study.

CHAPTER FOUR: RESULTS AND DISCUSSION

This chapter presents the analysis, interpretation of responses from questionnaires, and the findings of the study and discussion on the findings. The chapter is organized into three sections. The first part focuses on the response rate and the background information of the respondents. The second section states about the mean rank of the determinants as per the respondent's perception. The third section states about the results of correlation and logistics regression analysis along with the results of hypotheses tests. To analyze the collected data in line with the overall objective of the research undertaking, statistical procedures were carried out using SPSS version 26.

4.1 Response Rate and Demographic Information

4.1.1 Response Rate

The target population of the study was staffs of the pharmacy department in the public hospitals of AACAHB, Addis Ababa, Ethiopia. Self-administered questionnaires, which are simple and easy to understand, were designed to collect data from the target population. The questionnaires contained close-ended questions with a five-point Likert scale on which the respondents were asked to tick the boxes that apply to them. The researcher issued a total of 159 questionnaires in person and internet-based platforms such as email and telegram to the identified respondents and only 127 were filled and returned giving a response rate of 80% as indicated in table 4.1 below.

Table 4.1: Response Rate of the Respondents

No.	Description	Respondents
1	Total target population	159
3	Questionnaire distributed	159
4	Questionnaire returned	127
5	Response rate (%)	80%
6	Usable response	127

Source: - Computed by the Researcher, 2022

The researcher issued 159 questionnaires (having 44 questions) in person, email, and telegram to the respondents; out of which 127 were filled and returned giving a response rate of 80% as indicated in table 4.1 above. Therefore, the response rate considered adequate for the study.

The questionnaire was distributed across the public hospitals under the AACAHB and the response rate across these hospitals is presented as follow in table 4.2.

Table 4.2: Response Rate across the Target Population

No.	List of Hospitals	Targeted Sample Size	Responded Population	Response Rate
1	Yekatit 12 Hospital	38	30	79%
2	Menelik II Referral Hospital	32	24	75%
3	Gandi Memorial Hospital	18	17	94%
4	Zewditu Memorial Hospital	28	24	86%
5	Ras Desta Damtew Hospital	22	18	82%
6	Tirunesh Beijing General Hospital	21	14	67%
	Total	**159**	**127**	**80%**

Source: - Computed by the Researcher, 2022

As indicated in the above table, the response rate from Gandi memorial hospital is the highest followed by Zewditu memorial hospital, and Ras Desta Damtew hospital with a response rate of 94%, 86%, and 82% respectively. On the other hand, the least response rate is observed in Tirunesh Beijing General hospital followed by Menelik II Referal Hospital with a response rate of 67% and 75% each, respectively.

4.1.2 Demographic Information of Respondents

This section presents variables that show the demographic and socioeconomics characteristics of respondents including sex, age, education level, work experience in the hospitals, and occupational level within the pharmacy department of the hospitals of AACAHB with their frequencies and percentages.

Table 4.3: Demographic Information of Respondents

Characteristics	Description	Frequency	Percent	Cumulative Percent
Gender	Female	50	39.4	39.4
	Male	77	60.6	100.0
Age Group	21 – 30 years	60	47.2	47.2
	31 – 40 years	53	41.7	89.0
	41 – 50 years	8	6.3	95.3
	Above 51 years	6	4.7	100.0
Highest Education Level	Diploma	12	9.4	9.4
	Degree	96	75.6	85.0
	Master's degree	19	15.0	100.0
Years of Service	1– 5years	54	42.5	42.5
	6 – 10years	52	40.9	83.5
	11 – 15 years	16	12.6	96.1
	16 – 20 years	4	3.1	99.2
	Above 20 years	1	0.8	100.0
Occupational Level	Pharmacy administration	7	5.5	5.5
	Senior pharmacist	41	32.3	37.8
	Pharmacist	40	31.5	69.3
	Clinical pharmacy	27	21.3	90.6
	Druggist	12	9.4	100.0

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

Gender of Respondents

Out of the 127 respondents for the study, 50 were female (39.4%) whilst 77 (60.6%) were male. This shows that the ratio of male is greater than female in involving in the study. Even though, the focus of the study is examining the determinants of first line ART drugs in AACAHB, which has no gender consideration, the study considered a higher number of male than females.

Age Group Distribution of Respondents

The age distribution of respondents reported in Table 4.3 above shows that majority of the respondents fell within the age group of 21 – 30 years (n=60, 47.2%) followed by age groups 31 – 40 years (n=53, 41.7%). In contrary, respondents who fell within above 51 years group (n=6, 4.7%) constituted the least share followed by age groups of 41 – 50 years (n=8, 6.3%). This implies that age groups below 40 years occupy above three-fourth (i.e., 89%) of the respondents in the aforementioned hospitals. From the result, we can say that the significant majority of respondents were well matured.

Education Level of Respondents

With the educational background, majority of the respondents (n=96, 75.6%) have possessed their first degree; and 15% (n=19) possessed second-degree (master's degree) educational level. On the other hand, least share of respondents (n=12, 9.4%) possessed diploma certificate. Besides this, across all respondents, none of them have neither PhD degree, high school certificate, nor other certification, hence, 91% of the respondents have possessed above first-degree (Degree and Master) 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. This will have a great contribution for the quality of the collected data.

Year of Experience in SCIE

To ensure the quality of data for the study, 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 (n=54, 42.5%) had spent 1 up to 5 years in their respective organizations. Besides this, 40.9% (n=52) of the respondents had spent 6 up to 10 years whilst 12.6% (n=16) of the respondents had spent 11 up to 15 years in their respective hospitals. Only 1 respondent were found having a work experience of above 20 years and only 3.1% (n=4) of the respondents

have served 16 up to 20 years in their respective hospitals. None of the respondents have below one-year service. This implies that around 43% of the respondents have worked in their respective hospitals up to 5 years and more than half of the respondents (57%) have worked in their respective hospitals for more than 5 years. This also will have a great contribution to get quality of data hoping that they have a grounded and a testified experience to evaluate the existing scenarios in their hospitals.

Occupational Level of Respondents

As per the pre-collected data from the HR department of the identified public hospitals, pharmacy department is hierarchically organized in to pharmacy administration, senior pharmacist, pharmacist, clinical pharmacy, and druggist. Based on this, respondents were requested to indicate their occupational level and majority of the respondents (n=41, 32.3%) stated that they are working as senior pharmacist while 31.5% stated pharmacist, and 21.3% stated that their occupational level is termed as clinical pharmacist. Least number of respondents (n=7, 5.5%) are working as pharmacy administration followed by druggist (n=12, 9.4%). Hence, majority of the respondents (n=120, 94.5%) are working at the lower (i.e., working in dispensary level) while the other at administration level. This proportion will have a great contribution to get a reliable data about the study topic since they well understand most of the variables in the study.

4.2 Descriptive Analysis of Independent Variables

4.2.1 ART Drugs Supplier Performance

The Ethiopian pharmaceutical Fund and Supply Agency (PFSA) which was founded in 2007 with the goal of considerably enhancing the public's access to high-quality pharmaceuticals at a reasonable price is a responsible body for ensuring that all public health facilities have access to inexpensive, high-quality medications and that they are used appropriately. Hence, the performance of PFSA is believed to have a significant impact on the stock-out of ART drugs in public hospitals of AACAHB.

Keeping this in mind, the study sought to seek the response of the pharmacy staffs across all occupational levels found at the public hospitals of AACAHB about their perception about the supply performance of PFSA. Respondents were requested to examine the performance of PFSA in terms of their satisfaction about the supply performance of PFSA, delivery time, order-delivery quantity, ART drug availability, supply of long expiry drugs, and gap of order

fill rate of ART drugs. The following section presents the result of the collected data i.e., the response of the respondents.

Table 4.4: Frequency of Employee Perception about ART Supplier Performance

Attributes	Frequency					Mean
	SD	D	N	A	SA	
The service of PFSA is satisfactory in providing ART drugs to our hospital	-	32 25.2%	38 29.9%	52 40.9%	5 3.9%	3.2362
There exists on time in delivery of ART drugs from PFSA to our hospital	2 1.6%	18 14.2%	55 43.3%	50 39.4%	2 1.6%	3.2520
PFSA doesn't reduce quantity of ART drugs ordered by our hospital (it supplies reducing from ordered quantity)	2 1.6%	85 66.9%	36 28.3%	2 1.6%	2 1.62%	2.3465
There has not been stock out of ART drugs at PFSA in this year.	6 4.7%	89 70.1%	32 25.2%	-	-	2.2047
Our hospital not usually faced supply of short expiry ART drugs by PFSA	3 2.4%	105 82.7%	19 15.0%	-	-	2.1260
There is no visible gap of order fill rate of drugs in our suppliers	5 3.9%	71 55.9%	49 38.6%	2 1.6%	-	2.3780
Overall Average Mean						2.5906

Source: Compiled from Survey Questionnaires using SPSS V 26, 2022

From the above table 4.4 it can be seen that majority (45%) of respondents were agreed or highly agreed that the service of PFSA in providing ART drugs to their hospital is satisfactory. Besides this, 41% of the respondents perceived that PFSA is timely delivering ART drugs to their hospital.

In contrary, respondents have showed least agreement (highest disagreement i.e., 85%) for the statement stating that their hospital has not usually faced supply of long expiry ART drugs by PFSA. This implies that, PFSA is perceived by the staffs of pharmacy as they are supplying short expiry ART drugs to public hospitals of AACAHB. In addition, three-fourth (75%) of respondents showed their disagreement for a statement stating that "there has not been stock-out of ART drugs at PFSA in this year. This means that three-fourth of the respondents perceived that there has been a stock-out of ART drugs at PFSA in this year.

The mean value also indicates that respondents have relatively highly agreed (mean = 3.25) that PFSA is delivering ART drugs to their hospitals on time and the service of PFSA is satisfactory (mean = 3.24) in providing ART drugs to their hospital. The overall average mean is computed as 2.59. According to Almaquist *et al.* (2016), if the mean value of Liker scale is greater than 3.79, it will be considered as high; if it is between 3.40 and 3.79, it will be considered as moderate; and if the mean value is below 3.40, it will be considered as low.

As indicated in the above table, the mean value of all attributes of supplier performance ranges from 2.13 to 3.25 and the overall average mean value is 2.59. This implies consider as low as stated by Almaquist *et al*. (2016). From this, the research infers that the performance of ART supplier i.e., PFSA is perceived by respondents as low performance.

4.2.2 Health System Support

A study identified health system support or organizational support as a determinant factor for the stock-outs of ART drugs in hospitals under the AACAHB. Health system supports are described as a supportive supervision to the pharmacy department from the organization (i.e., top level management), the delivery of reliable logistics data to the supplier (i.e., PFSA), and the submission of appropriate report and request form (RRF) to the supplier (i.e., PFSA).

Respondents were asked to indicate their perceptions on the availability of the aforementioned health system supports and the following section presents the response of the respondents.

Table 4.5: Frequency of Employee Perception about Health System Support

Attributes	Frequency					Mean
	SD	D	N	A	SA	
Our department (Pharmacy) gets adequate supportive supervision from higher level managements in the last one-year.	-	23 18.1%	46 36.2%	48 37.8%	10 7.9%	3.3543
In our hospital, reliable logistics data is usually sent to PFSA	-	3 2.4%	22 17.3%	72 56.7%	30 23.6%	4.0157
RRF (Report and Request Form) is usually timely submitted to PFSA in our hospital.	-	-	13 10.2%	69 54.3%	45 35.4%	4.2520
Overall Average Mean						3.8740

Source: Compiled from Survey Questionnaires using SPSS V 26, 2022

From the above table 4.5 it can be seen that majority (90%) of respondents were agreed or highly agreed that Report and Request Form (RRF) is timely submitted to PFSA in their respective hospitals and 80% of the respondents agreed or highly agreed that reliable logistics data is usually sent to PFSA. Relatively, least share of respondents (46%) agreed or strongly agreed (while 18% disagreed or strongly disagreed) that the pharmacy department in their hospitals gets adequate supportive supervision from higher level managements in the last one-year.

The mean value also indicates that it ranges from 3.35 to 4.25 and the overall average mean value of the attributes of health system support is computed as 3.87. As stated by Almaquist *et al*. (2026) the overall average mean value implies that, respondents are highly agreed that there is health system support in their respective hospitals. However, they showed least agreement about the availability of supportive supervision from top management.

4.2.3 Information and Communication Technology (ICT) Use

The study has identified four attributes to measure the information communication technology uses in public hospitals of AACAHB. These are utilization of LMIS in their respective hospitals, availability and utilization of social media group within the organization for exchanging logistic information, non-internet-based communicating platform to exchange information with stakeholders, and availability and utilization of internet-based communication plat for to exchange pharmaceutical logistics data with stakeholders. The following section presents the response of the respondents.

Table 4.6: Frequency of Employee Perception about ICT Use

Attributes	Frequency					Mean
	SD	D	N	A	SA	
Our hospital usually involve in pharmaceutical logistics social media group (Viber, Telegram) for exchanging logistics information	53 41.7%	59 46.5%	6 4.7%	9 7.1%	-	1.7717
The use of SMS messaging and phone call for exchange of logistics data with stakeholders involve in pharmaceutical logistics management is practiced in our hospital	16 12.6%	79 62.2%	13 10.2%	19 15.0%	-	2.2756
The use of an internet to exchange pharmaceutical logistics data with stakeholders involved in pharmaceuticals logistics management is practiced in our hospital	6 4.7%	63 49.6%	33 26.0%	25 19.7%	-	2.6063
Electronic logistics management information system (LMIS) is not utilized in our hospital.	76 59.8%	46 36.2%	5 3.9%	-	-	1.4409
Overall Average Mean						3.9764

Source: Compiled from Survey Questionnaires using SPSS V 26, 2022

As indicated in table 4.6, majority (96%) of respondents were agreed or highly agreed that there is LMIS is utilized in their hospitals while 88% respondents agreed or strongly agreed that there is a social media group plat form (such as Viber and Telegram) and it is utilized for exchanging pharmaceutical logistics information among the internal staffs. Relatively least share of respondents (i.e., 54%) agreed or strongly agreed about there is the use of internet-based communication plat form to exchange pharmaceutical logistics data with stakeholders. Furthermore, 75% agreed or strongly agreed about there is the use of non-internet-based communication plat form (such as SMS message and phone call) for the exchange of pharmaceutical logistics data with stakeholders. The mean value of ICT use attribute ranges from 3.39 to 4.56 and the overall average mean value is computed as 3.98. As stated by Almaquist *et al.* (2026) the overall average mean value implies that, respondents perceived highly positive about the use of ICT in their respective hospitals. However, respondents perceived moderately positive about the use of internet-based and non-internet-based communication plat form to exchange pharmaceutical logistics information with stakeholders.

4.2.4 Human Resource

A study has identified human resource as a determinant factor for the stock-outs of ART drugs in hospitals found in AACAHB. Availability of appropriate trainings to the staff, availability of adequately qualified staff, ability of staffs in making timely requests and medicines orders, skill of record keeping and planning. And ability of anticipating the demand of ART drugs are the attributes of human resource. The following section presents the response of the respondents.

Table 4.7: Frequency of Employee Perception about Human Resource

Attributes	Frequency					Mean
	SD	D	N	A	SA	
In our hospital, in-service training related to pharmaceuticals logistics management is usually provided for professionals handling pharmaceuticals	2 1.6%	90 70.9%	16 12.6%	10 7.9%	9 7.1%	2.4803
The hospital has adequate number of staff responsible for management and dispensing medicines	-	-	1 0.8%	111 87.4%	15 11.8%	4.1102
The hospital has adequately qualified staff to manage medicines (ART drugs)	-	4 3.1%	19 15.0%	87 68.5%	17 13.4%	3.9213
The hospital staff usually make timely requests and medicines orders	-	22 17.3%	28 22.0%	63 49.6%	14 11.0%	3.5433
The hospital staff are well trained in record keeping and planning for ART drugs	2 1.6%	40 31.5%	26 20.5%	52 40.9%	7 5.5%	3.1732
In our hospital, the pharmacy personnel are able to anticipate ART needs of our hospital.	1 0.8%	39 30.7%	30 23.6%	48 37.8%	9 7.1%	3.1969
Overall Average Mean						3.4042

Source: Compiled from Survey Questionnaires using SPSS V 26, 2022

As indicated in table 4.7, almost all of the respondents (99%) were agreed or highly agreed that there is adequate number of staffs in the pharmacy department of each hospital. However, only 82% of the respondents agreed and strongly agreed about the availability of adequate qualified staffs in the hospitals of AACAHB. Furthermore, 61% of the respondents agreed and strongly agreed that the pharmacy personnel have a skill of anticipating ART needs of the hospitals.

In contrary, relatively highest proportion of respondents (i.e., 73% disagreement & 15% agreement) disagreed or strongly disagreed about the provision of in-service training related to pharmaceutical logistics management for professionals managing pharmaceuticals. Besides this, only 46% of the respondents agreed or strongly agreed (while 33% disagreed or strongly disagreed) that the pharmacy personnel of the hospitals are a well trained in record keeping and planning of ART drugs.

The mean value of human resource attributes ranges from 2.48 to 4.11 and the overall average mean value is computed as 3.40. As stated by Almaquist *et al.* (2026) the overall average mean value implies that, respondents perceived moderately positive about the attributes of human resource. Besides this, the mean value also implies that among the six attributes of human resource, respondents showed least agreement (have low positive perception) about the provision of training for the staffs (mean = 2.48), record keeping and planning skill of the staff (3.17), and skill of anticipating the needs of ART drugs (3.20) respectively. In addition, respondents moderately agreed (perceived moderately positive) about the practice of timely request and medicine order (mean = 3.54) in the hospitals. Besides this, respondents are highly agreed (perceived highly positive) about the availability of qualified staff (mean = 3.92) and the availability of adequate number of staffs (mean = 4.11) in the pharmacy department of public hospitals of AACAHB.

4.2.5 Inventory Management

The study also sought to seek the response of the respondents about their perception on the inventory management of their respective hospitals in the attributes of the assortment of ART drugs, stock management, skill of staff dedicated for the inventory management, periodic inventory of ART drugs, availability of rules, procedures, and guidelines; and the existence of effective communication among the staffs. The following section presents the response of the respondents.

Table 4.8: Frequency of Employee Perception about Inventory Management

Attributes	Frequency					Mean
	SD	D	N	A	SA	
In our hospital ART drugs are arranged on shelves with arrows pointing up, and with identification labels, expiry dates, and manufacturing dates clearly visible.	-	13 10.2%	10 7.9%	72 56.7%	32 25.2%	3.9685
HIV commodities in our hospital are stored and organized to FEFO (first expire first out) procedures, and were accessible for counting and general stock management.	-	11 8.7%	19 15.0%	70 55.1%	27 21.3%	3.8898
In our hospital, Pharmaceuticals in the drug store are managed by academically qualified staff (Trained Druggist or Pharmacist)	-	2 1.6%	10 7.9%	81 63.8%	34 26.8%	4.1575
In our hospital, appropriate inventory is conducted periodically.	-	-	1 0.8%	43 33.9%	83 65.4%	4.6457
The hospital's medication management is governed by a precise set of rules, procedures, and guidelines.	-	38 29.9%	46 36.2%	29 22.8%	14 11.0%	3.1496
In our hospital, there is effective communication among pharmacy, pharmaceutical warehouses and purchasing department	2 1.6%	50 39.4%	28 22.0%	37 29.1%	10 7.9%	3.0236
Overall Average Mean						3.8058

Source: Compiled from Survey Questionnaires using SPSS V 26, 2022

As indicated in table 4.8 above, almost all of the respondents (99%) agree or strongly agree that appropriate inventory is conducted in the public hospitals of AACAHB. Besides this, respondents are also highly agreed that pharmaceuticals in the drug store are managed by academically qualified staff and well-trained druggist or pharmacist. Furthermore, 82% of the respondents responded that ART drugs are arranged on shelves with arrows pointing up, and with identification labels, expiry dates, and manufacturing dates are clearly visible; while 76% of them also agreed that HIV commodities in their respective hospital are stored and organized to FEFO (first expire first out) procedures, and are accessible for counting and general stock management. Relatively, highest percentage (i.e., 41%) of respondents disagreed for the statement stating that "in our hospital, there is effective communication among pharmacy, pharmaceutical warehouses and purchasing department" followed by a statement stating that "the hospitals medication management is governed by a precise set of rules, procedures, and guidelines" (as stated by 30% of the respondents).

The mean value of the attributes of inventory management ranges from 3.024 to 4.646 and the overall average mean is computed as 3.806. This implies that respondents are highly agreed that the inventory management of ART drugs in public hospitals of AACAHB are perceived as good. The study further depicted that appropriate inventory is conducted periodically across all hospitals and the store management of the hospitals are managed by academically qualified and trained staffs.

The mean value of each independent variables indicated that respondents showed the highest agreement (highest positive perception) for the inventory management practice (mean = 4.646) in their respective hospitals followed by the use of ICT in the pharmaceutical logistics management (mean = 3.976) and health system support (mean = 3.874). In contrary, respondents showed least agreement/highest disagreement (least positive perception) about the ART drug supplier performance (mean = 2.591) and moderately agreed about the attributes of human resource (mean = 3.404).

4.3 Stock-Out Status of First Line ART Drugs on Public Hospitals of AACAHB

The treatment for HIV is called antiretroviral therapy (ART) (WHO, 2016). ART involves taking a combination of HIV medicines (called an HIV treatment regimen) every day. Stock-outs are defined by the WHO as the complete absence of a required medicine for at least one day at a storage or delivery point (WHO, 2016). A stock-out of any ARV routinely used, is an early warning indicator for the development of ART resistance (Ibid). The stock-out status of first line ART drugs was examined in two approaches i.e., bin card assessment of each ART drugs by the researcher and through requesting the respondents to indicate their level of agreement for the availability of first line ART drugs in general through the questionnaire.

As per the perception of respondents, first line ART drugs were stocked out in their respective hospitals during the period of Sep 2021 – Sep 2022 as stated by 63% of the respondents. The result across the identified public hospitals indicates that, 75% of the respondents in Menelik II referral hospital, 67% in Yekatit 12 hospital, 65% in Gandi memorial hospital, 58% in Zewditu memorial hospital, 57% in Tirunesh Beijing hospital, and 50% in Ras Desta Damtew hospital stated that there was a stock out of first line ART drugs during the last one year (i.e., Sep 2021 – Sep 2022).

The stock-out/availability of first line ART drugs in public hospitals of AACAHB were examined by the researcher in three pillars such as stock-out/availability of ART drugs during the last one year (i.e., Sep 2021 – Sep 2022), the frequency of stock-out, and number of days of stock-out. The following section presents the findings.

4.3.1 Stock Out/Availability of First Line ART Drugs

Availability/stock-out of first line ART drugs on the day of assessment (examining the stock-out status of the drugs during the last one year from the bin card) conducted by the researcher was expressed as the percentage of ARV drugs stock-out during the indicated period in the public hospitals of AACAHB. Table 4.9 presents the result of the assessment.

Table 4.9: Stock out of First line ART Drugs in Public Hospitals of AACAHB

No.	List of ART drugs	ART Stock-outs (Sep 2021 - Sep 2022) (n, %)	Avg. Frequency of Stock outs (Sep 2021 – Sep 2022)	No. of Days of Stock-out (mean, range)
1	TDF/3TC, 300/300mg	2 (33%)	1	31 (20 - 41)
2	AZT/3TC, 300/150mg	6 (100%)	3	36 (5 - 81)
3	DTG 50mg	3 (50%)	4	26 (17 - 41)
4	EFV, 50mg	4 (67%)	3	13 (5 - 27)
5	EFV, 200mg	1 (17%)	1	215 (215)
6	EFV, 600mg	6 (100%)	2	87 (61 - 183)
7	3TC, 150mg	0%	0	0
8	ABC, 300mg	0%	0	0
9	ABC/3TC, 120/60mg	6 (100%)	3	34 (10 - 71)
10	TDF/3TC/DTG, 300/300/50mg	3 (50%)	2	20 (5 - 48)
11	TDF/3TC/EFV, 300/300/400mg	4 (67%)	2	15 (8 - 22)
12	AZT/3TC, 60/30mg	3 (50%)	1	4 (3 - 14)
13	AZT, 10mg/ml solution	3 (50%)	3	38 (13 - 74)

Source: Own Computation (2022)

As indicated in table 4.9, as per the observation of bin card records, for a period of the last one year (Sep 2021 – Sep 2022), all of the public hospitals of AACAHB have encountered stock out for at least one of the first line ART drugs. The result also shows that out of 13 first line ART drugs, 23% of them (n=3; namely AZT/3TC, 300/150mg, EFV 600mg, and ABC/3TC, 120/60mg) have been stocked out in all public hospitals of AACAHB. The result further revealed that 15% of first line ART drugs (n=2; namely EFV 50mg and TDF/3TC/EFV, 300/300/400mg) were stocked out in 67% (n=4) of the public hospitals of AACAHB during the last one year. Besides this, 31% of first line ART drugs (n=4; namely DTG 50mg, TDF/3TC/DTG, 300/300/50mg, AZT/3TC 60/30mg, and AZT 10mg/ml solution) were stocked out in 50% (n=3) of the public hospitals of AACAHB during the indicated period. Among the 13 first line ART drugs, only 15% (n=2; namely as 3TC 150mg and ABC, 300mg) of them were never been stocked-out during the past one year, while the remaining 85% (n=11) have been stocked-out in either of the six public hospitals.

4.3.2 Frequency of Stock Outs of First Line ART Drugs

As clearly seen on table 4.9, as per the observation of bin card records, for a period of the last one year, the result shows that three products namely AZT/3TC, 300/150mg, EFV 600mg, and ABC/3TC, 120/60mg were found to be stock outs in all public hospitals of AACAHB for an average of three, two, and three times respectively in the indicated period. The assessment also indicates that two products namely EFV 50mg and TDF/3TC/EFV 300/300/400mg were found to be stocked-out in 67% (n=4) of the public hospitals of AACAHB for an average of three and two times respectively; and four products such as DTG 50mg, TDF/3TC/DTG 300/300/50mg, AZT/3TC 60/30mg, and AZT 10mg/ml solution were stocked out in 50% (n=3) of the public

hospitals of AACAHB for an average of four, two, one, and three times respectively in the indicated period.

The assessment revealed that, despite of those drugs which were never been stock-out (n=2; such as 3TC 150mg & ABC 300mg), the remaining 11 drugs were stocked-out for one up to four times in a year, and on average these drugs were stocked out for 2.3 times in a year. Among all first line ART drugs, DTG 50mg is found to be the most frequently stocked out drug (i.e., stocked out four times in a year) followed by AZT/3TC 300/150mg, EFV 50mg, ABC/3TC 120/60mg, and AZT, 10mg/ml solution which stocked out three times in the indicated period. In contrary, TDF/3TC 300/300mg, EFV 200mg, and AZT/3TC 60/30mg were found to be stocked out only one-times a year and hence these items are the least frequently stocked out items in a year.

4.3.3 Duration of First Line ART Drugs Stock Out

As clearly seen on table 4.9, as per the observation of bin card records, for a period of the last one year, the result shows that three products namely AZT/3TC, 300/150mg, EFV 600mg, and ABC/3TC, 120/60mg were found to be stocked out for an average 36 days of stock out (5 – 81 days), 87 days (61 – 183 days), and 34 days of stock out (10 – 71 days) respectively during the last one year. The assessment also indicates that two products namely EFV 50mg and TDF/3TC/EFV 300/300/400mg were found to be stocked-out in 67% (n=4) of the public hospitals of AACAHB for an average of 13 days (5 – 27 days) and 15 days (8 – 22days) of stock-out in the indicated period respectively; and four products such as DTG 50mg, TDF/3TC/DTG 300/300/50mg, AZT/3TC 60/30mg, and AZT 10mg/ml solution were stocked-out in 50% (n=3) of the public hospitals of AACAHB for an average total of 26 days (17 – 41days), 20 days (5 – 48days), 4 days (3 – 14days), and 38 days (13 – 74days) in the indicated period respectively.

The assessment revealed that, despite of those drugs which were never been stocked out (n=2; such as 3TC 150mg & ABC 300mg) in the last one year, the remaining 11 drugs were stocked-out for a range of 3 – 215 days in a year, and on average these drugs were stocked out for 47 days in a year. The mean duration of stock out days was longer for EFV 200mg (215 days) followed by EFV 600mg (87 days), AZT 10mg/ml solution (38 days), AZT/3TC 300/150mg (36 days), and ABC/3TC 120/60mg (34 days) respectively. In contrary, the mean duration of stock out days in the past one year was least for AZT/3TC 60/30mg (4 days) followed by EFV 50mg (13 days) and TDF/3TC/EFV 300/300/400mg (15 days) respectively.

4.3.4 Stock Out of First line ART Drugs across Public Hospitals of AACAHB

The stock out/availability of first line ART drugs, average frequency of stock out, and average number of stocks out days across public hospitals of AACAHB is assessed during the observation and examination of bin card records. The result of the assessment is presented in table 4.10 below.

Table 4.10: Stock Out of First Line ART Drugs across Public Hospitals of AACAHB

No.	List of Hospitals	No. of Stocked Out Items	Average Frequency of Stock Out	Average No. of Stock Out Days
1	Yekatit 12 Hospital	8 (62%)	2.1	63
2	Menelik II Referral Hospital	7 (54%)	1.3	55
3	Gandi Memorial Hospital	8 (62%)	5.0	25
4	Zewditu Memorial Hospital	5 (38%)	1.4	19
5	Ras Desta Damtew Hospital	8 (62%)	2.4	32
6	Tirunesh Beijing General Hospital	5 (38%)	1.4	19
	Total	**7 (54%)**	**2.3**	**36**

Source: - Computed by the Researcher, 2022

As indicated in table 4.10, as per the observation of bin card records, for a period of the last one year (Sep 2021 – Sep 2022), all of the public hospitals of AACAHB have encountered stock out for a range of five up to eight first line ART drugs i.e., on average 7 ART drugs or 54% of ART drugs were stocked out across the hospitals.

Out of the total first line ART drugs (n=13), 62% (n=8) were stocked out in Gandi Memorial Hospital, Ras Desta Damtew Hospital, and Yekatit 12 Hospital for an average of 3 times and for an average duration of 40 days of stock out in a year. On the other hand, 38% (n=5) of the first line ART drugs were stocked out during the last one year in Zewditu Memorial Hospital and Tirunesh Beijing General Hospital for an average of 1.4 times and for an average duration of 19 days of stock-out in the indicated period. On the other hand, the longest duration of ART stock out in the indicated period is observed in Yekatit 12 Hospital (63 days) followed by Menelik II Referral Hospital (55 days); whereas the least duration of ART drug stock out is observed in Zewditu Memorial and Tirunesh Beijing General Hospital with a stock out duration of each 19 days in a year. From the above table, it is indicated that on average 7 ART drugs (54% of ART drugs) were stocked out in the public hospitals of AACAHB for an average of 2.3 times in a year and for an average duration of 36 days of stock out in the indicated period. This implies that the average percent of days that first line ART drugs were out of stock in a year is computed as 10% (i.e., 36 days/365 days).

4.4 Correlation Analysis

Correlation is a bivariate analysis that measures the strength of association between two variables and the direction of the relationship (Kothari, 2004). In terms of the strength of relationship, the value of the correlation coefficient varies between +1 and -1. A value of ± 1 indicates a perfect degree of association between the two variables. As the correlation coefficient value goes towards 0, the relationship between the two variables will be weaker. The direction of the relationship is indicated by the sign of the coefficient; a + sign indicates a positive relationship and a – sign indicates a negative relationship. Usually, in statistics, we measure four types of correlations: Pearson correlation, Kendall rank correlation, Spearman correlation, and the Point-Biserial correlation.

The assumptions for Pearson correlation indicate that that both variables (dependent and independent variables) have to be an interval, ordinal, or ratio variable and are well approximated by a normal distribution (Kothari, 2004). Hence, these assumptions are fulfilled, Pearson correlation which is the most widely used correlation statistic to measure the degree of the relationship between linearly related variables were used in this study. The correlation analysis was conducted and presented as below;

Table 4.11: Results of Pearson Correlation Analysis

		SP	IM	HR	HS	ICT	ART Stockout
Supplier Performance	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	127					
Inventory Management	Pearson Correlation	-.086	1				
	Sig. (2-tailed)	.338					
	N	127	127				
Human Resource	Pearson Correlation	-.056	.628**	1			
	Sig. (2-tailed)	.531	.000				
	N	127	127	127			
Health System Support	Pearson Correlation	.124	.654**	.546**	1		
	Sig. (2-tailed)	.166	.000	.000			
	N	127	127	127	127		
ICT	Pearson Correlation	.163	.333**	.280**	.478**	1	
	Sig. (2-tailed)	.067	.000	.001	.000		
	N	127	127	127	127	127	
ART Stock-out	Pearson Correlation	-.023**	-.607**	-.384**	-.274**	-.249**	1
	Sig. (2-tailed)	.008	.000	.000	.002	.005	
	N	127	127	127	127	127	127

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

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

As stated by Cresswell (2009), correlation coefficients between .10 and .29 represent a small association, coefficients between .30 and .49 represent a medium association, and coefficients of .50 and above represent a large association or relationship. According to Table 4.11, the coefficients indicated that all determinants of first line ART drug stock out were negatively associated or related to stock out of ART drugs in public hospitals of AACAHB. Concerning the relationship or association between the independent variables, Table 4.11 clearly shows that figures 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 relationship between all independent variables and dependent variable.

Hence, the study revealed that there is statistically significant and negative relationship between supplier performance and first line ART stock out ($r = -0.123$, 0.008; $p<0.01$). This finding supports a study conducted by De Palencia *et al*. (2016). According to a study by De Palencia *et al*. (2016) on the factors that contribute to the stock-out of medicine in general and ART drug shortages in particular in small automated dispensing systems, drug supplier performance or supply shortage is a major factor in stock-out of medicines. There is also statistically significant and negative relationship between inventory management and ART stock out ($r = -0.607$, 0.000; $p<0.01$), between human resource and ART stock out ($r = -0.384$, 0.000; $p<0.01$), between health system support and ART stock out ($r = -0.274$, 0.002; $p<0.01$), and between ICT use and ART stock out ($r = -0.249$, 0.005; $p<0.01$).

According to the Cresswell (2009) classification of relationship based on r value, there is small association or relationship between supplier performance and ART stock out ($r = -0.123$), ICT use and ART stock out ($r = -0.249$), and between health system support and ART stock out ($r = -0.274$) respectively since their r value lies under the ranges of 0.1 – 0.29. On the other hand, there is a medium association or relationship between human resource and ART stock out since the r value of their relationship (i.e., -0.384) lies under the range of 0.30 – 0.49. Furthermore, there is a large association or relationship between inventory management and stock out of ART ($r = -0.607$) since the r value lies on the range above 0.50.

Hence, among the identified determinants of ART stock out, there is relatively largest association or relationship between inventory management and ART stock out followed by between human resource and ART stock out and health system support; while there is smallest relationship or association between supplier performance and ART stock out followed by ICT use.

4.5 Logistic Regression Analysis

Logistic regression model is a statistical technique for predicting the probability of an event, given a set of predictor variables (Kothari, 2004). In order to examine the impact of each independent variables on dependent variable thereby to test the hypotheses, a binary logistic regression analysis was conducted. This is because the binary logistic regression procedure empowers one to select the predictive model for dichotomous dependent variables.

4.5.1 Diagnostic Test of Assumptions

Logistic regression requires fulfilling certain assumptions before employing it. However, as stated by Hair *et al.* (2010), logistic regression does not make many of the key assumptions of linear regression and general linear models that are based on ordinary least squares algorithms – particularly regarding linearity, normality, homoscedasticity, and measurement level. To be confident with results from this model, the researcher has tested the assumptions of logistic regression model and the next section presents the diagnostic test results of these assumptions.

A. Linearity Test

Linearity test aims to determine the relationship between independent variables and the dependent variable is linear or not. Logistic regression requires a linear relationship between the dependent and independent variables. For linearity test, ANOVA test was conducted. As stated by Almquist *et al*. (2016), if the value of sig. deviation from linearity in the ANOVA test is greater than 0.05, then the relationship between the independent variables is linearly dependent; and if the value is less than 0.05, then the relationship between independent variables with the dependent is not linear. Table 4.13 as indicated in appendix A herewith this document indicates the result of linearity test.

Based on the ANOVA Output Table as indicated in table 4.12, the value of sig. deviation from Linearity of all independent variables is found greater than 0.05. The value of Sig. Deviation from Linearity of ART stock out and supplier performance is 0.102>0.05, ART stock out and inventory management is 0.573>0.05, between ART stock out and human resource 0.255>0.05, between ART stock out and health system support is 0.111>0.05, and between ART stock out and ICT use is 0.062>0.05. Therefore, this diagnostic test result indicates that there is linearity between the dependent and independent variables.

B. Multicollinearity Test

As stated by Hair *et al*. (2010), logistic regression requires there to be little or no multicollinearity among the independent variables. This means that the independent variables should not be too highly correlated with each other. As stated by Almquist *et al*. (2015), the decision-making criteria for the existence of multicollinearity is that; if the VIF (Variance inflation factors) value lies between 1 – 10, then there is no multicollinearity and if the VIF value < 1 or > 10, then there is multicollinearity. On the other hand, if the value of tolerance is less than 0.2 or 0.1 and, simultaneously, the value of VIF 10 and above, then the multicollinearity is problematic. Based on this criterion, multicollinearity test was conducted on the independent variables and the result is shown in Table 4.13 as indicated in appendix A herewith this document. As indicated in table 4.13 as indicated in appendix A, the VIF value of all independent variables lie between 1 to 10 i.e., supplier performance 1.091, inventory management 2.211, human resource 1.750, health system support 2.187, and ICT use 1.320. Simultaneously, the tolerance value of all independent variables is above 0.2 i.e., supplier performance 0.917, inventory management 0.452, human resource 0.571, health system support 0.457, and ICT use 0.757. This implies that there is no multicollinearity symptom. Hence, the pre-requisite for conducting logistic regression with this criterion is fulfilled.

C. Normality Test

In logistics regression analysis the requirements that must be met are data that are normally distributed. There are two well-known tests of normality, namely the Kolmogorov-Smirnov Test and the Shapiro-Wilk Test. The Shapiro-Wilk Test is more appropriate for small sample sizes (< 50 samples), but can also handle sample sizes as large as 2000 (Almquist *et al*., 2016). For this reason, Shapiro-Wilk test was conducted as a numerical means of assessing normality. The decision criteria are that, if the Sig. value of the Shapiro-Wilk Test is greater than 0.05, the data is normal and if it is below 0.05, the data significantly deviate from a normal distribution. Based on this criterion, the result of the normality test is shown in Table 4.14 as indicated in appendix A herewith this document. The normality test result indicates that Sig. value of all independent variables is greater than 0.05. Hence, the data is normally distributed. Therefore, this assumption of logistic regression is also fulfilled. As recommended by Hair *et al.* (2010), before running the logistic regression model, all required key assumptions were tested and all the statistical analysis reported accomplishment of these criteria.

4.5.2 The Model Result

As indicated in the preceding section, all assumptions are fulfilled for undertaking the logistic regression analysis and get a valid result. The researcher conducted a logistic regression to establish the likelihood of first line ART drugs stock out based on the supplier performance, inventory management, human resource, health system support, and ICT use. The following result presents the result of the logistic regression.

A. Goodness-of-Fit Test

Model fit or goodness of fit statistics helps to determine whether the model adequately describes the data. For checking this, Omnibus Tests of Model Coefficients were conducted. The Omnibus Tests of Model Coefficients is used to check that the new model (with explanatory variables included) is an improvement over the baseline model (Almquist *et al*., 2016). In Omnibus Tests of Model Coefficients, a p-value (sig) of less than 0.05 for block means that the block 1 model (the new model) is a significant improvement to the block 0 (baseline model) model. Based on this basis, the result is presented as follow;

Table 4.15: Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	68.591	5	.000
	Block	68.591	5	.000
	Model	68.591	5	.000

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

The above table shows full model, which indicates that our predictors are entered in the model simultaneously. As indicated in table 4.15, the chi-square value of Omnibus Tests of Model Coefficients is 68.591 with a p-value .000. This indicates that our model as a whole fit significantly better than an empty model (i.e., a model with no predictors). We can infer that variables entered in equation have significant impact on first line ART drugs stock out in public hospitals of AACAHB. The study also conducted goodness of fit test by using Hosmer and Lemeshow Test as indicated in the following table.

Table 4.16: Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	23.687	8	.233

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

The above output shows us that, the model is significant by using likelihood ratio test and the non-significance of Hosmer and Lemeshow test indicates the significance of the model. The decisions criteria are that the Hosmer and Lemeshow statistic indicates a poor fit if the

significance value is less 0.05. Here, the p-value is 0.233 and this shows the model adequately fits the data.

B. Variance Explained

In order to understand how much variation in the dependent variable i.e., first line ART drugs stock out be explained by the model (the equivalent of R^2 in multiple regression), estimation results of the logistic regression model is displayed as below in "Model Summary" table 4.17.

Table 4.17: Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	98.794[a]	.417	.570

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

Table 4.17 indicates the Cox & Snell R Square and Nagelkerke R Square values, which are both methods of calculating the explained variation. These values sometimes referred to as *pseudo* R^2 values. The result of model summary implies that the explained variation in the dependent variable (i.e., stock out of ART drugs) based on our model ranges from 41.7% to 57%, depending on Cox & Snell R^2 and Nagelkerke R^2 methods, respectively. Nagelkerke R^2 is a modification of Cox & Snell R^2. For this reason, it is preferable to report the Nagelkerke R^2 value.

Based on this, the logistic regression model revealed that 57% of first line ART drugs stock out in public hospitals of AACAHB is explained by the explanatory variables (i.e., supplier performance, inventory management, health system support, human resource, and ICT use. Alternatively, it indicates that between 41.7% and 57% of variability in ART stock out in public hospitals of AACAHB is explained by the identified independent variables in the model. This shows that our independent variables have big influence on whether there is first line ART drugs stock out or not.

C. Variables in the Equation

The SPSS also generated the variables in the equation output. The "Variables in the Equation" table shows the contribution of each independent variable to the model and its statistical significance. Table 4.18 shows the summary of the regression coefficients output.

Table 4.18: Variables in the Equation

		B	SE	Wald	Df	Sig.	Exp(B)	95% C.I. for EXP (B)	
								Lower	Upper
Step 1[a]	Supplier Performance (SP)	-0.254	1.010	0.063	1	.018	0.775	0.107	5.619
	Health System Support (HS)	-2.008	0.723	7.703	1	.006	7.448	1.804	30.749
	ICT Use (ICT)	-0.923	0.490	3.549	1	.040	0.397	0.152	1.038
	Human Resource (HR)	-0.144	0.689	0.044	1	.035	1.155	0.299	4.456
	Inventory Management (IM)	-5.453	1.080	25.505	1	.000	0.404	0.001	0.603
	Constant	17.834	3.915	20.754	1	.000			
a. Variable(s) entered on step 1: SP, IM, HR, HS, and ICT									

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

While B is convenient for testing the usefulness of predictors, Exp(B) is easier to interpret. Exp(B) represents the ratio-change in the odds of the event of interest for a one-unit change in the predictor (Exp (B) indicates an odds ratio. The Wald test ("**Wald**" column) is used to determine statistical significance for each of the independent variables and it tests the effect of individual predictor while controlling other predictors. The statistical significance of the test is found in the "**Sig.**" column. In general, if the significance level of the Wald statistic (which tests the effect of individual predictor while controlling other predictors.) is small (less than 0.05) then the parameter is useful to the model. The result of the model is interpreted as follow.

4.5.2.1 ART Drug Supplier Performance

Odds of ART supplier performance i.e., 0.775 as indicated in the above table indicate the likelihood of first line ART drug stock out in public hospitals of AACAHB. The B value (-0.254) and Sig. value (p = 0.018) of ART supplier performance in the above table indicates that ART supplier performance has negatively and significantly affected first line ART drug stock out in public hospitals of AACAHB. Hence, ART supplier performance added significantly to the model/prediction of affected first line ART drug stock out in public hospitals of AACAHB. In other words, ART supplier performance in public hospitals of AACAHB significantly predicts the likelihood of first line ART drug stock out. Alternatively, ART supplier performance has significant impact on first line ART drug stock out in public hospitals of AACAHB. The result of the binary logistic regression also revealed that, for each one-unit decrease on ART supplier performance, the odds of first line ART drug stock out increased by 0.775. Hence, the study rejected the null hypothesis i.e., ***Ho1: The performance of ART supplier has no significant impact on the stock out of first line ART in public hospitals of AACAHB*** and accept the alternative hypothesis. Hence, the study concluded that the performance of ART supplier has significant impact on the stock out of first line ART in public hospitals of AACAHB.

As indicated in the descriptive analysis, the gap of order fill rate of drugs, stock outs of the drugs in the supplier, and poor service provision of the supplier are the main contributing factor for the stock of ART drugs in the indicated hospitals. This finding supports the previous study conducted by Harries *et al*. (2007). A study conducted on Addis Ababa by Adino *et al.* (2013) also revealed that interruption of supplies by the concerned suppliers have affected the stock-outs of ART drugs in Addis Ababa. Another study in SNNPR by Damtie *et al*. (2020) also support our finding that the main contributing factors for the stock-outs of ART drugs in SNNPR health facilities is the poor performance of drug suppliers, specifically the long lead time of ordered items.

4.5.2.2 Health System Support

Odds of health system support i.e., 7.448 as indicated in the above table indicate the likelihood of first line ART drug stock out in public hospitals of AACAHB. The B value of health system support (-2.008) and Sig. value (p = 0.006) indicates that health system support has negatively and significantly affected first line ART drug stock out in public hospitals of AACAHB. Hence, health system support added significantly to the model/prediction of affected first line ART drug stock out in public hospitals of AACAHB.

In other words, health system support in public hospitals of AACAHB significantly predicts the likelihood of first line ART drug stock out. Alternatively, health system support has significant impact on first line ART drug stock out in public hospitals of AACAHB. The result of the binary logistic regression also revealed that, for each one-unit decrease on health system support, the odds of first line ART drug stock out increased by 7.448.

Hence, the study rejected the null hypothesis i.e., ***Ho2: Health system support has no significant impact on the stock out of first line ART in public hospitals of AACAHB*** and accept the alternative hypothesis. Hence, the study concluded that health system support has significant impact on the stock out of first line ART in public hospitals of AACAHB.

The study also revealed that among the attributes of health system support, familiarity timely submission of RRF to PFSA and lack of adequate supportive supervision from higher level managements are the core contributing factor for the stock out of first line ART drugs in public hospitals of AACAHB. This finding supports a previous study conducted by Gils *et al.* (2018) that conclude the stock out of HIV commodities are due to the insufficient support, inappropriate request order, and predication mistakes along with insufficient health system

support played a significant role. The finding of this study also supported a study in Lesotho by Harries, *et al*. (2007) that founds insufficient health system support has a significant impact on the stock-out of ART drugs. They elaborated that a lack of supervisory visits led to erratic stock levels.

4.5.2.3 Information and Communication Technology Use

Odds of ICT use i.e., 0.397 as indicated in the above table indicate the likelihood of first line ART drug stock out in public hospitals of AACAHB. The B value of ICT use (-0.9238) and Sig. value (p = 0.040) indicates that ICT use has negatively and significantly affected first line ART drug stock out in public hospitals of AACAHB. Hence, ICT use added significantly to the model/prediction of affected first line ART drug stock out in public hospitals of AACAHB.

In other words, ICT use in public hospitals of AACAHB significantly predicts the likelihood of first line ART drug stock out. Alternatively, ICT use has significant impact on first line ART drug stock out in public hospitals of AACAHB. The result of odds ratio is used to understand the effect of a predictor. Hence, the result of the binary logistic regression also revealed that, for each one-unit decrease on ICT use, the odds that first line ART drug stock out increase by 0.397. Hence, the study rejected the null hypothesis i.e., ***Ho3: The use of information and communication technology has no significant impact on the stock out of first line ART in public hospitals of AACAHB*** and accept the alternative hypothesis. Hence, the study concluded that the use of information and communication technology has significant impact on the stock out of first line ART in public hospitals of AACAHB.

The study also revealed that the lack of non-internet-based communication such as SMS messaging and phone call for the exchange of logistics data with stakeholders; and the lack of internet-based exchange of pharmaceutical logistics data with stakeholders are the main contributing factor for the first line ART drugs in public hospitals of AACAHB. The study conducted by Damtie *et al*. (2020) on SNNP also concluded that, the main contributing factors for the stock-outs of ART drugs were related with information system i.e., improper use of health center management information system. The finding of this study also supported a previous study conducted by Mabirizi *et al*. (2014) that found health information systems have a significant impact on the availability and stock-outs of medicines in general and ART drugs in particular.

4.5.2.4 Human Resource

Odds of human resource i.e., 1.155 as indicated in the above table indicate the likelihood of first line ART drug stock out in public hospitals of AACAHB. The B value of human resource (-0.144) and Sig. value (p = 0.035) indicates that human resource has negatively and significantly affected first line ART drug stock out in public hospitals of AACAHB. Hence, human resource added significantly to the model/prediction of affected first line ART drug stock out in public hospitals of AACAHB. In other words, human resource in public hospitals of AACAHB significantly predicts the likelihood of first line ART drug stock out. Alternatively, human resource has significant impact on first line ART drug stock out in public hospitals of AACAHB. The result of the binary logistic regression also revealed that, for each one-unit decrease on human resource, the odds of first line ART drug stock out increase by 1.155. Hence, the study rejected the null hypothesis i.e., ***Ho4: The human resource factor has no significant impact on the stock out of ART in public hospitals of first line AACAHB*** and accept the alternative hypothesis. Hence, the study concluded that the human resource factor has significant impact on the stock out of first line ART in public hospitals of AACAHB.

The study also revealed that the unavailability of in-service training related to pharmaceuticals logistics management for professionals handling pharmaceuticals, the lack of record keeping and planning skills, and the skill gap in anticipating the demand of ART are the core contributing factor for first line ART drugs stock out in public hospitals of AACAHB. This finding supports the previous stud conducted by Berhanemeskel *et al*. (2016) which concludes limited supply planning capacity of the staffs as the contributing factors for the stock out of ART drugs. Besides this, the study supports a study conducted in Lesotho by Harries, *et al*. (2007) that founds human resource factors have a significant impact on the stock-out of ART drugs. They elaborated that human resource capacity affects the stock-outs of the health facilities.

4.5.2.5 Inventory Management

Odds of inventory management i.e., 0.404 as indicated in the above table indicate the likelihood of first line ART drug stock out in public hospitals of AACAHB. The B value of inventory management (-5.453) and Sig. value (p = 0.00) indicates that inventory management has negatively and significantly affected first line ART drug stock out in public hospitals of AACAHB. Hence, inventory management added significantly to the model/prediction of affected first line ART drug stock out in public hospitals of AACAHB.

In other words, inventory management in public hospitals of AACAHB significantly predicts the likelihood of first line ART drug stock out. Alternatively, inventory management has significant impact on first line ART drug stock out in public hospitals of AACAHB. The result of the binary logistic regression also revealed that, for each one-unit decrease on inventory management, the odds of first line ART drug stock out increased by 0.404.

Hence, the study rejected the null hypothesis i.e., ***Ho5: Inventory management has no significant impact on the stock out of first line ART in public hospitals of AACAHB*** and accept the alternative hypothesis. Hence, the study concluded that inventory management has significant impact on the stock out of ART in public hospitals of AACAHB.

The study also found that lack of effective communication among pharmacy, pharmaceutical warehouses and purchasing department, lack of precise set of rules, procedures, and guidelines which govern medication management are the major contributing factor for the stock out of ART drugs in public hospitals of AACAHB. A study conducted by Berhanemeskel *et al.* (2016) on 20 health centers in Ethiopia also revealed that the contributing factors for the stock-outs of ART drugs are related with inventory management. A study conducted by Tilahun *et al.* (2016) and Shewarega, *et al.* (2015) also revealed that poor inventory system such as regular updating of bin cards and filling appropriate quantity order played a significant impact on the stock-outs of ART drugs.

Summary of Logistic Regression Results

The result of binary logistic regression model depicts that all independent variables of first line ART drugs stock out in public hospitals of AACAHB; supplier performance (p = .018), health system support (p = .006), ICT use (p = .040), human resource (p = .035), and inventory management (p = .000) added significantly to the model/prediction of first line ART drug stock out in public hospitals of AACAHB. In another word, based on the above table, all of the identified independent variables have statistically significant effect/impact on the first line ART drugs stock out in public hospitals of AACAHB. Based on the results of B value, first line ART drugs supplier performance, health system support, ICT use, human resource, and inventory management has negative and statistically significant effect on first line ART drugs stock out in public hospitals of AACAHB.

The result of the binary logistic regression also revealed that, for each one-unit decrease on ART drugs supplier performance, the odds of first line ART drugs stock out increased by 0.775. The odds of health system support indicates that for each one-unit decrease on health system support, the odds of first line ART drugs stock out increased by 7.448. The odds of ICT use also implies that, for each one-unit decrease on ICT use in public hospitals of AACAHB, the odds of first line ART drugs stock out in public hospitals of AACAHB increased by 0.397. The odds of human resource also imply that, for each one-unit decrease on human resource in public hospitals of AACAHB, the odds of first line ART drugs stock out in public hospitals of AACAHB increased by 1.155. The odds of inventory management imply that, for each one-unit decrease on inventory management in public hospitals of AACAHB, the odds of first line ART drugs stock out in public hospitals of AACAHB increased by 0.404.

Then the equation of the binary logistic regression would be:

$$SOT = \log\left(\frac{p(y=1)}{1-(p=1)}\right) = \mathbf{17.834 - 0.254SP - 5.453IM - 0.144HR - 2.008HS - 0.923ICT + \varepsilon}$$

CHAPTER FIVE: SUMMARY OF MAJOR FINDINGS, CONCLUSION, AND RECOMMENDATION

The study aimed to examine the determinants of stock-out of first line antiretroviral (ART) therapy drugs in the case of public hospitals of AACAHB. In conducting this study, the required data was obtained through self-administered 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. Moreover, the study has designed six specific objectives and five hypotheses to test and address in the study. The summary of the research findings is presented as follow.

The first objective of the study was to assess the stock level of first line ART drugs in public hospitals in Addis Ababa. The stock-out/availability of first line ART drugs in public hospitals of AACAHB were examined by the researcher in three pillars such as stock-out/availability of ART drugs during the last one year (i.e., Sep 2021 – Sep 2022), the frequency of stock-out, and number of days of stock-out. As per the observation of bin card records, for a period of the last one year (Sep 2021 – Sep 2022), all of the public hospitals of AACAHB have encountered stock out for at least one of the first line ART drugs. The result also shows that out of 13 first line ART drugs, 23% of them (namely AZT/3TC, 300/150mg, EFV 600mg, and ABC/3TC, 120/60mg) have been stocked out in all public hospitals of AACAHB. Among the 13 first line ART drugs, only 15% (namely as 3TC 150mg and ABC, 300mg) of them were never been stocked-out during the past one year, while the remaining 85% have been stocked-out in either of the six public hospitals. The study further revealed that three products out of first line ART drugs; namely AZT/3TC, 300/150mg, EFV 600mg, and ABC/3TC, 120/60mg were found to be stock outs in all public hospitals of AACAHB for an average of three, two, and three times respectively in the indicated period. The assessment revealed that, despite of those drugs which were never been stock-out (such as 3TC 150mg & ABC 300mg), the remaining 11 drugs were stocked-out for one up to four times in a year, and on average these drugs were stocked out for

2.3 times in a year. Among all first line ART drugs, DTG 50mg is found to be the most frequently stocked out drug (i.e., stocked out four times in a year) followed by AZT/3TC 300/150mg, EFV 50mg, ABC/3TC 120/60mg, and AZT, 10mg/ml solution which stocked out three times in the indicated period. In contrary, TDF/3TC 300/300mg, EFV 200mg, and AZT/3TC 60/30mg were found to be stocked out only one-times a year and hence these items are the least frequently stocked out items in a year. The assessment revealed that, despite of those drugs which were never been stocked out in the last one year, the remaining 11 drugs were stocked-out for a range of 3 – 215 days in a year, and on average these drugs were stocked out for 47 days in a year. The mean duration of stock out days was longer for EFV 200mg (215 days) followed by EFV 200mg (87 days), AZT 10mg/ml solution (38 days), AZT/3TC 300/150mg (36 days), and ABC/3TC 120/60mg (34 days) respectively. In contrary, the mean duration of stock out days in the past one year was least for AZT/3TC 60/30mg (4 days) followed by EFV 50mg (13 days) and TDF/3TC/EFV 300/300/400mg (15 days) respectively.

For addressing the remaining five objectives and hypothesizes, the study utilized correlation and logistics regression analysis. The correlation analysis revealed that there is statistically significant and negative relationship between all independent variables (such as performance of ART supplier, health system support, ICT, human resource factor, and inventory management) and dependent variables (i.e., stock out of first line ART drugs) in the public hospitals of AACAHB. The correlation analysis further revealed that, among the identified determinants of the stock out of first line ART drugs, there is relatively largest association or relationship between inventory management and ART stock out followed by between human resource and ART stock out and health system support; while there is smallest relationship or association between supplier performance and ART stock out followed by ICT use.

In order to examine the effect of the identified independent variables on the dependent variable, the study conducted Binary logistic regression analysis. The result of binary logistic regression model depicts that all independent variables of first line ART drugs stock out in public hospitals of AACAHB added significantly to the model/prediction of first line ART drug stock out in public hospitals of AACAHB. In another word, all of the identified independent variables have statistically significant effect on the first line ART drugs stock out in public hospitals of AACAHB. Among the identified independent variables, inventory management has the greatest impact on the stock out of first line ART drugs in the public hospitals followed by health system support, ICT, ART supplier performance, and human resource factors

respectively. The result of hypotheses also revealed that, the study has rejected all of the null hypotheses and accepted alternative hypotheses.

5.2 Conclusions

Based on the above findings, all of the public hospitals of AACAHB have encountered stock out for at least one of the first line ART drugs during the last one year. Among the first line ART drugs, AZT/3TC, 300/150mg, EFV 600mg, and ABC/3TC, 120/60mg have been stocked out in all public hospitals of AACAHB. Among the 13 first line ART drugs, only 3TC 150mg and ABC 300mgwere never been stocked-out during the past one year. Among all first line ART drugs, DTG 50mg is found to be the most frequently stocked out drug (i.e., stocked out four times in a year) followed by AZT/3TC 300/150mg, EFV 50mg, ABC/3TC 120/60mg, and AZT, 10mg/ml solution which stocked out three times in the indicated period. The mean duration of stock out days was longer for EFV 200mg (215 days) followed by EFV 200mg (87 days), AZT 10mg/ml solution (38 days), AZT/3TC 300/150mg (36 days), and ABC/3TC 120/60mg (34 days) respectively. On the other hand, the longest duration of ART stock out in the indicated period is observed in Yekatit 12 Hospital (63 days) followed by Menelik II Referral Hospital (55 days); whereas the least duration of ART drug stock out is observed in Zewditu Memorial and Tirunesh Beijing General Hospital with a stock out duration of each 19 days in a year.

The study concludes that there is statistically significant and negative relationship between all independent variables (such as performance of ART supplier, health system support, ICT, human resource factor, and inventory management) and dependent variables (i.e., stock out of first line ART drugs) in the public hospitals of AACAHB. The study concluded that there is relatively largest association or relationship between inventory management and ART stock out followed by between human resource and ART stock out and health system support; while there is smallest relationship or association between supplier performance and ART stock out followed by ICT use. The study further concluded that all of the identified independent variables have statistically significant effect on the first line ART drugs stock out in public hospitals of AACAHB. Among the identified independent variables, inventory management has the greatest impact on the stock out of first line ART drugs in the public hospitals followed by health system support, ICT, ART supplier performance, and human resource factors respectively.

5.3 Recommendations

Based on the conclusions as shown in previous section, the following measures are recommended for the public hospitals of AACAHB and other concerned bodies.

- As indicated in the finding of the study regarding with the stock out of first line ART drugs in public hospitals of AACAHB, AZT/3TC, 300/150mg, EFV 600mg, and ABC/3TC, 120/60mg have been stocked out in all public hospitals of AACAHB. Hence, both the concerned supplier of these products as well as the public hospitals have to give much emphasis in ensuring the availability of these drugs in the public hospitals. Besides this, since the longest duration of ART stock out is observed in Yekatit 12 Hospital followed by and Menelik II Referral Hospital, these hospitals have to identify the reasons affecting this to happen and tackle the problems thereby ensure minimizing the lead time of getting these items in their hospitals.
- Among the identified independent variables, the study concluded that inventory management has the greatest impact on the stock out of first line ART drugs in the public hospitals. Regarding with this, the study recommended the following points based on the descriptive analysis results.
    - The hospitals have to establish effective communication system among pharmacy, pharmaceutical warehouses, purchasing department, and other players in the supply chain.
    - As indicated in the study, the hospitals are reluctant in following the rules and procedures of inventory management. Hence, the hospitals should be governed by rules, procedures, and guidelines of medication management.
- Health system support is the second main determinant affecting the stock out of first line ART drugs in the public hospitals. Regarding with this, the study indicated that the pharmacy department in the hospitals didn't get adequate supportive supervision from higher level managements. Hence, the hospitals should establish a comprehensive monitoring tool in order to track the stock out level of the drugs and provide frequent supportive supervision to the pharmacy departments.
- ICT is ranked as the third determinant affecting the stock out of first line ART drugs in the public hospitals. Regarding with this, the study recommends that the public hospitals have to strengthen their ICT and have to utilize the internet-based and non-

internet-based communication plat form to exchange pharmaceutical logistics information with stakeholders.

- ART supplier performance is ranked as the fourth determinant affecting the stock out of first line ART drugs in the public hospitals. Regarding with this, the study recommends that:
  - The hospitals have to work closely with the suppliers and ensure the procurement of long expiry ART drugs.
  - The hospitals have to provide the forecasted demands of ART drugs and notified to the suppliers a head time and ensure the availability of the drugs in the store of the supplier.
- Human resource factor is ranked as the fifth determinant affecting the stock out of first line ART drugs in the public hospitals. Regarding with this, the recommendation is presented as below.
  - The hospitals have to provide in-service training related to pharmaceutical logistics management for professionals managing pharmaceuticals.
  - Record keeping and planning of ART drugs have to be provided to the pharmacy personnel of the hospitals.

5.4 Future Research Direction

This study only limited to first line ART drugs supply chain management of public hospitals of AACAHB and did not include pharmaceutical fund and supply agency (PFSA) and also didn't include the first line ART supply chain management with client's perspective. Hence further research should be conducted on the supply chain management of ART drugs to triangulate the hospital supply chain management with PFSA and to see the ART client's satisfaction on the supply chain management of ART drugs from customer service perception. Besides this, among different determinants of the supply chain management of pharmaceutical products, this study examined only inventory management, suppliers' performance, human resource factors, and health system support. Besides this, only quantitative approaches were utilized. Hence, future researches should examine a wide range of dimensions of the supply chain management of pharmaceuticals and use mixed approach.

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Appendices

Appendix A: Diagnostic Test Results of Logistic Regression Assumptions

Table 4.12: Linearity Test (ANOVA Table)

			Sum of Squares	df	Mean Square	F	Sig.
ART Stockout * Supplier Performance	Between Groups	(Combined)	1.811	8	.226	1.059	.000
		Linearity	.055	1	.055	.258	.030
		Deviation from Linearity	1.755	7	.251	1.174	.102
	Within Groups		25.213	118	.214		
	Total		27.024	126			
ART Stockout * Inventory Management	Between Groups	(Combined)	12.778	15	.852	5.619	.000
		Linearity	10.891	1	10.891	71.837	.000
		Deviation from Linearity	1.887	14	.135	.889	.573
	Within Groups		16.829	111	.152		
	Total		29.606	126			
ART Stockout * Human Resource	Between Groups	(Combined)	7.334	13	.564	2.862	.000
		Linearity	4.364	1	4.364	22.143	.000
		Deviation from Linearity	2.970	12	.247	1.256	.255
	Within Groups		22.272	113	.197		
	Total		29.606	126			
ART Stockout * Health System Support	Between Groups	(Combined)	7.124	7	1.018	5.387	.000
		Linearity	2.224	1	2.229	11.797	.001
		Deviation from Linearity	4.895	6	.816	4.318	.111
	Within Groups		22.482	119	.189		
	Total		29.606	126			
ART Stockout * ICT	Between Groups	(Combined)	8.859	10	.886	4.953	.000
		Linearity	1.836	1	1.836	10.264	.002
		Deviation from Linearity	7.023	9	.780	4.363	.062
	Within Groups		20.748	116	.179		
	Total		29.606	126			

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

Table 4.13: Multicollinearity Test

	Tolerance	VIF
Supplier Performance	.917	1.091
Inventory Management	.452	2.211
Human Resource	.571	1.750
Health System Support	.457	2.187
ICT	.757	1.320

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

Table 4.14: Normality Test (Shapiro-Wilk)

	Statistic	Df	Sig.
Supplier Performance	.519	127	.062
Inventory Management	.750	127	.077
Human Resource	.729	127	.122
Health System Support	.630	127	.231
ICT	.533	127	.056

Source: *Own Survey Result (2022), SPSS V 26*

Appendix B: 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: Determinants of Stock-Out of First Line Antiretroviral Therapy (ART) Drugs: The case of Hospitals of Addis Ababa City Administration Health Bureau, Addis Ababa, Ethiopia

Dear Respondent,

My name is Tewodros Zewde, a student of Addis Ababa University, School of Commerce pursuing a Master of Arts Degree in Logistics and Supply Chain Management. Kindly spare some minutes to answer these questions. Information obtained will be treated with confidentiality and will be used only for the purpose of this study. Your involvement in this study is extremely valuable and greatly appreciated to address the study's concerns.

Thank You for Your Cooperation

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. Senior Pharmacist ☐
   C. Pharmacist ☐
   D. Clinical Pharmacy ☐
   E. Druggist ☐

Part -II: Factors Affecting the Stock-out of ART drugs

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	***ART Drugs Supplier Performance***					
6	The service of PFSA is satisfactory in providing ART drugs to our hospital					
7	There exists on time in delivery of ART drugs from PFSA to our hospital					
8	PFSA doesn't reduce quantity of ART drugs ordered by our hospital (it supplies same as ordered quantity)					
9	There has not been stock out of ART drugs at PFSA in this year.					
10	Our hospital not usually faced supply of short expiry ART drugs by PFSA					
11	There is no visible gap of order fill rate of drugs in our suppliers					
B	***Inventory Management***					
12	In our hospital ART drugs are arranged on shelves with arrows pointing up, and with identification labels, expiry dates, and manufacturing dates clearly visible.					
13	HIV commodities in our hospital are stored and organized to FEFO (first expire first out) procedures, and were accessible for counting and general stock management.					
14	In our hospital, Pharmaceuticals in the drug store are managed by academically qualified staff (Trained Druggist or Pharmacist)					
15	In our hospital, appropriate inventory is conducted periodically.					
16	The hospital's medication management is governed by a precise set of rules, procedures, and guidelines.					
17	In our hospital, there is effective communication among pharmacy, pharmaceutical warehouses and purchasing department					
C	***Human Resource Factor affecting ART drugs Stock-Out***					
18	In our hospital, in-service training related to pharmaceuticals logistics management is usually provided for professionals handling pharmaceuticals					
19	The hospital has adequate number of staff responsible for management and dispensing medicines					
20	The hospital has adequately qualified staff to manage medicines (ART drugs)					
21	The hospital staff usually make timely requests and medicines orders					
22	The hospital staff are well trained in record keeping and planning for ART drugs					
23	In our hospital, the pharmacy personnel are able to anticipate ART needs of our hospital.					

No.	Attributes	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
D	***Health System Support (Management Support)***					
24	Our department (Pharmacy) gets adequate supportive supervision from higher level managements in the last one-year.					
25	In our hospital, reliable logistics data is usually sent to PFSA					
26	RRF (Report and Request Form) is usually timely submitted to PFSA in our hospital.					
E	**Information and Communication Technology (ICT) Use**					
27	Our hospital usually involve in pharmaceutical logistics social media group (Viber, Telegram) for exchanging logistics information					
28	The use of SMS messaging and phone call for exchange of logistics data with stakeholders involved in pharmaceutical logistics management is practiced in our hospital					
29	The use of an internet to exchange pharmaceutical logistics data with stakeholders involved in pharmaceuticals logistics management is practiced in our hospital					
30	Electronic logistics management information system (LMIS) is utilized in our hospital.					

31. have you ever observed a stock out of first line ART drugs at your hospital during the last one year (Sep 2021 – Sep 2022)?

A. Yes ☐

B. No ☐

Part-III: Stock Out Status of First Line ART Drugs at Your Hospital

32. Fill in the following table based on the inspection on inventory or Bin or stock cards. (To be filled by the researcher)

No.	List of ART drugs	Stock outs within the study period (Sep 2021 to Sep 2022) (Yes/No)	Avg. Frequency of Stockouts (Apr 2021 – Apr 2022)	No. of Days of Stock-out (Mean, range)
1	TDF/3TC, 300/300mg			
2	AZT/3TC, 300/150mg			
3	DTG 50mg			
4	EFV, 50mg			
5	EFV, 200mg			
6	EFV, 600mg			
7	3TC, 150mg			
8	ABC, 300mg			
9	ABC/3TC, 120/60mg			
10	TDF/3TC/DTG, 300/300/50mg			
11	TDF/3TC/EFV, 300/300/400mg			
12	AZT/3TC, 60/30mg			
13	AZT, 10mg/ml solution			

Thank you for your time!