ASSESSMENT OF MOLECULAR LABORATORY LOGISTICS MANAGEMENT PRACTICES AND THE CHALLENGES DURING COVID-19 EMERGENCY IN ETHIOPIA: THE CASE OF ETHIOPIA PUBLIC HEALTH INSTITUTE AND ETHIOPIA PHARMACEUTICAL SUPPLY SERVICE.

BY

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Assessment of molecular laboratory logistics management practices and its challenge during Covid-19 emergency in Ethiopia: The Ethiopia Public Health Institute and EthiopianPharmaceutical Supply Service.

Approved by Board of Examiners

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DECLARATION

I, the undersigned, declare that this thesis entitled 'Assessment of molecular laboratory logistics management practices and ITS challenge during Covid-19 emergency in Ethiopia: The case of Ethiopia Public Health Institute and Ethiopia Pharmaceutical Supply Service.' is my original work and that I have not previously in its entirety or in part submitted at any university for a degree and all the sources of materials used for the thesis have been duly acknowledged.

Name: Henok Birhanu Belay

Signature:_____

Date of submission: 06/24/2022

LETTER OF CERTIFICATION

This is to certify that Henok Birhanu has carried out this study under my supervision on the topic of"Assessment of molecular laboratory logistics management practices and the challenges during Covid-19 emergency in Ethiopia: The Ethiopia Public Health Institute and Ethiopian Pharmaceutical Supply Service". This work is original in its nature and is acceptable for Submission in partial fulfillment of the requirement for the award of Masters of Arts Degree in Logistics and Supply Chain Management.

Advisor:Dr Shiferaw Mitiku

Signature_____

Date _____

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The researcher

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ABBREVIATIONS AND ACRONYMS

AAU----------Addis Ababa University

BSL ----------Biosafety Levels

COVID----------Corona Virus Disease 2019

CDC----------Center of Disease Control.

COVID-19 ----------Coronavirus Disease-19

EFDA----------Ethiopia Food and Drug Authority

EPHI----------Ethiopian Public Health Institute

EUA----------Emergency Use Authorizations

EPSA----------Ethiopian Pharmaceuticals Supply Agency

EPSS----------Ethiopian Pharmaceuticals Supply Service

FDA----------Food and Drug Administration

FMOH----------Federal Ministry of Health

LMIC ----------Low and Middle-Income Country

LIS----------Logistics Information System

MERS-COV----------Middle East Respiratory Syndrome Corona Virus

MOH----------Ministry of Health

NGO----------Non-Governmental Organization

NAAT----------Nucleic Acid Amplification Test

PPE----------Personal Protective Equipment

RNA----------Ribonucleic Acid

RT- PCR----------Reverse Transcriptase Polymerase Chain Reaction

SPSS----------Statistical Package for Social Sciences

USAID----------United State Aid for International Development

WHO----------World Health Organization

Abstract

In order to control public health emergency disease laboratories, need good-quality, uninterrupted supplies of test reagents and other consumables Covid-19 molecular diagnosis is one of such tests that need reagents and supplies be available in each testing site timely, with physical integrity and with the right quantity for successfully combating the pandemics. The main objective of this study was to assess the molecular laboratory logistics management practice and its challenge during Covid-19 emergency in Ethiopia in the case of Ethiopian Pharmaceuticals Supply Agency and Ethiopian Public Health Institute. These included the logistics management practices in procurement, warehouse and storage, inventory, transportation and distribution, logistics management information system and related challenges. Descriptive research design was used to address the objectives. The population of the study consisted of employees of the Ethiopian Pharmaceuticals Supply Agency and Ethiopian Public Health Institute deployed for the emergency. The operational areas included warehouse and inventory management, distribution and fleet management, tender and contract management, emergency operation center, molecular laboratory, and logistics unit from which the sample was drawn. The appropriate sample has been drawn through applying stratified random sampling.Primary data sources were used for this research. A self-administered questionnaire was designed to collect relevant information from the selected 96 respondents. Among these 96 questionnaires were returned and analyzed using Statistical Package of Social Science (SPSS) version 24. The percentage, mean and standard deviation of descriptive analysis were employed. Through the descriptive statistical analysis, an overall mean score was computed for logistics management practicein the case ofEthiopian pharmaceuticals Supply service. The study revealed that inventory management practice (M=3.6143) was relatively highly agreed practice logistics activity in Ethiopian pharmaceuticals Supply service and followed by procurement (M=3.5669) and logistics management information system (M=3.4740). In the case of Ethiopian Public Health institute, the logistics management practice of Covid-19 molecular laboratory reagents and consumables showed that the transportation and distribution management practice(M=2.86) and warehouse and storage management practice(M=3.12) were medium practiced. The study indicated that during Covid-19 pandemic the Ethiopian public health institute were facing different challenges among those human resource related challenges was the major one in affecting Covid-19 molecular laboratory logistics management. Furthermore, internal and external challenge, infrastructural related challenge; top management support related challenge and legal issue were pointed outby many of the respondent from Ethiopian Public Health Institute. On the contrary, in the case Ethiopian Pharmaceutical supply Service the highly rated challenge was related with external challenge followed by internal challenge, infrastructural related challenge, and top management support related challenge.

In conclusion Ethiopian Pharmaceutical Supply Service should handle all laboratory reagents and consumables logistics management practice and Ethiopian public Health institute should focus on quality assurance, specification development and innovative local reagents production.

***Key words**: Logistics, Procurement, warehouse, storage, inventory management, transport, and distribution information system*

CHAPTER ONE

INTRODUCTION

This chapter introduces the background, Ethiopian public health institute background, statement of the problem, objectives, significance, scope, limitation, and delimitation of the study, definition of terms and organization of the study in detail

1.1. Background of the study

Three major coronavirus viruses have threatened humanity in the past 20 years: SARS-CoV-1 in 2003, MERS-CoV in 2012, and the SARS-CoV-2 pandemic in 2019. In December 2019, Wuhan, Hubei Province, China, reported the discovery of the epidemic. The epidemic was declared a public health emergency of worldwide concern by the World Health Organization (WHO) on January 30, 2020, and it was identified as an outbreak on March 11, 2020. (Tolu,2020).

It is crucial to consider the testing requirements and the ways in which the logistics, purchasing, and testing capabilities of diverse nations frequently affect these requirements. Africa's response to COVID-19 makes it clear that the motto of "test, test, and test" is unachievable in many African countries due to the difficulty in obtaining the necessary reagents and supplies for the necessary testing. The continent's ability to increase its testing capacity has been severely constrained by its reliance on outside sources. This frequently occurs in spite of the pooled test procurement made possible by the WHO's global access to COVID-19 instruments. It's crucial to note that while only a few countries on the continent record the majority of cases, other nations don't necessarily have poor case reporting rates.

Although the African Union intends to distribute one million COVID-19 test kits across the continent, there is still a critical shortage, as there is in many other parts of the world. Despite being severely fragmented at the moment, the global supply chain is crucial for providing essential medical and laboratory supplies, including personal protective equipment for healthcare workers. Given the low manufacturing capability of the continent, this is especially troublesome for Africa. Up until routine supply chains are rebuilt, there is a need for trustworthy humanitarian aid corridors and services to ensure the availability of necessary goods (Philip J, 2020).

A number of borders were closed, flights were canceled, and commercial flights were grounded as a result of COVID- 19 pandemic lockdown measures supported by the majority of governments in the Region, which hampered the delivery of vital medical supplies and equipment to various countries. In order to ensure improved, fair access to necessities throughout each nation in the African region, WHO mandated the creation of humanitarian corridors and Solidarity Flights. In order to overwhelm the disjointed supply chain, cooperation among nations and organizations was crucial. Ethiopian Airlines was one of the few airlines still in business with a sufficient fleet, storage space, and a negative cold chain, which explains the decision to deliberately choose the national capital as a central hub to receive all cargo from various parts of the country and distribute them to countries in the African Region.

To ensure that as many nations as feasible within the WHO African Region were prepared to test for COVID-19 by RT-PCR, WHO started preparing its Member States and mobilizing the influenza laboratory network. WHO provided assistance when the first COVID-19 case was discovered in the region, during 2020, (WHO Africa region, 2020).

Ethiopia was unable to take the COVID-19 test, just like practically all of Africa. The National Institute for Communicable Diseases (NICD) Laboratory in South Africa, a WHO regional reference laboratory, was first tasked with examining the samples. By 7 February 2020, EPHI had created the National Influenza and Arboviruses Reference Laboratory, the first COVID-19 testing facility in the nation, with assistance from WHO and the Africa Centers for Disease Control and Prevention. After the CoVID-19 diagnostic laboratory was established at EPHI, training was offered to lab staff, and donations of COVID-19 detection and extraction kits and reagents were made. Early in the reaction, the pre-existing laboratory network with regional public health laboratories was used to expand COVID-19 laboratory testing locations to the regional state, universities and laboratories under the Ministry of Agriculture (Lanyero B,2021).

This research is proposed to assess the experience of the Ethiopian public health institute and Ethiopia pharmaceutical supply service on their role in the shipment of Covid-19 reagents and consumables from sources around the world to testing laboratories to equip the Covid-19 diagnostics laboratory with the required logistics. Moreover, to dealwith a number of the logistical challenge faced by the EPHI and EPSS to test the novel Covid-19 virus during the pandemic. The findings can potentially help with future preparedness on epidemics or pandemics and identify challenges within the logistical aspect of Covid-19 diagnosis and management.

1.2. Background of the study area

A. The Ethiopian Public Health Institute (EPHI): It is the result of the merger in April 1995 of the former National Research Institute of Health (NRIH), the Ethiopian Nutrition Institute (ENI) and the Department of Traditional medicine (DTM) of the Ministry of Health.The merger was affirmed by the council of minister's regulation No 4/1996, which recognized the Institute as an autonomous public authority having its own legal personality. The institute is accountable for the Federal Minister of Health.

The Ethiopian Public Health Institute (EPHI) was established in 2014. EPHI's work builds upon the strong foundation of the Ethiopian Health and Nutrition Research Institute (EHNRI) which opened in 1996 with the goal of using health research to inform national health policy. Valid health information is crucial as the basis for effective decisions to improve health and general well-being of the population, and the government is committed to improve and develop health-related research activities in the country. In response to prevailing and newly emerging health problems, EPHI has developed and implemented different projects based on HSDP focus areas (EPHI, 2014).

Currently, EPHI has running more than 72 programs. In each program there are several short terms like one-time surveys or research and long-lasting projects. As per the informal information, all these programs/projects are planned by the individual principal investigator because most of the projects are research related. Since EPHI is the operational wing of FMOH, most of the health-related projects conducted in Ethiopia are passes through EPHI; the major projects of the institutes are granted or funded by FMOH, WHO, CDC, different NGO, Universities and so on.

B. Ethiopia Pharmaceutical Supply Service: The continuous availability of quality-assured and affordable pharmaceuticals accompanied by their rational use is critical for the provision of quality health services. Pharmaceuticals Supply Agency (PSA), formerly known as Pharmaceuticals Fund and Supply Agency (PFSA), was established as a semi-autonomous public institution in 2007 to supply quality assured and affordable pharmaceuticals to all public health facilities in the country. The Agency has contributed its part for the achievements made in the health sector regarding the reduction of morbidity and mortality associated with both communicable and non-communicable diseases. Since its establishment, the Agency has been building its capacity in terms of human resource and supply chain systems at all levels. As a result, the Agency's capacity in procuring, storing and distributing pharmaceuticals through the Revolving Drug Fund (RDF) and various programs has increased significantly.

The Agency has also played a pivotal role in increasing the capacity of the supply chain workforce at all levels in all aspects of the supply chain management system. The Integrated Pharmaceuticals Logistics System (IPLS) implemented since 2010 to integrate the supply management of pharmaceuticals that were previously managed in a vertical manner has improved the management of pharmaceuticals thereby contributing to an increased availability of essential pharmaceuticals at service delivery points (SDPs). The Agency has made great efforts to make it more accessible to health facilities by establishing new branches at strategic locations throughout the country to meet the target set on the Pharmaceutical Logistics Master Plan (PLMP). Despite these achievements, there remains a gap in meeting the ever-increasing pharmaceutical demand of the country which emanates from various operational inefficiencies as revealed by the Business Process Re-engineering (BPR) study and the recently conducted Pharmaceutical Supply Transformation Plan (PSTP) midterm review. To address the identified gaps and thereby achieve the continuous supply of pharmaceuticals, the Agency is designing and implementing various initiatives. The Agency has taken critical steps defining the list of pharmaceuticals it avails by developing a national pharmaceutical procurement list through a consultative process.

Other commendable initiatives have also been instituted such as establishing the warehouse operations management center of excellence, the Strategic Plan on Human Resource Development, the Strategic Plan on Immunization Supply Chain Management, the Pharmaceutical Supply Chain Management Monitoring & Evaluation Framework, and the launching of a procurement system through framework agreement. Taking findings from the BPR study and the PSTP mid-term review into consideration, the Agency has now revised its strategic plan that will be used for the coming two and half years. The Agency strives to excel in customer relations management, supply chain workforce development and management, and information management and usage with the ultimate goal of achieving the continuous supply of quality assured and affordable essential pharmaceuticals to health facilities. (Revised PSTP, 2018).

1.3. Statement of the problem

The COVID-19 outbreak has resulted in a severe lack of materials and life-saving medical supplies like personal protective equipment (PPE), diagnostic tools, and clinical care items that are required to lessen suffering and prevent fatalities within the WHO African Region. Travel restrictions put in place by nations at the start of the pandemic worsened market imbalances, making it extremely difficult to get

vital medical supplies and equipment to countries in the Region. For low-income nations, it will be very difficult, if not impossible, to go to the world market alone to purchase commodities and negotiate fair rates. Priority medical products, such as laboratory reagents and pharmaceuticals, were subject to export restrictions due to country lockdowns and border closures, which might have led to unrest and stockouts(WHO Africa region, 2020).

Infectious disease outbreaks are frequently viewed as high-impact, low-frequency supply chain disruptions. When supply, demand, and logistical infrastructure are disrupted at the same time, they pose a supply chain risk. Both in the manufacturing disturbance that was noticed and in the downstream logistics system that delivers diagnostic tests to end users, this disruption for COVID-19 diagnostic tests was perceptible. In order to access the biological components and the primary sources for production, a double bottleneck appeared early in the pandemic. (Oliver, 2020).

Due to these, Africa has had significant logistical difficulties obtaining the appropriate COVID-19 testing kits, falling behind in the diagnostic market. The collapse of international solidarity and global collaboration has forced Africa out of the diagnostics market. While there are a number of initiatives, such as the Africa CDC's Partnership to Accelerate COVID19 Testing and the WHO global pool procurement mechanism, it is becoming more and more obvious that the majority of African nations will not be able to quickly overcome the logistical difficulties to provide enough testing to all patients who are either suspected of having an infection or who are recovering from infection. (Lydia,2021).

Healthcare systems generally have appallingly poor data tracking and inventory management tracking capabilities. Healthcare procurement departments commonly use third-party distributors to buy their products, which are frequently selected based on the lowest price. They also maintain a minimal inventory and rely on the weekly just-in-time deliveries from these wholesalers. As a result, many of these wholesalers rely on affordable countries like China (masks and gowns), Vietnam, Indonesia, and other Asian countries as their main suppliers of gloves (ventilators). Healthcare systems in these nations were brought to their knees in March 2020 when a global crisis stopped exports from them. (D.J. Finkenstadt,2021).

Real-time reverse transcriptase-polymerase chain reaction (rRT-PCR), a precise and sensitive molecular technique, is the "gold standard" for the diagnosis of COVID-19. To maintain their bioactivity, PCR reagents must be transported and stored at low temperatures. This poses difficulties for the already

overworked transportation logistics networks and the cold storage facilities at diagnostic and medical facilities. (Jiasu U,2020).

Almost all diagnostic consumables and the test kit itself are dependent on the worldwide market under national import rules and permits, which presents a logistical difficulty. It is tough to find small yet necessary products in the neighborhood market. As a result, the Ethiopian Food and Drug Authority (EFDA) and other organizations are significantly accelerating the approval process for Covid-19-related items, even if each procurement process must follow the current regulatory requirements. (Andargachew M, 2021).

The recommended method for verifying COVID-19 is laboratory diagnosis using nucleic acid amplification assays (NAATs), such as reverse-transcriptase polymerase chain reaction (RT-PCR). However, the readiness assessment carried out by WHO in February 2020 revealed that many nations, including Ethiopia, lacked the ability to test for COVID-19. Additionally, the resource-intensive RT-PCR technology may have been constrained in environments with low resources(Adisu K, 2021).

The availability of SARS-CoV-2 diagnostic testing for patients was quickly made possible by clinical laboratories, but supply chain constraints have limited testing capacity and created bottlenecks that have prevented widespread availability of these critical tests. The initial data set on the effectiveness of SARS-CoV-2 diagnostics reflected only symptomatic patients, biased toward the ill due to these critical shortages and CDC recommendations providing specific clinical presentation and epidemiologic criteria to identify those eligible for diagnostic testing. (Fredericks, 2020).

The deployment of COVID-19 molecular diagnostics was slowed in the early stages of the pandemic due to a lack of equipment, reagent capacity, and laboratory environmental protection measures, including personal protective equipment. This added to the stress and exhaustion of laboratory professionals who had to deal with unexpectedly high and urgent testing demands. (Kenneth P, 2021).

Since the majority of this equipment is either assembled or manufactured by in Western countries, the infrastructural design of such laboratories as well as equipment servicing contracts may present a barrier for many African countries. The production cannot be scaled up rapidly enough by the companies that make PCR platforms, including Roche, Abbott, Hologic, Thermo Fisher, and Cepheid. And even if they could, it's likely that the West would be their top focus. The provision of laboratory supplies is always essential to facilitate timely testing and the release of test results for suspected patients. However, this is

currently severely fragmented, and the availability of test reagents and consumables is constrained, making capacity mobilization difficult(Lydia M, 2021).

Numerous nations have seen the advantages of extensive COVID-19 testing. However, the majority of LMICs, including most of those in Africa, lack the resources necessary for large-scale testing. In their attempts to identify suspect cases, track down contacts for additional testing, and implement surveillance testing, these nations are up against a number of obstacles. Among other issues, a lack of test kits was primarily mentioned as a result of excessive global demand. (Kobiaf, 2020).

1.4. Research Questions

The research answers the following research question

- How Covid-19 molecular laboratory logistics is being practiced in EPHI and EPSS in terms of (procurement, transportation, storage, distribution, logistics management information system and inventory management)?
- What are the major challenges of Covid-19 molecular laboratory logistics management at EPHI and EPSS?

1.5. Objective of the study

1.5.1. General objectives

- To assess the Covid-19 molecular laboratory logistics practices and identify its challenge during Covid-19 emergency in Ethiopia Public Health Institute and Ethiopia Pharmaceutical Supply Service.

1.5.2. Specific objectives

- To assess the Covid-19 Molecular laboratory logistics practices of EPHI and EPSS in terms of (procurement, transportation, storage, distribution, logistics management information system and inventory management)
- To assess Covid-19 Molecular laboratory logistic related challenges of EPHI and EPSS

1.6. Significance of the study

Security of supplies is a growing worldwide concern as developing nations like Ethiopia face significant challenges due to a lack of resources and rising consumer demand for goods. As a result, demand is not

being met by supply. To face the problem of supplying supplies security, proper management of health products when they are obtained and subsequently ensuring that they reach the end users for whom they are meant are essential.

Once we have the data it would be the great input for the organization and the ministry to consider the result as an input to help the country to consider the experience and work on it to improve diagnostic testing response for current COVID-19 pandemic and future emerging outbreaks and they also help to full fill the gap identified during the study. The analyzed information helps to identify issues and opportunities and, from those, used to outline further assessment and/or appropriate interventions to undertake.

The results can be used to monitor and improve system performance and to provide critical data that can identify a country's laboratory commodity security strengths and weaknesses. Moreover, it provides stakeholders with a comprehensive view of all aspects of a logistics system raise collective awareness and ownership of system performance and goals for improvement and provide input for work planning.

1.7. Scope of the study

Qualitative cross-sectional study using structured questionnaire, focuses on the assessment of (procurement, transportation, storage, distribution, logistics management information system and inventory management) on Covid-19 molecular laboratory commodities by focusing on the Covid-19 testing reagents and consumables by considering the two institutions namely EPSS and EPHI.

1.8. Delimitation of the Study

The procurement, transportation, storage, distribution, inventory management and LMI on the supply of Covid-19 laboratory commodities in the country can be best studied by considering all the testing sites established during the pandemics. However, because of time and budget constraint, the researcher limits the objective to assess molecular laboratory logistics and challenge during Covid-19 emergency in four diagnostic testing sites established in Ethiopia Public Health institute and Ethiopia pharmaceutical supply service.

1.9. Definition of Terms/ Operational Terms

Inventory: Raw materials, work in process, finished goods and supplies required for creation of a company's goods and services; the number of units and/or value of the stock of goods held by a company (Kate V, 2006).

Pandemic: an epidemic occurring over a widespread area (multiple countries or continents) and usually affecting a substantial proportion of the population (CDC, 2006).

Personal protective equipment: Protective clothing (gowns, gloves, boots etc.) and equipment (masks, shields, respirators, earplugs etc.) necessary to shield or isolate a person from biological, chemical, physical, sonic and thermal exposure (WHO,2020).

Coronavirus: A family of related viruses. Many of them cause respiratory illnesses. Coronaviruses cause COVID-19, SARS, MERS, and some strains of influenza, or flu. The coronavirus that causes COVID-19 is officially called SARS-CoV-2, which stands for severe acute respiratory syndrome coronavirus 2 (UVAHealth, 2022).

Procurement: The business functions of procurement planning, purchasing, inventory control, traffic, receiving, incoming inspection, and salvage operations (Kate V, 2006).

Transportation Method: A linear programming technique that determines the least-cost allocation of shipping goods from plants to warehouses of from warehouses to customers (Kate V, 2006).

Distribution: Outbound logistics, from the end of the production line to the end user. The activities associated with the movement of material, usually finished goods or service parts, from the manufacturer to the customer. These activities encompass the functions of transportation, warehousing, inventory control, material handling, order administration, site and location analysis, industrial packaging, data processing, and the communications network necessary for effective management. It includes all activities related to physical distribution, as well as the return of goods to the manufacturer. In many cases, this movement is made through one or more levels of field warehouses. (Kate V, 2006).

COVID-19: The name of the illness caused by the coronavirus SARS-CoV-2. COVID-19 stands for "coronavirus disease 2019" (UVAHealth, 2022).

1.10. Organizations of the study

This research is arranged into five chapters. The first chapter briefs the background of the study, research problem, objectives, research questions, significant of the study, scope, delimitation, and definition of terms and organization of the study. While the second chapter reviews empirical literatures, the theoretical, conceptual framework of the study and identified literature gap. The third chapters focus on the description of study area, research approach, research design, target population, sampling techniques, sample size, data source, measurement instrument, data analysis, validity, reliability and ethical consideration. Finally, the last chapter deals with the summary of findings, conclusions, and recommendation.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter summarizes the review of theoretical and empirical literatures, conceptual framework of the study and identified literature gap

2.1. Theoretical Literature Review

2.1.1. Concept of Logistics

The military, which has long understood the need of logistical tasks for national defense, is where logistics had its start, claims the Council of Logistics Management (1998). Both personnel and supplies are included in the military concept of logistics. According to legend, the word logistics entered the military jargon in Europe in the 18th century. The logistics office was in charge of setting up camp, housing the soldiers, and stocking supply depots(Kumurya, A. 2015).

In the 1960s, the idea of logistics first appeared in business-related literature under the heading of physical distribution, which concentrated on the outward side of the logistics system. Military logistics started to put more of an emphasis on modeling and quantitative analysis in the 1960s as they started to concentrate on engineering aspects of logistics reliability, maintainability, configuration management,

life-cycle management, continuing supply support, etc. The corporate or commercial uses, in contrast, were typically more concerned with consumer nondurable items in relation to marketing and actual distribution of finished goods.The engineering related logistics, as practiced by the military, attracted attention among businesses that produced industrial products that had to be maintained with repair parts over the life cycle of the product, for example, generators, airplanes, manufacturing equipment, and so on. In fact, engineers developed a separate professional organization called the Society of Logistics Engineers, which has had active participation from both the military and commercial enterprises Businesses that created industrial products that needed to be maintained with maintenance parts during the course of the product, such as generators, airplanes, manufacturing equipment, and so on, were interested in the engineering-related logistics as done by the military. In reality, engineers established a distinct professional association called the Society of Logistics Engineers, in which both the military and business organizations actively participate(Kumurya, A. 2015).

Inbound logistics (materials management to support manufacturing or operations) and outbound logistics (physical distribution of finished goods to support marketing) are two branches of the corporate or commercial sector approach to logistics that emerged in the 1970s and 1980s. The business or commercial sector then started to consider logistics in the context of a supply or demand chain that connected all of the organizations from the vendor's vendor to the customer's customer in the 1990s(Gleissner & Femerling, 2013).

The planning, management, and control of all material flow activities, from raw materials through final consumption and reverse flows of manufactured items to satisfy customers, i.e. to deliver good customer service at a cheap cost and with minimal environmental impact, is known as logistics (Jonsson & Mattsson, 2005). The Seven R's, or actions linked to receiving the right product or service in the right quantity, in the right quality, in the right place, at the right time, delivering to the right client, and accomplishing this at the right cost, are the basis for the definition of logistics. (Shapiro & Heskett, 1985).

Contrarily, logistics management is a branch of supply chain management that organizes, carries out, and oversees the efficient, effective forward and reverse flow and storage of products, services, and associated information from the point of origin to the point of consumption in order to satisfy customer needs. Inbound and outbound transportation management, fleet management, order fulfillment, warehousing, material handling, supply/demand planning, logistics network design, inventory

management, and administration of third-party logistics service providers are among the tasks of logistics management(CSCMP, 2004).

Along with packaging and assembly, customer service, production planning and scheduling, and sourcing and procurement, the logistics function is involved in all stages of strategic, operational, and tactical planning and execution. Marketing, sales, production, finance, and information technology are all integrated with other areas through the logistics management function, which coordinates and optimizes all logistics activities(CSCMP, 2004).

2.1.2. Dimension of Logistics Management

It has long been understood and shown that logistics play a crucial role in a military campaign's eventual success. For more than 4,000 years, the term "war" has been used to describe logistical tasks and how they relate to strategy and tactics. Essentially, logistics is about ensuring client satisfaction. Every single one of us participates in the economy as both a supplier and a buyer. Even an employee serves as a supplier to their employer. It fulfills its purpose. This indicates that before a logistics plan can be created and put into place to meet those objectives, management must first understand what those requirements are. Where they are needed today, products are typically no longer produced. Therefore, they must be transported to the customers. Products are today manufactured, where it is most inexpensive. Logistic processes can be seen by different sides which comprises many components. In fact, some are major while the others are supportive activities (Dorn C, 2003).

Logistics is the global network that organizes and manages the shipping of goods to customers all over the world. Professionals in logistics manage and coordinate activities in this global pipeline where so many activities are involved even though one includes the other to ensure an effective and efficient flow of products and information from the time a need arises until it is satisfied. However, some of the key logistics-related tasks include product distribution, transportation management, and inventory management(Council of Logistics Management, 1998).

2.1.2.1. Procurement

Making sure the right products are on hand in the country and prepared for distribution when they are required requires careful planning and execution during the procurement process. You couldn't fulfill the six rights without procurement procedures and processes. The effective application of national procurement legislation and procedures is also ensured by a staff-staffed procurement unit. Public health supply purchases are typically managed by a purchasing division under the ministry of health,

central medical stores, or another such organization. The unit makes the necessary procurement of high-quality products in the right quantity to guarantee ongoing product availability. The procurement unit typically receives instructions from another department within the health system regarding what to buy, how to pay for it, how many of each item to buy, and other details. The personnel in charge of quantification typically have knowledge of product prices, budget development, and order amounts. However, they are likely to have experience with prior procedures. When you acquire items, you use procurement to make your decision; there are typically lots of options. The majority of the procurement process is focused on making it as fair and competitive as feasible because this involves the transfer of money, which is frequently considerable amounts of money. In order to prevent any party from claiming that one group was unfairly favored over another, good public sector procurement relies on rigorous documentation and transparency throughout the process. This implies that each step needs to be standardized and governed by laws and regulations that apply to the general public. However, this can also lengthen the procurement procedure. Understanding how long the typical procurement process takes is crucial for supply managers, program managers, procurement units, and other supply chain management interested parties; in order to ensure continuous availability, they must be able to plan procurement schedules and order quantities in a timely manner(USAID,2011).

2.1.2.2. Transportation and Physical Distribution

Practices in Transportation Management Transport refers to a group of activities that involve the efficient transportation of people, goods, and materials. Due to the transportation of commodities and the development of supplemental services, it is crucial to logistics (Grabara, 2014). The transport system is the component of a company's logistics system that contributes the most to economic activity. It establishes a physical connection by moving and storing production-related materials, as well as outbound logistic by moving and storing produced items for customers(Sabry, 2015).

From the point of manufacture of the good through its final delivery at the desired location, transportation is a key operation in the logistics chain. Transportation provides the crucial service of connecting an organization to its suppliers and customers by transporting goods from locations where they are sourced to locations where they are needed (Reddy and Jayam, 2016). Transportation is a crucial and essential sub-function of logistics that gives items their time and locational utility. The transportation management that enables the achievement of the illustrious seven Rs is, in fact, the foundation of the entire supply chain.

These are the right product in the right quantity and the right condition, at the right place, at the right time, for the right client at the right cost (Kumar and Shirisha, 2014). Transport plays a vital connecting function between the various phases that result in the conversion of resources into useable items. In order to reduce costs and improve customer service, company logistics entails organizing all of these operations and sub-functions into a system of product transportation (Tseng et al., 2005). Transport management deals with modes of transportation, fleet size, route choice, vehicle scheduling, and freight consolidation. These four regions are all economically interconnected and should be planned as a whole to maximize benefits(Reddy and Jayam, 2016).

In shipping goods to its warehouse, dealers and customers, the company chooses among five transportation modes namely road, rail, water, pipeline and air (Kotler, 2005).

i. Road - Trucks are highly flexible in their routing and time schedules. They are well organized for short hauls of high-value products. Also, there is increasingly greater freedom for international haulers to transport goods between destinations within one country, resulting in greater efficiency in the use of trucks.

ii. Rail - Railroads are one of the most cost-effective modes for shipping large amounts of bulk products namely coal, sand, minerals, farm and forest products over long distances

iii. Water - In countries favorably served by coastal and inland waterways, a large amount of goods can be moved by ships and barges. Water transportation is the slowest mode and is affected by the weather however, its cost is very low for shipping bulky, low-value, nonperishable products such as sand, coal, grain, oil and metallic ores.

iv. Pipeline - Pipelines are a specialized means of shipping raw commodities such as petroleum, natural gas and chemicals from sources to markets. Most pipelines are used by their possessors to ship their own resources.

v. Air - Although the use of air carriers tends to be limited to low-bulk goods, cargos freights are becoming more important as a transportation mode. Air freight is the best option when speed is required or distant markets must be reached, even when rail or truck rates are less expensive than air freight rates. The most frequently air-freighted items are those that are perishable (such as fresh seafood and cut flowers) as well as high-value and low-bulk (such as jewelry and technical equipment). Air freight has advantages since it requires fewer warehouses, lowers packaging costs, and lowers inventory levels.

Shippers must weigh a variety of factors when deciding on a mode of transportation for a product, including speed, dependability, availability, cost, capabilities, and others. When a shipper needs to move quickly, air and truck are the best options. Water or a pipeline may be more expensive if cost cutting is the goal. In practice, companies may depend on a combination of transportation means which would best able them to meet logistics objectives lucratively (Kotler *et al.* 2005).

Companies face more management difficulties when it comes to finished items since they are more worried about the flow from the end of the production line to the client. (Dorn C, 2003). A system where products flow from central medical shops to districts and regions, and finally to service delivery sites, is the most typical in-country distribution system because the majority of product manufacturers are based abroad.

Distribution is crucial to the health logistics system, much like the storage of medical supplies. Distribution is the process of moving things from the country's central warehouse to the point where they are distributed to the end consumers. However, you must take into account a number of crucial factors in the design and execution of transportation in order to maintain a well-functioning distribution system.

Managers should decide which vehicle types are most appropriate for the needs of the goods they will transport and the clients they will service while designing the transportation network. For instance, on rough or congested roads where small pick-up trucks could readily pass, heavy-duty vehicles might struggle. Additionally, while some products need to be transported chilled, others do not. Financial planning can benefit from the transportation design process. Both the variable expenses, such as gasoline, personnel per-diem, and vehicle maintenance, as well as the fixed transportation costs, such as car depreciation and insurance, can be projected. (USAID,2011).

2.1.2.3. Inventory Management

Inventory management involves striking a balance between the expense of keeping extra products on hand and the risk of not having those commodities available when the customer needs them (i.e. the cost of lost sales). As businesses increasingly reduced their inventory levels, this task has grown more challenging. The difficulty in this case is managing the remainder of the logistics system to account for the shortage of inventory without compromising customer service. Nevertheless, inventory management is still vital for providing customer service in many markets, despite the emphasis in lowering stockpiles(Dorn C, 2003).

2.1.2.4. Logistics Management Information System

LMIS is the procedure used to manage laboratory supplies in a systematic and uniform manner, which includes gathering the necessary data. Reagents, consumables, supplies, and equipment are all considered laboratory commodities. Stock cards, requisition forms, registers, and report templates/formats, which should be generated on a regular basis, are the primary tools used for data recording. Logistics management is more difficult due to the large number of supplies that laboratories require. (Pharasi B, 2007).

The data on commodity availability and product flows that can be obtained from an evaluation using the LIAT will frequently be produced in large part by a well-functioning LMIS. As a cost-saving option, stakeholders that have a restricted budget for assessments may decide to evaluate LMIS data rather than perform a facility-based survey. But it's crucial to keep in mind that such a choice is predicated on the assumption that the LMIS has reliable data from all system facilities. For its part, the LIAT is not only used to collect data on product availability, but also to support these findings. The LIAT helps determine stock out rate, how to met LMIS reporting requirement, type of training and supervision for staffs, storage conditions and how LMIS records are being maintained routinely & accurately (USAID, 2006).

The LMIS system provides the information needed to maintain an inventory control system, including the quantity available at the service delivery point, the quantity received and used during the reporting period, the number of customers served during the reporting period, and the quantity of the commodity needed each time to bring it to the acceptable level (maximum level). Forms and documentation are used to move objects from one location to another inside the healthcare facility and to other facilities, track usage, keep track of things, and create reports on the logistics system in order to reach the necessary degree of achievement.The facility can use the information obtained through LMIS to decide whether or not to place an urgent order with the supplier before the order interval, when stocks will be compared to the maximum stock level established and the facility will order the necessary amount to raise stock levels to the maximum(Emmanuel U *et al,* 2017).

An LMIS aids workers in gathering and managing the data required to enable good and impartial decision-making in managing the supply chain, with the aim of ensuring a continuous supply of commodities and identifying any issues in the supply pipeline. The LMIS is made up of all the paperwork and forms necessary to keep track of information and generate reports about the logistics

system. Decision-makers have regular access to current information thanks to an efficient LMIS. Long-term procurement and program management decisions as well as those on immediate resupply are made using information. For the performance of the logistics system, timely and reliable commodities data are essential(BITRI, 2015).

2.1.2.5. Storage

Storage Almost everyone involved in the supply chain is in charge of product storage, which takes place at every location along the pipeline. Throughout the numerous storage facilities and until they are distributed to customers, storage maintains the physical integrity and safety of the products and their packaging. Correct product staging to enable order fulfillment and distribution is a key objective of health product storage. The primary operational operations for storage are quite similar regardless of the size of the storage facility—from a tiny health center to a large central warehouse. The amount of products to be managed, the size of the storage facility, and any special requirements, such cold storage, will all influence how complex these activities become.

Visual inspection is the process of inspecting goods and their packaging for glaring flaws in the quality of the goods. In a perfect pipeline, all items would be kept at the right temperature, with the right amount of humidity, and in accordance with the recommended storage practices. In the real world, storage conditions might differ greatly from one location to another in terms of quality. Some products' qualities may need to be confirmed. The best way for storekeepers to ensure product quality in a warehouse is to routinely visually inspect all of the products inside.

Making efficient use of storage space is part of proper storage. A storehouse is underutilized, and money is lost if there is too much empty space. However, because proper storage practices are more difficult to adhere to when things are jammed into a tiny space, they may be destroyed.

In order to determine the space needed to hold incoming shipments and the total amount of storage needed for the warehouse, as well as the appropriate layout, warehouse managers must understand how to do so.

It is crucial to recognize the different warehouse activities that would affect layout planning, figure out the space requirements and ideal layout for each activity, and then balance space requirements with any constraints in order to develop a workable layout and calculate storage requirements at a large warehouse that may serve multiple purposes. Larger warehouses would need pallets, racking, shelving, and/or material-handling tools like forklifts to maximize storage capacity.

Throughout this handbook, we have discussed how stock-on-hand information is recorded on stockkeeping records. But how do you know if the information recorded on the stock card is correct? The only way to be certain is to conduct a physical inventory count. While conducting the physical inventory count, be sure that a

physical inventory count is you compare the quantities on hand with the quantities that used to compare actual stock have been entered in stockkeeping records (for example, on hand for each commodity inventory control cards). A physical inventory count enables with the amount recorded on you to confirm how much stock you have and whether forms the stock card. are being completed correctly. For quality assurance, a physical inventory count is also an opportunity to inspect your products visually, as described above. The frequency of physical inventory counts may be governed by local regulations. Large central warehouses should conduct a physical inventory count at least once a year. Depending on the level of the facility, you may want to conduct a physical inventory count more often. At the clinic level, for example, you may want to conduct a physical inventory count as often as once a month when you complete your monthly report. If you find that the stockkeeping records do not match the actual stock, conduct a physical inventory count more often and take steps to improve recordkeeping. When you conduct a physical inventory count, remember, when boxes are sealed and the rules of proper storage are followed, only one box or carton is open at a time. A physical inventory count, therefore, can be a quick, routine exercise, especially if you follow good storage practices. One factor that may deter storekeepers from conducting a physical inventory count is the large number of products in a warehouse or storeroom that must be counted. Some facilities are able to shut down for a few days each year to do a complete physical inventory count, but many situations make this impossible (USAID,2011).

2.2. Empirical literatures review

2.2.1. Logistics management practice

2.2.1.1. Procurement management practices

There are substantial difficulties in obtaining the required reagents and supplies for the required testing, according to Lydia's study from 2020. The continent's ability to expand its testing capacity has been severely constrained by its reliance on outside sources. This is true notwithstanding the pooled testing procurement made possible by COVID-19 tools' global accessibility through the WHO. Despite the fact that only a few countries on the continent report the majority of cases, it is important to remember that the presumed low case reporting in other nations is likely not caused by a lack of cases but rather by a lack of the necessary diagnostic tools, supplies, and procurement difficulties due of the pandemic and the requirement to increase testing. (Lydia M,2021).

To ascertain the level of operational readiness, Lanyero B. Edae conducted the following study in Ethiopia. This study showed that the coordination structures, case management, infection prevention and control (IPC), logistics, risk communication, and community engagement and surveillance had adequate readiness capacities.

Rapid response teams and laboratory capacity both had limited capabilities. Due to the disruption of the importation to the worldwide supply chain, there was also a scarcity of Personal protective equipment in the nation. The risk of infections among healthcare workers rose due to a lack of Protective stockpiles across the nation and limited local production capability(Lanyero B,2021).

2.2.1.2. Transportation and Distribution management practice

Amy Lavelle and Janine's study revealed that lockdowns had an effect on supply chains for laboratory consumables and reagents, which in turn had an effect on the laboratories and clinical locations. Due to increased demand, manufacturing problems, and a lack of personnel to handle orders, almost all supplies, including biological matrices, reagents, equipment, and PPE, experienced shortages and longer delivery lead times. As a result, the pharmaceutical and contract pharmaceutical businesses adopted strategic 6-month supply stockpiles and built partnerships with new or secondary vendors in order to ensure vital supply inventory. Inventory shipments were delayed as a result of international border constraints and custody flow. (Amy L,2021).

According to a study by Kara Canon in the United States, the network of laboratories and diagnostics companies positioned to offer testing services faced difficulties with access to testing supplies, coordination of testing services, and the capacity to scale up to meet demand as the number of infections increased. There is ample evidence that healthcare systems (including those that lead in molecular diagnostics) were unprepared to deal with the health challenges brought on by a pandemic of this scope and duration, even though the U.S. and global response to the spread of SARS-CoV-2, the causative agent of COVID-19, is far from over. (Kara C,2021).

According to a cross-sectional qualitative study conducted in Saudi Arabia with laboratory employees and suppliers, the pandemic had a moderate to minor impact on the supply chain's resilience. Lead time (58%) and purchasing (33%) had the most impact on supply chain operations, while inventories had the least (25 percent). Only two hospitals had a major impact on the actual lab supplies. Seven hospitals (or 58 percent) had a moderate impact, and two hospitals had a little impact. In addition to price changes and a lack of alternatives, the absence of reagent supply was the most significant impact of the disruption (50 percent). Although they claimed to have enough resilience measures and processes to support their operations, almost (86 percent) of suppliers reported that their service was only marginally disrupted in most supply chain functions. (Amani A,2021).

2.2.1.3. Inventory management practice

In order to evaluate inventory management procedures for program commodities, the Ethiopian Pharmaceutical Supply Agency conducted a descriptive cross-sectional study. The results revealed that, out of the total of 70 program commodities administered by the agency, 2.1 percent were wasted due to expiration and damage. Over US $2 million was lost as a result of these. Antimalarials experienced the largest wastage, accounting for 13.1% of the total inventory value of the malaria commodities.

Only 14.8% of the orders had a fulfillment rate of more than 80%. For an average of 8.5 days, 37 goods were out of stock. For TB commodities, a longer stock out period (260 days) was noted. Emergency orders were used to buy 17 different products from various programs, with levonorgestrel purchases occurring more frequently. Just 6 (or 60%) of the warehouses had suitable storage conditions. inadequate space, obsolete (Boche,2020).

One of the major issues they were facing was a lack of trained personnel to conduct the tests and a shortage of certified biomedical engineers qualified to calibrate and maintain biosafety and laboratory equipment, according to a study done by Andargachew in January 2021 on the challenges of COVID-19 testing the Ethiopian experience. Additionally, sub-Saharan African nations have very little in the way of health infrastructure, particularly in the form of laboratory facilities with qualified staff. A non-propagative SARS CoV-2 diagnosis should be made in a biosafety class II level-P2 laboratory, according to the WHO. However, there are very few labs in the nation that have bio-safety class II facilities. Additionally, the majority of hospitals and diagnostic facilities are not well-equipped to handle the large intake of samples(Andargachew M,2021).

2.2.1.4. Logistics Management Information System practice

In a study on the logistics management of COVID-19 personal protective equipment and its challenges that was conducted in all hospitals in the Bench-Sheko, Kafa, and Sheka zones, it was discovered that all hospitals had bin cards, reporting and resupply forms, model 19 (receiving models), and model 21 (issue model). However, they weren't using the majority of these forms to handle PPE logistics. N-95 respirator masks, surgical masks, gowns, surgical gloves, and aprons were all present in the inventory of the institutions that were evaluated. However, given that both surgical masks and N-95 respirators were below emergency order points, the quantities were insufficient for the available human power. Except for surgical gloves and disposable gloves, no hospital adopted bin cards as a logistics record-keeping system for PPEs (Fikadu E,2021).

A different study on the effectiveness of logistics management information systems at public health facilities in the East Wollega Zone of the Oromia Regional State revealed that 39% of them had an automated recording system. Regarding data accuracy, 97.8% of the reports were determined to be complete, while 65.5% of RRFs and 79.1% of bin-cards were correctly filled out. The upper level received reports from 69% of the facilities in a timely manner, making the overall reporting rate for the facilities 97 percent. The type of profession, trainings, educational status, and supervision were all found to be significantly correlated with RRF data correctness. The main performance bottlenecks for logistics management information system were determined to be a lack of competent human resources and a lack of worker commitment(Kefyalew and tadesse,2018).

2.2.1.5. Storage management practice

The significance of medications being stored correctly in pharmacy facilities until they are delivered to the consumer is emphasized by this study. The efficacy and safety of medications may be impacted by the loss of potency during storage.

Pharmaceutical items must be transported and stored under controlled circumstances to maintain their quality. The overall drug control system includes storage as a key component. Everywhere pharmaceuticals and supplies are kept on the premises, correct environmental management must be maintained, including the right temperature, light, and humidity as well as sanitary, ventilation, and segregation conditions. (Kausar S,2013)

The storage conditions of the majority of hospitals are poor, according to a study by Habtamu Molla and Kelemwork Hussien on Assessment on Storage Conditions of Medical Laboratory Commodities at Government Hospital. In half of the facilities, there was a lack of sufficient space and infrastructure to store medical laboratory supplies. (Tesfaw HM, 2017).

2.2.2. Challenges of Laboratory logistics management

Infectious Diseases Subdivision Leadership of the Association for Molecular Pathology (AMP) study, Fredrick S. Nolte found that although laboratories have proven diagnostic testing methodologies due to continuous supply chain constraints, test availability and laboratory testing capacity have been restricted by shortages and/or manufacturer prioritization of testing reagents, sample collecting equipment, and laboratory supplies required to receive and process patient samples. Additionally, in order to maintain and expand testing capacity, molecular laboratories have implemented multiple alternative SARS-CoV-2 laboratories-developed and FDA EUA assays. (Fredrick S,2020).

In a separate study by Brenda Silva, it was discovered that the demand for personal protective equipment (PPE) to protect lab staff and healthcare workers from the risk of infection has increased significantly. Additionally, several labs reported trouble locating test supplies in the supply chain, including disposable items like PPE (masks, gloves, face shields, etc.) and consumables like swabs, controls/reagents, and transport media. The vast majority of study participants claimed they had trouble keeping a supply of testing products to fulfill their rising lab testing requests, and perhaps they still do. However, only a small portion of responses claimed they have enough testing equipment to meet the daily demands placed upon their lab personnel (Brenda S,2020).

A further study by Idris Nasir Abdullahi in Nigeria in 2020 found that the biggest obstacles to COVID-19 diagnostics in Africa are a lack of test kits and qualified lab staff as a result of the increased demand for COVID-19 tests. The acceptance and nature of RTPCR as the gold standard for COVID-19 diagnosis further contributed to the significant testing challenge. The majority of African countries find it challenging to obtain these molecular assay kits and equipment due to their high cost. (Abdullahi,2020).

A.-A. Seidu did yet another investigation. Public and private clinical facilities are under a tremendous amount of strain as a result of the sharp rise in probable COVID-19 cases in Africa. The laboratory-based reverse transcription-polymerase chain reaction (RT-PCR) assay is currently the most widely used technique for determining and validating the virus.

Unfortunately, insufficient test kits have prevented scaling up beyond the few public health laboratories at designated locations, which has constrained testing capacities in many parts of Africa. (A-A Siedu,2020)

According to a study by Elijah Kolawole oladipoet, fighting the new virus in Africa is difficult due to a lack of test kits and other necessary laboratory equipment. Additionally, there is a lack of competent workers, which could be a serious risk should COVID-19 infection instances increase. In Africa, there are only two diagnostic options accessible; globally, there are six. This reduces the possibility of additional diagnosis, which would further increase the likelihood of improper diagnosis and compromise the accuracy of diagnostic reports. Additionally, issues like insufficient power supply, the technique utilized to collect samples, and the storage and transportation of specimens are important because they also pose their respective implication (Elijah K,2020).

2.3. Conceptual Framework of the Study

This study focuses on of molecular testing supplies on EPHI and EPSS to show their practices during the last 2 years.

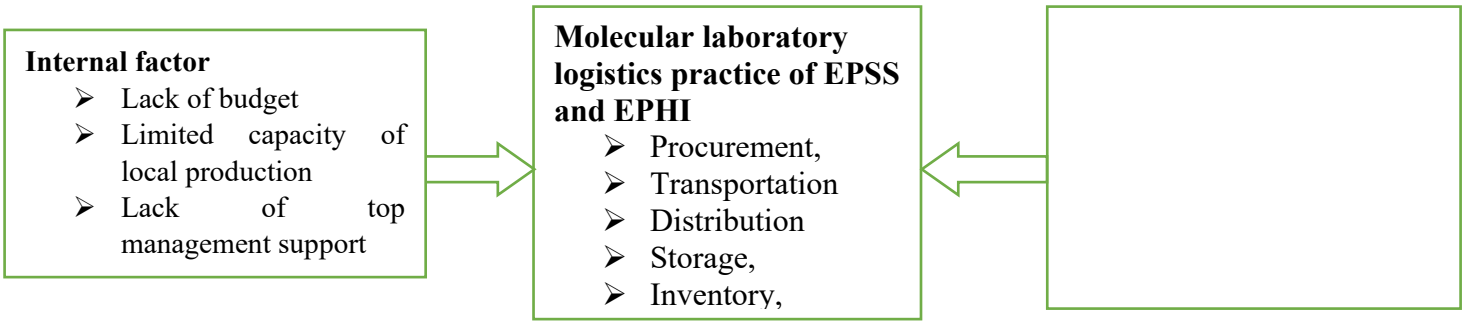

Figure 1:Conceptual Framework of the Study

2.4. Identified Literature Gap

The researcher is aware of no prior research that has been done with the trust area of Covid-19 testing products particularly with the Ethiopian context. Therefore, it was evident from all the studies that were reviewed that there was a lack of testing kits and safety supplies that were required for the molecular laboratory as a whole but not specifically for the logistics operations during pandemics. A deeper investigation is needed into the logistics cycle, particularly Procurement, Transportation, Storage, Inventory, LMIS, and Distribution, as Molecular Laboratory Commodities require special handling, storage conditions, and distribution.

CHAPTER THREE

METHODS OF THE STUDY

This chapter briefly describes the research design, sampling techniques applied, the population area including the data sources, ethical consideration, method of data analysis & presentation and Validity & reliability test.

3.1. Description of the study area

The study was carried out in Ethiopia's capital city of Addis Ababa. The study area was selected due to its accessibility, the presence of the national Covid-19 testing laboratory, and the fact that EPSS is based there. Additionally, it was chosen due to its better implementation of the laboratory logistics system compared to other areas of the region, exploring the functioning systems will allow us to see the challenges and practices in other parts of the country.

3.2. Research Approach

Qualitative research approach was employed. This approach enquires non-numerical and things which are not quantifiable. The data are primary which was collected with close ended questionnaires about procurement, transportation, storage, distribution, logistics management information system and inventory management of EPHI and EPSS. The data was analyzed using descriptive summary statistics such as frequency and percentage, summarized, presented and interpreted.

3.3. Research Design

Descriptive study design was employed to explore on Covid-19 Molecular laboratory supplies. Qualitative data collection methods were employed. Data was collected from informants responsible for managing laboratory commodities at both EPHI and EPSS using structured questionnaire adapted from logistics system assessment tool (LSAT) andAssessment Tool for Laboratory Services (ATLAS). Moreover, central level staffs were also questioned to understand the challenges facing the logistics systems and to obtain a description of the supply chain system for Covid-19 laboratory commodities.

3.4. Population of the study

All the staff of the four directorates of EPSS namely pharmaceutical and medical supplies warehousing and inventory directorate, pharmaceutical and medical supplies distribution and fleet management directorate, pharmaceutical and medical supplies contract management directorate and pharmaceutical and medical supplies tender management directorate and all the staff of Emergency Operation Center(EOC) of EPHI namely Molecular laboratory team and logistics team involved in logistics management of molecular laboratory were the target population for study.

In EPSS the warehouse and inventory management directorate have two teams namely, warehousing and inventory management team with 26 employees including the director, coordinators, officers and warehouse managers. Also, there are two teams under distribution and fleet management directorate, the distribution and fleet management teams which comprise total of 15 employees including the

director, coordinators and officers. Furthermore, contract management and tender management directorate have a total of 22 employees.

In EPHI there was a team organized in the institute, the emergency operation center in this unit there were subdivision like laboratory section, which had 18 personnel, logistics unit which had 20 and molecular laboratory which had 25 professionals deployed for combating the pandemics.

3.5. Sampling Design and Sample Size

In this study, stratified random sampling technique was used to collect the data. Stratified random sampling offers more accurate estimates for each stratum since each stratum is more homogeneous than the entire population. Up till the sample size is reached, we shall conveniently sample the proportionate staff. Employees of EPSS and EPHI who have worked in logistics management and related working units were the target group. To select a representative from each working unit, stratified sampling is more suitable. Yamane's (1967) presents a simplified method to compute sample size in order to obtain a representative sample for the population being studied, for which the size is known.

$n= N/1 + N * (e)^2$ Where, n= sample size

N= population size

e= the desired level of precision or Tolerance at desired level of confidence, take 0.05 at 95%

confidence level for this study.

So based on Yamane's formula sample size is determined as follows:

$n=126/1+126(0.05)^2 = 96$

Accordingly, the number of sample items from the total population of EPSS and EPHI 126 employees' accounts 96 was participating in the study. In order to determine the number of sample items from each stratum, the questionnaires with sample size 96 were distributed as follows.

Table 3.1: Tabular view of sampling plan and Sampling Frame

Strata by working unit	Organization	Target Population (N)	Sampling Fraction I=M(Ni/P)	Sample Size (I)
WIM	EPSS	26	96(26/126)	20
DFM	EPSS	15	96(15/126)	11
Tender and Contract management	EPSS	22	96(22/126)	17
EOC	EPHI	18	96(18/126)	14
Molecular laboratory	EPHI	25	96(25/126)	19
Logistics unit	EPHI	20	96(20/126)	15
TOTAL		126		96

Source: based on employee 's information taken from emergency operation center (EOC) and EPSS human resource in 2022.

3.5.1 Inclusion Criteria

All employees of the EPSS head office and EPHI deployed to handle the logistics management were included as the respondents to the study. Accordingly, employees working in procurement, warehouse and inventory management, distribution, and transportation management and LMIS.

3.5.2 Exclusion Criteria

Employees who have not been deployed in the logistics management were excluded as respondents to the research. Moreover, all employees working in departments which were not related with logistics management practices and departments and those who refused to respondents were excluded. The total number of employees who have been working in Covid-19 reagents and supplies in EPSA were 48 and 48 from EPHI based on employee 's information taken from emergency operation center (EOC) and EPSS human resource in 2022.

3.6. Data Source and Collection Procedures

All employees at the Ethiopian Public Health Institute and the Ethiopian Pharmaceutical Supply Service Head Office were considered as the source population. So, for the purpose of the research, we used those employees as a study population. In order to obtain the correct respondents for the study,

those who had the necessary background information, exposure to the topic, and experience were included.

Primary data sources were employed to get pertinent data. Questionnaires were used to gather the main data.

The researcher visited each stratum and delivered questionnaires. To gather the data, JSI/DELIVER (2009)'s Logistics System Assessment Tool (LSAT) and Assessment Tool for Laboratory Services and Supply Chains (ATLAS), both of which were modified for this study, were usedto collect the information from both EPHI and EPSS. We used Primarily, a set of questionnaires were distributed to EPHI and EPSS professional who were working in logistics management specifically in procurement, transportation, storage, inventory, LMIS and distribution department to assess Molecular laboratory logistics and its challenge.

3.7. Measurement Instruments

The study used a questionnaire system to collect primary data. The questionnaire was intended to inquire answers in the form of open-ended and close-ended questions. The questionnaire has four sections. The first section (section A) contained questions that helped to generate general information about respondents like gender, education level, working unit/department and work experience. The second section (section B) represent the logistics management practices of EPSS and EPHI, the third section (section C) addressed the challenges faced by EPSS and EPHI in managing its logistics management practices and the fourth section was open ended question to reflect their thought on the logistics practices and the challenge they faced during managing the logistics of Covid-19 molecular reagents and supplies.

3.8. Data Analysis

After collection of the data, its completeness was verified, coded and entered in computer using SPSS for qualitative data. The data were analyzed using application software packages Statistical Package for Social Sciences (SPSS) of version 20. In descriptive statistics for interval scale items mean, standard deviation, Pearson correlation and regression were used to see distribution and association. Frequencies were used for summarizing overall data. Based on pre-determined thematic areas of section B and C questionnaire, responses were analyzed at respective nodes for the qualitative data. Result will be presented with tables, figures and narration and p value will be considered significant if less than 0.05.

3.9. Validity and Reliability test

A set of samples questionnaire were distributed to the respondent who are specifically working on Covid-19 molecular laboratory supply management each unit to test the validity of the research questionnaire as a pilot test. Accordingly, the sample questionnaire was also distributed to Logistic Experts and their comments are incorporated.

In this study we used logistics system assessment developed by JSI/DELIVER (2009) on logistics system assessment tool (LSAT) and Assessment Tool for Laboratory Services and Supply Chains (ATLAS) to collect the data, so it is already prepared and well-organized format containing all important parameters that associated with the study.

Moreover, to deal with the correlation between measuring variables, Cronbach's alpha value is the most common internal consistency reliability coefficient to check whether the designed tools under each categories measure the intended variable or not. The Cronbach's alpha value determined like if $\alpha > 0$ .9 it will be excellent, $\alpha > 0.8$ it will be good, $\alpha > 0.7$ it will be acceptable, $\alpha > 0.6$ it will be questionable, $\alpha > 0.5$ it will be poor and Finally, $\alpha < 0.5$ it will be unacceptable‖ (Garson, 2006).

Table 3.2 Cronbach 's alpha reliability test of Ethiopian Pharmaceutical Supply Service

S.N	Variable of this study	No of Respondent	No of items	Cronbach's Alpha	Reliability
1.	Procurement	48	18	0.840	Good
2.	Transportation and distribution	48	14	.859	Good
3.	Warehouse and storage	48	15	.917	Excellent
4.	Inventory	48	11	.733	Acceptable
5.	LMIS	48	8	.741	Acceptable
6.	Challenges	48	21	.929	Excellent
	Overall	48	69	0.8365	Good

Source: researcher, 2022

Table 3.3 Cronbach ‘s alpha reliability test of Ethiopian Public Health Institute (N=48)

S.N	Variable of the study	No of items	Cronbach’s Alpha	Reliability
1.	Transportation and distribution	14	0.71	acceptable
2.	Warehouse and storage	15	0.87	Good
3.	Inventory	11	0.71	Acceptable
4.	LMIS	8	0.71	Acceptable
5.	Challenges	21	0.94	Excellent
	Overall	69	0.79	acceptable

As you can see in the table above Cronbach’s alpha was computed and compared with the threshold value of 0.7. An overall value of 0.84 and 0.79 was obtained which implied high level of internal consistency of research instruments.

3.10. Ethical consideration

The study was first approved by Addis Ababa University (AAU) Institutional Review Board of the Faculty and research and ethical committee of the Ethiopia public health institute and Ethiopian Pharmaceutical Supply Service before the study, and then a letter informing the facility administrators was written from the Addis Ababa University, School of Commerce and the Ethiopia public health institute. There was a high degree of confidentiality during data collection and no name of any health facility and participating subjects is disclosed in the result instead the aggregate result of the facilities and summary of results are projected.

CHAPTER FOUR

RESULTS, DISCUSSION, AND INTERPRETATION

In this chapter the finding is analyzed and discussed from the questionnaire finding the cover different logistical practices including procurement, warehouse and storage, inventory, LMIS and transport and distribution. The questionnaires were disseminated to the employee of EPSS and EPHI who are working in different department who were working in the WIM, DFM, tender and contract management, EOC, molecular laboratory and logistics unit who are knowledgeable to the activity.

4.1. Response Rate

The questionnaires were distributed to the two organization namely EPSS and EPHI employees and. Total number of 96 questionnaires was distributed and 96 were filled properly and returned to the researcher which represents a response rate of 100%.

Table 4.1 response rate

Response status	Number	Percent
Filled and returned	96	100%
Not returned	0	0%
Total	96	100

Source, researcher,2022

4.2 Respondents General Information

This section presents general information about respondents. The general information collected was on gender, level of education, work department and work experience. Gender was included to signify the involvement of both genders in the study. The level of education was important to imply that the respondents were well educated and had the ability to understand and respond to the issues. Work department was required to infer that the respondents were able to understand the different logistics practices required by the research. Work experience was important to guarantee the aspects of familiarity and experience of the respondents in matters of logistics management practices.

4.2.1 Gender respondents

The study conducted and found gender details of the respondents as presented in table 4.2 below.

Table 4.2: Gender of respondents

Gender	Items	Frequency	Percent
Gender EPHI	Male	30	62.5
	Female	18	37.5
	Total	48	100.0
GenderEPSS	Male	32	66.7
	Female	16	33.3
	Total	48	100.0

Source: researcher,2022

From the table 4.2 above, the study showed that 62.5% of the respondents were male and 347.5% were females in the case of EPHI and 66.7% of the respondents were male and 33.3% were females. From this finding one can conclude that both genders were involved in the study and the finding of the study did not suffer from gender bias.

4.2.2 Education Level of Respondents

As shown on the table below, the study revealed that 72.9% of the respondents had second degree and above and 27.1% had first degree level of education in the case of EPHI. In addition, 47.9% of the respondent had first degree level of education and 52.1% had second degree and above level of education in the case of EPSS. This shows that the respondents had sufficient levels of education to understand and respond to the issues required by the study.

Table 4.3: Educational level of respondents

Educational level		**Frequency**	**Percent**
Educational level EPHI	**Item**	**Educational level**	**Educational level**
	First degree	13	27.1
	Second degree and above	35	72.9
	Total	48	100.0
Educational level EPSS			
	First degree	23	47.9
	Second degree and above	25	52.1
	Total	48	100.0

Source: Researcher, 2022

4.2.3 Work Department of Respondents

The study required to identify the various work department that the respondents belonged to determine whether they had relevant knowledge in their area of specialization. The responses were analyzed, and the results are presented in table 4.4 below:

Table 4.4: Work department of respondents

	Work department	Frequency	Percent
Work department EPHI	EOC	14	29.2
	Logistics unit	15	31.3
	Molecular laboratory	19	39.6
	Total	48	100.0
Work department EPSS	Tender and contract management	17	35.4
	Warehouse and inventory management	20	41.7
	Distribution and fleet management	11	22.9
	Total	48	100.0

Source: Researcher, 2022

As shown in above table 4.4 the result displayed that 29.2% of the respondents were from EOC ,31.3% were from logistics units and 39.6 were from molecular laboratory in the case of EPHI. Furthermore,

in the case of EPSS 41.7% were from Warehouse and Inventory Management Directorate followed by Tender and Contract Management Directorate (35.4%) and Distribution and Fleet Management (22.9%). This indicates that the respondents were able to understand the different logistics management practices required by the research based on the different departments they belong.

4.2.4 Work Experience of Respondents

The respondent work experience in both organization in the logistics management. The responses were analyzed, and the results are presented in table 4.5 below:

Table 4.5: Work experience of respondents

		Frequency	Percent
Work experience EPHI	2-3 years	11	22.9
	4-5 years	13	27.1
	6-7 years	13	27.1
	above 7 years	11	22.9
	Total	48	100.0
Work experience EPSS	2-3 years	17	35.4
	4-5 years	13	27.1
	6-7 years	6	12.5
	above 7 years	10	25
	Total	48	100.0

Source: Researcher, 2022

The result in table 4.5 shows that 22.9% of the respondents had work experience of a 2-3 years, 27.1% respondents work experience ranged from 4 to 5 years, 27.1% of the respondents had work experience of a 6-7 years and 22.9% of the respondents had work experience of above 7years in the case of EPHI. On the other hand, 35.4% of the respondents had work experience of a 2-3 years, 27.1% respondents work experience ranged from 4 to 5 years, 12.5% of the respondents had work experience of a 6-7 years and 25% of the respondents had work experience of above 7years in the case of EPSS. This shows that majority of the respondents had served for more than two years period which means that they were able to give reliable information relating to the study.

4.3 Logistics Management Practices in Ethiopian Pharmaceuticals Supply Service

The first objective of the study was to examine the statues of the Covid-19 molecular laboratory logistics management practices in Ethiopian Pharmaceuticals Supply Service and Ethiopian Public Health Institute. The respondents were requested to show the state of logistics management practices in both organizations. The logistics management practices consisted of warehouse and storage management practices, inventory management practices transportation and distribution management practices, logistics management information practices and procurement practices of Ethiopian Pharmaceuticals Supply Service. However, the responsibility of Ethiopian Public Health Institute during the pandemic were for donated reagents and consumables. These reagents and consumables were directly brought to the institute and managed. The logistics management consisted of warehouse and storage management practices, inventory management practices, transportation and distribution management practices and logistics management information practices were considered in this institution. Procurement practice of the Covid-19 molecular laboratory reagents and consumables were handled by Ethiopian Pharmaceuticals Supply Service and Federal Ministry of Health. The ministry initiates the activity and handover the activities to EPSS. So, the reagents and consumables procured by EPSS were managed by the organization. In this study we were using a five-point Likert scale with 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 =Strongly to rate the state of logistics management practices questionnaire. Analysis of the statues of the logistics management practices was done using means and standard deviations. 1.00 - 1.80 is considered as very low, 1.81 - 2.60 as low, 2.61 - 3.20 as medium, 3.21 - 4.2 as high and 4.21 - 5.00 as very high(Alexander B,2009).

4.3.1 Procurement management practicesin Ethiopian Pharmaceutical Supply service

The study wanted to determine the Covid-19 molecular laboratory reagents and consumable procurement management practice in EPSS. The research findings are presented in table 4.6 below:

Table 4.6: Procurement management practices in Ethiopian Pharmaceuticals Supply Service (N=48)

Procurement management practices	Mean	Std. Deviation
The vendor submitted a complete request for payment and breakdown of the purchaser	3.90	.515
The finance department issued a purchase order to the vendor after the purchase request approval	3.90	.831
A well-trained team is equipped in procurement unit to carry out processes effectively and efficiently	3.83	.859
Finance sends over the payment to the vendor in the preferred method of payment after the Covid-19 molecular reagents and consumables have been received	3.81	.982
Tenders request provided to potential suppliers who will be invited to submit tender proposals	3.73	1.005
All invoices, orders, and other accompanying documentation are documented for internal and external audits	3.71	1.202
Appropriate need identification is in place for procurement of covid-19 Molecular reagents and consumables	3.60	.844
The procurement department investigate vendors, request quotes for the item needed before making a final decision	3.52	1.091
The organization inspect all Covid-19 Molecular laboratory reagents and consumables delivered by the supplier to ensure that they meet the requirements and conditions stipulated by the organization.	3.40	1.106
Clear specification has been provided to the potential suppliers	3.40	1.250
Technical proposals is evaluated prior to the opening of the financial proposal in order to confirm that the technical proposal conforms with the conditions and requirements set forth by the organization	3.35	.785

The organization select suitable suppliers of Covid-19 Molecular Laboratory reagents and consumables to be purchased from among registered supplier	3.33	1.209
Supplier relationships is strengthened to reduce supply chain disruptions and bottlenecks enable them to identify potential disruptions early	3.29	1.237
The organization negotiate terms and conditions with the most advantageous tenderer to organization among those tenderers which meet the specified technical condition and requirement	3.29	1.184
The vendor sends over an order, which is another detailed description of the goods or services requested to give the last chance to your organization to double-check both the invoice and the order for the correct items/services at the correct price	3.29	.922
The organization automating procurement processes to prevent disruptions and to reduce the repetitive operational parts of procurement	3.13	1.084
Contract management practice in place maintaining good relationships with suppliers and reducing risks	3.10	1.016
A formalized system of monitoring, managing and continuously improving the supplier and the Organization's performance against the contract in place	3.08	.964
Grand mean of Procurement management practices	**3.4815**	

Source: Researcher,2022

Grand mean of Covid-19 molecular laboratory reagents and consumable procurement management practices of Ethiopian Pharmaceutical Supply Service was (M=3.4815) indicated that the procurement management practice was highly practiced in EPSS. Procurement management practices should ensure the availability of laboratory commodities. As you can see from the result table 4.5 the respondent agreed on some activities like the vendor submitted a complete request for payment and breakdown of the purchaser (M=3.90 and SD 0.515), The finance department issued a purchase order to the vendor after the purchase request approval (M=3.90 and SD=0.831), a well-trained team is equipped in procurement unit to carry out processes effectively and efficiently(M=3.83 and SD=0.859), finance

sends over the payment to the vendor in the preferred method of payment after the Covid-19 molecular reagents and consumables have been received(M=3.81 and SD=0.982), tenders request provided to potential suppliers who will be invited to submit tender proposals(M=3.73 and SD=1.005), all invoices, orders, and other accompanying documentation are documented for internal and external audits(M=3.71 and SD=1.202), the appropriate need identification is in place for procurement of covid-19 Molecular reagents and consumables(M=3.60 and SD=0.844) and the procurement department investigate vendors, request quotes for the item needed before making a final decision(M=3.52 and SD=1.091).

The finding about Covid-19 reagents and consumable procurement practice in Ethiopian Pharmaceuticals Supply Service (table 4.6) showed that there is a need to improve on supplier relationship that may help in preventing unexpected supply disruption supported by the literature review that was presented by Lydia in 2020 that described that as there are significant challenges procuring the necessary reagents and supplies for the needed Covid-19 molecular testing.

4.3.2 Warehouse and Storage management practicesin Ethiopian Pharmaceutical Supply Service

The result showed on the warehouse and storage management practices in Ethiopian Pharmaceuticals Supply Service. The results are shown in table 4.7 below:

Table 4.7: Warehouse and storage management practicesin EPSS(N=48)

Warehouse and storage management practices	Mean	Std. Deviation
The cold chain is monitored to ensure that Covid-19 Molecular reagents are consistently maintained at recommended storage temperatures	4.08	.739
Warehouse records and reports are up to date	3.79	.713
Dispatch processes are ensured that damages are minimized from the time items leave the warehouse	3.75	.601
There is regular visual quality assurance inspections of Covid-19 Molecular reagents and consumables conducted at the storage facility	3.71	.713
Put away process is to move goods for storage to their most optimal location in a fast, efficient, and effective manner	3.48	.922

The warehouse inspects the received Covid-19 Molecular reagents and consumables are in the correct quantity and in good condition before store the items in the designated storage area	3.37	1.142
Warehouse is convenient to load & unload Covid-19 Molecular reagents and consumables to the appropriate transportation option	3.35	1.021
The warehouse is kept Ventilated and Air conditioned to prevent stored product	3.29	1.202
The warehouse stayed organized with labels and signage to ensure employees know where to find things and/or where they belong	3.21	1.031
There is enough storage space to handle the current quantities of Covid-19 Molecular reagents and consumables.	3.19	1.249
The organization have written guidelines for storage and handling of Covid-19 Molecular reagents and consumables.	3.02	1.021
There are not overstocked or no longer used items on the shelves	3.00	.968
The warehouse is well organized to provide a safe environment for the employees and be highly efficient	2.94	1.080
The right technologies are used for picking process and guide the employee in executing the picking process properly	2.90	.973
There is allocated regular hour to cleaning the warehouse that improve employees can move around more quickly and get things done easily	2.75	1.062
Grand mean of warehouse and storage management practices	3.32	

Source: researcher,2022

The purpose of a storage and warehouse to ensure the physical integrity and safety of reagents and commodities this will help ensure that commodities reach the laboratory in usable condition. The result showed warehouse and storage management of EPSS was the grand mean of 3.32 that indicates it was highly practiced. The following practice were highly practice activities like the cold chain monitoring to ensure that Covid-19 Molecular reagents are consistently maintained at recommended storage

temperatures with the grand mean was (M=4.08) followed by the warehouse records and reports were up to date (M=3.79 and SD=0.713), dispatch processes were ensured that damages were minimized from the time items leave the warehouse(M=3.75 and SD=0.601), there was regular visual quality assurance inspections of Covid-19 Molecular reagents and consumables conducted at the storage facility(M=3.71 and SD=0.713) and put away process is to move goods for storage to their most optimal location in a fast, efficient, and effective manner(M=3.48 and 0.922).

On the other hand, activities which was medium practice were the warehouse is well organized to provide a safe environment for the employees and be highly efficient (M=2.94 and SD=1.080), the right technologies were used for picking process and guide the employee in executing the picking process properly(M=2.90 and SD=0.973) and there was allocated regular hour to cleaning the warehouse that improve employees can move around more quickly and get things done easily(M=2.75 and SD=1.062). The result indicated there were a need of improvement on warehouse organization.

This finding disagrees with the finding by the Tesfaye HM,2017 that stated the storage conditions of majority of the hospitals have problems. Lack of adequate space and infrastructures to store medical laboratory commodities were challenges in half of the facilities

4.3.3 Inventory management practice in Ethiopian Pharmaceuticals Supply service

The study required to identify the state of inventory management practices in Ethiopian Pharmaceuticals Supply Service. The results are shown in table 4.8 below:

Table 4.8 Inventory management practice in EPSS(N=48)

Inventory management practice	Mean	Std. Deviation
Damaged/expired Covid-19 molecular laboratory reagents and consumables are physically separated from inventory and removed from stock records	3.98	1.082
Covid-19 molecular laboratory reagents and consumables inventory are reviewed, sorted and stored in their respective stock areas	3.98	.785
stock balances are monitored regularly so that procurement decisions and actions can be made on time to avoid stockouts or overstocks	3.96	.683
The organization manages and issue stock according to first expiry/first out inventory control procedures.	3.94	1.156

The organization regularly review, maintain up to date and accurate records of Covid-19 molecular laboratory reagents and consumables	3.90	.722
Covid-19 molecular reagents and consumables inventory level are monitored through different method to minimize the chance of error	3.69	.971
The organization using automated inventory recording systems to keep track of their inventory and to ensure timely reorders Covid-19 molecular laboratory reagents and consumables	3.35	.956
The organization have a system for tracking product losses and other adjustments of Covid-19 molecular laboratory reagents and consumables	3.31	1.151
The organization prevent stock-outs typically caused by incorrect forecasting or unforeseen changes in customer demand by keeping Safety stock inventory of Covid-19 reagents and consumables	3.29	1.031
Current inventory model targets & applies to minimize inventory holding, ordering & stock out	3.21	.874
the organization have a physical labelling system that matches the digital inventory count	3.17	.953
Grand mean of Inventory management practice	**3.6155**	

Source: researcher,2020

The result displayed in the in the table 4.6 showed that the grand mean of the inventor management practice of Covid-19 molecular laboratory reagents and consumables were (M=3.6155) which means most inventory practices were highly practiced. As indicated in the table the practice like damaged/expired Covid-19 molecular laboratory reagents and consumables are physically separated from inventory and removed from stock records (M=3.98 and SD=1.082), Covid-19 molecular laboratory reagents and consumables inventory are reviewed, sorted and stored in their respective stock areas (M=3.98 and SD=0.785), stock balances were monitored regularly so that procurement decisions and actions can be made on time to avoid stockouts or overstocks(M=3.96 and SD=0.683), the organization manages and issue stock according to first expiry/first out inventory control procedures (M=3.94 and SD=1.156), the organization regularly review, maintain up to date and accurate records of Covid-19 molecular laboratory reagents and consumables(M=3.90 and SD=0.722), and the Covid-19 molecular reagents and consumables inventory level are monitored through different method to minimize the chance of error (M=3.69 And SD=0.971) were highly practiced.

The findings in the above table disagree with the literature review that was conducted by Boche,2020 0n a descriptive cross-sectional study at Ethiopian Pharmaceutical Supply Agency aimed to assess inventory management practices of program commodities showed that commodities wasted due to expiration and damage, stock out, longer duration of stock out, items from different programs were purchased through emergency orders and lack of precise data.

4.3.4Transportation and Distribution management practicesin Ethiopian Pharmaceuticals Supplyservice

The study attempted to identify the state of transportation and distribution management practices in Ethiopian Pharmaceuticals Supply service. The outcomes were analyzed as shown in table 4.9 below:

Table 4.9: Transportation and Distribution management practices in EPSS.

Transportation and distribution	Mean	Std. Deviation
Warehouse workers keep track of stock to make sure items are secure the entire time they are in the warehouse	3.90	.692
The Covid-19 molecular laboratory reagents and consumables are delivered using the right mode of transportation	3.83	.781
Employees make inspection of deliveries to make sure incoming products match the purchase order and nothing was damaged in transit.	3.56	.823
When a customer returns a product, it is inspected by a warehouse worker to ensure it hasn't expired and no parts are missing. Once it passes quality control, it gets restocked	3.48	.825
Vehicles are scheduled to deliver the product to appropriate customer	3.31	1.170
There is written procedures specify what type of distribution system is to be used to distribute products between each level.	3.29	1.148

There are a sufficient number of functioning vehicles with available petrol/drivers, at appropriate levels, to meet the desired distribution schedule	3.23	1.207
The organization inspect vehicle regularly based on the schedule	3.23	1.115
The transportation management practices enable timely delivery of products to customer	3.06	1.210
Vehicle route planning ensure the shortest route for customers at different locations and return to the starting point.	3.02	1.062
The vehicles have vehicle tracking system to truck the route of the product delivery	2.85	1.255
Refrigerated trucks are used for the distribution of covid-19 molecular laboratory reagents and consumables to different location.	2.83	1.226
The warehouse Conduct regular audits on Covid-19 Molecular reagents and consumables	2.75	1.021
The organization uses automatic data collection technology via bar code and radio frequency identification	2.37	.937
Grand mean ofTransportation and distribution	3.1949	

Source: researcher,2020

When we evaluate the overall perception of respondents towards transport management practices, the overall mean showed (M = 3.1949) that transportation management was medium practiced. As can be observed in the above table (table 4.8) there were practices that was categorized in high like Warehouse workers keep track of stock to make sure items are secure the entire time they are in the warehouse (M=3.90 and SD=0.692), the Covid-19 molecular laboratory reagents and consumables are delivered using the right mode of transportation(M=3.83 and SD=0.781), employee make inspection of deliveries to make sure incoming products match the purchase order and nothing was damaged in transit(M=3.56 and SD=0.823) and When a customer returns a product, it is inspected by a warehouse

worker to ensure it hasn't expired and no parts are missing. Once it passes quality control, it gets restocked (M=3.5000 and SD=0.82741).

However, the respondent disagrees with the practice that the organization uses automatic data collection technology via bar code and radio frequency identification (M=2.37 and SD=0.937). so, this was lowpractice.

The findings in the above table (table 4.8) agree with the literature review that was conducted by Amy Lavelle and Janine found out the laboratories and clinical sites were also affected by the impact lockdowns had on supply chains for laboratory consumables and reagents saw shortages and increased delivery lead times due to increased demand, manufacturing issues as well as staff to process orders. Study conducted by Kara cannon also support the diagnostics companies and the network of laboratories positioned to provide testing services faced challenges including access to testing supplies, coordination of testing services, and the ability to scale up to meet demand as the number of infections rose.

4.3.5 Logistics management information system practice in Ethiopian Pharmaceuticals Supply Service

The study tried to establish the state of logistics management practice in Ethiopian Pharmaceuticals Supply Service. The outcomes were analyzed as shown in table 4.10 below:

Table 4.10: Logistics management information system practice

Logistics management information system practice	Mean	Std. Deviation
Logistics information is provided to decision makers for the appropriate logistical planning	3.83	.781
The forms for collecting and reporting the data are well designed, easy to fill out, and easy to aggregate	3.77	.627
There is logistics management information system in place to monitor Covid-19 molecular reagents and consumables.	3.63	.914
The information system is used to monitor and evaluate the program's performance	3.44	1.029
The LMIS records and forms properly maintained and kept up to date	3.40	1.067
The information system reports at the organization presented with quality and accuracy	3.35	.934

LMIS data are periodically reconciled against physical inventories and validated using a standard survey	3.19	.960
LMIS or other information system reports received at the central level provide appropriate information on stock status at the lower facility level	3.19	.960
Grand mean of Logistics management information system practice	3.4740	

Source: researcher,2022

As the result showed in the table 4.9 showed that LMIS the overall mean and standard deviation were (M=3.4740) which means the LMIS management practice were high. In the organization the following activities practice were high like Logistics information is provided to decision makers for the appropriate logistical planning (M=3.83 and SD=0.781), the forms for collecting and reporting the data are well designed, easy to fill out, and easy to aggregate (M=3.77 and SD=0.627), there is logistics management information system in place to monitor Covid-19 molecular reagents and consumables(M=3.63 and SD=0.914) and The information system is used to monitor and evaluate the program's performance(M=3.44 and SD=1.029).

The findings in the above table disagree with the literature review that was conducted by Fikadu E,2021 in Bench-Sheko, Kafa, and Sheka zones on Logistics Management of COVID-19 Personal Protective Equipment and its Challenges found that they were not record and update their inventory information and were not used logistics record-keeping, none of them had submitted a report to the supplier and put an order for personal protective equipment. however, the finding agreed with the study conducted by Kefyalew and tadesse,2018, by report were complete and accurate, timely submitted their report to the higher level.

4.3.6 Challenges affected logistics management practices EthiopianPharmaceuticals Supply Service

The second objective of the study was to determine the challenges of Covid-19 molecular laboratory logistics management practices in Ethiopian Pharmaceuticals Supply Agency. The respondents were requested to share their experiences of the extent to which the different challenge parameters that affect the Covid-19 molecular laboratory logistics practices. Analysis of the challenges of logistics management practices was done using means and standard deviations.

Table 4.11: Challenges of logistics management practices in EPSS

Challenges of logistics management practices	Mean	Std. Deviation
lack of local production affects the Covid-19 molecular laboratory logistics practices	4.15	.945
Lack of integrated system and faced lengthy bureaucratic procedures affects the Covid-19 molecular laboratory logistics practices	4.10	.857
Increased delivery lead time due to increased demand and international border restriction affects the Covid-19 molecular laboratory logistics practices	4.00	.744
lack of supplier of Covid-19 molecular reagents and consumables affects the Covid-19 molecular laboratory logistics practices	3.96	.683
Lack of trained employee affected the Covid-19 molecular laboratory logistics practices	3.92	.767
Global supply chain disruption affects the Covid-19 molecular laboratory logistics practices	3.92	.964
Sourcing country hit by the Covid-19 pandemics that makes difficult to get Covid-19 molecular reagents and consumables for the test affects the Covid-19 molecular laboratory logistics practices	3.90	.778
The distribution/collection of goods is generally inefficient due to poor road infrastructure affects the Covid-19 molecular laboratory logistics practices	3.88	.606
Lack of training for the employee affected the Covid-19 molecular laboratory logistics practices	3.85	.714
Dependency on external supplier affects the Covid-19 molecular laboratory logistics practices	3.85	1.052
Lack of employee motivation affected the Covid-19 molecular laboratory logistics practices	3.83	1.098
Customs administration hinders the efficient transit of goods, there is much delay caused by customs affects the Covid-19 molecular laboratory logistics practices	3.81	.915
Infrastructure maintenance and development is/is not adequately planned and financed due to limited resources affects the Covid-19 molecular laboratory logistics practices	3.79	.849

Being land locked, no international waterways affect the Covid-19 molecular laboratory logistics practices	3.75	.934
lack of management to commit appropriate resources affected the Covid-19 molecular laboratory logistics practices	3.71	.898
Lack of budget and foreign currency affects the Covid-19 molecular laboratory logistics practices	3.54	1.166
Dalliance in decision making by top management affected the Covid-19 molecular laboratory logistics practices	3.52	.922
Government regulation and restriction on imported items affects the Covid-19 molecular laboratory logistics practices	3.52	.945
New information technology implementation does not meet business requirements, use at rudimentary level affects the Covid-19 molecular laboratory logistics practices	3.50	.744
Customs administration does not emphasize customer satisfaction adequately affects the Covid-19 molecular laboratory logistics practices	3.50	.715
Skilled and experienced labor is not available with searching country's labor market	3.13	1.362
Grand mean of Challenges of logistics management practices in EPSS	**3.7679**	

Source: researcher,2022

As indicated in the above table (table 4.10), the study has shown that Ethiopian Pharmaceuticals Supply Service faced logistics management challenges that affected the Covid-19 molecular laboratory logistics practices as shown by the Grand mean of (M=3.7679) was high. All most all the challenges that were affecting the Covid-19 molecular laboratory logistics practices as indicated in the above table showed high. Relatively, the medium challenge was Skilled and experienced labor is not available with searching country's labor market (M=3.09 and SD=1.389).

Table 4.12 Summary on challenges of logistics management practices in EPSS (n=48)

Summary of the challenges of logistics management practices	Mean	Std. Deviation
External challenges	3.9427	.70756
Internal challenges	3.9115	.81621
Infrastructural related challenge	3.7292	.66611
Top management support related challenge	3.6944	.64443
Human resource related challenge	3.6250	.91642
Legal factor	3.6111	.63146
Grand mean of Summary of the challenges of logistics management practices	**3.7523**	

Source: researcher,2022

The Ethiopian Pharmaceutical Supply Service the highly rated challenge was related with external challenge followed by internal challenge, infrastructural related challenge, top management support related challenge

These findings were agreed with the study conducted by Fredrick S,2020 shortages and/or manufacturer prioritization of testing reagents, sample collection devices, and laboratory supplies needed to obtain and process patient samples has limited both test availability and laboratory testing capacity. In addition, another Study conducted by Brenda silva also agreed with the research finding that difficulty in maintaining a supply of testing products to meet their increased lab testing demands.

Another study conducted by Idris Nasir Abdullahi in 2020 also agreed with the major challenges associated with COVID-19 Diagnostics in Africa is mainly due to inadequate test kit, skilled laboratory personnel, molecular assays kits and equipment not cost effective.

4.4. Logistics Management Practices in Ethiopian Public Health Institute

In this study the questionnaire was distributed to the institute for getting the status of their logistics management of Covid-19 molecular laboratory reagents and consumables of donated reagents and consumables. The institute provided support and deliver Covid-19 reagents and consumables for different region testing site. So, the institute had the responsibility to manage the logistics issue of the testing site. So, here we looked the warehouse and storage, inventory, transportation and storage,

logistics information management system and the challenge that affected the logistics management practice.

4.4.1 Warehouse and Storage managements in Ethiopian Public Health Institute

The result showed on the warehouse and storage management practices in Ethiopian Pharmaceuticals Supply Service. The results are shown in table 4.13 below:

Table 4.13: Warehouse and storage management practices in EPHI(N=48)

Warehouse and storage management practices	Mean	Std. Deviation
The cold chain is monitored to ensure that Covid-19 Molecular reagents are consistently maintained at recommended storage temperatures	4.08	.679
Warehouse records and reports are up to date	3.79	.651
There is regular visual quality assurance inspections of Covid-19 Molecular reagents and consumables conducted at the storage facility	3.75	.700
Dispatch processes are ensured that damages are minimized from the time items leave the warehouse	3.75	.601
Warehouse is convenient to load & unload Covid-19 Molecular reagents and consumables to the appropriate transportation option	3.42	1.028
Put away process is to move goods for storage to their most optimal location in a fast, efficient, and effective manner	3.42	.942
The warehouse inspects the received Covid-19 Molecular reagents and consumables are in the correct quantity and in good condition before store the items in the designated storage area	3.27	1.216
The warehouse is kept Ventilated and Air conditioned to prevent stored product	3.17	1.209
There are not overstocked or no longer used items on the shelves	3.06	1.040
The organization have written guidelines for storage and handling of Covid-19 Molecular reagents and consumables.	2.90	1.016
There is allocated regular hour to cleaning the warehouse that improve employees can move around more quickly and get things done easily	2.85	1.091

The warehouse is well organized to provide a safe environment for the employees and be highly efficient	2.63	.981
The warehouse stayed organized with labels and signage to ensure employees know where to find things and/or where they belong	2.50	.875
The right technologies are used for picking process and guide the employee in executing the picking process properly	2.48	.989
There is enough storage space to handle the current quantities of Covid-19 Molecular reagents and consumables.	1.87	.393
Grand mean of warehouse and storage management practices	3.1292	

Source: researcher, 2022

As we can see in the above table the institute had low practice on the following activities like did not have enough storage space to handle the current quantities of Covid-19 Molecular reagents and consumables (M=1.87 and SD=0.393), the right technologies were not used for picking process and guide the employee in executing the picking process properly (M=2.48 and SD=0.989) and the warehouse did not stayed organized with labels and signage to ensure employees know where to find things and/or where they belong(M=2.50 and 0.875).

The purpose of a storage and warehouse to ensure the physical integrity and safety of reagents and commodities this will help ensure that commodities reach the laboratory in usable condition. The result showed that the following practice like the first the cold chain monitoring to ensure that Covid-19 Molecular reagents are consistently maintained at recommended storage temperatures(M=4.08 and SD=0.679) followed by the warehouse records and reports were up to date (M=3.79 and SD=0.651), there was regular visual quality assurance inspections of Covid-19 Molecular reagents and consumables conducted at the storage facility(M=3.75 and SD=0.7) and dispatch processes were ensured that damages were minimized from the time items leave the warehouse(M=3.75 and SD=0.601) was highly practiced.

This finding agrees with the finding by the Tesfaye HM,2017 that stated the storage conditions of majority of the hospitals have problems. Lack of adequate space and infrastructures to store medical laboratory commodities were challenges in half of the facilities

4.4.2 Inventory management practice inEthiopian Public Health Institute

The study required to identify the state of inventory management practices in Ethiopian Public Health Institute. The results are shown in table 4.14 below:

Table 4.14 Inventory management practice in EPHI(N=48)

Inventory management practice	Mean	Std. Deviation
The organization manages and issue stock according to first expiry/first out inventory control procedures.	4.08	.986
Damaged/expired Covid-19 molecular laboratory reagents and consumables are physically separated from inventory and removed from stock records	4.06	.954
Covid-19 molecular laboratory reagents and consumables inventory are reviewed, sorted and stored in their respective stock areas	4.02	.729
stock balances are monitored regularly so that procurement decisions ar actions can be made on time to avoid stockouts or overstocks	3.98	.526
The organization regularly review, maintain up to date and accurate recor of Covid-19 molecular laboratory reagents and consumables	3.81	.673
Covid-19 molecular reagents and consumables inventory level are monitore through different method to minimize the chance of error	3.50	1.031
The organization have a system for tracking product losses and oth adjustments of Covid-19 molecular laboratory reagents and consumables	3.31	1.095
Current inventory model targets & applies to minimize inventory holdin ordering & stock out	3.06	.885
The organization prevent stock-outs typically caused by incorrect forecastin or unforeseen changes in customer demand by keeping Safety stoc inventory of Covid-19 reagents and consumables	2.98	1.021
The organization have a physical labelling system that matches the digital inventory count	2.42	.871

The organization using automated inventory recording systems to keep trac of their inventory and to ensure timely reorders Covid-19 molecular laboratory reagents and consumables	1.40	.494
Grand mean of Inventory management practice	**3.3295**	

Source: researcher,2022

The result displayed in the able in the table 4.14 showed that the overall mean a of the inventor management practice of Covid-19 molecular laboratory reagents and consumables were (M=3.3295) highly practiced. As indicated in the above table the organization using automated inventory recording systems to keep track of their inventory and to ensure timely reorders Covid-19 molecular laboratory reagents and consumables (M=1.40 and SD=0.494) was very low practiced and the organization a physical labelling system that matches the digital inventory count (M=2.42 and SD=0.871) was low practiced.

Highly practiced activities were like where the organization manages and issue stock according to first expiry/first out inventory control procedures (M=4.08 and SD=0.986),Damaged/expired Covid-19 molecular laboratory reagents and consumables are physically separated from inventory and removed from stock records (M=4.06 and SD=0.954) and Covid-19 molecular laboratory reagents and consumables inventory are reviewed, sorted and stored in their respective stock areas (M=4.02 and SD=0.729).

The findings in the above table agree with the literature review that was conducted by Boche,2020 on a descriptive cross-sectional study at Ethiopian Pharmaceutical Supply Agency aimed to assess inventory management practices of program commodities showed that commodities wasted due to expiration and damage, stock out, longer duration of stock out, items from different programs were purchased through emergency orders and lack of precise data.

4.4.3 Transportation and Distribution management practices in Ethiopian Public Health Institute

The study attempted to identify the state of transportation and distribution management practices in Ethiopian Public Health Institute. The outcomes were analyzed as shown in table 4.15 below:

Table 4.15: Transportation and distribution management practices in EPHI

Transportation and distribution management practices	Mean	Std. Deviation
Employees make inspection of deliveries to make sure incoming products match the purchase order and nothing was damaged in transit.	4.15	.945
Warehouse workers keep track of stock to make sure items are secure the entire timethey are in the warehouse	3.83	.753
The Covid-19 molecular laboratory reagents and consumables are delivered using the right mode of transportation	3.79	1.010
When a customer returns a product, it is inspected by a warehouse worker to ensure it hasn't expired and no parts are missing. Once it passes quality control, it gets restocked	3.54	.922
There is written procedures specify what type of distribution system is to be used to distribute products between each level.	2.44	.848
Vehicle route planning ensures the shortest route for customers at different location and return to the starting point.	2.40	1.047
The transportation management practices enable timely delivery of products t customer	2.25	.911
There are a sufficient number of functioning vehicles with available petrol/drivers, at appropriate levels, to meet the desired distribution schedule	2.19	1.085
Refrigerated trucks are used for the distribution of covid-19 molecular laboratory reagents and consumables to different location.	2.17	.694
The warehouse Conduct regular audits on Covid-19 Molecular reagents and consumables	2.13	.841
Vehicles are scheduled to deliver the product to appropriate customer	2.00	.715

The organization uses automatic data collection technology via bar code and radio frequency identification	1.87	.334
Grand mean transportation and distribution management practices	**2.8631**	

Source: research, 2022

When we evaluate the overall perception of respondents towards transport and distribution management practices, the overall mean showed (M = 2.8631) that the practice was medium . As can be observed in the above table (table 4.8), the low practiced activities were the organization uses automatic data collection technology via bar code and radio frequency identification (M=1.87 and SD=0.334), vehicles were scheduled to deliver the product to appropriate customer (M=2.00 and SD=0.715), the warehouse Conduct regular audits on Covid-19 Molecular reagents and consumables (M=2.13 and SD=0.841), refrigerated trucks are used for the distribution of covid-19 molecular laboratory reagents and consumables to different location (M=2.17 and SD=0.694), there are a sufficient number of functioning vehicles with available petrol/drivers, at appropriate levels, to meet the desired distribution schedule(M=2.19 and SD=1.085), the transportation management practices enables timely delivery of products to customer(M=2.25 and SD=0.911), vehicle route planning ensure the shortest route for customers at different locations and return to the starting point(M=2.40 and SD=1.047), there is written procedures specify what type of distribution system is to be used to distribute products between each level(M=2.44 and SD=0.848).

The findings in the above table agree with the literature review that was conducted by Amy Lavelle and Janine,2021 found out the laboratories and clinical sites were also affected by the impact lockdowns had on supply chains for laboratory consumables and reagents saw shortages and increased delivery lead times due to increased demand, manufacturing issues as well as staff to process orders. Study conducted by Kara cannon also support the diagnostics companies and the network of laboratories positioned to provide testing services faced challenges including access to testing supplies, coordination of testing services, and the ability to scale up to meet demand as the number of infections rose.

4.4.4 Logistics management information practice in Ethiopian Public Health Institute

The study tried to assess the state of logistics management practice in Ethiopia Public Health Institute. The outcomes were analyzed as shown in table 4.16 below:

Table 4.16: Logistics information management practice in EPHI(N=48)

Logistics management practice	Mean	Std. Deviation
There is logistics management information system in place to monitor Covid-19 molecular reagents and consumables.	3.96	.651
The forms for collecting and reporting the data are well designed, easy to fill out, and easy to aggregate	3.83	.559
Logistics information is provided to decision makers for the appropriate logistical planning	3.81	.790
The LMIS records and forms properly maintained and kept up to date	3.38	1.123
The information system is used to monitor and evaluate the program's performance	3.27	1.047
LMIS data are periodically reconciled against physical inventories and validated using a standard survey	2.73	.893
The information system reports at the organization presented with quality and accuracy	2.60	.869
LMIS or other information system reports received at the central level provide appropriate information on stock status at the lower facility level	2.37	.815
Grand mean of Logistics management practice	**3.2448**	

Source: researcher,2022

As the result showed in the table 4.16 the LMIS overall mean were (M=3.2448). In the institute the LMIS or other information system reports received at the central level provide appropriate information on stock status at the lower facility level (M=2.37 and SD=0.815) and the information system reports at the organization presented with quality and accuracy(M=2.60 and SD=0.869) were low practiced .

The findings in the above table agree with the literature review that was conducted by Fikadu E,2021 in Bench-Sheko, Kafa, and Sheka zones on Logistics Management of COVID-19 Personal Protective Equipment and its Challenges found that they were not record and update their inventory information and were not used logistics record-keeping, none of them had submitted a report to the supplier and put

an order for personal protective equipment. However, the finding disagreed with the study conducted by Kefyalew and tadesse,2018, by report were complete and accurate, timely submitted their report to the higher level.

4.4.5 Challenges affected logistics practices in Ethiopian Public Health Institute

The second objective of the study was to determine the challenges of Covid-19 molecular laboratory logistics management practices in Ethiopia public health institute. The respondents were requested to share their experiences of the extent to which the different challenge parameters that affect the Covid-19 molecular laboratory logistics practices. Analysis of the challenges of logistics management practices was done using means and standard deviations

Table 4.17 Challenges affected logistics management practices in EPHI(N=48)

Challenge affected logistics management practice	Mean	Std. Deviation
lack of local production affects the Covid-19 molecular laboratory logistics practices	4.23	.973
Lack of trained employee affected the Covid-19 molecular laboratory logistics practices	4.06	.755
Infrastructure maintenance and development is/is not adequately planned and financed due to limited resources affects the Covid-19 molecular laboratory logistics practices	4.06	.755
Lack of training for the employee affected the Covid-19 molecular laboratory logistics practices	4.04	.410
Lack of integrated system and faced lengthy bureaucratic procedures affects the Covid-19 molecular laboratory logistics practices	4.04	.967
Sourcing country hit by the Covid-19 pandemics that makes difficult to get Covid-19 molecular reagents and consumables for the test affects the Covid-19 molecular laboratory logistics practices	3.98	.699
Lack of employee motivation affected the Covid-19 molecular laboratory logistics practices	3.96	1.166
Increased delivery lead time due to increased demand and international border restriction affects the Covid-19 molecular laboratory logistics practices	3.92	.739

Dependency on external supplier affects the Covid-19 molecular laboratory logistics practices	3.81	1.142
The distribution/collection of goods is generally inefficient due to poor road infrastructure affects the Covid-19 molecular laboratory logistics practices	3.81	.394
Skilled and experienced labor is not available with searching country's labor market	3.79	1.288
Being land locked, no international waterways affect the Covid-19 molecular laboratory logistics practices	3.79	.713
Global supply chain disruption affects the Covid-19 molecular laboratory logistics practices	3.79	1.010
lack of supplier of Covid-19 molecular reagents and consumables affects the Covid-19 molecular laboratory logistics practices	3.79	.944
Customs administration hinders the efficient transit of goods, there is much delay caused by customs affects the Covid-19 molecular laboratory logistics practices	3.79	.874
Dalliance in decision making by top management affected the Covid-19 molecular laboratory logistics practices	3.67	.663
lack of management to commit appropriate resources affected the Covid-19 molecular laboratory logistics practices	3.65	.956
Government regulation and restriction on imported items affects the Covid-19 molecular laboratory logistics practices	3.60	.765
New information technology implementation does not meet business requirements, use at rudimentary level affects the Covid-19 molecular laboratory logistics practices	3.48	.618
Lack of budget and foreign currency affects the Covid-19 molecular laboratory logistics practices	3.46	1.202
Customs administration does not emphasize customer satisfaction adequately affects the Covid-19 molecular laboratory logistics practices	3.35	.729
Grand mean of challenge affected logistics management practice in EPHI	**3.8135**	

Source: researcher,2022

As indicated in the above table (table 4.17), the study has shown that Ethiopia Public Health Institute faced Covid-19 molecular laboratory logistics management challenges as shown by the overall mean of

(M=3.7679). All most all were high challenges that were affecting the Covid-19 molecular laboratory logistics practices as indicated in the above table.

Table 4.18 Summary of the challenges of logistics management practices in Ethiopian Public Health Institute

Summary of the challenges of logistics management practices	Mean	Std. Deviation
Human resource related challenges	3.9375	.98609
Internal challenges	3.8854	.94385
External challenges	3.8698	.78210
Infrastructural related challenge	3.7865	.49462
Top management support related challenge	3.7847	.39792
Legal factor	3.5833	.45870
Grand mean of Summary of the challenges of logistics management practices	3.8079	.

Source: researcher,2022

The study indicated that during Covid-19 pandemic the Ethiopian public health institute were facing different challenges among those challenges human resource related challenges was the major challenge in affecting Covid-19 molecular laboratory logistics management followed by internal challenge, external challenge, infrastructural related challenge, top management support related challenge and legal factor were those challenge that the respondent agreed up on in the case of Ethiopian Public Health Institute.

These findings were agreed with the study conducted by Fredrick S,2020 shortages and/or manufacturer prioritization of testing reagents, sample collection devices, and laboratory supplies needed to obtain and process patient samples has limited both test availability and laboratory testing capacity. In addition, another Study conducted by Brenda silva also agreed with the research finding that difficulty in maintaining a supply of testing products to meet their increased lab testing demands.

Another study conducted by Idris Nasir Abdullahi in 2020 also agreed with the major challenges associated with COVID-19 Diagnostics in Africa is mainly due to inadequate test kit, skilled laboratory personnel, molecular assays kits and equipment not cost effective.

Respondent open ended question reflection on how Covid-19 molecular laboratory logistics is being practiced in EPHI and EPSS and the major challenges of Covid-19 molecular laboratory logistics management showed below

Challenge in Ethiopian Public Health Institute perspective in managing Molecular laboratory reagents and consumables

1. Most covid 19 molecular laboratory logistics received with donation and storage based on the recommendation and
2. The challenges where those items are near expiry and poor packaging and unable to stack
3. Dependency on external suppliers and shortage of foreign currency are major challenges
4. Most of them are mentioned on above. some of them are shortage of suppliers, fluctuation of global market,transportation related issue, trained manpower, lack of continuous training regarding new innovation of COVID-19 products and related issue
5. Store problem and during procurement all responsible persons didn't engaged.
6. In the warehouse there is no adequate storage space to store items can lead to inappropriate handling in EPHI and b/c of shortage of transportation in EPSS can leads prolonged lead-time
7. Sometimes, there will be communication problem between FMO, EPSS and EPHI. they don't work together closely in planning and specification
8. FMOH initiates procurement with the budget secured and then transferred to EPSA after that procurement starts based on procurement law, distribution and storage process well organized in EPSA.
9. Procurement was initiated with FMOH using in higher expert without consulting EPHI so, high amount ofcommodities were exposed to expired.
10. Procurement unit with difficulty in finding the supplier due to country hardly hit by the pandemics specially China our most commodities are procured from them
11. Lack of WHO approved Covid-19 reagents and consumables in the market, all reagents were getting from donation so difficulty to inspect and monitor the quality and specification and vehicle shortage
12. Feed the data to the system in order to control the inventory so the donators will be updated the status of the stock and distribution based on the ministry of health breakdown for the regional health office and distributed based on the standard distribution practice guideline for covid19 items.

13. Testing facilities come and collect their quota based on the distribution plan done by themselves.
14. The store room is not enough to store all supplies so items were stored at corridors and degu system were used to save and analyzed any logistics related data and Inventory held once a year.

Challenges in Ethiopian Pharmaceutical Supply Service perspective in managing Molecular laboratory reagents and consumables

1. In terms of storage and distribution of Covid-19 reagents, they are stored in a refrigerated cold room with temperature monitoring device and transported to different facilities by refrigerated vehicles to keep the products intact during transportation.
2. In EPSS Procurement of COVID-19 products done based on proper quantification and well-planned way. goods are transported by Airfreight and sea freight transportation and carefully handled and managed. Once, the products arrived our warehouse, they are store at good and recommended storage condition the distributed to health facilities in proper way. All the above Supply chain components are supported by are IT system we call it HCMIS.
3. Different procurement options were tried to facilitate the procurement and it was effective.
4. No system for emergency management, bureaucracy and delay in custom clearance
5. No local production company; demand in international market; foreign currency
6. Lack of the required supply, bureaucracy at Airport to clear the custom, poor inventory management at EPSA
7. Poor forecasting & quantification exercise in the preparation phase of the pandemic (January, 2020) and shortage of Molecular Consumable Supplies & Poor Warehouse in EPHI,
8. EPSS does not had good system for managing supplies on emergency situation since they always stick to their routine procedure tomanage emergency supplies.
9. Procurement is currently centrally managed by FMOH & EPSS, Transportation, Storage and Distribution is also managed by EPSS & EPSS have electronic based logistic management system.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5 Introduction

The study was proposed to assess the Covid-19 Molecular laboratory logistics practices and related challenges in Ethiopian Pharmaceuticals Supply Service and Ethiopia Public Health Institute. This chapter presents the summary of key data findings with respect to the objectives of the study with conclusions drawn from the findings and makes appropriate recommendations. Accordingly, the conclusions and recommendations drawn focused on addressing the two objectives of the study: which were to assess the Covid-19 Molecular laboratory logistics practices and related challenges in both organizations. Furthermore, this chapter provides limitations and suggestions for future research.

5.1 Summary of Findings

In this study efforts were made to assess the Covid-19 Molecular laboratory logistics practices and related challenges in Ethiopian Pharmaceuticals Supply Service and Ethiopia Public Health Institute. The study was also an attempt to determine the statues of the practices of Procurement, warehouse and storage, inventory management, transportation and distribution management, logistics management information system. Furthermore, efforts were made to determine the challenges of logistics management practices in both organizations. The study tried to describe important concepts in relation to the research objectives in consideration. That included review of related literatures regarding theories of logistics, logistics cycle, logistics management practices, and challenges of logistics management and empirical literature reviews manifesting actual practices. Data for the study was obtained through distribution of questionnaires to a pre-determined sample of employees in Ethiopian Pharmaceuticals Supply Service and Ethiopia public Health Institute. A total of 48 questionnaires were distributed to each organization respondents and a total of 96 questionnaires were returned with a response rate of 100%. An overall value of Cronbach ‘s alpha of EPSS (α =0.8365) and Cronbach ‘s alpha of EPHI (α =0.7912) were obtained, and the overall internal consistency test of research instruments was found in good and acceptable respectively and also within the reliability range. Regarding the general information of respondents, 62.5% of them were male and 37.5% were female in the case of EPHI and 66.7% of them were male and 33.3% were female in the case of EPSS. Thus, gender of respondents was balanced. The respondent educational level 72.9% of the respondents had second degree and above and 27.1% had first

degree in the case of EPHI and 52.1% of the respondents had second degree and above and 47.9% had first degree this implies that respondents had sufficient level of education to understand and respond the items included in the study. Similarly, the work experience of the respondent of both EPHI and EPSS had above 2-3 years.

The first objective of the study was to assess the Covid-19 molecular laboratory logistics management practices in Ethiopian pharmaceuticals Supply service and Ethiopia Public Health institute. Through the descriptive statistical analysis, an overall mean score was computed for each independent variable (logistics management practices). The study revealed that inventory management (M=3.6143) was relatively the highly practiced logistics activity in Ethiopian pharmaceuticals Supply service and followed by procurement (M=3.5669) and logistics management information system (M=3.4740).

In the case of Ethiopian Public Health Institute, the study also revealed that logistics management practice of Covid-19 molecular laboratory reagents and consumables showed that the transportation and distribution management practice (M=2.86), LMIS(M=3.2) and warehouse and storage management(M=3.12) were medium practiced in the institute. On the other hands, inventory management was highly practiced.

The second objective of the study was to determine the challenges of Covid-19 molecular laboratory logistics management practices in both organizations. The study indicated that during Covid-19 pandemic the Ethiopian public health institute were facing different challenges among those challenges human resource related challenges was the major challenge in affecting Covid-19 molecular laboratory logistics management followed by internal challenge, external challenge, infrastructural related challenge, top management support related challenge and legal factor were those challenge that the respondent agreed up on in the case of Ethiopian Public Health Institute. On the contrary, the Ethiopian Pharmaceutical supply Service the highly rated challenge was related with external challenge followed by internal challenge, infrastructural related challenge, top management support related challenge

5.2 Conclusions

Based on the results presented in the previous sections, the study has drawn the following conclusions. In the case of Ethiopia public health institute, the Covid-19 molecular laboratory logistics management practice of donated reagents and consumables in terms of warehouse management, inventory management, transportation and distribution and logistics information management system were not good in general. Specially the warehouse and storage management and transportation and distribution practice of reagents and consumables need major improvement. Hence molecular reagents were more sensitive to temperature and easily wasted if not properly managed in the cold chain system. As indicated in the result out put the storage and the warehouse space of the institute were not ready to handle the unexpected pandemics reagents and consumables. Furthermore, there were also transportation and distribution problem hence all of the reagents were need refrigerator truck that was not available in the institution. They were using regions vehicle with cold box to deliver the regent to the testing site so, these may cause quality issue and dalliance in delivery time. Finally, the institute didn't digitalize the warehouse and logistics information system that brought difficulty in managing the stock status of the institute and lower-level testing facility data accurately and timely.

From the descriptive statistical analysis result concerning the statues of logistics management practice in Ethiopian Pharmaceuticals Supply Service the study came up with there were relatively best performing in the logistics management practice in terms of procurement, inventory, and logistics information management systems. On the other hand, the organization need some kind of improvement on the organization of the warehouse that enables them to create safe environment and perform efficiently.

The study indicated that during Covid-19 pandemic the Ethiopian public health institute were facing different challenges among those challenges human resource related challenges was the major challenge in affecting Covid-19 molecular laboratory logistics management followed by internal challenge, external challenge, infrastructural related challenge, top management support related challenge and legal factor were those challenge that the respondent agreed up on in the case of Ethiopian Public Health Institute. On the contrary, the Ethiopian Pharmaceutical supply Service the highly rated challenge was related with external challenge followed by internal challenge, infrastructural related challenge, top management support related challenge

Miscommunication between most importantly the three organization namely Ethiopian Pharmaceutical Supply Service, Federal ministry of health and Ethiopian Public Health Institution and all were working for one program with interwoven activities.

5.3 Recommendation

Laboratories play a central role in public health emergency disease control and, yet many millions of people still don't have access to reliable basic laboratory testing services. To support public health emergency disease control effectively Laboratory testing services, need to provide reliable, valid, and timely results. In order to be effective in the support they need good-quality equipment and uninterrupted supplies of test reagents and other consumables are mandatory. Reagents and consumables that are required for Covid-19 molecular test need to arrive in-country and must be available in each testing site timely, in needed quantity and with quality for successfully combating the pandemics.

The main responsibility of the Ethiopian Public Health institute was to ensure the physical integrity and safety of reagents and consumables until reached the laboratory in usable condition. so, the institute should be equipped with enough amount of refrigerator, well-organized storage space, digitalize information system and most importantly the institution should focus on the local production of the reagents and leave the logistics management activities for the Ethiopian Pharmaceutical supply service hence they were established for such kind of activities and already had established network for timely and safely deliver of the reagents and consumables. The institute should focus on the quality assurance, providing clear specification in close collaboration with technical staff and local production of the reagents.

This helps to secure timely and safely delivery of the reagents and consumable to the testing site and the country not dependent on other supplier this contribute most importantly they prevent the country from low quality donated reagents and consumables.

Federal Ministry of Health, Ethiopian Public Health Institute and Ethiopian Pharmaceutical Supply Service should fill their communication gap by working closely.

5.4 Limitations and suggestions for future research

In this study only the higher facility was considered on the logistical management practice. Although there are distinguished contributions concerning the Covid-19 molecular laboratory logistics management practices on both organizations, the significance of this study needs to be viewed and acknowledged in lights of its limitation. Thus, there are limitations in this study which are left for future investigation and can be addressed by the future studies. First, the study focused on procurement, warehouse and storage, distribution and transportation, inventory and logistics management information system as stated in the previous sections. But the study did not include entire logistics management practices. The scope of the study can be further increased and enriched to include other variables (other logistics management practices) under the theoretical framework in future studies that might predict organizational performance of the two organizations. Therefore, it proposes conducting further studies considering several other types of logistics management practices.

Second, the study only focused on the logistics management practices of Ethiopian Pharmaceuticals Supply Service (focused on the Head Office excluding the branches) and Ethiopian Public Health Institute (national laboratory). Therefore, future research should be conducted on a wider scale by considering branches hubs and regional testing site. The sample size can be bigger and broader to increase the representativeness and the results can be more rewarding. Lastly, the study considered the challenges of logistics management practices faced by Ethiopian Pharmaceuticals Supply Service and Ethiopian Public Health Institute. But the study did not exhaustively consider the possible solutions. Therefore, the suggestion for further studies is about dealing with other challenges of logistics management practices in Ethiopian Pharmaceuticals Supply Service with their alleviation/improvement mechanisms.

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APPENDIX II: Questionnaire

ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

MASTER OF BUSINESS ADMINISTRATION PROGRAM

Questionnaire to be filled by employees of Ethiopian Pharmaceuticals Supply Service and Ethiopian Public Health Institute

Dear Participant,

I am a postgraduate student at Addis Ababa University college of Business and Economics, and I am conducting a study on "Assessment of molecular laboratory logistics management practices and its challenge during Covid-19 emergency in Ethiopia: The case of Ethiopia Public Health Institute AND Ethiopia Pharmaceutical Supply Service. The purpose of the questionnaire is to collect primary data to conduct the study for the partial fulfillment of Master of Logistics and supply chain management. This is purely for academic purpose and the information you provide will be kept strictly confidential. Hence, I kindly request you to fill the questionnaire genuinely. Thanks in advance for your cooperation.

General Instruction

- Please do not write your name or address on the questionnaire.
- please put a tick (√) mark in the appropriate box of your answer
- Contact address: if you have any question, please contact me through the following addresses:
- Telephone: 0913 462723
- Email: birhanuhenok68@yahoo.com

Section A: General information

1. Gender:

Male ☐ Female ☐

2. Education level:

Certificate ☐ Diploma ☐

First degree ☐ Second degree and above ☐

3. Your work department:

Warehouse and inventory management ☐ Contract management ☐

Distribution and fleet management ☐ Tender management ☐

☐

EOC Molecular laboratory

Logistics unit

4. Work experience in your work unit: 2-3 year 4-5 years

6-7 years above 7 years

SECTION B: The statues of Logistics Management Practices in Ethiopian Pharmaceuticals Supply Agency and Ethiopian public health institute

5.Questions related with logistics management practices. Please put a tick (√) mark on the appropriate number to indicate the state of logistics management practice in Ethiopian Pharmaceuticals Supply Agency and EPHI. Hence please rate your level of agreement where 1 stands for Strongly Disagree, 2 stands for Disagree, 3 stands for Neutral,4 stands for Agree and 5 stands for Strongly Agree.

A. Logistics management information system (LMIS) practice	1	2	3	4	5
1. There is logistics management information system in place to monitor Covid-19 molecular reagents and consumables.					
2. The information system reports at the organization presented with quality and accuracy					
3. LMIS or other information system reports received at the central level provide appropriate information on stock status at the lower facility level					
4. LMIS data are periodically reconciled against physical inventories and validated using a standard survey					
5. Logistics information is provided to decision makers for the appropriate logistical planning					
6. The forms for collecting and reporting the data are well designed, easy to fill out, and easy to aggregate					
7. The LMIS records and forms properly maintained and kept up to date					
8. The information system is used to monitor and evaluate the program's performance					

B. Obtaining supplies/procurement	1	2	3	4	5
1. Appropriate need identification is in place for procurement of covid-19 Molecular reagents and consumables.					
2. The organization select suitable suppliers of Covid-19 Molecular Laboratory					

reagents and consumables to be purchased from among registered supplier					
3. The procurement department investigate vendors, request quotes for the item needed before making a final decision					
3. Tenders request provided to potential suppliers who will be invited to submit tender proposals.					
5. The finance department issued a purchase order to the vendor after the purchase request approval					
6. The vendor submitted a complete request for payment and breakdown of the cost to the purchaser					
7. The vendor send over an order, which is another detailed description of the goods or services requested to give the last chance to your organization to double-check both the invoice and the order for the correct items/services at the correct price					
8. Finance sends over the payment to the vendor in the preferred method of payment after the Covid-19 molecular reagents and consumables have been received					
9. All invoices, orders, and other accompanying documentation are documented for internal and external audits					
10. Contract management practice in place maintaining good relationships with suppliers and reducing risks					
11. A formalized system of monitoring, managing and continuously improving the supplier and the Organization's performance against the contract in place.					

12. Technical proposals is evaluated prior to the opening of the financial proposal in order to confirm that the technical proposal conforms with the conditions and requirements set forth by the organization					
13.The organization negotiate terms and conditions with the most advantageous tenderer to organization among those tenderers which meet the specified technical condition and requirement					
14.The organization inspect all Covid-19 Molecular laboratory reagents and consumables delivered by the supplier to ensure that they meet the requirements and conditions stipulated by the organization.					
15.The organization automating procurement processes to prevent disruptions and to reduce the repetitive operational parts of procurement					
16. Supplier relationships is strengthened to reduce supply chain disruptions and bottlenecks enable them to identify potential disruptions early					
17. A well-trained team is equipped in procurement unit to carry out processes effectively and efficiently					
18. Clear specification has been provided to the potential suppliers					

C. Inventory control procedures	1	2	3	4	5
1. Covid-19 molecular reagents and consumables inventory level are monitored through different method tominimize the chance of error					
2. stock balances are monitored regularly so that procurement decisions and actions can be made on time to avoid stockouts or overstocks					
3. The organization manages and issue stock according to first expiry/first out inventory control procedures.					

4. Damaged/expired Covid-19 molecular laboratory reagents and consumables are physically separated from inventory and removed from stock records.					
5. The organization have a system for tracking product losses and other adjustments of Covid-19 molecular laboratory reagents and consumables					
6. Covid-19 molecular laboratory reagents and consumables inventory are reviewed, sorted and stored in their respective stock areas					
7. The organization prevent stock-outs typically caused by incorrect forecasting or unforeseen changes in customer demand by keeping Safety stock inventory of Covid-19 reagents and consumables					
8. Current inventory model targets & applies to minimize inventory holding, ordering & stock out					
10. The organization using automated inventory recording systems to keep track of their inventory and to ensure timely reorders Covid-19 molecular laboratory reagents and consumables					
11. The organization regularly review, maintain up to date and accurate records of Covid-19 molecular laboratory reagents and consumables					
12.the organization have a physical labelling system that matches the digital inventory count					

D. Warehousing and storage	1	2	3	4	5
1. The organization have written guidelines for storage and handling of Covid-19 Molecular reagents and consumables.					
2. There is enough storage space to handle the current quantities of Covid-19 Molecular reagents and consumables.					
3. There is regular visual quality assurance inspections of Covid-19 Molecular reagents and consumables conducted at the storage facility					
4. The cold chain is monitored to ensure that Covid-19 Molecular reagents are consistently maintained at recommended storage temperatures					
5. The warehouse is well organized to provide a safe environment for the employees					

and be highly efficient					
6. warehouse is convenient to load & unload Covid-19 Molecular reagents and consumables to the appropriate transportation option					
7. The warehouse stayed organized with labels and signage to ensure employees know where to find things and/or where they belong					
8. The warehouse inspects the receivedCovid-19 Molecular reagents and consumables are in the correct quantity and in good condition before store the items in the designated storage area					
9. There is allocated regular hour to cleaning the warehouse that improve employees can move around more quickly and get things done easily					
10. putaway process is to move goods for storage to their most optimal location in a fast, efficient, and effective manner					
11. The right technologies are used for picking process and guide the employee in executing the picking process properly.					
12. dispatch process are ensured that damages are minimized from the time items leave the warehouse.					
12. warehouse records and reports are up to date					
13. The warehouse are kept Ventilated and Air conditioned to prevent stored product					
14. There are not overstocked or no longer used items on the shelves					

E. Transport and distribution	1	2	3	4	5
1. There is written procedures specify what type of distribution system is to be used to distribute products between each level.					
2. There are a sufficient number of functioning vehicles with available petrol/drivers, at appropriate levels, to meet the desired distribution schedule					
3. Refrigerated trucks are used for the distribution of covid-19 molecular laboratory reagents and consumables to different location.					

4. The transportation management practices enables timely delivery of products to customer					
5. The Covid-19 molecular laboratory reagents and consumables are delivered using the right mode of transportation					
6. Vehicles are scheduled to deliver the product to appropriate customer					
7. Vehicle route planning ensure the shortest route for customers at different locations and return to the starting point.					
8. The organization inspect vehicle regularly based on the schedule					
9. The vehicles have vehicle tracking system to truck the route of the product delivery					
11. Employee make inspection of deliveries to make sure incoming products match the purchase order and nothing was damaged in transit.					
12. Warehouse workers keep track of stock to make sure items are secure the entire time they are in the warehouse					
13. When a customer returns a product, it is inspected by a warehouse worker to ensure it hasn't expired and no parts are missing. Once it passes quality control, it gets restocked.					
14. The warehouse Conduct regular audits on Covid-19 Molecular reagents and consumables					
16. The organization uses automatic data collection technology via bar code and radio frequency identification					

F. Challenges faced when managing logistics of covid-19 molecular laboratory reagents and consumables	Scale				
A. External challenge	1	2	3	4	5
1.lack of supplier of Covid-19 molecular reagents and consumables affects the					

Covid-19 molecular laboratory logistics practices					
2. Sourcing country hit by the Covid-19 pandemics that makes difficult to get Covid-19 molecular reagents and consumables for the test affects the Covid-19 molecular laboratory logistics practices					
3. Global supply chain disruption affects the Covid-19 molecular laboratory logistics practices					
4. Increased delivery lead time due to increased demand and international border restriction affects the Covid-19 molecular laboratory logistics practices					
B. Internal challenges	1	2	3	4	5
1. Lack of budget and foreign currency affects the Covid-19 molecular laboratory logistics practices					
2. Dependency on external supplier affects the Covid-19 molecular laboratory logistics practices					
3. lack of local production affects the Covid-19 molecular laboratory logistics practices					
4.. Lack of integrated system and faced lengthy bureaucratic procedures affects the Covid-19 molecular laboratory logistics practices					
C. Infrastructural challenge	1	2	3	4	5
1.The distribution/collection of goods is generally inefficient due to poor road infrastructure affects the Covid-19 molecular laboratory logistics practices					
2. Infrastructure maintenance and development is/is not adequately planned and financed due to limited resources affects the Covid-19 molecular laboratory logistics practices					
3. Being land locked, no international waterways affect the Covid-19 molecular laboratory logistics practices					
4. New information technology implementation does not meet business requirements, use at rudimentary level affects the Covid-19 molecular laboratory logistics practices					
D. Legal factor	1	2	3	4	5
1. Customs administration hinders the efficient transit of goods, there is much delay					

caused by customs affects the Covid-19 molecular laboratory logistics practices					
2. Government regulation and restriction on imported items affects the Covid-19 molecular laboratory logistics practices					
3. Customs administration does not emphasize customer satisfaction adequately affects the Covid-19 molecular laboratory logistics practices					
E. Human resources related challenges	1	2	3	4	5
1. Lack of trained employee affected the Covid-19 molecular laboratory logistics practices					
2. Lack of employee motivation affected the Covid-19 molecular laboratory logistics practices					
3. Skilled and experienced labor is not available with searching country's labor market					
F. Top management support related challenge	1	2	3	4	5
1. lack of management to commit appropriate resources affected the Covid-19 molecular laboratory logistics practices					
2. Lack of training for the employee affected the Covid-19 molecular laboratory logistics practices					
3. Dalliance in decision making by top management affected the Covid-19 molecular laboratory logistics practices					

G. Open ended question

1. How Covid-19 molecular laboratory logistics is being practiced in your organization in terms of (procurement, transportation, storage, distribution, logistics management information system and inventory management)?

1._____

_____

_____

2. What are the major challenges of Covid-19 molecular laboratory logistics management at EPHI and EPSS?

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