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**Health Commodities Inventory Management Performance and Challenges
in Selected Public Health Facilities of South Gondar Zone, Amhara Region,
Ethiopia**

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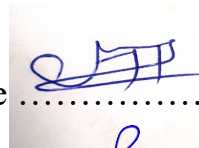
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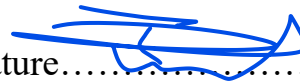
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ABSTRACT

Introduction: Assessing inventory management system effectiveness has always been a crucial task in health-care organizations in order to discover and close gaps. In order to demonstrate inventory management performance fully in this research area, none of the prior studies analyzed integrated both financial and non-financial measuring variables from different perspectives.

Objective: To assess health commodities inventory management performance and challenges in selected public health facilities of South Gondar Zone, Amhara Regional State, Ethiopia.

Methods: A facility-based cross-sectional descriptive study, following a concurrent mixed method approach with both qualitative and quantitative methods of data collection, was done. The study included 18 health facilities or 30% of the 57 health institutions or study population. Expert opinions were added to learn about the interdependent links of indicators in the decision-making trial and evaluation laboratory technique. The numeric data was input and analyzed using Microsoft Excel, while the qualitative data was thematically evaluated.

Results: The average prescription fill rate and affordability utilizing prospectively selected 1800 prescriptions at selected health institutions were $84.36 \% \pm 5.08$ and 1.6 ± 0.39 , respectively. During the 2012 EFY, the majority of surveyed health institutions 15(83.33%) used emergency orders at least once. During the 2013 EFY, however, nearly all 18 (100%) of the selected health institutions used at least two emergency orders. According to the study, the average inventory accuracy rate in the study area was $71.33 \% \pm 9.63$, and the average wastage rate of selected health commodities was $1.59 \% \pm 1.25$ in 2019/2020 and $1.78 \% \pm 1.33$ in 2020/2021, resulting in a total loss of 750,398.78 ETB. In the qualitative part of the study majority of participants believed that there is insufficient short and long-term training and supervision to fill employees' skill gaps, which helps to improve inventory management performance. The most influential performance indicators, according to the classical decision-making trial and evaluation laboratory approach, was the frequency of emergency orders, with R+C values of 3.52 which is associated to more indicators.

Conclusion: This investigation discovered that the frequency of emergency orders is the most important indicator, and any responsible bodies should pay more attention to reducing it in addition to implementing other sound inventory management operations to build a strong health care delivery system.

Key words: *Challenges, Commodities, Facilities, Health, Inventory and Performance*

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Abbreviations and Acronyms

ART	Anti-Retroviral Therapy
BSC	Balance Score Card
DEMATEL	Decision Making Trial and Evaluation Laboratory
EFY	Ethiopian Fiscal year
EIM	Electronic Inventory Management
ETB	Ethiopian Birr
EPSA	Ethiopian Pharmaceutical Supply Agency
EPSS	Ethiopian Pharmaceutical Supply Service
FMOH	Federal Ministry of Health
HC	Health Center
HCMIS	Health Commodity Management Information System
HSCM	Health Supply Chain Management
IMAT	Inventory Management Assessment Tool
LIAT	Logistic Inventory Assessment tool
MSH	Management science for Health
NGO	Non-Governmental Organization
OPD	Out Patient Department
PM	Performance Measurement
PMS	Performance Measurement System
PMTCT	Prevention of Mother to Child Transmission
RRF	Report and Requisition Form
SCM	Supply Chain Management
SCOR	Supply Chain Operation Reference
SPSS	Statistical Package for Social Science
STG	Standard Treatment Guideline
TB	Tuberculosis
TD	Tracer Drug
USAID	United State Agency for International Development
USD	United State Dollar
WHO	World Health Organization

1. Introduction

1.1 Background

In primary health care settings, the reliable supply of health commodities (i.e., medicines, laboratory reagents, chemicals, supplies, and consumable medical supplies) is critical for detecting and treating illnesses (Agarwal *et al.*, 2018).

A properly functioning inventory management system plays a vital part in the supply chain since it increases the amount of demand that can be met by having health commodities ready and available when the consumer needs them (Bray and Awuah, 2019). It helps to reduce healthcare costs while maintaining the quality of service to patients by improving the efficiency and throughput of the healthcare system (Rachmania and Basri, 2013).

Inventory management is a field of corporate management involved with planning and controlling inventories, according to the American Production and Inventory Control Society (APICS) and its primary goal in health facilities is to reduce healthcare costs while maintaining the quality of service to patients by improving the efficiency and throughput of the healthcare system (Rachmania and Basri, 2013). Inventory management of medicines is thus the backbone of healthcare delivery. To avoid frequent stock outs of health commodities and other inventory management issues, particularly in public health facilities, effective inventory management systems, in addition to other supply chain management practices, must be in place (Barasa, Oluchina and Cholo, 2018).

The performance of an organization's inventory control is directly measurable by how well it provides high levels of customer service while maintaining a modest inventory investment (Rajab *et al.*, 2017). In general, inventory management performance measurement is the

process of assessing and evaluating the efficiency and effectiveness of actions against pre-set targets using well-defined criteria (Damtie, Ibrahim and Yikna, 2020). A performance assessment as part of monitoring and evaluation assists in identifying inventory management errors and bottlenecks. Inventory management efficiency is measured using a variety of measures. The indicators utilized are determined by the organization's goal and context (John Snow, Inc. 2017).

The Kaplan and Norton (1992) Balance Scorecard (BSC) model, which examines the integration of performance metrics, financial like the value of product wastage, and non-financial variables like RRF data quality, inventory accuracy rate, stock out rate, and the like, has received a lot of attention in the supply chain management performance measurement study (Severgnini *et al.*, 2019).

Regardless of the government's unreserved support and fair budget allocation for improving pharmaceutical supply chain management performance, there are still complaints about the inventory control system's poor implementation. Despite the importance of supply chain management as a competitive tool, supply chain operational excellence for health commodities inventory management in Ethiopia is understudied, and there is a knowledge gap on how well the supply chain management practice in Ethiopia is performing (FDRE, 2003).

As a result, the attention of this study was on examining the performance of inventory management systems, because health facilities must monitor numerous lookouts in order to appraise results on a regular basis and establish a consistent feedback system. It also provides an empirical snapshot of current health commodities inventory management performance, as well as baseline data for tracking changes and improvements over time at selected public health institutions in Ethiopia's Amhara region, South Gondar Zone.

1.2 Statement of the problem

Healthcare commodities inventory management systems are intricate systems that are influenced by a variety of circumstances. Its performance must be improved on a regular basis in order to make healthcare services more accessible and affordable. A comprehensive and systematic modeling and analysis of inventory management systems that satisfy the objectives of the healthcare industry is a requisite to take into account all of these factors (Saha and Ray, 2019).

In terms of major features, healthcare supply chain management differs from other system logistics operations in that it tends to be misaligned, expensive for healthcare providers, and reliant on third parties. There are several aspects to consider in order to assure on-time delivery, product protection, and integrity from origin to destinations (Lenin, 2014). If we could accurately predict what people want and when they want it, we could confidently plan to meet demand. Demands and lead times for obtaining an item, on the other hand, are unclear, potentially resulting in stock outs and customer unhappiness. As a result, carrying extra inventory to defend against uncertainty may be necessary (Urissa W. , 2019).

Due to a lack of a robust inventory management techniques, vital medicines have been reduced by 30% and medical delivery lead times have increased by 10% to 20%. In the second scenario, inventory errors cut profits by 10%, while misplaced products cut profits by 25%. This demonstrates how performance monitoring can reveal a problem and lead to better inventory management (Kihara and Ngugi, 2021). Inventory management's goal is to maintain a consistent supply at a reasonable price. In Ethiopia, however, a study indicated that for the previous 12 months, the average length of necessary pharmaceutical stock out days was 40.6 days. Stock outs have far-reaching consequences that go beyond lost revenue. As a result, drug

scarcity may obstruct health-care delivery, endangering public health (Boche, Mulugeta and Gudeta, 2020).

Ethiopia's Pharmaceutical Supply Service (EPSS) and the Ethiopian Ministry of Health (FMOH) have teamed up to ensure Ethiopians have access to a safe, equitable, and cost-effective health supply chain (EPSA, 2018). The country's spending on drug imports has risen in recent years, from roughly \$300 million two years ago to \$450 million in 2020. Product quantity and value are likely to exceed these levels in the next years (Nbe and Behak, 2020, accessed date on 11/26/2021). However, several investigations in Ethiopia indicated that essential pharmaceuticals were in short supply. This means that a well-established inventory management practice, as well as ongoing monitoring and assessment, is one of the measures to be undertaken (Mohammed SA *et al.*, 2020; Taddele *et al.*, 2019). There are other reports in S/Gondar Zone that show percentage of clients with 100% Prescribed drugs is 86 %, RRF reporting rate is 98.5 %, and Inventory accuracy rate is 89 %, all of which are below the recommended 100% figure. The wastage rate is also higher than the national recommendation of less than 2%, which is 2.2 percent in this Zone (ARHB, 2013).

Despite the fact that the reviewed studies attempted to evaluate some aspects of inventory management performance, the majority of them relied on quality indicators adopted from LIAT delivered by the USAID/DELIVER Project; however, none of the studies evaluated includes both financial and non-financial perspectives in various viewpoints, i.e. Customer perspectives, Financial perspectives and Operational perspectives to comprehensively assess the inventory management of the facilities they have included in their study as to the knowledge of the researcher, in Ethiopia.

Therefore, this study is tried to fill this gap by employing these three types of perspectives supplemented by the qualitative method to assess the inventory management performance of those health facilities in detail.

1.3 Significance of the study

The goal of this research is to evaluate the performance and issues with health commodity inventory management at government health facilities in Ethiopia, South Gondar Zone, Amhara Region. As a result, the study assessed the level of performance of health commodities inventory management, identified the key challenges that can affect health supplies inventory management. It can also give appropriate suggestions or recommendations to solve or mitigate the problems and challenges identified in the study. So that it can readily satisfy client needs at the lowest feasible cost and with the least amount of inventory investment. It also provides some guidance to government and non-governmental groups working in this field on how to focus on the issue and participate in efforts to enhance health commodity inventory management. The DEMATEL with modified BSC model was utilized at the time to categorize and prioritize complicated and tough inventory management issues. Furthermore, the study may aid scholars in conducting more research on the public sector's inventory management performance.

2. Literature review

2.1 Overview of health supply chain management concept

Health care is the ongoing maintenance of one's health through the prevention, diagnosis, and treatment of diseases, physical disabilities, and mental illnesses in humans. Pharmaceuticals, medical and surgical supplies, devices, and other things required by healthcare professionals such as doctors, nurses, and administrative employees make up the logistics in healthcare. In healthcare, a supply chain can be defined as the sequence of physical and technical resources required to provide excellent service to patients while staying under budget (Arora and Gigras, 2018).

Health supply chain management (HSCM) is the application of value imperatives to all aspects of the health-care supply chain, including sourcing, product creation, manufacture, location, transportation, packaging, storage, retrieval, disposal, and follow-up health-care services (Min and Hokey, 2017). Physical, information, and financial flows are all part of the SCM processes in healthcare. Pharmaceuticals, surgical consumables, medical devices, hygiene consumables, food supplies, equipment, and other auxiliary products are all part of the physical flows that support doctors, nurses, and patients. For optimal product flow and organizational performance improvement, Supply chain (SC) choices are linked to information and financial flows. Through the integration of critical processes, a successful SCM includes planning, managing, and regulating these flows (Pinna, Carrus and Marras, 2015).

Customer disappointment, rising health-care costs, competition, and reduced compensation for services are just some of the issues that health-care organizations face as a result of new mandates. All of these issues compel health organizations to implement a robust HSCM system capable of meeting these demands (Al-Saa'da *et al.*, 2013).

2.2 Inventory management

Global economic integration is a prominent trend in worldwide economic development that has presented health care organizations with both unusual opportunities and serious obstacles in recent years. As a result, implementing effective inventory management will help to balance both supply and demand (Zhao and Tu, 2021). Inventory management is the safe process of storing items properly, distributing them, and keeping accurate records. It is the heart of the medication delivery system, and without it, the entire health-care system would collapse. Internal Facility Report and Resupply Form (IFRR) and Report and Requisition Form (RRF), Bin card (BC), and Stock record card (SRC) are all common inventory tracking and documentation types. Inventory receipts, issues, losses, orders, balances, suppliers, customers, and prices are all recorded in these files (Bayked, Kahissay and Workneh, 2021).

Inventory management is now aided by a computerized logistics management information system (LMIS), which simplifies the documentation of all medical transactions and integrates all levels of supply chains. Despite its relevance in enhancing the overall efficiency of the inventory management process, LMIS is underused in underdeveloped nations such as Ethiopia (Kefale and Shebo, 2019). It is vital that a good inventory management system allows managers to access real-time inventory and overall service quality information. This will help management make correct and well-informed decisions, save time and money on labor, and effectively manage inventory (Gurmu and Ibrahim, 2017).

However, due to a lack of strong pharmaceutical inventory management culture in Ethiopia, health facilities were unable to reach their goals. Pharmaceutical inventory control is frequently cited as a severe deficiency in supply chain competence in various health facilities around the country. Its inadequacies have resulted in the non-availability of important pharmaceuticals, as

well as wastage due to inefficient storage, stock management, irrational use, improper dispensing, and prescribing practices (Jobira *et al.*, 2021).

2.3 Inventory management challenges

Despite the fact that the difficulties of inventory management differ from one facility to another, they exist in all circumstances. Here are some of the researches that have been done in this field.

The issues of inventory management with the usage of the electronic inventory management (EIM) application across public hospitals in South Africa were highlighted in a research by (Modisakeng *et al.*, 2020). However, EIM was being misused, with some employees failing to enter the stock that was received and issued into the system appropriately. As a result, incorrect consumption data was created, resulting in the system's future order quantities being insufficient, potentially causing drug shortages in certain institutions.

Assessing the challenges in health commodity supply chain in regional medical stores in Ghana discovered that there was insufficient forecasting in the supply chain function, insufficient funding of health commodities, and poor information flow between regional medical stores and health facilities and finally, poor road infrastructure and a lack of cars hinder the efficient distribution of health commodities to multiple health institutions (Mcobrein and Ackah, 2019).

In the qualitative portion of their study, at the Ethiopian pharmaceuticals supply agency discovered issues such as insufficient storage space, outdated warehouse designs, and a lack of warehouse equipment (Boche, Mulugeta and Gudeta, 2020). According to the World Health Organization, maintaining optimal storage conditions for health commodities is critical to ensuring their quality and serving clients appropriately (WHO, 2007). In addition, according to a study, the logistic abilities of employees involved in medicine supply in the hospitals

evaluated were low. The three district hospitals' medicine inventories were not effectively handled. The majority of the employees were unfamiliar with inventory control and pharmaceutical quantification techniques. One of the key causes contributing to stock outs was a lack of cash to buy the medicines (Kagashe and Massawe, 2012).

From the study conducted in the case of Dubo primary hospital, 11 (14.10 percent) of the 78 respondents said that the organization was having difficulty with the complexity of ordering and stocking of items, 25 (32.05 percent) said that the organization was having difficulty with supplier performance, and 34 (43.58 percent) reported that the business was having trouble with material scarcity and supplier performance, but that it also had issues with ordering complexity, stocking, and product damage (Urissa, 2019). Another study at private Ethiopian pharmaceutical wholesalers found that all of the facilities surveyed lacked adequate product handling equipment for unloading and moving incoming goods, and that the receiving area/space in the majority of the facilities surveyed (80%) was inconvenient for the movement of goods and materials (Yimenua, Nigussie and Workineh, 2021).

2.4 Measurement of inventory management performance

To achieve great public health outcomes, a good inventory optimization system is essential. It decreases the risk of basic essential medicines being out of stock, which could result in a weakened public health system due to large gaps in inventory management, monitoring, and evaluation. Inventory performance is a metric for determining how well and efficiently inventory is used and refilled. Inventory performance measures compare actual on-hand dollars to predicted cost of goods sold. According to many lean practitioners, inventory performance is the single best measure of a facility's total operational performance (Kihara and Ngugi, 2021).

A complicated value-creating system is held together by performance measurement, which formulates and monitors a plan implementation. It is a multidisciplinary field with applications in logistics (Kucukaltan, Irani and Aktas, 2016). Each supply chain's performance monitoring system should be customized to meet its unique needs. In a tumultuous climate and competitive global markets, the proper selection of a collection of indicators and their dimensions aids in the identification of problem areas and is critical in managing businesses and whole supply chains that give the required information for decision-makers (LEOŃCZUK, 2016). In general, performance measurement is the process of quantifying and comparing an action's efficiency and effectiveness against pre-set goals using established standards (Damtie, Ibrahim and Yikna, 2020).

2.5 Inventory management performance measurement models and tools

Metrics for performance assessment and improvement should represent the essence of organizational performance and reflect a balance of financial and non-financial measurements (Sarode, Sunnapwar and Khodke, 2008). A proper measurement approach must first be chosen before a measurement tool can be designed. A review of the literature was conducted to see whether there were any existing procedures that might be used. The Balanced Score Card (BSC) is a well-known strategy when it comes to these techniques (Davarynejad M.*et al.*, 2010).

2.5.1 Supply chain operation reference -model (SCOR)

The Supply Chain Council's suggested Supply Chain Operation Reference (SCOR) model can be used to measure inventory management performance as one of the primary tasks in supply chain management. The model measures performance by identifying SC performance indicators across the supply chain process of the firm so it can be used to assess and improve performance. The SCOR model offers a holistic approach to improving strategy, defining

structure (including human capital), managing processes, and evaluating performance and is built around five distinct management processes: plan, source, make, deliver, and return (Prasetyaningsih E. *et al.*, 2020). The SCOR model's key performance characteristics are dependability, responsiveness, flexibility, cost, and asset management (Ambe, 2014). The first three categories are customer-facing since they are directly tied to customers. The remaining metrics, which are measures taken within the SC's internal operations, are referred to as internal facing metrics (Rao *et al.*, 2019). It helps organizations manage their supply chains by allowing them to review and measure their processes, identify weak links, and make adjustments (Andarini D. and Adhiutama, 2013).

2.5.2 Balanced score card model

Kaplan and Norton were the first to propose the balanced scorecard (BSC) in 1992. BSCs try to create a comprehensive measurement system that integrates strategic measurement and management systems across businesses, using both financial and non-financial metrics to measure both external and internal aspects of business operations (Chang *et al.*, 2013). It also allows for causal linkages between indicators to be established in order to evaluate and improve supply chain performance (Moons, Waeyenbergh and Pintelon, 2018).

As a result, the Balanced Scorecard (BSC) concept, which is a widely established technique and was deemed to be appropriate for the current study with some modifications due to its exceptional qualities, such as incorporating financial and non-financial variables from many perspectives as indicated by (Kucukaltan, Irani and Aktas, 2016).

Customer perspectives: These are end-user-perceived critical goals that might lead to client contentment or discontent. For example, the rate at which patients fill their prescriptions and the rate at which customers are satisfied. Customer satisfaction has long been recognized as an

important criterion for assessing the competency of any health-care system around the world (Bakar *et al.*, 2010). Internal business operations include objectives aimed at increasing operational efficiency. It frequently refers to metrics like throughput, quality, cycle time, and so on. This is also known as the "internal process. Human capital development focuses on manpower development and motivation. Financial perspectives discusses cost-related objectives that have an impact on the revenue like inventory costs, sales, delivery costs, and the cost of returns and unusable products are all examples of this (Bhagwat and Sharma, 2007).

2.5.3 Inventory management assessment tool (IMAT)

This tool was developed by the INFORM Program at Management Sciences for Health (MSH) to improve warehouse performance. It generates indicators to assess the effectiveness of a warehouse's record-keeping and stock management practices and makes recommendations for improvement. The tool guides users through the data collection process (based on the stock levels of a group of representative products over a specific time period, calculating indicators, analyzing and interpreting the results, and identifying appropriate improvement strategies) (Msh, 2005).

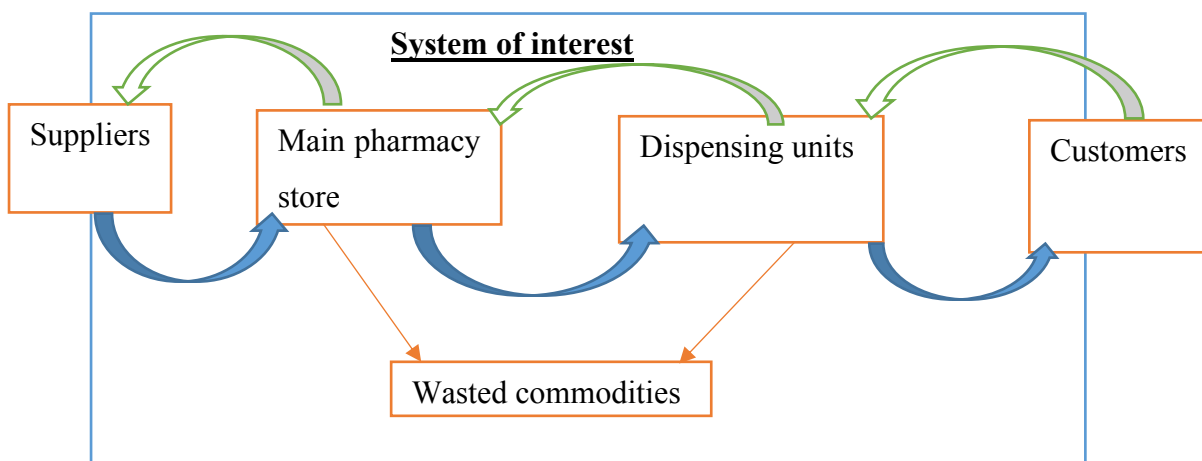



Figure 1: Health commodities and demand flow (area of interest for this work)

Source- (Gebicki *et al.*, 2013) NB:  = orders/demands,  = supply flow

Here are some findings done by different authors related to the above measurement perspectives i.e., customer perspectives, operational perspectives and financial perspectives.

A study conducted on assessment of patient satisfaction with pharmaceutical services in hospital pharmacies in Dares Salaam, Tanzania using a prospective cross-sectional study found that unavailability of prescribed medicines was a problem in government hospital pharmacies, which was complained about by 17.45 percent of those who went to the government pharmacies (JANDE M. *et al.*, 2013). Another study on the same case at Tikur Anbessa Specialized Hospital's outpatient pharmacy in Ethiopia found that only 38.0 percent of drugs are available from recommended medications (Semegn and Alemkere, 2019). A similar study on assessment of clients' satisfaction with health service deliveries at Jimma university specialized hospital, found that 88.2% of total clients received a prescription paper for drugs and supplies, only 33.3 percent received all of the prescribed drugs (Assefa, Mosse and H/Michael, 2011).

According to a study on an evaluation of rational prescribing in hospital outpatient practice in Sierra Leone and assessment of prescription affordability as an outcome, the average cost per prescription was Le. 29,376.30 (\$6.78), which is equivalent to 43 days of work for the lowest-paid government employee (Cole and Routledge, 2018). Another study on access to essential drugs in primary health care units of South Wollo Zone, Ethiopia discovered that 56 % of the 815 respondents' dispensed medicines spent more than 12.65 ETB (one day's lowest paid government wage) on medicines. For the three health facility groups, 92 (65.7%), 107 (44.6%), and 258 (58.9%) of patients in the primary hospital, urban health centers, and rural health centers, respectively, spent more than 12.65 ETB on drugs (Hussien and Tafese, 2015).

A study conducted on the availability of essential medicines and pharmaceutical inventory management practices at health centers in Adama town, Ethiopia, using an institutional-based cross-sectional survey and inventory management assessment tool (IMAT) indicators revealed that the average length of stock out days for tracer drugs from each HC over the previous 12 months was 40.6 days. Among the TDs tested at HCs, oral rehydrating salt was stock out for 144 days, whereas paracetamol was only stock out for 1.4 days. The TD mismatch between physical count and on bin-card for which physical inventory is less than the balance on bin-card varies between 0% and 33.3 percent (Kefale and Shebo, 2019).

Another study using HF based descriptive cross-sectional study with both quantitative and qualitative methods based on the USAID delivery project logistics indicators assessment tool (LIAT) on inventory management performance of key essential medicines in health facilities in East Shewa Zone, Oromia Regional State, Ethiopia found that the average stock out rate of vital necessary medications was around 27.25 %, with a 35.31 days average stock out duration. A total of 174,366.98 Ethiopian birr (ETB) was lost due to the disposal of 10.43 % of medications, with Medroxy progesterone accounting for 65.74 % of the total. Only 5 (25%) of health care facilities meet the criterion for satisfactory storage condition. Budget limits, a lack of human resources, and an oversupply of pharmaceuticals that are about to expire were recognized as important inventory management issues (Gurmu and Ibrahim, 2017).

A study conducted on inventory management performance for laboratory commodities in public hospitals in Jimma zone, Southwest Ethiopia was found to have placed at least one or two emergency orders in the previous six months in four of the hospitals. Budget limits, a lack of timely administrative support, a lack of personnel commitment, and periodic commodity shortages on the part of suppliers were all key inventory management bottlenecks (Befekadu *et al.*, 2020).

Another study, which used a facility-based descriptive cross-sectional quantitative triangulated with qualitative method to examine inventory management performance for family planning, maternal, and child health medicines in public health facilities in the West Wollega zone of Ethiopia, found that average medicine availability was 14 (61.30 percent) with a mean stock-out duration of 70.71 days. 559 (78.40 %) of the drugs had bin cards, and 374 (52.45 %) of the bin cards were accurate. The report submission percentage was 116 (84.06%), with 47 (40.52%) report and resupply forms submitted on time, 73 (62.93%) of them complete, and 69 (59.48%) of them accurate. Inventory management concerns cited include supplier issues, a lack of human resources, administrative issues, and a lack of computer equipment (Kebede and Tilahun, 2021).

Another cross-sectional study design to investigate Anti-Tuberculosis commodities management performance and factors affecting it at public HFs in Dire Dawa City administration, Ethiopia found that on average, 43 percent of HFs accurately reported a report and requisition format (RRF), 50 percent of the HFs had good storage conditions and standards. Isoniazid 300 mg, rifampicin, isoniazid, pyrazinamide (RHZ fixed dose), and ethambutol 400 mg were stocked out in about 50 %, 18.9 %, and 66.6 % of HFs, respectively, with a mean stock out duration of 10.8, 18.9, and 70.5 days (Tola, Anbessa and Yikna, 2020).

A study on warehousing and inventory management performance after health commodity management information system (HCMIS) implementation at Tikur Anbessa Specialized Hospital in Addis Ababa, Ethiopia, using a facility-based retrospective quantitative method research design for the years (2015/2016 and 2017/2018), revealed that wastage rate(0.029) and wastage amount (2.60 percent) (Tefera G. and Messele B., 2020).

Blank bin cards, IFRRs, and RRFs are widely available in hospitals (over 90%) and health centers (close to 80 %). Moving down the supply chain, however, the availability of recording and reporting formats decreases (Shewarega *et.al*, 2015). The median percent adequacy of storage conditions in all HC store rooms was determined to be 50% in a study on assessment of medicine supply management and its quality assurance practice in health centers in the South West Shewa Zone, Oromia Regional State, Ethiopia. The suitability of storage conditions was discovered to be 83.3 percent in one HC store. Four of the health center store rooms met more than half of the required criteria for adequate storage conditions, while the other five met less than half (Gebremariam ET and Unade TT , 2019).

Organizations should select and monitor the core indicators because measuring everything is inefficient in terms of resources. To determine those key metrics, we must first determine our main work activities, or those procedures that add the most value to the company and examine the products and/or services we offer to customers. Each of these indicators has its own set of objectives, on which various performance measures are based. Each viewpoint in this framework offers a unique perspective on inventory management and the difficulties that it raises.

2.6 Conceptual frame work

A conceptual framework is a framework that the researcher believes best explains the natural course of the subject under investigation. It is linked to the researcher's conceptions and description of how the research question will be investigated (Adom, Hussain and Joe, 2018).

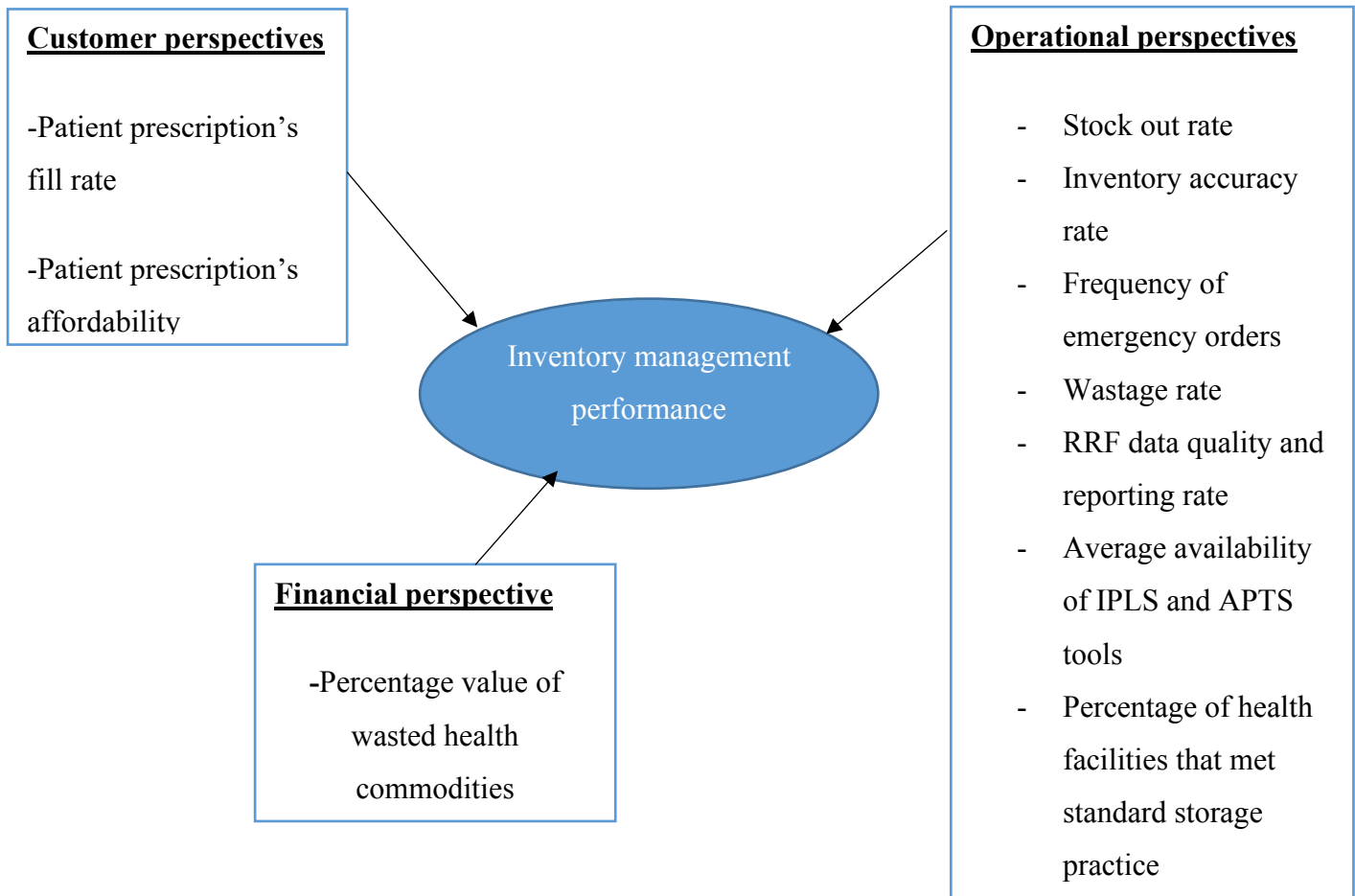


Figure 2: Conceptual frame work

Adopted from (Bhagwat and Sharma, 2007) and intensive literature search

3. Objective

3.1 General objective

To assess health commodities inventory management performance and challenges in selected public health facilities of South Gondar zone, Amhara Regional State, Ethiopia.

3.2 Specific objectives

1. To describe the performance of the health commodities inventory management of the selected health facilities from the perspectives of customers.
2. To assess the performance of the health commodities inventory management of the selected health facilities in-terms of operational perspectives.
3. To determine the performance of the health commodities inventory management of the selected health facilities in-terms of financial attributes.
4. To explore the challenges and influential measuring indicators related to managing inventory at the selected health facilities.

4. Research methods

4.1 Description of the study area

This study was carried out in government health facilities located in South Gondar Zone, Amhara region, North Central Ethiopia. Debre Tabor is the capital city of South Gondar Zone and is located 50 kilometers east of Lake Tana, 100 kilometers from Bahirdar, the capital city of the Amhara region and 667 kilometers from Addis Ababa, capital city of Ethiopia. The zone is divided into 18 districts (five urban and 13 rural). According to Federal Democratic Republic of Ethiopia central statistical agency, this zone has a projected population size of 2,364,603, with 1,196,318 men and 1,168,285 women in 2014 (*FDRE Central Statistical Agency, 2014*). The zone had 10 public hospitals (1 comprehensive referral and 9 primary hospitals), 96 health centers, 406 health posts, 13 pharmacies, 57 drug stores and 76 private health facilities (hospitals and clinics) based on the annual report of the 2020/2021 Zonal Health Department (SGZHD, 2020/2021).

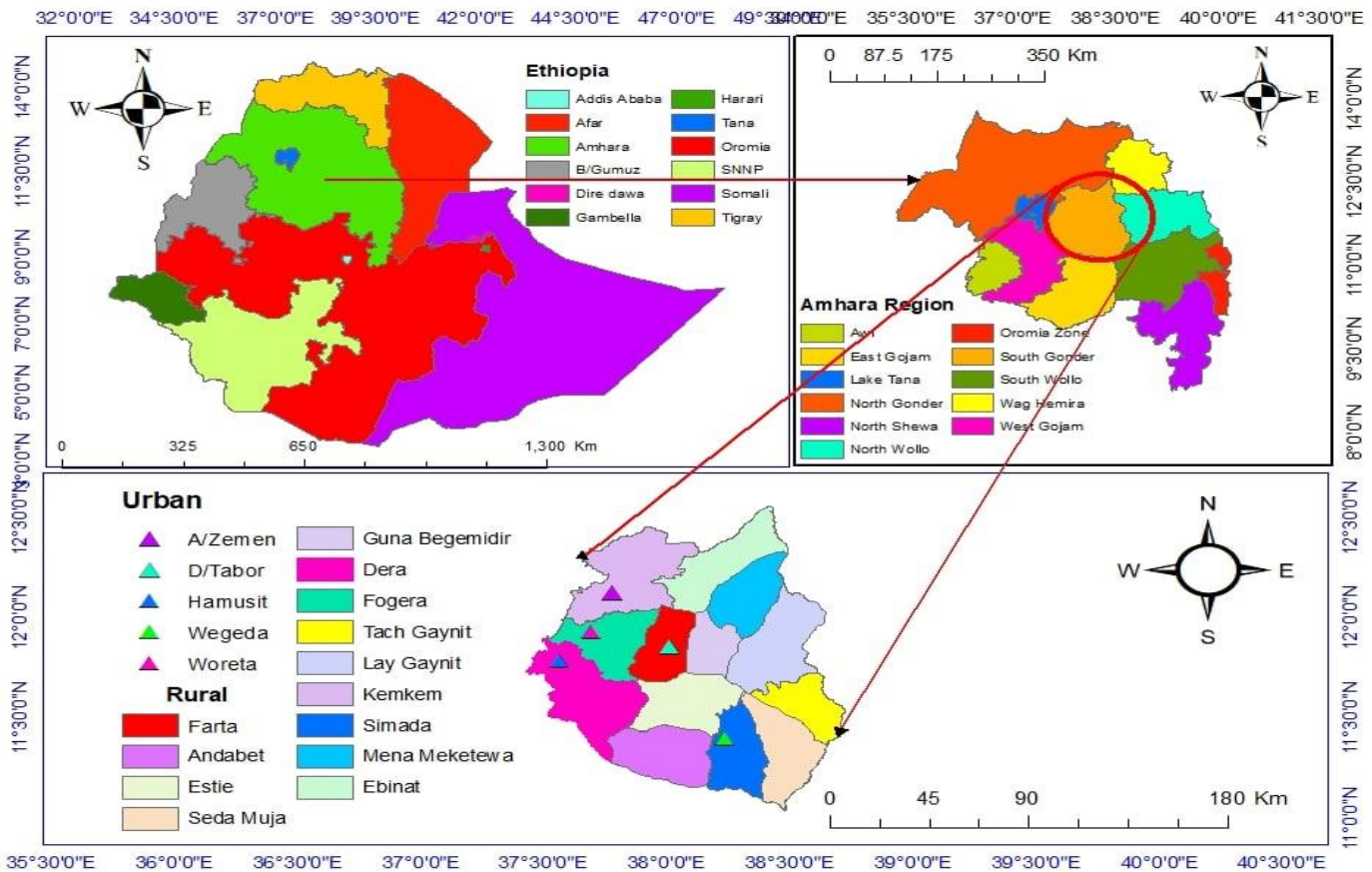


Figure 3: Location of study area, Source: (Computed by ArcGIS)

4.2 Study approach

In order to achieve the research's goal, this study used both qualitative and quantitative approaches. The quantitative approach used a structured questionnaire to collect data from the primary data source to assess inventory management performance using various standard operating procedures and key performance indicators with different perspectives, whereas the qualitative approach employed a semi structured questionnaire to capture information that cannot be gathered quantitatively and to supplement the quantitative data.

4.3 Study design and period

A concurrent mixed method design was applied, in which a facility-based cross-sectional descriptive study supplemented with qualitative data. The data were collected between January 5th and March 30th, 2022.

4.4 Source and study population

❖ For quantitative data

The study's source population included public health facilities in the South Gondar zone while the study population was those health facilities that provide ART services (including hospitals and health centers). Because these health-care facilities serve a large number of people and have a complex inventory management system. In addition, ART medication is one of the tracer health commodities chosen for this investigation to show inventory management performance comprehensively. There are 8 hospitals and 49 health centers in the South Gondar zone that offer ART and PMTCT services. The study included hospitals and health centers that were operating prior to the 2011 EFY and had an annual inventory and report of expired pharmaceuticals from the 2012 and 2013 EFY.

In addition, registry review was done for the selected RRF, Bin cards, Stock cards, Model 19 (receiving voucher) and Model 22 (issuing voucher) for the sake of beginning and ending balance as well the amount and or value of the product each facility received and issued, selected health commodities, purchase orders and HCMIS to collect the necessary data. To evaluate the storage condition, all selected health facilities stores were observed.

Customers came to OPD pharmacy with prescription were used as source population whereas prescriptions having at least one medication with its cost were considered as study population.

❖ For qualitative data

Health professionals work in health facilities were used as source population but those who have more than six months work experience considered as study population.

4.5 Eligibility criteria

4.5.1 Inclusion criteria

The study focused on health-care facilities that are providing ART and PMTCT services and were established before the 2011 EFY.

4.5.2 Exclusion criteria

- Health facilities damaged by recent conflicts
- Health facilities prepared as a COVID-19 treatment center
- Prescriptions for patients without a cost and prescription with medical supplies only
- Health Professionals who served for less than six months and those who were not present during the study time

4.6 Sample size determination and sampling techniques

The required number of health facilities to be included in the survey were determined based on (Nthambi, 2014; Patton M., 2002), which states that the sample size of the study should be 30 percent of the target population in proportion to the size of the stratum, as this has been proven to be sufficient for a descriptive survey study. The target population consists of 64 ART and PMTCT-serving health facilities in the South Gondar Zone, six of which were distracted due to local conflicts, and one of which was designated as a COVID-19 treatment center. As a result, the study was involved in 18 of the 57 health institutions located in the target demographic. Health-care institutions were categorized into three types based on the level of care they provide: health centers, primary hospitals, and referral hospitals. Thirty percent of the HFs were chosen at random from each category. One referral hospital, two primary hospitals, and fifteen HCs were all involved in the study.

Based on the top 10 diseases identified in the South Gondar zone's 2013 EFY report and by consulting logistics experts from the Zonal Health Department, Amhara Regional Health Bureau, and neighboring pharmaceutical suppliers (Bahirdar EPSA Hub), a total of 25 health commodities was used in the study, as recommended by MSH's inventory management assessment tool (IMAT) (Msh, 2005), including first-line medicines for the ten top morbidities in accordance with a national standard treatment guideline third edition (FMHACA, 2014).

Bin cards, model 19, and the registry of damaged/expired products were examined to determine the rate of wastage and percentage of the value of unused items. Since each HF is required to provide six times per year to corresponding pharmaceutical suppliers, or every two months, all RRF reports from selected 18 health facilities were analyzed for RRF data quality and reporting rate.

The number of patient prescriptions were determined using the WHO guide on how to assess medicine management and usage in health facilities, which recommends that 100 prescriptions be included for each individual HF. Based on this, a total of 1800 prescriptions were prospectively examined using a systematic random sampling technique (World Health Organization, 1993).

Key informants for the qualitative data were store managers, pharmacy department heads, the head of the health center, and the hospital's chief executive officer (CEO) because they are expected to have more knowledge than other health care providers related to the topic. Following the classical DEMATEL (Decision Making Trial and Evaluation Laboratory) approach, pharmacy personnel having more than 3 years' work experience and who are actively involved in health commodity management practice was used as expert to collect opinions or perceptions after providing clear descriptions of each indicator to establish the interdependence relationships and the weight of the metrics that were used. To do this 5-15 experts are more appropriate as recommended by (Atthirawong W., 2011). The most important consideration when establishing the sample size is to keep it manageable and to allow the researcher to obtain detailed data at a reasonable cost in terms of time, money, and human resources (Rotich, Aburi and Allan, 2014).

4.7 Data collection and management

4.7.1 Data collection instrument

To examine health commodities inventory management performance and issues from various perspectives, an interview guide and data collection format were created and categorized following modified BSC and DEMATEL model based on existing research with certain revisions as well a standard inventory management evaluation method was used (Tefera G. and Messele B., 2020; Gurmu and Ibrahim, 2017; WHO , 2007; PFSA, 2017; Msh, 2005; Kagashe, Minzi and Matowe, 2011;Leksono, Suparno and Vanany, 2019).

The quantitative data was acquired using questionnaires, checks of records and reports, and physical observations but the qualitative data was gathered using semi-structured questionnaires for key informants.

4.7.2 Data collection procedure

❖ For quantitative data

Filling checklists by observation for storage standards, physical count of stocks, review of patient prescriptions and relevant documents were used to collect data by data collectors who have received prior training on the data collection procedure for this study. The use of bin cards and RRFs were assessed from July 1, 2011 to June 30, 2013 EFY.

❖ For qualitative data

Key informants were approached in order to acquire qualitative data. The interview guide was written in Amharic, the region's native language. As a result, the interview took place in Amharic and was recorded. The findings were translated into English by the lead investigator. Each key informant interviewed for a minimum of 30 minutes as recommended by (DiCicco-Bloom and Crabtree, 2006).

4.8 Data quality control and analysis

4.8.1 Data quality control

❖ For quantitative data

Under the direction of the principal investigator, data was collected by trained data collectors (with a pharmacy background), and a pretest was completed outside of the selected health facilities before the main study data collection procedures were carried out. The data was validated for completeness and accuracy before being entered into an Excel spreadsheet version 2013 for analysis. Also, before to data collection, the primary investigator had a more in-depth discussion regarding the instruments with the research supervisors. The collected data was reviewed for accuracy, summarized, and recorded on the computer for each facility on the same day.

❖ For qualitative data

Qualitative data does not have the same level of validity and reliability control as quantitative data. As a result, participants were very clear about the nature and purpose of the research, audiotaped recordings and peer examinations were used in order to establish trustworthiness and improve the validity and reliability of the qualitative part of the research.

4.8.2 Data analysis

❖ For quantitative data

Using an Excel spreadsheet, the quantitative data was entered and analyzed. The research was carried out in groups, with descriptive statistics being used (frequency, mean, SD, percentage, and graph).

The following formula measures were used.

1. Stock out rate = $\left(\frac{\text{Number of facilities that experienced a stockout of a specific product}}{\text{Total number of facilities that are expected to offer that product}} \right) \times 100$
2. Stock wastage rate = $\left(\frac{\text{unusable stock of an item during 1year}}{\text{Begining stock + quantity recived of the item during 1year}} \right) \times 100$

3. Percentage value of unusable stock = $\left(\frac{\text{value of unusable stock}}{\text{total inventory value}}\right) \times 100$
4. Percent of stores that met standard criteria = $\left(\frac{\text{Number of stores that fulfilled criteria}}{\text{Total number of stores visited}}\right) \times 100$
5. Inventory accuracy rate = $\left(\frac{\text{Number of Stock record count} = \text{Physical stock count}}{\text{Total number of items assessed}}\right) \times 100$
6. RRF data quality
 - RRFs accuracy rate = $\left(\frac{\text{Number of accurate report}}{\text{Total number of RRF report submitted}}\right) \times 100$
 - RRF timelines rate = $\left(\frac{\text{Number of timely reached report}}{\text{Total number of report submitted}}\right) \times 100$
 - RRF completeness rate = $\left(\frac{\text{Number of complet report}}{\text{Total number of report submitted}}\right) \times 100$
 - RRF reporting rate = $\left(\frac{\text{Number of facilities submitted their report in the specified schedule}}{\text{A total number of facilities expected to submit their report}}\right) \times 100$
7. Prescriptions fill rate = $\left(\frac{\text{Number of products actually dispensed}}{\text{Total number of products prescribed per prescription}}\right) \times 100$
8. Prescription affordability = $\left(\frac{\text{Average cost of prescribed products}}{\text{Daily lowest paid unskilled government worker.}}\right) \times 100$

❖ **For qualitative data**

All key informant responses were entered and evaluated in Microsoft Word, which was used to help with data coding and theme analysis. Framework analysis was used to explain a theme or concept and included definitions of words and related concepts. It is helpful when researcher was attempting to compare themes or concepts (Nowell *et al.*, 2017).

We attentively listened to the audio and read the transcriptions, details, and field notes after the interview to review the collected data and analyze it using the six processes outlined below.

1. **Familiarize with the data:** We understood the obtained data and spent time going through it and becoming acquainted with the various themes in the data.
2. **Generating initial codes:** During this phase, we began to categorize the data and identify concepts.

3. **Searching for themes or sub themes:** During this step, the researcher generated themes and identified links between themes.
4. **Reviewing themes:** The themes identified in the third phase are evaluated and analyzed at this point. We also compared the results to other studies that used a similar approach. Even though studies differ in many ways, this comparison aids in validating data analysis results.
5. **Defining and naming themes:** This phase entails naming and defining all of the themes. We also looked at if any of the topics could be combined or removed from the analysis.
6. **Producing the report:** The final stage is the study's actual authoring. We produced a summary paragraph and detailed descriptions for each of the themes.

The significance of the idea, probable concept connections, and compliance with the research purpose were all examined throughout the analytical processes.

DEMATEL's level of importance and influence is used to construct correlations between indicators. Between 1972 and 1976, the Geneva Battel Memorial organization's Science and Human Relations department created DEMATEL, a comprehensive approach for developing and assessing a structural model comprised of causal links between intricate criteria (Leksono E., Suparno S. and Vanany I., 2019).

Expert opinions was used to undertake a pair-wise comparison between indicators using the following steps (0 = no influence, 1 = weak influence, 2 = medium influence, 3 = high influence, 4 = extremely high influence) (Huang *et al.*, 2020).

A. Gather Experts opinions and calculate the average matrix

An $n \times n$ direct matrix would be produced by each expert. Each value in the matrix represents the magnitude of a factor's interaction influence. The diagonal values of the matrix are set to 0

when $i=j$. Assume that m is the number of experts who took part in the research. The mean of the identical components in the distinct direct matrices of the experts is then used to calculate an average matrix Z , which is $Z = [z_{ij}] n \times n$: as follows;

$$\left[\frac{z_{ij} = [a_{ij}(1) + a_{ij}(2) + \dots + a_{ij}(m)]}{m} \right] \dots \dots \dots (1)$$

B. Calculate the normalized initial direct relation matrix X:

$X = [\bar{X}_{ij}] n \times n$ and $0 \leq x_{ij} \leq 1$ Can be acquired from the equation (2) and (3), all diagonal elements are equal to zero, $X = S * Z$ (2)

$$S = \frac{1}{\max_{1 \leq i \leq n} \sum_{j=1}^n z_{ij}}; i, j = 1, 2 \dots n \dots \dots \dots (3)$$

C. Derive the total relation matrix T:

The total-relation matrix T can be obtained by using the equation (4), where I is denoted as the identity matrix. $T = X(I - X)^{-1}$ (4)

D. Calculate the sum of rows (R) and columns (C) of matrix T:

The sum of rows and the sum of columns are separately denoted as R and C within the total relation matrix T through the equations (5) - (7): $T = [t_{ij}] n \times n$ $ij = 1, 2 \dots n$ ---- (5)

$$R = \sum_{j=1}^n t_{ij} \dots \dots \dots (6)$$

$$C = \sum_{i=1}^n t_{ij} \dots \dots \dots (7)$$

Where R and C represent the sum of rows and the sum of columns respectively.

E. Set the threshold value (α):

Calculation of the average of T (α): $\bar{X} = \frac{\sum T}{\sum ij}$; where, i = the sum of the row and j = the sum of the column. An indicator having more weight than the threshold value had more influence and make relevant relationships in the cause and effect diagram.

F. Build a cause and effect relationships of diagram

If $R-C > 0$, the factor is above the horizontal axis in the Cartesian coordinate system, the factor is the causal factor, indicating that the influence of this factor on other factors is greater than the impact on itself; if $R-C < 0$, the factor is below the horizontal axis, indicating that factors are more influenced by other factors than they have for other factors, so this factor is the resulting (effect) factor. $R+C$ indicates the level of importance relative to each other.

4.9 Ethical considerations

The Addis Ababa University School of Pharmacy's Ethics Review Committee granted ethical approval. The research was also approved by the Amhara Regional Public Health Institution, the South Gondar Zone Health Department, EPSA Bahirdar and Gondar hub and the local Woreda Health Office. Oral consents were taken from the participants regarding their willingness to participate in the study. Study participants were informed about the study's goal and the importance of their participation during the consent process. Participants in the study were also informed that they could skip any questions they didn't want to answer totally or partially, as well as terminate the procedure at any time, and that their participation was completely voluntary. Because no personal identifiers were utilized during the study, participants were ensured of the anonymity of the information obtained.

4.10 Operational definitions

- Inventory management is the process of effectively managing the constant movement of units into and out of an existing inventory in order to meet customer requests (Mishra A. and Salunkhe H., 2018).
- Inventory management performance is a metric that measures how well and efficiently inventory management is implemented (Sarmad, 2019).

- Stock out rate: The drug is termed stock-out if the ending balance on the logistical recording tool (bin card) is zero in the six months prior to data collection and there is no any usable quantity in physical stock during survey time.
- RRF data quality: It is the timeliness, accuracy, and completeness of logistical data.
- The completeness of reports: A report is complete if all of the columns for each product listed in the RRF report are filled out, unless the facility does not manage the product and all columns of the RRF are completed, reporting period and facility name is recorded (Bekele and Anbessa, 2021).
- Timeliness : A report is considered timely if health centers and hospitals submit their RRF to the higher supplier (EPSS) until the 10th day and to the woreda health office until the 5th day after the reporting period (PFSA, 2017).
- RRFs data accuracy: When transferring data from Bin card to RRF, there is no discrepancy, and there are no calculation mistakes in each column for the selected health commodities, RRF is regarded correct (Tefera, Yihunie and Bekele, 2021).

Finally, the study's findings are presented using tables, various charts, and, where applicable, statements. The research findings also summarized, conclusions drawn, and recommendations are made.

5. Results

Based on the specific aims of the research, the findings are classified into two categories: quantitative findings and qualitative findings.

5.1 Quantitative findings

5.1.1 Customer perspective metrics

For this study, 1800 prescriptions (100 from each health facility) were collected systematically in order to analyze both prescription fill rate and prescription affordability. Affordability was determined by prescribing health commodities that cost less than or equivalent to the average daily wage of the lowest-paid unskilled government worker. At the time of the survey, the lowest-paid government employee received an average daily income of 32.43 Ethiopian Birr (ETB), which corresponded to 0.655 US dollars. According the National Bank of Ethiopia exchange rate for the months of January 5th, 1 USD was equivalent to 49.506 ETB. In all selected public health facilities, the average percentage of prescription fill rate was $84.36\% \pm 5.08$ (Min=75.29 %, Max=94.88 %) and prescription affordability was expressed as 1.69 ± 0.39 (Min=1.33, Max=3.01) day's wage is required for the lowest unskilled government employee's and both indicators are showed in the following Table-1 in detail.

Table 1. Average percentage of prescription fill rate and prescription affordability in selected public health facilities of S/Gondar Zone, Amhara, Ethiopia from Jan5/2022-Mar15/2022

HF name(code)	Prescription fill rate (%)					Prescription affordability (in days)				
	Mean	Min	Max	SD	Optimal value	Mean	Min	Max	SD	Optimal value
RH1	85.98	16.67	100.00	23.46	100	3.01	0.13	10.78	2.68	≤1
PH2	80.83	0	100	26.82	100	1.47	0.23	8.18	1.39	≤1
PH3	94.88	33.33	100	13.58	100	1.91	0.04	12.67	2.06	≤1
HC4	88.11	0	100	25.19	100	2.00	0.06	9.31	2.36	≤1
HC5	86.63	0	100	25.12	100	1.62	0.09	6.62	1.28	≤1
HC6	89.23	25	100	19.53	100	1.85	0.09	7.31	1.42	≤1
HC7	79.75	0	100	28.07	100	1.54	0.14	6.6	1.24	≤1
HC8	79.6	25	100	27.25	100	1.78	0.11	9.44	1.97	≤1
HC9	84.39	0	100	24.48	100	1.41	0.26	9.99	1.3	≤1
HC10	77.37	25	100	24.13	100	1.97	0.31	8.65	1.63	≤1
HC11	75.29	33.33	100	25.28	100	1.33	0.03	9.99	1.64	≤1
HC12	79.57	0	100	29.62	100	1.5	0.13	9.22	1.4	≤1
HC13	89.06	33.33	100	20.88	100	1.56	0.2	9.74	1.44	≤1
HC14	84.76	0	100	27.49	100	1.44	0.17	6.97	1.2	≤1

HC15	80.19	0	100	25.6	100	1.53	0.06	8.45	1.37	≤1
HC16	87.21	33.33	100	20.53	100	1.36	0.23	3.82	0.84	≤1
HC17	88.3	33.33	100	20.27	100	1.46	0.15	8.17	1.12	≤1
HC18	87.31	0	100	24.45	100	1.68	0.23	7.89	1.34	≤1
Total										
average	84.36					1.69				

5.1.2 Operational perspective metrics

This study's perspective comprises the percentage of IPLS and APTS tool availability and utilization status, frequency of emergency orders, storage standard practice, inventory accuracy rate and stock out rate, wastage rate in amount, RRF data quality, and reporting rate in selected 18 public health facilities in the study area. Except for stock out rate, which was collected during the survey period and the six months prior to data collection due to the difficulty in obtaining reliable data over a long period of time due to HF's Bin card accuracy, retrospective data was collected for two years, from 1 July 2011 to 30 Jun 2013 EFY.

5.1.2.1 Percentage of availability and usage status of IPLS and/ APTS tools

Despite some challenges regarding the consistent usage of bin cards and IFRR, the availability of various IPLS and APTS resources such as bin cards, RRF, IFRR, new Model-19 (Receiving voucher), and new Model-22 (issuing voucher), tablet counting trays, calculators, and scissors is met in almost all facilities evaluated. Despite the fact that, stock cards are available in almost one third (66.67%) of the health facilities, just only three (16.7 %) were have an up to date stock cards.

Table 2. Percentage of IPLS and/ APTS tools/resources availability and use status in selected public health facilities of S/Gondar Zone, Amhara, Ethiopia March/2022

S. N	Tools/Resources	Availability		Use status	
		Yes N (%)	No N (%)	Yes N (%)	No N (%)
1	New Model-19	18(100)	0(0)	18(100)	0(0)
2	New Model-22	18(100)	0(0)	18(100)	0(0)
3	Bin card	18(100)	0(0)	18(100)	0(0)
4	Stock card	12(66.67)	6(33.33)	3(16.67)	15(83.33)
5	RRF	18(100)	0(0)	18(100)	0(0)
6	IFRR	18(100)	0(0)	16(88.89)	2(11.11)
7	E-recording	10(55.56)	8(44.44)	10(55.56)	8(44.44)
8	Dispensing registers	16(88.89)	2(11.11)	12(66.67)	6(33.33)
9	Labeling stickers	10(55.56)	8(44.44)	7(38.89)	11(61.1)
10	Tablet counting trays	17(94.44)	1(5.56)	17(94.44)	1(5.56)
11	Calculators	18(100)	0(0)	18(100)	0(0)
12	Scissors	18(100)	0(0)	18(100)	0(0)
13	STG	18(100)	0(0)	0(0)	18(100)
14	Formulary manual	17(94.44)	1(5.56)	17(94.44)	1(5.56)
15	Facility specific list	12(66.67)	6(33.33)	10(55.56)	8(44.44)
	Total average	88.15%	11.85%	74.07%	25.93%

The average tools/resources availability and usage status by the selected surveyed health facilities were 86.65% ±11.23 (Min=66.67, Max= 100) and 78.48 % ±12.62 (Min=53.33, Max=93.33) respectively and showed in Figure-4.

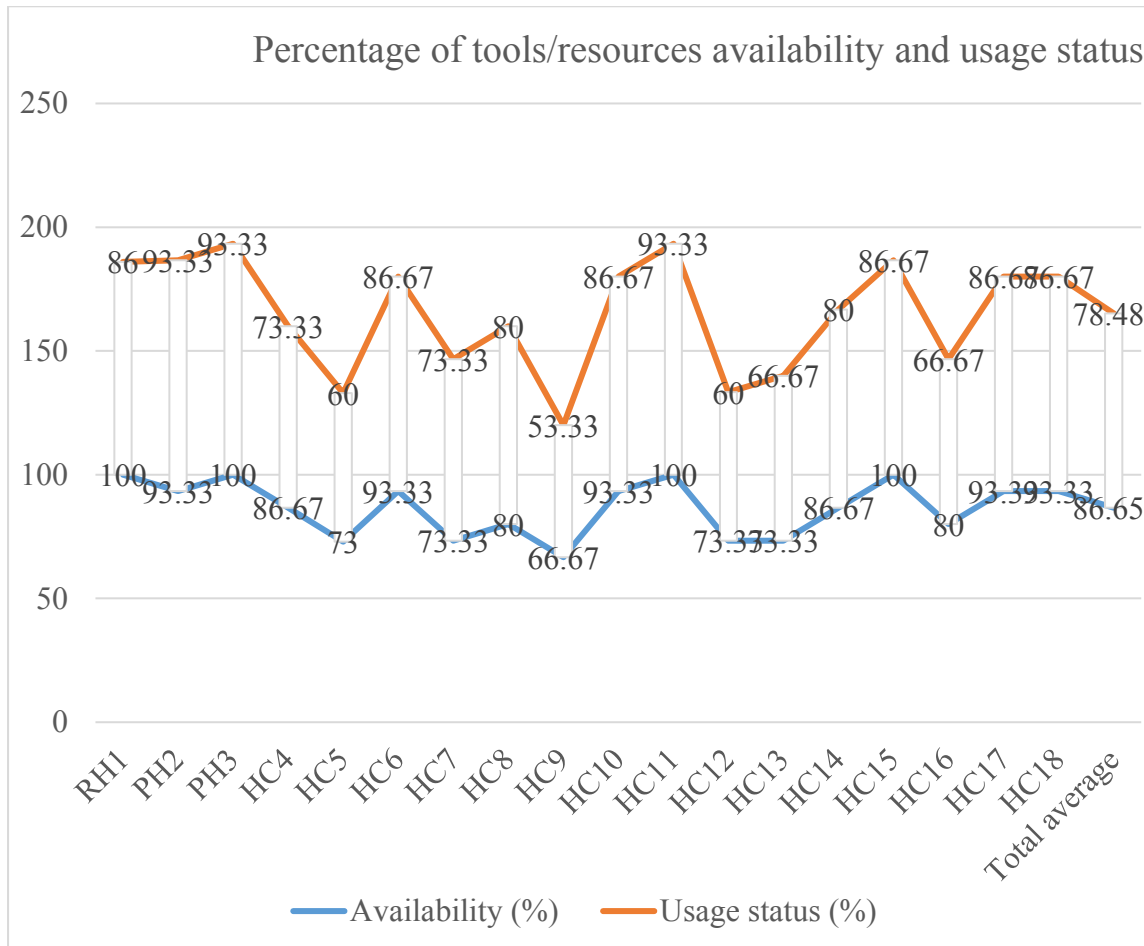


Figure 4. Percentage of IPLS and / APTS tools or resources availability and usage status in selected public health facilities of S/Gondar Zone, Amhara, Ethiopia, March/2022 (N=18)

5.1.2.2 Frequency of emergency orders

IPLS suggests placing emergency orders to avoid stock outs if the stock on hand is below the defined emergency order points, which for hospitals and health facilities is two weeks. According to key personnel interviews, in addition to using the RRF, the majority of assessed health institutions 15 (83.33 percent) used emergency orders at least once in the 2012 EFY. However, for the 2013 EFY, practically all 18 (100%) of the selected health institutions made at least two emergency orders, usually for program health goods due to frequently stock outs.

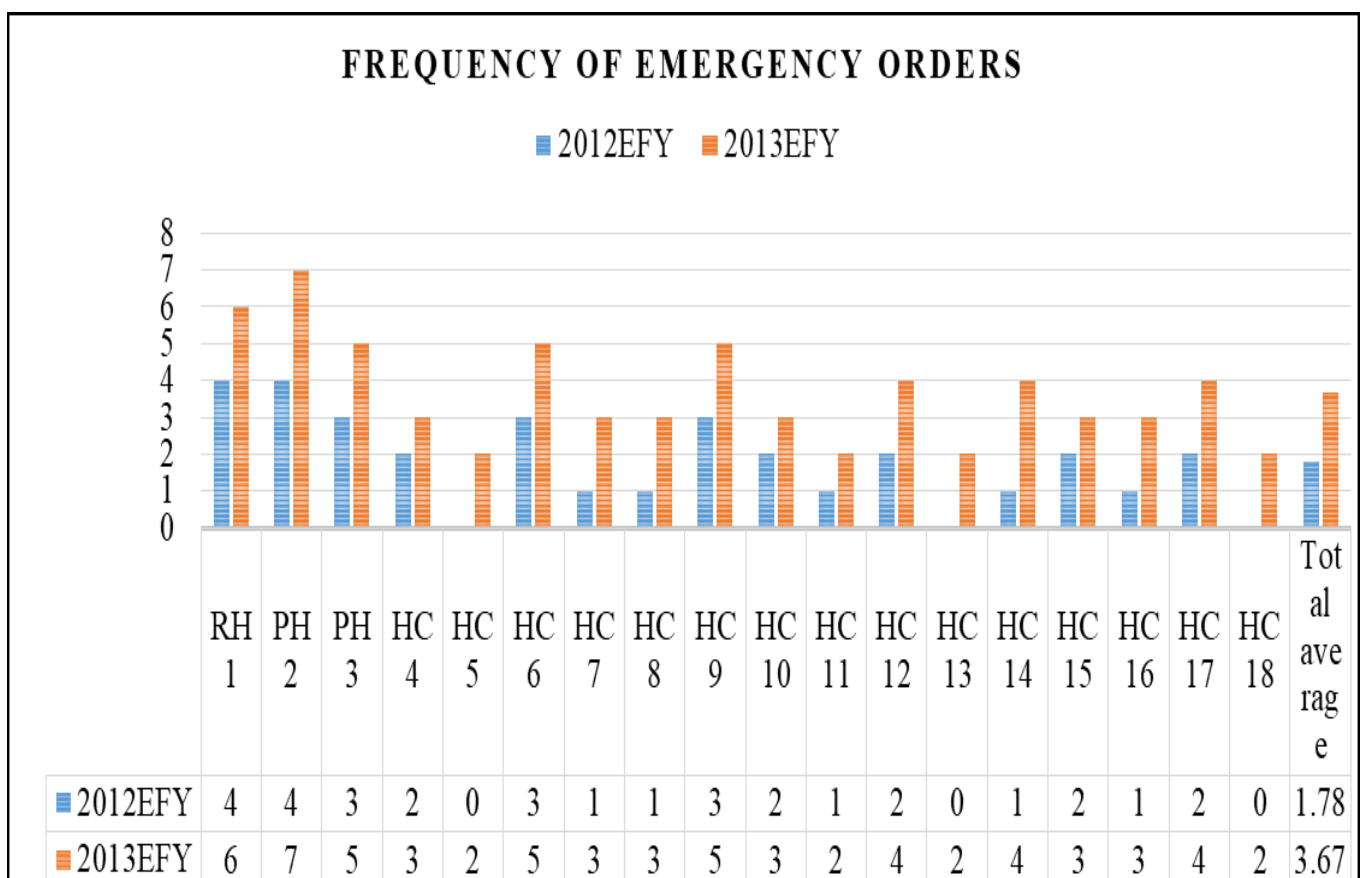


Figure 5. Frequency of emergency orders in selected public health facilities in S/Gondar Zone, Amhara, Ethiopia, from July/2019-Jun/2021

5.1.2.3 Percentage of inventory accuracy and stock out rate

The study was used to assess the quality of data by cross-checking the correctness of the bin card balance with the physical count for each of the selected goods on the day of the visit, in addition to checking the use and updating of bin cards. An accurate bin card is one that has no disparity between the bin card and the physical count. For the health commodities evaluated, no health facilities in the research area met the recommended inventory accuracy rate of 100%. According to the study, the average inventory accuracy rate in the study area is 71.33 %± 9.63 (Min=52, Max=92). On the day of the visit, 5.39 (21.28 %) of the specified health commodities in each HF were out of stock. The findings show that, on average, each HF stocked out 15.28 % (61.11%) of chosen health commodity items in the previous six months.

Table 3. Percentage of inventory accuracy and stock out rate in selected health facilities of S/Gondar Zone, Amhara, Ethiopia, March/2022

Health facilities name (Code)	Inventory accuracy		
	rate at survey time (%)	Stock out rate during survey time N (%)	Stock out rate during past six months N (%)
RH1	64	2(8%)	12(48%)
PH2	80	4(16%)	16(64%)
PH3	92	6(24%)	19(76%)
HC4	68	3(12%)	13(52%)
HC5	76	4(16%)	16(64%)
HC6	72	3(12%)	12(48%)
HC7	72	8(32%)	17(68%)
HC8	52	10(40%)	19(76%)
HC9	60	6(24%)	18(72%)
HC10	68	7(28%)	12(48%)
HC11	76	9(36%)	18(72%)
HC12	72	7(28%)	11(44%)
HC13	84	5(20%)	17(68%)

HC14	76	3(12%)	14(56%)
HC15	60	8(32%)	15(60%)
HC17	80	4(16%)	16(64%)
HC18	68	5(20%)	13(52%)
Total average	71.33	5.39(21.28%)	15.28(61.11%)

Five of the 25 health commodities were available in all HFs on the day of visit (Stat pack, Pentavalent vaccine, RHZE+RH (Adult TB kit), Normal saline (1000ml), and Hydrochlorothiazide 25 mg tablet), while Metronidazole 250 mg had the highest average length of stock out duration in the last six months 58.4%± 32.48 (Min=15.56, Max=100).

Table 4. Percentage of selected health commodities stock out rate at survey time and stock out duration from (July 1st-Dec.30th EFY) in selected public health facilities of S/Gondar Zone, Amahra, Ethiopia, March/2022

Name of products	Percentage	Average length of stock		Min	Max	SD
	of HF stock out at survey time	out duration past six months (in days)				
3TC-TDF- DTG (300+300+50mg/tab	3(16.67%)	2.50		0.00	18.33	5.29
Metronidazole 250mg cap	12(66.67%)	58.40		15.56	100.00	32.48
Stat pack (HIV test kit)	0(0%)	6.36		0.00	20.56	6.33
40% Glucose	3(16.67%)	12.28		0.00	35.56	9.84
Ready to use therapeutic food	1(5.56%)	9.88		0.00	25.00	7.83
Coartem (24*30) tab	2(11.11%)	7.13		0.00	26.67	8.67
Depo-Provera inj.	2(11.11)	21.27		0.00	34.44	9.26
Mebendazole 100mg tab	5(27.78%)	11.20		0.00	42.22	13.22
Oxytocin (10 IU) inj.	2(11.11%)	4.63		0.00	16.67	5.47
MgSo4 (50% inj.)	6(33.33%)	23.18		0.00	100.00	28.67
Oral rehydration salt	4(22.22%)	18.46		0.00	83.33	23.06
ALOH + MgOH+Simth.SP	5(27.78%)	18.70		0.00	67.22	20.81
Amoxicillin 125mg/5ml	10(55.56%)	13.24		0.00	53.33	13.34
Pentavalent vaccine	0(0%)	0.00		0.00	0.00	0.00

RHZE+RH (Adult TB kit)	0(0%)	0.49	0.00	8.89	2.10
Paracetamol 500 mg tab	6(33.33%)	15.00	0.00	56.11	15.15
Amoxicillin 500 mg caps	4(22.22%)	9.44	0.00	22.78	6.38
Salbutamol puff(100µg)	4(22.22%)	26.67	0.00	87.22	21.17
Ceftriaxone 1g inj.	2(11.11%)	9.26	0.00	54.44	14.56
Ciprofloxacin 500mg tab.	1(5.56%)	12.13	0.00	63.33	17.93
Cotrimoxazole 480 mg tab	14(77.78%)	49.20	0.00	100.00	28.92
Normal saline(1000ml)	0(0%)	3.24	0.00	23.89	6.11
Primaquine 7.5mg tab	2(11.11%)	11.30	0.00	35.56	11.76
TTC eye ointment (1%)	1(5.56%)	7.13	0.00	36.67	10.45
Hydrochlorothiazide 25mg tab	0(0%)	2.81	0.00	25.00	6.54
Total average	3.56(19.77%)	14.16	–	–	–

5.1.2.4 RRF data quality and reporting rate

Reliable recordkeeping is essential for the proper execution of inventory management in order to offer a regular flow of health commodities to our clients, and RRF must then be communicated to higher levels for effective logistics decision making. The study gathered all RRF submitted by chosen health facilities from proximal pharmaceutical suppliers, EPSA Bahirdar and Gondar branch between 2019/2020 and 2020/2021 GC. The majority of health facilities submit the RRF report, despite the fact that maintaining the time schedule, completeness, and accuracy is a challenge. The study health facilities submitted 212 (98.15 percent) of the planned 216 RRF reports between 2019/2020 and 2020/2021 GC.

Table 5. Percentage of RRF data quality and reporting rate in selected public health facilities of S/Gondar Zone, Amhara, Ethiopia, from July1, 2019-Jun 30, 2021

Health facilities name (Code)	2019/2020				2020/2021			
	Reporting rate N (%)	Timelines N (%)	Completeness N (%)	Accuracy N (%)	Reporting rate N (%)	Timelines N (%)	Completeness N (%)	Accuracy N (%)
RH1	6(100%)	5(83.33%)	2(33.33%)	4(66.67%)	6(100%)	4(66.67%)	3(50%)	3(50%)
PH2	6(100%)	3(50%)	2(33.33%)	3(50%)	5(83.33%)	4(80%)	4(80%)	5(100%)
PH3	6(100%)	6(100%)	5(83.33%)	6(100%)	6(100%)	5(83.33%)	6(100%)	6(100%)
HC4	5(83.33%)	4(80%)	2(40%)	3(60%)	6(100%)	6(100%)	1(16.7%)	3(50%)
HC5	6(100%)	3(50%)	2(33.33%)	2(33.33%)	6(100%)	5(83.33%)	4(66.67%)	2(33.33%)
HC6	6(100%)	6(100%)	3(50%)	2(33.33%)	6(100%)	6(100%)	5(83.33%)	3(50%)
HC7	5(83.33%)	3(60%)	1(20%)	2(40%)	6(100%)	6(100%)	4(66.67%)	3(50%)
HC8	6(100%)	6(100%)	0(0%)	3(50%)	6(100%)	5(83.33%)	2(33.33%)	2(33.33%)
HC9	6(100%)	6(100%)	6(100%)	5(83.33%)	6(100%)	6(100%)	6(100%)	6(100%)
HC10	6(100%)	5(83.33%)	5(83.33%)	4(66.67%)	6(100%)	6(100%)	3(50%)	5(83.33%)
HC11	6(100%)	6(100%)	4(66.67%)	6(100%)	6(100%)	5(83.33%)	5(83.33%)	5(83.33%)
HC12	6(100%)	1(16.67)	2(33.33%)	5(83.33%)	6(100%)	5(83.33%)	5(83.33%)	6(100%)
HC13	6(100%)	5(83.33%)	3(50%)	4(66.67%)	6(100%)	6(100%)	5(83.33%)	6(100%)
HC14	6(100%)	6(100%)	4(66.67%)	4(66.67%)	6(100%)	4(66.67%)	6(100%)	6(100%)

HC15	6(100%)	5(83.33)	2(33.33%)	6(100%)	6(100%)	6(100%)	3(50%)	5(83.33%)
HC16	6(100%)	2(33.33%)	6(100%)	5(83.33%)	6(100%)	3(50%)	5(83.33%)	5(83.33%)
HC17	5(83.33%)	4(80%)	4(80)	5(100%)	6(100%)	5(83.33%)	3(50%)	6(100%)
HC18	6(100%)	6(100%)	3(50%)	4(66.67%)	6(100%)	4(6667%)	5(83.33%)	6(100%)
Total								
average	97.22%	75.93%	36.11%	67.60%	99.07%	84.25%	69.44%	76.85%

5.1.2.5 Wastage rate in amount for health commodities

The wastage rate of selected health commodities was collected from July 1, 2019, to Jun 30, 2021 GC, in 18 public health facilities. The result indicated that 1.59% \pm 1.25 (Min=0, Max=5.7) in 2019/2020 and 1.78% \pm 1.33 (Min=0.16, Max=4.97) in 2020/2021 which is under the national recommended <2% figures.

Table 6. Selected health commodities wastage rate in S/Gondar Zone public health facilities, Amhara, Ethiopia from July 1, 2019-Jun 30, 2021

Name of product	Unit	Beginning balance		Wasted quantity		% Wastage	
		+Total received					
		2019/2020	2020/2021	2019/2020	2020/2021	2019/2020	2020/2021
3TC-TDF- DTG							
(300+300+50mg) tab	Tab	3,489,360	3,001,460	0	4,806	0.00	0.16
Metronidazole 250mg cap	Cap	636,000	405,000	21,100	15,500	3.32	3.83
Stat pack (HIV test kit)	Kit	67,040	71,650	449	1,529	0.67	2.13
40% Glucose	Ampule	108,180	115,109	1,750	1,697	1.62	1.47
Ready to use therapeutic food	Sachet	165,500	200,950	4,563	5,729	2.76	2.85
Coartem (24*30) tab	Tab	975,280	919,440	55,570	39,640	5.70	4.31
Depo-Provera inj.	Each	97,443	98,770	1,321	1,719	1.36	1.74
Mebendazole 100mg tab	Tab	218,290	245,560	4,920	12,210	2.25	4.97
Oxytocin (10 IU) inj.	Ampule	38,759	42,303	540	1,165	1.39	2.75
MgSo4 (50% inj.)	Ampule	10,443	10,650	301	339	2.88	3.18
Oral rehydration salt	Sachet	418,683	586,950	7,222	14,588	1.72	2.49
AlOH + MgOH +Simth. SP	Bott	11,980	14,835	148	320	1.24	2.16
Amoxicillin 125mg/5ml	Bott	27,309	17,696	136	95	0.50	0.54

Pentavalent vaccine	Vial	49,158	48,823	241	229	0.49	0.47
RHZE+RH (Adult TB kit)	Kit	838	874	17	23	2.03	2.63
Paracetamol 500 mg tab	Tab	2,537,500	3,290,500	18,500	18,000	0.73	0.55
Amoxicillin 500 mg tab	Cap	2,082,000	2,260,000	26,500	11,600	1.27	0.51
Salbutamol puff(100µg)	Tub	14,630	18,936	195	368	1.33	1.94
Ceftriaxone 1g inj.	Vial	68,867	85,332	245	696	0.36	0.82
Ciprofloxacin 500mg tab.	Tab	984,400	1,236,550	5,600	8,950	0.57	0.72
Cotrimoxazole 480 mg tab	Tab	511,000	141,200	12,000	2,000	2.35	1.42
Normal saline(1000ml)	Bag	74,532	108,377	238	294	0.32	0.27
Primaquine 7.5mg tab	Tab	129,600	163,300	3,550	2,060	2.74	1.26
TTC eye ointment (1%)	Tub	41,291	44,021	250	293	0.61	0.67
Hydrochlorothiazide 25mg tab	Tab	810,800	872,420	12,150	6,600	1.50	0.76
Average wastage rate						1.59	1.78

5.1.2.6 Percentage of health facilities that met standard storage practice

All health facilities are supposed to maintain standard pharmaceutical stores with appropriate equipment, storage processes, and stock management systems. These promote excellent customer satisfaction by ensuring medicine quality, decreasing wastage, and ensuring a consistent supply to health facilities. The majority of the HFs 16 (94.12 %) used proper vaccine storage temperatures (2-8 degrees Celsius) and followed first-in-first-out inventory management processes, according to the study. However, only 4 of the HFs (or 23.53 %) have fire safety equipment such as a working fire extinguisher.

Table 7. Percentage of storage standard observation criteria in selected public health facilities of S/Gondar Zone, Amhara, Ethiopia, March/2022

S.N	Observation criteria	Frequency Yes (%)
1	Storage sites are securely locked.	12(70.59)
2	Access to storage and pharmacy is limited to authorized personnel only.	6(35.29)
3	Storeroom is clean, all trash removed, sturdy shelves, organized boxes.	5(29.41)
4	Cold storage facilities for vaccines are maintained at (2-8 degrees centigrade)	16(94.12)
5	Inventory is protected from excessive humidity according to product specifications.	13(76.47)
6	Inventory is protected from harmful light sources (Must not be in direct sunlight).	13(76.47)
7	Corrosives and combustibles products held separately.	10(58.82)
8	Separate Storage of non-pharmaceutical products from drugs.	7(41.18)
9	Shelves must be at least 10 cm off floor, no more than 2.5m high, 30 cm away from the walls.	6(35.29)
10	Fire safety equipment is available and accessible e.g. Functional fire extinguisher	4(23.53)
11	Cartons placed with arrows up, labeled and expiry dates visible.	15(88.24)
12	Separation of damaged or expired products and remove from stock.	15(88.24)
13	Sufficient space for free tracking of items.	9(52.94)
14	Inventory is arranged in manner accessible for first-to expire, first out (FEFO).	16(94.12)
15	Packages and containers are closed.	13(76.47)
16	Packages are clean in both pharmacy and store room.	10(58.82)
17	Packages and boxes are not crushed.	13(76.47)
Total average		63.32%

The percentage of facilities meeting acceptable storage conditions by facility type was also shown in figure-6. On average, only three (16.7%) of the facilities met acceptable storage conditions (80% of the criteria or more).

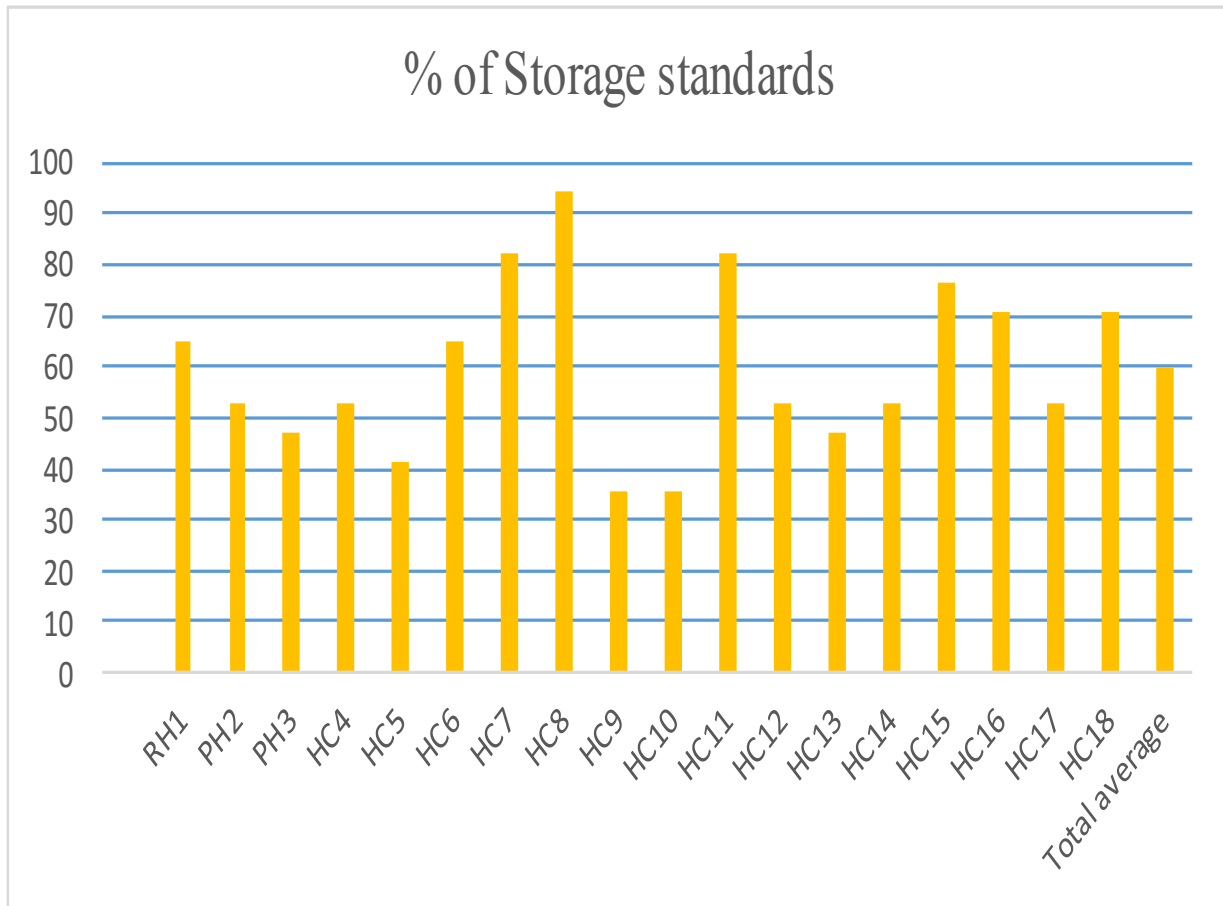


Figure 6. Percentage of storage standards by study health facility in S/Gondar zone, Amhara, Ethiopia, March/2022

5.1.3 Financial perspective metrics

This viewpoint assesses how much money each selected health facility loses due to wastage of health commodities that disrupt the smooth operation of the health care system.

5.1.3.1 Percentage value of wasted commodities

The total value of wasted selected health commodities for each health facility were used to calculate the wastage rate of health products from 1 July, 2019 to 30 Jun, 2021. The study indicated a total value of 750,398.78 ETB lost due to wastage during the two years period. For the selected health commodities, the average wastage rate was 1.39 ± 0.86 (Min=0.11, Max=3.33) in 2019/2020 and 1.76 ± 1.16 (Min=0.26, Max=5.49) in 2020/2021.

Table 8. Wastage rate in value of study facilities in S/Gondar Zone, Amhara, Ethiopia from July 1, 2019 to Jun 30, 2021 (N=18)

Health facilities name (Code)	Beginning balance +Total received in value (ETB)		Wasted money (ETB)		% Wastage	
	2019/2020	2020/2021	2019/2020	2020/2021	2019/2020	2020/2021
RH1	7,637,134.50	12,015,742.50	8,566.60	31,267.85	0.11	0.26
PH2	2,443,627.30	3,671,370.90	22,241	72,180.70	0.91	1.97
PH3	2,786,970.50	3,685,463.09	38,708	100,049.02	1.39	2.71
HC4	1,142,961.95	2,087,503.12	12,030.60	23,836.96	1.05	1.14
HC5	526,643.90	806,604.81	5,345.90	19,581.97	1.02	2.43
HC6	3,626,125.70	4,289,974.10	7,857.80	36,677.45	0.22	0.85
HC7	355,837.93	437,723.47	11,861.80	9,947.60	3.33	2.27
HC8	2,058,767.04	2,286,234.20	26,480.19	51,339.05	1.29	2.25
HC9	805,091.25	1,201,398	15,049.30	21,720.75	1.87	1.81
HC10	643,638.50	767,723.40	14,777	14,666.60	2.30	1.91
HC11	1,497,641.50	3,064,809.70	8,867.26	20,226	0.59	0.66
HC12	306,621.75	459,852.84	8,153.10	25,232	2.66	5.49
HC13	403,536.80	415,039.69	7,712.96	3,840.11	1.91	0.93
HC14	1,577,560.50	1,050,634.90	11,244.45	15,539.96	0.71	1.48
HC15	3,256,138	4,152,463.40	21,970.35	28,493.35	0.67	0.69

HC16	427,748.80	476471.5	8306.67	8704.3	1.94	1.83
HC17	582,094.05	563,293.55	11,521.55	6,511.87	1.98	1.16
HC18	745,877.55	659,140.42	7,820.10	12,068.61	1.05	1.83
Total						
average	30,824,017.52	42,091,443.59	248,514.63	501,884.15	1.39	1.76

*NB: RH=Referral hospital
PH=Primary hospital,
HC=Health center*

5.2 Qualitative study findings

5.2.1. Interdependence relationships of inventory management performance measuring indicators by using DEMATEL approach.

The data for this purpose is gathered by administering a questionnaire to thirteen professionals with knowledge and expertise in health commodities inventory management. The processing of data is the outcome of a pair-wise comparison of performance indicators obtained from the inner dependence. As a result, the values of the pair-wise comparison are dependent on the preferences of the expert responses that were purposefully chosen. The majority of the responders 10(76.92%) have a bachelor's degree with additional training in the field. According to their opinion, the most essential and critical performance indicators are the frequency of emergency orders, stock out rate, and wastage rate, which are related with more indicators with R+C values of 3.52, 3.16, and 3.15, respectively. The availability of tools, storage standards, RRF data quality, RRF reporting rate, inventory accuracy rate, and wastage rate are placed on the cause group in the cause and effect relation diagram, with R-C values of 1.81, 1.7, 0.97, 0.84, 0.62 and 0.48, respectively. The remainder are the effect group. Following the socio-demographic information of the respondents, the essential results (Total relation matrix) are displayed. This result was acquired by implementing several steps of the DEMATEL technique, which are listed in the appendix (XII).

Table 9. Socio-demographic characteristics of respondents for DEMATEL procedure in S/Gondar Zone, Amhara, Ethiopia, March /2022 (N=13)

Variable		Frequency N (%)
Sex	Female	3(23.08)
	Male	10(76.92)
Age in years	25-30	5(38.46)
	31-40	8(61.54)
Positioned at	Store man	3(23.08)
	OPD pharmacy coordinators	3(23.08)
	HSCM coordinators	3(23.08)
	Pharmacy Dept. head	4(30.77)
Educational level	College diploma	2(15.38)
	First degree	10(76.92)
	Master's degree	1(7.69)
Work experience	5 _ 10	9(69.23)
	11 _ 15	4(30.77)
Training taken	IPLS	13(100)
	APTS	12(92.3)
	Others	10(76.92)
Type of HF	Health center	5(38.46)
	Primary hospital	4(30.77)
	Referral hospital	4(30.77)

The total relation matrix is the key stage of the DEMATEL approach for displaying the most critical elements and cause and effect groups. The finding was based on the responses of these 13 professionals, which had a Cronbach's alpha (α) score of 0.96 having 110 number of questions, indicating strong internal data consistency as showed by short table at appendices XII. The total relation value produced the following R+C (importance or influential) and R-C (cause and effect group) results.

Table 10. Total relation matrix of respondent's opinions, March/2022

Effect Cause	A1	A2	B1	B2	B3	B4	B5	B6	B7	C1	D1
A1	0.06	0.09	0.06	0.05	0.02	0.02	0.18	0.01	0.02	0.05	0.02
A2	0.07	0.05	0.07	0.11	0.02	0.02	0.06	0.01	0.02	0.05	0.01
B1	0.26	0.21	0.08	0.11	0.04	0.02	0.24	0.04	0.05	0.08	0.02
B2	0.31	0.31	0.28	0.09	0.07	0.04	0.31	0.04	0.07	0.24	0.07
B3	0.23	0.15	0.19	0.13	0.03	0.01	0.15	0.03	0.18	0.08	0.07
B4	0.35	0.25	0.26	0.19	0.12	0.02	0.25	0.10	0.21	0.15	0.12
B5	0.24	0.30	0.20	0.10	0.08	0.02	0.11	0.04	0.08	0.10	0.05
B6	0.24	0.21	0.22	0.10	0.03	0.01	0.22	0.02	0.05	0.11	0.03
B7	0.33	0.32	0.29	0.22	0.05	0.02	0.30	0.02	0.04	0.24	0.05
C1	0.11	0.21	0.06	0.03	0.01	0.01	0.07	0.01	0.01	0.02	0.01
D1	0.35	0.28	0.30	0.22	0.16	0.02	0.31	0.09	0.20	0.21	0.04

Table 11. Importance and cause and effect groups of inventory management measuring indicators by using DEMATEL model, March/2022

Indicators	R	C	R+C	R-C	Descriptions
Prescription fill rate(A1)	0.565	2.557	3.12	-1.99	Effect
Prescription affordability(A2)	0.472	2.389	2.86	-1.92	Effect
Stock out rate(B1)	1.167	1.993	3.16	-0.83	Effect
Wastage rate(B2)	1.813	1.337	3.15	0.475	Cause
Inventory accuracy rate(B3)	1.242	0.625	1.87	0.617	Cause
Availability of tools(B4)	2.031	0.22	2.25	1.81	Cause
Frequency of emergency orders(B5)	1.316	2.2	3.52	-0.88	Effect
RRF reporting rate(B6)	1.25	0.413	1.66	0.838	Cause
RRF data quality(B7)	1.897	0.931	2.83	0.966	Cause
Percent value of wastage(C1)	0.54	1.323	1.86	-0.78	Effect
Storage standards(D1)	2.191	0.495	2.69	1.696	Cause

*NB: (R=sum of rows, C=sum of columns)
of total relation matrix*

The cause and effect groups of the indicators and their interdependence relationships was showed by DEMATEL diagram separately in the figure-7. Indicators having negative values are effect group while those with positive values are belong to cause group.

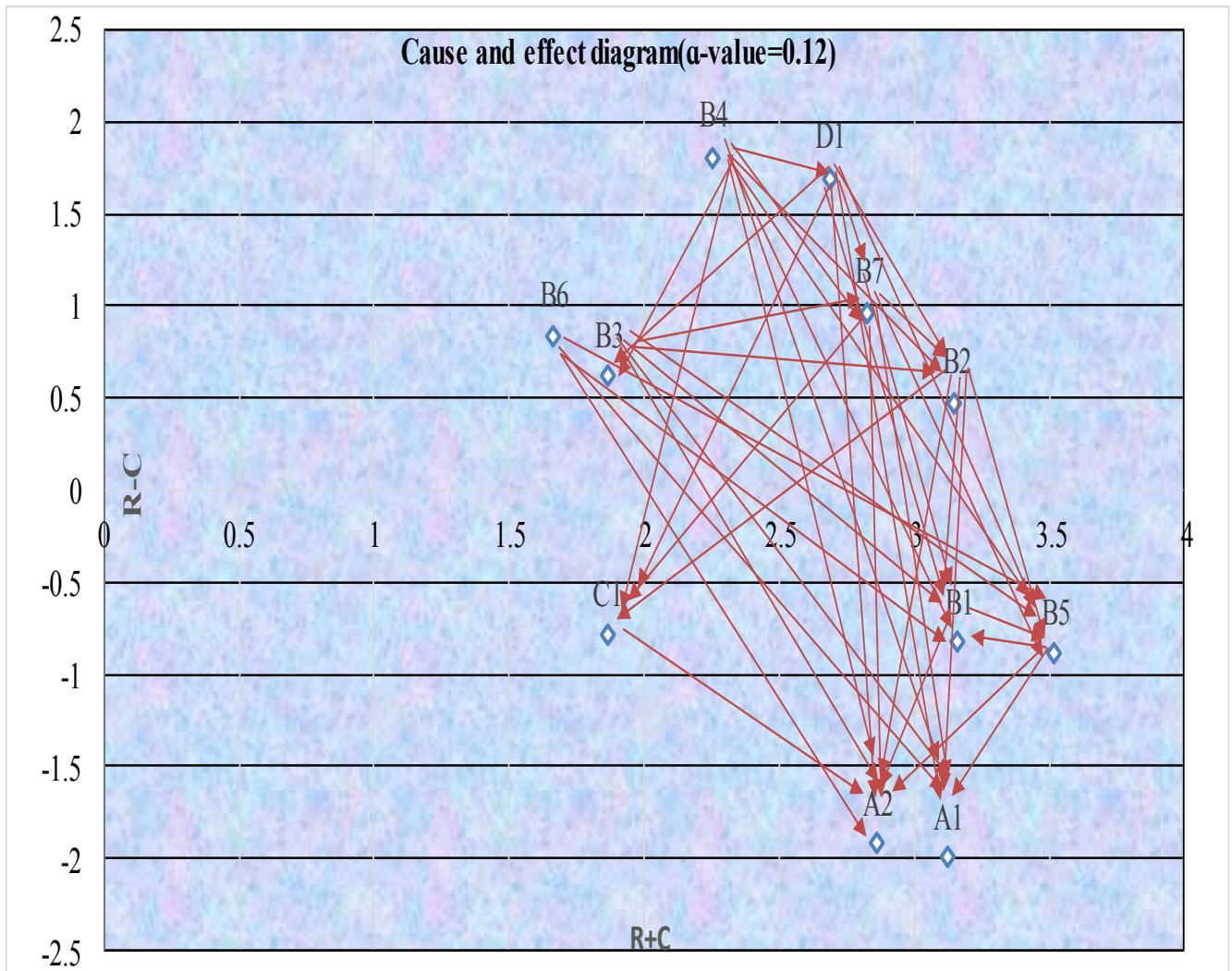


Figure 7. Cause and effect diagram of inventory management measuring indicators by using DEMATEL approach (α value=0.12), March/2022

5.2.2 Challenges identified using key informant interviews

To investigate the difficulties impacting inventory management performance that result in poor service delivery, interviews were performed with 21 key informants working in the selected health institutions, South Gondar Zone health department, and EPSS Bahirdar branch.

Table 12. Socio-demographic characteristics of key informants in selected organizations and public health facilities of S/Gondar Zone, Amhara, Ethiopia, March /2022

Variables		Frequency N (%)
Sex	Female	5(23.8)
	Male	16(76.2)
Age in years	20-30	11(52.38)
	31-40	7(33.33)
	40-50	3(14.29)
Place of work	EPSS	1(4.76)
	ZHD	1(4.76)
	Hospital	6(28.57)
	Health center	13(61.9)
Educational level	Diploma	10(47.61)
	First degree	9(42.86)
Work experience	Master's degree	2(9.52)
	1_5	9(42.86)
Positioned at	6_10	12(57.14)
	WIM officer	1(4.76)
	Logistics coordinators	3(14.28)
	CEO	2(9.52)
Positioned at	Pharmacy dept. head	5(23.8)
	Dispenser	4(19.04)
	Store man	6(28.57)

NB: EPSS=Ethiopian pharmaceutical supply service

WIM=Warehouse and inventory management

CEO=Chief executive officer, ZHD=Zonal health department

Thematic analysis with inductive approach was used to assess the qualitative data manually. As a result, by listening to and taking notes during the interview, the investigator was acquainted with the audio-recorded material. The information was then coded and translated into English using a table in an MS Word document. The coded data was arranged in order to find subthemes. Moreover, related subthemes were merged, named, and described. Finally, five primary topics emerged, and the report was written in narration form as shown below.

Logistics management information system data quality issues

The majority of responders stated that before and currently, the health commodity management information system (HCMIS) / Dagu software was not effective, which prevented us from providing suitable transaction reports (logistics data) to various stakeholders. Furthermore, the high patient flow and lack of suitable human resources have an impact on our activities in logistical data management and usages such as continual Bin card updating, timeliness, completeness, and accuracy of various reports in the majority of facilities. This was marked from one of the participants:

“...our data management and usage status are troublesome because there is no standard and visible automated electronic system in place between different stakeholders. Not only has that, but a lack of coordination and cooperation among our employees, which results in inadequate information exchanges, exacerbated the problem in our institution.” [Male, pharmacist working at hospital]

Another key informant from zonal health department was strengthen the idea as follows:

“The lack of a qualified focal person at the woreda level to support and coordinate reports is a major issue for proper data management in this zone. We also have a problem with a weak feedback mechanism, and a lack of electricity in some health facilities affects data quality.” [Male, pharmacist working at south Gondar zonal health department]

The above challenge was exemplified by another key informant:

“Employees' uneven sense of ownership and commitment as a result of a limited internal carrier path, a lack of integrated human resource utilizations, and high staff turnover... are the primary issues in this sector, influencing the overall inventory management data quality.”

[Female, Druggist working at health center]

Challenges to avail cost effective health commodities

Almost all key informants stated that pharmaceuticals are significantly more expensive when acquired from private vendors. The main issue in our country that influences product cost effectiveness is free market situations in private whole sellers. Indeed, EPSS and other stakeholders must work hard to improve product availability. The affordability of numerous pharmaceutical items in the majority of HFs has extremely visible concerns, and medications may sometimes be more expensive than private stores. This is because of EPSS stock pattern issues. This issue was also strengthened by one respondent in following way:

“...most of the time, traveling to EPSS is a formality to obtain just stock out guarantee to purchase our requirements from private whole sellers, which affects product cost effectiveness and therefore poor product affordability to our clients.” [Male, pharmacist working at hospital]

Another respondent from zonal health department was added that:

“...I strongly believe that EPSS is incapable of meeting the needs of our health-care institutions; as a result, most medicine procurement is accomplished through private wholesale transactions, which raises the cost of items. Even when distributed by EPSS, some products are unaffordable, necessitating the presence of competent government oriented pharmaceutical providers in the country.” [Male, pharmacist working at south Gondar zonal health department]

One respondent from EPSS tried to counteract the problem mentioned on their institution by many health facilities as the following way:

“We tried to deliver products at the appropriate cost as the main EPSS hub had sent to us, but the big problem here is that sometimes health facility employees don't want to wait at least 1-2 days when products are on transportation phase from the main EPSS hub to us, rather they have high ambition to procure from private wholesalers even though it takes a long time, but I don't want to say anything without adequate evidence why they do this....”[Male, MSc holder working in Ethiopian Pharmaceutical Supply Service (EPSS)]

Issues on capability of health commodities store houses

Some participants believed that storage room infrastructures were not standardized, such as having a very small ceiling, a dirty floor, a lack of proper shelves and pallets, and so on. Also, medications are not kept apart from supplies and equipment. Our storage practice requirements are also impacted by store man shortages.

One respondent mentioned that:

“We had a serious problem with our store room, particularly its cleanliness, as a result of a lack of attention on the part of our cleaners; even when we contact them to clean the space, they refuse to answer. Furthermore, the building's specifications are deficient. The ceiling is quite low and cannot accommodate enough things, particularly when receiving.” [Male, druggist working at hospital]

Another key informant added that:

“To your surprise, our warehouse contains rodents such as rats that contaminate fluids such as normal saline, as well as ready-to-use therapeutic foods that increase our wastage and stock out rates. There is also an overabundance of waste commodities in our storeroom, which has overcrowded our storage area due to poor timely disposal practices and a lack of coordination among health facilities to exchange near-expired products.” [Male, druggist working at health center]

Participant from Zonal health department argued that:

“Due to financial constraints in our region, we were unable to construct a new and uniform pharmaceutical storage room in time. Not only that, but many pharmaceutical storage rooms have a shortage of vaccine refrigerators due to a lack of maintenance by a lack of experienced cold chain technicians and spare parts.” [Male, pharmacist working at south Gondar zonal health department]

Challenges for continuous professional development (CPD)

The majority of participants believed that there is insufficient short and long-term training and supervision to fill employees' skill gaps, which helps to improve inventory management performance. This is due to financial constraints and the responsible bodies' lack of focus on the area. Some respondents also claimed that staff motivation and gap filling activities do not exist. This could be because of recent events in our country, which have affected a variety of health-related activities, including short and long-term training. Because of our country's instability, numerous stakeholders' attention has been diverted away from issues like employee empowerment.

One respondent was also argued that:

“...Since my first day of work at this facility, I haven't seen any training. I believe that no one considered us (pharmacy professionals) to be medical professionals. Even when some treatment guidelines are revised, we do not receive any information, which causes some friction between the pharmacy department and prescribers regarding prescription-related concerns.”
[Male, pharmacist working at hospital]

Another participant mentioned that:

“Even though our facility asked us to propose an area where there is a skill gap that needs to be filled through onsite training and discussion, our department was unable to do so because onsite training does not provide incentives (financial support) for employees, which is a bad

habit of requesting financial support to attend training all of the time, and it has an impact on our work performance.” [Female, pharmacist working at hospital]

Administrative related issues

According to some participants, inequitable competent human resources and resource mobilization for proper work flow, as well as a lack of competence to apply regulatory frameworks such as external audits, has a negative influence on overall inventory management performance.

One key informant added that:

“Lack of attention by non-professional government officials to public health facilities in order to allocate enough budget to run various supply chain activities successfully. The push approach used by EPSS and the regional health bureau for some health commodities has a significant effect on inventory management performance....” [Male, pharmacist working at hospital]

Another respondent mentioned also:

“We don't have any transport vehicles for health commodities transportation as a significant health institution that serves a huge number of customers, thus we try to employ private contract vehicles the majority of the time. This has an effect on the product's quality and timeliness of delivery....” [Male, druggist working at health center]

6. Discussion

Inventory management is a problematic part of health supply chain management that is regularly discussed and contested owing to its significant impact on health care service delivery. This study focused on critical indicators of inventory performance and assessed facilities with particular emphasis to the perspectives of customers in addition to that of financial and operational aspects.

Regarding the customer perspective, the study's findings revealed that the average percentage of prescription fill rate in all selected public health institutions was 84.36 %. This was less than the recommended optimal value of 100 percent and average national report of 92.43 % and similar study from Eastern part of Ethiopia 86.22 % (PFSA, 2017; Bilal, Osman and Mulugeta, 2016). However, the finding in this study was greater than the findings in Kenya (76.3%) and in Tibebe-Ghion Comprehensive Specialized Hospital, Bahirdar, Ethiopia (65%) (Nyabuti, Okalebo and Guantai, 2020; Yilma *et al.*, 2020). The disparity could be attributable to the large sample size employed in this study and the trend of prescribers and pharmacy departments exchanging information rather than prescribing stock-out products.

For this study, the value of prescription affordability was expressed as 1.69 day's income for the lowest unskilled government employee on average. This study is comparable to the finding of another study conducted in Ethiopia's South Wollo Zone, which found that patients spent an average of 19.8 ETB (1.6 days wage) on drugs (Hussien and Tafese, 2015). In contrast, a study from reported unaffordable prices which demand 43 days wage (based on the lowest paid government worker's minimum wage) to be able to pay for the drugs given (Cole and Routledge, 2018). The use of unnecessarily expensive pharmaceuticals when less expensive effective alternatives are available, as well as polypharmacy, are two major aspects of irrational

prescribing that affect prescription affordability. Essential medications list encourages the use of a small number of well-chosen medicines in order to ensure that they are used more wisely and at the lowest possible cost to the health system and consumers. Findings from the qualitative interviews suggest that EPSS's low level of health commodity availability, which could result in a low prescription fill rate and a shift in the procurement system to private whole sales, which could result in lower prescription affordability.

Concerning the operation perspective, the current study reflected that the average availability and usage status of tools in the surveyed facilities for the deployment of a robust inventory management system were 86.65 % and 78.48 %, respectively. The value for the availability of assessed tools in this study is significantly lower than in the national survey of Ethiopian hospitals average of 90%, but slightly higher than or comparable in health centers close to 80 % (Shewarega *et al.*, 2015). The discrepancy could be attributed to the fact that the tools utilized to evaluate this indication were not identical to those employed in this investigation. The finding, however, is matching to an assessment report (86.4%) completed for APTS sites in Ethiopia (Gedif *et al.*, 2016). Appropriate health service delivery is the outcome of having accessible data and working tools. Moreover, it should be noted that the usage of those evaluated tools alone may not be adequate; they must also be updated on a regular basis and carefully documented.

In the current assessment, the majority of the 15 assessed health institutions (83.33 %) used emergency orders at least once during the 2012 EFY. However, for the 2013 EFY, nearly all 18 (100%) of the selected health institutions placed at least two emergency orders, usually for program health goods. This could be due to the COVID-19 pandemic in our country in the late 2012 EFY, which disrupted various health supply chain activities and the increment of health commodities demand due to various displacement of the people from different parts of the

country. These findings are comparable to the national assessment in Ethiopia, which found that 68 % of hospitals and 43 % of health centers placed at least one emergency order within three months (Mengesha *et al.*, 2020) . Another study in Southwest Ethiopia was also found that at least one or two emergency orders within six months in four of the hospitals have placed (Befekadu *et al.*, 2020). Stock out was caused by poor selection, quantification, procurement, and insufficient stock control and management and unexpected service demand or increased patient flow. Each dimension of supply chain management difficulties has a detrimental impact on responsiveness, collaboration, flexibility, and cost performance. As a result, emergency orders were usually placed.

In terms of keeping accurate and timely records of stocks, which alerts logistics personnel about the facility's stock status and allows them to take corrective action, this study found that the average inventory accuracy rate in the study area is 71.33 %, which is higher than the study 52.45 % conducted in public health facilities of West Wollega zone, Ethiopia (Kebede and Tilahun, 2021). This study's inventory accuracy rate value is likewise significantly greater than the study (28.5 %) conducted in East Shewa Zone, Ethiopia (Gurmu and Ibrahim, 2017). The difference could be indorsed to the health products utilized and the store managers' commitment to keeping Bincards updated on a regular basis. The work load, a lack of appropriate human resources, and store managers' dedication all have an impact on our operations in the logistical data management system, such as inventory accuracy rate, according to the key informants in the current study's qualitative sections. The inventory accuracy rate or logistic recording accuracy, is critical in the management of health commodities since it contributes to the production of trustworthy data for determining the proper quantity and type of commodities. When bin cards or logistic data are not updated, the

flow of information is disrupted, resulting in overstocking or understocking and the expiration of medications.

This investigation showed that on the day of the visit, 21.28 % of the required health items at each HF were out of stock. The findings also showed that 61.11 % of the chosen health commodity items were stock out in the surveyed health facilities in the six months preceding the data collection period, and the total average length of stock out duration was 14.16 days, which is less than the study (42.37 days) done in anti-malaria pharmaceuticals at health centers in Ethiopia (Mengesha *et al.*, 2021) and also less than the study (70.71 days) done in family planning, maternal and child health (Kebede and Tilahun, 2021) . From selected 25 health commodities, Stat pack, Pentavalent vaccine, RHZE+RH (Adult TB kit), Normal saline (1000ml), and Hydrochlorothiazide 25 mg tablet) were available in all HFs on the day of visit while Metronidazole 250 mg capsules had the highest average length of stock out duration in the last six months before the data collection period 58.4% (105.11 days) which is less than 100% (180 days) for female condom and Ampicillin injection as indicated by the study (Kebede and Tilahun, 2021). The difference might be due to the selected health commodities used, supplier capacity to fill the required amount and study area difference. Cotrimoxazole 480 mg tablet was out of stock in 14 (77.78%) of the study area's health facilities on the day of the visit, which could be due to a change in treatment guidelines or the drug being replaced by more potent and effective antibiotics such as ciprofloxacin 500 mg tab.

The current study assessed the percentage of RRF reporting rate, timeliness, completeness, and accuracy in the study area submitted from July 1, 2011 to June 30, 2013 EFY, which revealed that on average 98.13 %, 80.09 %, 52.78 %, and 72.22 %, respectively, which is lower than the study (100 %, 86.2 %, 86.2 %, 82.8 %) done in public health facilities of Oromia special zone, Ethiopia (Mengesha *et al.*, 2021). However, the value of these indicators for this study was

higher than the study (84.06%, 40.52%, 62.93%, 59.48%) as described above (Kebede and Tilahun, 2021). Particularly in the first year of the study or 2011/2012 EFY in this study area, RRF completeness was very low, just 36%, providing insufficient information to decision makers. The variation could be due to differences in the report feedback system and competency of assigned professionals. Participants in key informant interviews were also told that a lack of well-functioning electronic software precluded them from sending appropriate transaction reports such as RRF to various stakeholders. Decent RRF data quality is crucial to assist transmit accurate information to the higher level every two months to enable suitable and effective decision making by giving reliable information on their prior performance and stock on hand using the same RRF form.

The current study revealed that the wastage rate of selected health commodities collected from July 1, 2011-Jun 30, 2013 EFY, in 18 public health facilities was 1.59% in 2019/2020 and 1.78% in 2020/2021 resulting in on average 1.69% in the study area which is under the global and national recommended <2% figures but lower than the study (2.60%) (Tefera G. and Messele B., 2020). The discrepancy may be due to poor availability or high consumption of pharmaceuticals in this study area.

In terms of storage standards practice, only three (16.7 %) of the surveyed health facilities met acceptable storage conditions (80 % of the criteria or more), which is lower than the study (8 HFs or 50 %) done at public health facilities of Dire Dawa city administration in Ethiopia (Tola, Anbessa and Yikna, 2020). The majority of the HFs 16 (94.12 %) used proper vaccine storage temperatures (2-8 degrees Celsius) and first-in-first-out inventory management processes as per this study. However, only 4 of the HFs (or 23.53 %) have a working fire extinguisher. The total percentage of storage standards in the study area was around 59.82 %, which is lower than the recommended 80 % value but higher than the study (50 %) found in South West Shoa Zone,

Ethiopia (Gebremariam ET and Unade TT, 2019). The discrepancy could be attributed to differences in research area, criteria employed, and management assistance.

Regarding the financial perspective, the average wastage rate in value for the current study was 1.39% during 2019/2020 and 1.76% in 2020/2021. The cumulative average for the two years resulted in 1.58% which caused in a total loss of 750,398.78 ETB. This is higher than the study conducted in Tikur Anbessa Specialized Hospital, which was 0,029% following the HCMIS implementation (Tefera G. and Messele B., 2020). But the result is lower than the study done in other part of Ethiopia (2.1% in APTS sites, 3% non APTS sites) (Beyene, Abuye and Tilahun, 2020). The difference could be related to the tracer health commodities used and the inventory control mechanism. It is still vital to reduce additional health commodity wastage in order to minimize total financial loss and to compromise frequent stock out of health commodities, which would have a good impression on the success of a health service delivery system. As a result, a robust inventory management system results in a well-maintained stock level and minimal waste.

To demonstrate the interdependence relationships of the indicators used to measure health commodities inventory management performance using the classical DEMATEL approach, this study discovered that the most important and critical performance indicators are the frequency of emergency orders, stock out rate, and wastage rate, all of which are from operational perspectives and are related to more indicators with R+C values of 3.52, 3.16, and 3.15, respectively. As a result, these elements should be evaluated for effective criteria that will boost customer satisfaction by improving inventory management overall performance.

The DEMATEL procedure for this study also showed that the availability of tools, RRF data quality, RRF reporting rate, inventory accuracy rate, wastage rate and storage standards (all are

from operational perspectives), are placed on the cause group in the cause and effect relation diagram, with R-C values of 1.81, 0.48, 0.97, 0.84, 0.62 and 1.7, respectively. In a previous study conducted in Turkey on humanitarian supply chain performance using the Balanced Scorecard-DEMATEL approach, the financial dimension with a negative R-C value is included in the effect group, indicating that it is affected more by the other dimensions, whereas the customer and operational perspectives with positive R-C values are included in the cause group, indicating that these dimensions have a greater impact on the financial dimension. In this abroad study, it was discovered that the customer dimension, as represented in the results, ranks first with the greatest weight (0.261). The financial dimension is ranked second. The operational viewpoints have the lowest weight value and are hence the least essential dimension (0,239) (BAKÍ and ABUASAD, 2020). The difference between the current study and the previous one could be attributed to the goal of the prior study, which was on humanitarian supply chain performance evaluation, as well as the precise indicators utilized to measure performance in each dimension or perspective.

7. Limitation of the study

While the study tried to include different perspectives, it did not include indicators such as inventory turnover ratio. Moreover, the findings are limited to public health facilities in only one zone, potential limiting generalizability. Internal strife in several regions of our nation during the past three years, along with the global Covid-19 pandemic, have had a negative impact on how well our study area's inventory management has performed.

Furthermore, some of the interview guide questions may induce recall bias, and the study's accuracy is contingent on the accuracy of the document utilized in the study.

8. Conclusion and Recommendations

8.1 Conclusion

People may lack access to medicines because of affordability issues, and they may be unable to receive the items they require to prevent or treat a medical condition. This could be due to the fact that, either the products are unavailable or not being supplied, or it is unaffordable. This investigation discovered flaws in RRF data quality, inventory record accuracy, and storage standard practice. In general, the inventory management performance of health commodities was found to be deficient due to limited competent human resources, inadequate management support and budget, a lack of continuous professional training, insufficient record and updating practice, inaccurate data quality, poor storage conditions, a high stock out rate, and wastage. Finally, various initiatives are ongoing in different areas of the country to improve health supply chain management, including inventory management, much work is expected to be done to address inventory management performance difficulties and related obstacles outlined by this study.

8.2 Recommendations

Based on the findings the following recommendations were made:

- Establish continuous professional development platform in the area to improve health supply chain management activities particularly inventory management control system.
- Create an end-to-end data visibility system from the ground up, such as health posts, to the highest levels, such as EPSS and MOH, to share trustworthy data for accurate decision making.

- Assign well-trained or competent pharmaceutical professionals to coordinate activities, provide supportive supervision, and establish a vigorous report feedback system to improve logistics-related reporting data quality at the woreda and zonal supply chain levels.
- Use an internal and external health commodity auditing system in health institutions to ensure accountability and ease of monitoring inventory management performance metrics.
- Set up a method to increase the satisfaction of pharmacy professionals in government public health facilities in order to reduce staff turnover.
- Similar studies had better be conducted in other parts of the country in order to provide a complete picture of health commodities inventory management performance.

The above-mentioned recommendations should be implemented collaboratively by MOH, EPSS, Regional health bureau, Zonal health department, Woreda health office, and the respective health facilities, as they may not be feasible for a single institution.

9. References

- Abdulsalam Y. and Schneller E. (2017) 'Hospital Supply Expenses : An Important Ingredient in Health Services Research', *Medical Care Research and Review*, 00(0), pp. 1–13. doi: 10.1177/1077558717719928.
- Adom D., Hussain E. and Joe A. (2018) 'Theoretical and conceptual framework : mandatory ingredients', *International Journal of Scientific Research*, 7(1), pp. 93–98. Available at: <https://www.researchgate.net/publication/322204158%0A>.
- Adzimah E., Agyemang P. and Gyawu M. (2014) 'An assessment of health commodities management practices in health care delivery ; a supply chain perspective . The case of selected hospitals in ashanti region-Ghana', *European journal of Business and social sciences*, 3(8), pp. 78–103. Available at: <http://www.ejbss.com/recent.aspx/>
- Agarwal S. *et al.* (2018) 'Tracking health commodity inventory and notifying stock levels via mobile devices', *Cochrane Database of Systematic Reviews*, (1), p. 3. doi: 10.1002/14651858.CD012907.
- Al-Saa'da R. *et al.* (2013) 'Supply Chain Management and Its Effect on Health Care Service Quality: Quantitative Evidence from Jordanian Private Hospitals', *Journal of Management and Strategy*, 4(2), pp. 42–51. doi: 10.5430/jms.v4n2p42.
- Alemu T. *et al.* (2020) 'Integrated pharmaceutical logistics system implementation in selected health facilities of Ethiopia : The case of four wollega zones', *Research in Social and Administrative Pharmacy*. doi: 10.1016/j.sapharm.2020.07.026.
- Ambe I. (2014) 'Key Indicators For Optimising Supply Chain Performance : The Case Of Light Vehicle Manufacturers In South Africa', *The Journal of Applied Business Research*, 30(1), pp. 277–290.
- Mishra A. and Salunkhe H (2018) 'A Study of Inventory Management System of Linamar India Pvt. Ltd, Pune', *Amity Journal of Operations Management*, 3(1), pp. 35–41.

Andarini D. and Adhiutama A. (2013) 'Supply Chain Performance Measurement: The Case Of A State Owned Pharmaceuticals Company (BFM)', *GATR Global Journal of Business Social Sciences Review*, 1(1), pp. 33–49. doi: 10.35609/gjbsr.2013.1.1(5).

Mcobrein A. and Ackah A. (2019) 'Social Entrepreneurship and Social Net- Works for Sustainable Rural Development in India', *African Journal of Procurement, Logistics & Supply Chain Management*, 1(4), pp. 01–20. doi: 10.15373/22501991.

Arora M. and Gigras Y. (2018) 'Importance of supply chain management in healthcare of third world countries', *International Journal of Supply and Operations Management*, 5(1), pp. 101–106.

Assefa F., Mosse A. and H/Michael Y. (2011) 'Assessment of Clients' Satisfaction with Health Service Deliveries at Jimma University Specialized Hospital', *Ethiopian Journal of Health Sciences*, 21(2), pp. 101–109. doi: 10.4314/ejhs.v21i2.69050.

Atthirawong W. (2011) 'Using DEMATEL to explore the relationship of factors affecting consumers ' behaviors in buying green products', in *Proceedings 32nd European Conference on Modelling and Simulation* ©ECMS Lars Nolle, Alexandra Burger.

Bakar A. *et al.* (2010) 'Measuring supply chain performance among public hospital laboratories', *International Journal of Productivity and Performance Management*, 59(1), pp. 75–97. doi: 10.1108/17410401011006121.

BAKİ B. and ABUASAD N. (2020) 'the Evaluation of Humanitarian Supply Chain Performance Based on Balanced Scorecard-Dematel Approach', *Alphanumeric Journal*, 8(2). doi: 10.17093/alphanumeric.736730.

Barasa N., Oluchina S. and Cholo W. (2018) 'Influence of inventory management practices on availability of medicines in public health facilities in Bungoma County , Kenya', *International Journal of Academic Research and Development*, 3(6), pp. 53–60.

Bayked E., Kahissay M. and Workneh B. (2021) 'Assessment of inventory and store management practices of pharmaceuticals in public health centers and hospitals of Dessie

Town, Ethiopia’, *Innovare Journal of Health Sciences*, 9(3), pp. 1–4. doi: 10.21203/rs.2.14307/v1.

Befekadu A. *et al.* (2020) ‘Inventory management performance for laboratory commodities in public hospitals of Jimma zone, Southwest Ethiopia’, *Journal of Pharmaceutical Policy and Practice*, 13(1), pp. 1–12. doi: 10.1186/s40545-020-00251-1.

Bekele A. and Anbessa G. (2021) ‘Logistics Management Information System Performance of Program Medicines in Public Health Facilities of East Gojjam Zone , Northwest Ethiopia : A Cross-Sectional Study’, *Journal of Multidisciplinary Healthcare*, 14, pp. 81–89.

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

Bhagwat R. and Sharma M. (2007) ‘Performance measurement of supply chain management: A balanced scorecard approach’, *Computers and Industrial Engineering*, 53(1), pp. 43–62. doi: 10.1016/j.cie.2007.04.001.

Bilal A., Osman E. and Mulugeta A. (2016) ‘Assessment of medicines use pattern using World Health Organization’s Prescribing, Patient Care and Health facility indicators in selected health facilities in eastern Ethiopia’, *BMC Health Services Research*, 16(144), pp. 1–8. doi: 10.1186/s12913-016-1414-6.

Boche B., Mulugeta T. and Gudeta T. (2020) ‘Assessment of Inventory Management Practices at the Ethiopian Pharmaceuticals Supply Agency, Addis Ababa, Ethiopia’, *Integrated Pharmacy Research and Practice*, Volume 9, pp. 175–183. doi: 10.2147/iprp.s269421.

Bray A. and Awuah S. (2019) ‘Distribution challenges of health commodities’, *9th International Conference on Operations and Supply Chain Management, Vietnam, 2019*, pp. 7–8.

Chang H. *et al.* (2013) ‘Using the balanced scorecard on supply chain integration performance- a case study of service businesses’, *Service Business*, 7(4), pp. 539–561.

Cole C. and Routledge P. (2018) ‘An evaluation of rational prescribing in hospital outpatient practice in Sierra Leone and assessment of affordability of a prescription as an outcome’, *Pan African Medical Journal*, 31, pp. 1–9. doi: 10.11604/pamj.2018.31.174.16729.

Chen D., Preston D. and Xia W. (2013) ‘Enhancing hospital supply chain performance: A relational view and empirical test’, *Journal of Operations Management*, 31(6), pp. 391–408.

Damtie T., Ibrahim A. and Yikna B. (2020) ‘Supply Chain Management Performance of HIV / AIDS Commodities and Factors Affecting It at Health Facilities of SNNPRS of Ethiopia ; from the Perspective of Achieving 90-90-90 Strategies’, *Integrated Pharmacy Research and Practice*, 38(131), pp. 11–21.

Davarynejad M., Heck G., Berg J., Duin R. and Roskott B. (2010) ‘Improving Inventory Management Performance Using a Process-Oriented Measurement Framework’, pp. 279–288. doi: 10.1007/978-3-642-16402-6.

Debbarma M. and Rani U. (2020) ‘A Review Study on Pharmaceutical Inventory Management & Store Keeping Practices of Pharmacy in Rural Hospitals’, *Indian Journal of Public Health Research and Development*, 11(02), pp. 544–548.

DiCicco-Bloom B. and Crabtree B. (2006) ‘The qualitative research interview’, *Medical Education*, 40(4), pp. 314–321. doi: 10.1111/j.1365-2929.2006.02418.x.

EPISA (2018) *Revised Pharmaceutical supply Transformation Plan, 2018-2020*, Federal democratic republic of Ethiopia pharmaceutical supply agency.

Ethiopia, N. B. (2020) <https://newbusinessethiopia.com/health/ethiopian-agency-spent-450-million-on-medicines/>. Available at: <https://newbusinessethiopia.com/health/ethiopian-agency-spent-450-million-on-medicines/>.

Ethiopian pharmaceuticals Supply Agency (PFSA) (2017) *Integrated Pharmaceuticals Logistics System (IPLS) in Health Facilities of Ethiopia*.

FDRE (2003) Assessment of the pharmaceutical sector in Ethiopia, Health (San Francisco).

Federal democratic republic of Ethiopia central statistical agency population projection of

Ethiopia for All Regions At Wereda Level from 2014 – 2017.

FMHACA (2014) Food , Medicine and Healthcare Administration and Control Authority of Ethiopia Standard Treatment Guidelines,Third Edition, Addis Ababa: Manual for Medicines Good Prescribing Practice;

Fredrick M. and Muturi W. (2016) ‘Factors Influencing Frequent Stock-outs of Essential Medicines in Public Health Facilities in Kisii County , Kenya’, *Journal of Business and Management.*, 18(10), pp. 63–75. doi: 10.9790/487X-1810066375.

Gebicki M. *et al.* (2013) ‘Evaluation of hospital medication inventory policies’, *Health Care Manag Sci*, pp. 1–15. doi: 10.1007/s10729-013-9251-1.

Gebremariam ET and Unade T. (2019) ‘Assessment of Medicine Supply Management and its Quality Assurance Practice in Health Centers in South West Shoa Zone, Oromia Regional State, Ethiopia’, *Journal of Pharmaceutical Care & Health Systems*, 06(01), pp. 1–6. doi: 10.4172/2376-0419.1000201.

Gedif T. *et al.* (2016) *Outcome of Auditable Pharmaceutical Transactions and Services Implementation: Assessment Report Outcomes of APTS Implementation: Assessment Report ii.*

Gurmu T. and Ibrahim A. (2017) ‘Oromia Bölgesel Devleti Doğu Shewa, Etiyopya’daki sağlık tesislerinde en önemli temel ilaçların envanter yönetimi performansı’, *Cukurova Medical Journal (Çukurova Üniversitesi Tıp Fakültesi Dergisi)*, 42(2), pp. 277–291. doi: 10.17826/cutf.322908.

Hailu A., Ahmed S. and Yimer Y. (2020) ‘Integrated Pharmaceutical Logistic System in Ethiopia : Systematic Review of Challenges and Prospects’, *Journal of Biology and Medicine : Open Access*, 1(2), p. 113.

Huang W. *et al.* (2020) ‘A comprehensive method for performance analysis of green supply chain management in steel enterprises integrating TAHP , LMBP and DEMATEL’, *International Journal of Logistics: Research and Applications*, 0(0), pp. 1–24.

Hussien M. and Tafese F. (2015) 'Access to Essential Medicines in Primary Health Care Units of South Wollo Zone, Ethiopia', *Open Access Library Journal Access*, 02(01), pp. 1–10. doi: 10.4236/oalib.1100983.

Jande M, Liwa A., Kongola G. and Justin-Temu M. (2013) 'Assessment of Patient Satisfaction with Pharmaceutical Services in Hospital Pharmacies in Dar es Salaam, Tanzania', *East and Central African Journal of Pharmaceutical Sciences*, 16(1), pp. 24–30.

Jobira T. *et al.* (2021) 'Evaluation of Pharmaceuticals Inventory Management in Selected Health Facilities of West Arsi Zone, Oromia, Ethiopia', *Integrated Pharmacy Research and Practice*, 10, pp. 1–11. doi: 10.2147/iprp.s298660.

John Snow I. (2017) *The Supply Chain Manager's Handbook, A Practical Guide to the Management of Health Commodities*.

Kagashe G. and Massawe T. (2012) 'Medicine Stock Out and Inventory Management Problems in Public Hospitals in Tanzania : a Case of Dar Es Salaam Region', *Int J Pharm*, 2(2), pp. 252–259.

Kagashe G., Minzi O. and Matowe L. (2011) 'An assessment of dispensing practices in private pharmacies in Dar-es-Salaam, Tanzania', *International Journal of Pharmacy Practice*, 19(1), pp. 30–35. doi: 10.1111/j.2042-7174.2010.00075.x.

Kebede O. and Tilahun G. (2021) 'Inventory management performance for family planning, maternal and child health medicines in public health facilities of West Wollega zone, Ethiopia', *Journal of Pharmaceutical Policy and Practice*, 14(1), pp. 1–11. doi: 10.1186/s40545-021-00304-

Kefale A. and Shebo H. (2019) 'Availability of essential medicines and pharmaceutical inventory management practice at health centers of Adama town, Ethiopia', *BMC Health Services Research*, 19(1), pp. 1–7. doi: 10.1186/s12913-019-4087-0.

Kihara and Ngugi (2021) 'Inventory management systems and performance of public hospitals in Kenya; case of counties under universal health care programme', *international journal of social Sciences and information Technology*, 7(2), pp. 66–77.

Kiswii C. and Kenyatta J. (2018) 'Effects of Pharmaceutical Inventory Management on Procurement Performance in Coast Provincial General Hospital in Kenya', *IJARKE Business & Management Journal*, 1(2), pp. 144–152. doi: 10.32898/ibmj.01/1.2article13.

Kucukaltan B., Irani Z. and Aktas E. (2016) 'A decision support model for identification and prioritization of key performance indicators in the logistics industry', *Computers in Human Behavior*, 65, pp. 346–358. doi: 10.1016/j.chb.2016.08.045.

Leksono E., Suparno S. and Vanany I. (2019) 'Integration of a balanced scorecard, DEMATEL, and ANP for measuring the performance of a sustainable healthcare supply chain', *Sustainability (Switzerland)*, 11(13), pp. 1–18. doi: 10.3390/su11133626.

Lenin K. (2014) 'Measuring supply chain performance in the healthcare industry', 2(5), pp. 136–142. doi: 10.11648/j.sjbm.20140205.14.

LEOŃCZUK D. (2016) 'Categories of Supply Chain Performance Indicators: an Overview of Approaches', *Business, Management and Education*, 14(1), pp. 103–115. doi: 10.3846/bme.2016.317.

Mengesha H. *et al.* (2020) 'Integrated Pharmaceutical Logistic System in Ethiopia : Systematic Review of Challenges and Prospects', *Journal of Biology and Medicine : Open Access*, 1(2), p. 113.

Mengesha H. *et al.* (2021) 'Practices of anti-malaria pharmaceuticals inventory control system and associated challenges in public health facilities of Oromiya special zone , Amhara region ', *BMC Public Health*, 21(2026), pp. 1–14. Available at: <https://doi.org/10.1186/s12889-021-12033-8>.

Min H. (2017) 'Health care supply chain research: Where are we going?', *Logistics Research, ISSN 1865-0368, Bundesvereinigung Logistik (BVL), Bremen*, 10(5), pp. 1–19. doi: 10.23773/2017.

Modisakeng C. *et al.* (2020) 'Medicine shortages and challenges with the procurement process among public sector hospitals in South Africa; Findings and implications', *BMC Health Services Research*, 20(1), pp. 1–10. doi: 10.1186/s12913-020-05080-1.

Moons K., Waeyenbergh G. and Pintelon L. (2018) 'Measuring the logistics performance of internal hospital supply chains – a literature study R', *Omega*, 0, pp. 1–13. doi: 10.1016/j.omega.2018.01.007.

Msh (2005) *Inventory Management Assessment Tool (IMAT)*.

Nowell L. *et al.* (2017) 'Thematic Analysis: Striving to Meet the Trustworthiness Criteria', *International Journal of Qualitative Methods*, 16(1), pp. 1–13. doi: 10.1177/1609406917733847.

Nthambi C. (2014) *An Investgation on the Effects of Rewards on Employee Performance Among Operational Staff at Kenya Bureau of Standards*.

Nyabuti A., Okalebo F. and Guantai E. (2020) 'Examination of WHO/INRUD Core Drug Use Indicators at Public Primary Healthcare Centers in Kisii County, Kenya', *Advances in Pharmacological and Pharmaceutical Sciences*, 2020, pp. 1–7. doi: 10.1155/2020/3173847.

Otchere A., Adzimah E. and Aikens I. (2016) 'Assessing the inventory management practices in a selected company in Ghana', *International Journal of Development and Sustainability*, 5(3), pp. 105–119.

Patton M. (2002) *Nontraditional Regulations, and Innovations in Darning-Centered, Doctoral Education, including faculty meetings that are interesting and important, an indication of knovation of the highest order, qualitative inquiry*. Available at: http://books.google.com/books/about/Qualitative_research_and_evaluation_meth.html?id=FjBw2oi8E14C.

PFSA (2017) *Pharmaceutical Sector Assessment in Ethiopia*.

Pinna R., Carrus P. and Marras F. (2015) 'Emerging Trends in Healthcare Supply Chain Management - An Italian Experience', in *Applications of Contemporary Management Approaches in Supply Chains*. doi: 10.5772/59748.

Prasetyaningsih E., Muhamad C. and Amolina S. (2020) 'Assessing of supply chain performance by adopting Supply Chain Operation Reference (SCOR) model', in *IOP*

Conference Series: Materials Science and Engineering, pp. 1–6. doi: 10.1088/1757-899X/830/3/032083.

Rachmania I. and Basri M. (2013) ‘Pharmaceutical Inventory Management Issues in Hospital Supply Chains’, *Management*, 3(1), pp. 1–5. doi: 10.5923/j.mm.20130301.01.

Rajab N. *et al.* (2017) ‘Factors Influencing Inventory Management in Public Sector: A Case Study of Kajiado County Hospital’, *Kabarak Journal of Research & Innovation*, 4(2), pp. 37–47. Available at: <http://eserver.kabarak.ac.ke/ojs/>.

Rao A. *et al.* (2019) ‘A review on supply chain performance systems models for capacity optimization in Industry Trade-off between used capacity and operational’, *Procedia Manufacturing*, 30, pp. 40–47. doi: 10.1016/j.promfg.2019.02.007.

Rotich G., Aburi O. and Allan K. (2014) ‘The influence of specific supplier development practices on a firm’s competitive advantage: a case study of safaricom limited’, *International Journal of Social Sciences and Entrepreneurship*, 1(11), pp. 1–12.

Saha E. and Ray P. (2019) ‘Computers & Industrial Engineering Modelling and analysis of inventory management systems in healthcare: A review and reflections’, *Computers & Industrial Engineering*, 137(September), pp. 1–16. doi: 10.1016/j.cie.2019.106051.

Sarmad S. (2019) ‘Performance measurement : The next station Performance measurement : The next station’, *International Journal of Research Studies in Management*, 7(1), pp. 85–98. doi: 10.5861/ijrsm.2018.3011.

Sarode A., Sunnapwar V. and Khodke P. (2008) ‘A Literature Review for Identification of Performance Measures for Establishing a Framework for Performance Measurement in Supply Chains’, *International Journal of Applied Management and Technology*, 6(3), pp. 241–273.

Semegn S. and Alemkere G. (2019) ‘Assessment of client satisfaction with pharmacist services at outpatient pharmacy of Tikur Anbessa Specialized Hospital’, *PLoS ONE*, 14(10), pp. 1–10. doi: 10.1371/journal.pone.0224400.

Settanni E., Harrington T. and Srai J. (2017) ‘Pharmaceutical supply chain models : A synthesis from a systems view of operations research’, *ELSEVIER*, 4, pp. 74–95. doi: 10.1016/j.orp.2017.05.002.

Severgnini E. *et al.* (2019) ‘Applicability of Performance Prism in SMEs : a multiple case study’, *Gestão & Produção*, 26(4), pp. 1–13. doi: 10.1590/0104-530x3014-19.

Shaik M. and Abdul-kader W. (2012) ‘Performance measurement of reverse logistics enterprise : a comprehensive and integrated approach’, *MEASURING BUSINESS EXCELLENCE*, 16(2), pp. 23–34. doi: 10.1108/13683041211230294.

Shewarega, Abiy, Dowling P., Necho W., Tewfik S., and Yiegezu Y. (PFSA) (2015) *Ethiopia: National Survey of the Integrated Pharmaceutical Logistics System [Internet]. Arlington: USAID | DELIVER PROJECT Task Order 4, and Pharmaceuticals Fund and Supply Agency (PFSA)*. Available at: <http://apps.who.int/medicinedocs/en/m/abstract/Js21807en/>. Accessed date November 6, 2018.

Taddele B. *et al.* (2019) ‘ABC-VEN Matrix Analysis of the Pharmacy Store in a Secondary Level Health Care Facility in Arbaminch Town, Southern Ethiopia’, *Journal of Young Pharmacists*, 11(2), pp. 182–185. doi: 10.5530/jyp.2019.11.38.

Tefera B., Yihunie W. and Bekele A. (2021) ‘Integrated pharmaceutical logistics system implementation in chagni primary hospital and injibara general hospital, awi zone, ethiopia’, *Journal of Multidisciplinary Healthcare*, 14(June), pp. 1673–1682. doi: 10.2147/JMDH.S316595.

Tefera G. and Messele B. (2020) ‘Warehousing and inventory management performance after HCMIS implementation in Tikur Anbessa Specialized Hospital , Addis Ababa , Ethiopia’, *The Pharma Innovation Journal*, 9(3), pp. 672–677.

Tola F., Anbessa G. and Yikna B. (2020) ‘Anti-tuberculosis commodities management performance and factors affecting it at public health facilities in dire dawa city administration, Ethiopia’, *Journal of Multidisciplinary Healthcare*, 13, pp. 1677–1691.

Urissa W. (2019) ‘Assessing Challenges of Inventory Management Practice (In Case of Dubo Primary Hospital)’, *Industrial Engineering Letters*, 9(1), pp. 1–8. doi: 10.7176/iel/9-1-01.

WHO (World Health Organization) (2007) *WHO Operational package for assessing , monitoring and evaluating country pharmaceutical situations Guide for coordinators and data collectors*, World Health Organization.

World Health Organization (1993) ‘How To Investigate Drug Use In Health Facilities, Selected drug use indicators’.

Yilma Z. *et al.* (2020) ‘Assessment of Prescription Completeness and Drug Use Pattern in Tibebe-Ghion Comprehensive Specialized Hospital, Bahir Dar, Ethiopia’, *BioMed Research International*, 2020, pp. 1–7. doi: 10.1155/2020/8842515.

Yimenua D., Nigusie A.. and Workineh T. (2021) ‘Assessment of Pharmaceutical Warehouse Management Practice: The Case of Private Pharmaceutical Wholesalers in Ethiopia’, *International Journal of Supply and Operations Management*, 8(3), pp. 314–327.

Zhao B. and Tu C. (2021) ‘Research and Development of Inventory Management and Human Resource Management in ERP’, *Wireless Communications and Mobile Computing*, 2021, pp. 1–12. doi: 10.1155/2021/3132062.

10. Appendices

10.1 Appendix I: Consent form

Dear Sir/ Madam,

I am a student at University of Addis Ababa (AAU), pursuing a Master of Health supply chain management (HSCM). I am undertaking a research project in partial fulfillment of the academic requirements. My study is on “Assessment of Health commodities inventory management performance and challenges in selected Public health facilities of South Gondar Zone”. Your organization has been chosen to participate in my study. If you could take a few moments out of your busy schedule to reply to the semi-structured interview guide questions written in Amharic, I would be thankful. Your answer will be kept completely private. If you request it, the results of this study may be made available to you once it is completed. I truly appreciate your aid and cooperation.

Yours sincerely,

Zewdu Tessema

AAU, HSCM, STUDENT

Email: zewdutessema1@gmail.com

Mobile: +251918320931

10.2 Appendix II: Interview guide for key informants

Part I: Biographical details

1. HF type a. HC b. Primary hospital c. Referral hospital

2. What is your Profession _____?

3. Age in year _____

4. Sex: Male Female

5. What is the highest level of education have you attained?

a. College education

b. Undergraduate degree

c. Master's Degree

d. Doctorate

e. Others (Specify) _____

6. Position you hold in the organization _____

7. Number of years you have worked in the organization _____

Part II: Qualitative part of questions

1. How do you describe the current inventory management performance situations in your health facility?

2. What are the current challenges to improve inventory management performance in your health facility in terms of the following aspects?

A. Logistics management data quality

B. Availability of cost-effective health commodities

C. Capability of store houses

D. Continuous professional development

3. What do you think are the possible interventions to resolve the current problems mentioned above?

4. What other additional factors affect inventory management in your health facility?

5. Do you have anything else to say about this topic in this interview?

With this, I believe we will conclude the discussion, and I would like to thank you again for your active participation, sharing your experiences, and making recommendations for the challenges.

10.3 Appendix III: Data collection format for availability of IPLS and APTS tools

S. N	Tools/Resources	Availability		Use status	
		Yes	No	Yes	No
1	New Model-19				
2	New Model-22				
3	Bin card				
4	Stock card				
5	RRF				
6	IFRR				
7	E-recording				
8	Dispensing registers				
9	Labeling stickers				
10	Tablet counting trays				
11	Calculators				
12	Scissors				
13	STG				
14	Formulary manual				
15	Facility specific list				
16	Average availability & use status				

10.5 Appendix V: Operational perspectives metrics data Collection Form,

HF name(code)-----

Date-----

Part I: Emergency order data collection format

HF name (code)	Total no. of purchases in		No. of emergency orders employed in 2012EFY	No. of emergency orders employed in 2013EFY
	2012 EFY	2013 EFY		
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				

Part II: Inventory accuracy rate and stockout rate data collection format

Name of products	Applicable yes/No	Unit	Balance on Bin card	Balance on physical stock	Stock out during survey period Yes/No	Stock out past, 6months (Yes/No)	If yes #of days out of stock within the last 6 months
3TC-TDF- DTG (300+300+50MG/tablet)							
Metronidazole 250 mg cap							
Stat pack (HIV test kit)							
Glucose 40%							
Ready-to-use therapeutic food							
Coartem (24 tab)							
Depo-Provera							
Mebendazole 100 mg tab							
Oxytocin (10 IU injectable)							
MgSO4 (50% injectable)							
Oral Rehydration Salts							
AlOH/MgOH/Simethicone suspension							
Amoxicillin 125mg/5ml suspension							
Pentavalent Vaccine							
RHZE (150mg+75mg+400mg+275mg) +RH (150mg+75mg tab) Kit							
Paracetamol 500 mg tab							
Amoxicillin 500mg cap							
Salbutamol puff							
Ceftriaxone 1g inj.							
Ciprofloxacin 500mg tab							
Cotri- 480mg tab							
Normal Saline 0.9 %							
Primaquine 7.5 mg tab							
IITC 1%							
Hydrochlorothiazide 25 mg tab							

Part III Wastage rate in value and amount data collection format in 2012 /2013 EC.

Name of products	Applicable yes/No	Unit	Total quantities of the items	Total value of the items	Total wasted quantities of the items	Value of wasted quantities	
						Unit price(ETB)	Total price(ETB)
3TC-TDF- DTG (300+300+50MG/tablet)							
Metronidazole 250 mg cap							
Stat pack (HIV test kit)							
Glucose 40%							
Ready-to-use therapeutic food							
Coartem (24 tab)							
Depo-Provera							
Mebendazole 100 mg tab							
Oxytocin (10 IU injectable)							
MgSO4 (50% injectable)							
Oral Rehydration Salts							
AlOH/MgOH/Simethicone suspension							
Amoxicillin 125mg/5ml suspension							
Pentavalent Vaccine							
RHZE (150mg+75mg+400mg+27 5mg) +RH (150mg+75mg tab) Kit							
Paracetamol 500 mg tab							
Amoxicillin 500mg cap							

<i>Salbutamol puff</i>							
Ceftriaxone 1g inj.							
Ciprofloxacin 500mg tab							
Cotri- 480mg tab							
Normal Saline 0.9 %							
Primaquine 7.5 mg tab							
TTC 1%							
Hydrochlorothiazide 25 mg tab							

Part IV: RRF report data quality assesement format for each facility(Yes/No) for both 2012 & 2013 EC (Check RRF reports).

Product name	Period one		Period two		Period three		Period four		Period five		Period six	
	Accurate	Complet	Accurate	Complet	Accurate	Complet	Accurate	Complet	Accurate	Complet	Accurate	Complet
3TC-TDF- DTG (300+300+50MG/t ab												
Metronidazole 250 mg cap												
Stat pack (HIV test kit)												
Glucose 40%												
Ready-to-use therapeutic food												
Coartem (24 tab)												
Depo-Provera												
Mebendazole 100 mg tab												
Oxytocin (10 IU injectable)												
MgSO4 (50% injectable)												
Oral Rehydration Salts												
Amoxicillin 125mg/5ml suspension												
RHZE (150mg+75mg+40 0mg+275mg) +RH (150mg+75mg tab) Kit												
Paracetamol 500 mg tab												

Cotri- 480mg tab												
Normal Saline 0.9 %												
Primaquine 7.5 mg tab												
TTC 1%												

Part V. RRF Reporting rate and timeliness (Yes/No) in 2012/2013 EC.(Check RRF reports)

HF name /code	Period 1		Period 2		Period 3		Period 4		Period 5		Period 6	
	Was the report submitted?	Was it timely?	Was the report submitted?	Was it timely?	Was the report submitted?	Was it timely?	Was the report submitted?	Was it timely?	Was the report submitted?	Was it timely?	Was the report submitted?	Was it timely?

10.6 Appendix VI: Facility Storage Condition Observation Check List

Facility Name (Code): _____ Facility type: _____

Date: _____

0= No 1= Yes				
S. No.	Security and access	0	1	Specific comments
1	Storage site can be securely locked (Check both store room and pharmacy).			
2	Access to storage and pharmacy is limited to authorized personnel only (are there any locks on the doors, who has keys, who is allowed in and who authorizes entry)			
General comment				
S. No.	Conditions of Storage site	0	1	Specific comment
3	Storeroom is maintained in good condition (clean, all trash removed, sturdy shelves, organized boxes.)			
4	Cold storage facilities for vaccines and biological products are maintained at (2-8 degrees centigrade)			
5	Inventory is protected from excessive humidity according to product specifications (Look for signs of dampness on boxes and walls).			
6	Inventory is protected from harmful light sources according to product specifications (Must not be in direct sunlight).			
7	Corrosives and combustibles held separately			
8	Storage separation of non-pharmaceutical products with drugs			
9	Physical dimensions of storage site meet appropriate standards. (Shelves must be at least 10 cm off floor, no more than 2.5m high, 30 cm away from the walls, there must be no medicines stored on the floor)			
General comment				
S. No.	Availability and Organization of Commodities	0	1	Specific comment
10	Fire safety equipment is available and accessible e.g. Functional fire extinguisher			

11	Cartons placed with arrows up, labeled and expiry dates visible.			
12	Separation of damaged or expired products and remove from stock			
13	Sufficient space for free tracking of items			
14	Inventory is arranged in manner accessible for first-to expire, first out (FEFO). <i>Check if medicines are arranged such that those with the shortest expiry dates are at the outermost and first to be dispensed)</i>			
General comments				
S. No.	Packaging of Medicines	0	1	
15	Packages and containers are closed (Only check immediate packages and containers)			
16	Packages are clean in both pharmacy and store room			
17	Packages and boxes are not crushed			
General comment				

10.7 Appendix VII: Questionnaire format to collect expert opinion in DEMATEL approach

Dear Sir/ Madam

First of all, thank you for taking the time to answer. The purpose of this research is to assess the performance and challenges of Health Commodity Inventory Management in Public health facilities. Professionals in the organizations and academies aim to find out the interrelationships of the metrics or indicators used to show Inventory Management Performance. This research is purely academic and all the contents of the questionnaire are strictly confidential. Please fill in with confidence based on your experience and actual conditions. Your support will be the key to the success of this research. We sincerely invite you to give us your insights as a reference for this research.

Thank you again for your patience to help fill out the answers and generous advice. If you have any questions about the contents of the questionnaire, please feel free to contact by phone or E-mail.

Zewdu Tessema

AAU, HSCM, Student

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E-mail= zewdutessema1@gmail.com

Part I: Performance measurement perspectives and metrics representations

Customer perspectives(A)	Operational perspectives (B)	Financial perspectives (C)	Storage perspectives (D)
Prescriptions fill rate (A1)	Stock out rate (B1)	Percentage of value of wasted commodity (C1)	Percentage of HF met standards of storage practice (D1)
	Wastage rate (B2)		
	Inventory accuracy rate (B3)		
Prescription affordability (A2)	Availability of IPLS and APTS tools (B4)		
	Frequency of emergency orders (B5)		
	RRF reporting rate (B6)		
	RRF data quality (B7)		

Part II: Measurement scale explanations

Scale	The extent of impact	Explanation
0	Has no influence	Represents that the two evaluations criteria are not related to each other
1	Low influence	Represents a low correlation between the two criteria
2	Medium influence	Represents a moderate correlation between the two criteria
3	High influence	Represents a high degree of correlations b/n the two criteria
4	Very high influence	Represents a very high degree of correlations b/n the two evaluations criteria

Part III: Fill Out the Questionnaire please,

Effect												
Cause	A1	A2	B1	B2	B3	B4	B5	B6	B7	C1	D1	
A1												
A2												
B1												
B2												
B3												
B4												
B5												
B6												
B7												
C1												
D1												

Remarks: The total of 110 squares, please note whether they have been actually filled in///

10.8 Appendix VIII: List of Selected Health commodities

S. No.	Item Name
1	3TC-TDF- DTG (300+300+50MG/tablet)
2	Metronidazole 250 mg cap
3	Stat pack (HIV test kit)
4	Glucose 40%
5	Ready-to-use therapeutic food
6	Artemether+ Lumefantrine 20mg + 120mg tab
7	(Depot Medroxy-progesterone Acetate 150 mg Vial) (Depo-Provera)
8	Mebendazole 100 mg tab
9	Oxytocin (10 IU injectable)
10	MgSO4 (50% injectable)
11	Oral Rehydration Salts (ORS)
12	Aluminum Hydroxide (225 mg) / Magnesium Hydroxide(225mg)/ Simethicone (50mg) suspension
13	Amoxicillin 125mg/5ml suspension
14	Pentavalent Vaccine
15	RHZE (150mg+75mg+400mg+275mg) +RH (150mg+75mg tab) Kit
16	Paracetamol 500 mg tab

17	Amoxicillin 500mg cap
18	<i>Salbutamol Sulfate puff 100micro gram/dose</i>
19	Ceftriaxone 1g inj.
20	Ciprofloxacin 500mg tab
21	Trimethoprim-Sulphamethoxazole 400mg/80mg tab
22	Sodium Chloride 0.9% (Normal Saline) 1000ml
23	Primaquine 7.5 mg tab
24	Tetracycline eye ointment 1%
25	Hydrochlorothiazide 25 mg tab

10.9 Appendix IX: Name of indicators and data sources

S. No.	Name of Indicators	Data sources
1	Stock out rate	Bin card, HCMIS, Physical observation
2	Wastage rate	Bin card, disposal report, HCMIS
3	% Of value of wastages	Model-19, Bin card, disposal report, HCMIS
4	Storage practice	Physical observation
5	% Of emergency orders	Purchasing document, RRF
6	Patient prescription fill rate and affordability	Patient prescriptions, prescription registration log book
7	Availability of IPLS and / APTS tools	Physical observation
8	Inventory accuracy rate	Bin card, physical count, HCMIS
9	RRF data quality and reporting rate	RRF report, Bin card, Bahirdar EPSA hub report receiving log book

10.10 Appendix X: List of South Gondar Zone top ten diseases in 2013 EFY

S.no.	Diseases name
1	Pneumonia
2	Acute upper respiratory infections
3	Dyspepsia
4	Malaria
5	Fever of unknown origin
6	Helminthiasis
7	Disorders of urinary system
8	Gastro intestinal disorder
9	Conjunctivitis
10	Typhoid and paratyphoid

10.11 Appendix XI: Amharic version of guide for key informant interviews

አዲስ አበባ ዩኒቨርሲቲ
የፋርማሲ ትምህርት ቤት

የፋርማሲዮቲክስና ሶሻል ፋርማሲ ዲፓርትመንት

በአማራ ብሔራዊ ክልላዊ መንግስት በደ/ጎንደር ዞን የ HIV/AIDS ምርመራ እና የህክምና አገልግሎት በሚሰጡ የመንግስት ጤና ተቋማት ውስጥ ያለውን የጤና ግብአት አስተዳደር እና አፈፃፀም በተመለከተ ከሚመለከታቸው አካላት ጋር የሚደረግ ቃለ-መጠይቅ የተዘጋጀ መመሪያ።

መግቢያ፡ ጤና ይስጥልኝ ስሜ ዘውዱ ተሰማ ይባላል። በአሁኑ ሰዓት በአዲስ አበባ ዩኒቨርሲቲ የመድኃኒት ሰንሰለት አስተዳደር የሁለተኛ ዲግሪ ተማሪ ስሆን በደ/ጎንደር ዞን የ HIV/AIDS ምርመራ እና የህክምና አገልግሎት በሚሰጡ የመንግስት ጤና ተቋማት ውስጥ ያለውን የጤና ግብአት አስተዳደር እና አፈፃፀም በተመለከተ የሚገመገመው ጥናት ዋና ተመራማሪ ነኝ። በመጀመሪያ ወድ ጊዜዎን ሰጥተው ለቃለ መጠይቁ ፍቃደኛ ስለሆኑልኝ ከልብ አመሰግናለሁ።

የቃለ-መጠይቁ ዋና አላማ፡- የጤና ግብአት አስተዳደር እና አፈፃፀም ሁኔታ የመገምገም ስራ እና የሚከሰቱ ችግሮችን መለየትና መሻሻል የሚገባቸውን ነገሮች መጠቆም ለህክምና አገልግሎት ደረጃ ከፍተኛ አስተዋጽኦ እንዳለው ይታወቃል። በመሆኑም በጤና ተቋማቹ ውስጥ የተገለፀውን ሁኔታ በሚመለከት ያለዎትን የግል አስተያየት በግልፅ እንዲነግሩኝ በአክብሮት እጠይቃለሁ። በቃለ-መጠይቁ ወቅት የሚያነሱዎቸውን ነጥቦች ሙሉ በሙሉ ለማስቀረት ይረዳን ዘንድ የርሶ ፍቃድ ከሆነ ይህ ቃለ-መጠይቅ በመቅረጹ-ድምጽ የሚቀዳ ይሆናል። ይህም በመሆኑ ድምፅዎን በሚሰማ መልኩ ጮክ ብለው እንዲናገሩ አሁንም በማክበር እጠይቃለሁ። ይህም ከጊዜዎት ከአንድ ሰዓት ያልበለጠ ጊዜ ይወስዳል። በዚህ የቃለ መጠይቅ ሂደት የሚገኙ ማናቸውም መረጃዎች በምስጢር የሚጠበቁ ይሆናል። እርስዎ መናገር ስለማይፈልጉት ነገር ለመናገር እንደማይገደዱ እና ቃለ-መጠይቁን በማንኛውም ጊዜ ማቋረጥ እንደሚችሉም ላስታውሱዎት እወዳለሁ።

በቃለመጠይቁ- መጠይቁ ለመሳተፍ ፍቃደኛ ነዎት? አዎ----- አይደለሁም--- በቃለመጠይቁ ለመሳተፍ ፍቃደኛ ከሆኑ ቃለ-መጠይቁ ይቀጥላል፡ ፡

1. የመነሻ መረጃ

1.1. እድሜ _____ 1.2. የታ _____

1.3. የትምህርት ደረጃ _____ 1.4. የስራ ልምድ _____

1.5. የስራ ድርሻ _____ 1.6. ሙያ _____

1.7 የጤና ተቋሙ አይነት ሀ. ጤና ጣቢያ ለ. የመጀመሪያ ደረጃ ሆስፒታል ሐ. ጠቅላላ ሪፈራል ሆስፒታል

2. በቃለ መጠይቁ ወቅት የሚነሱ ነጥቦች ዝርዝር:-

2.1. እርሶ በሚሰሩበት ተቋም የጤና ግብአት አስተዳደር ሁኔታን እንዴት ያዩታል?

2.2. በአሁኑ ወቅት የጤና ግብአት አስተዳደር እና የአፈፃፀም ደረጃ ለማሻሻል በሚከተሉት ተግባራቶች ላይ ምን አይነት ተግዳሮት ገጥመወት ያወቃል?

ሀ. በጤና ግብአት መረጃ አያያዝ እና አጠቃቀም ለ. ተመጣጣኝ ዋጋ ያላቸውን የጤና ግብአቶች ከማቅረብ አንጻር ሐ.

በመድሀኒት መጋዘን ክፍሎች ብቃት እና አግባብነት ሁኔታ

መ. የባለሙያውን ክህሎት ከማሳደግ አኳያ

2.3. የጤና ግብአት አስተዳደር ደረጃን ከፍ ለማድረግ እና ከላይ የተተነሱትን ችግሮች ለመቅረፍ ምን ተግባራት ቢከናወኑ ጥሩ ነው ይላሉ?

2.4. የጤና ግብአት አስተዳደር ደረጃን ከፍ ለማድረግ ተፅዕኖ የሚያሳድሩ ተጨማሪ ተግዳሮቶች ካሉ ቢጠቅሱልን?

2.5. የሚሰጡት ተጨማሪ አስተያየት ካለዎት?

ቃለ-መጠይቁን ጨርሰናል፣ ስላደረጉሉን ትብብር ከልብ እናመሰግናለን!!!!!!

10.12 Appendices XII- Parts of DEMATEL procedure results

Part I-Average initial and normalized matrix using DEMATEL procedure of expert opinions

Effect Cause	A1	A2	B1	B2	B3	B4	B5	B6	B7	C1	D1
A1	0.00	0.54	0.23	0.38	0.00	0.38	2.85	0.00	0.00	0.38	0.15
A2	0.31	0.00	0.54	1.85	0.15	0.23	0.23	0.00	0.08	0.31	0.08
B1	3.31	2.08	0.00	1.15	0.31	0.15	3.00	0.62	0.38	0.54	0.08
B2	3.08	2.77	3.38	0.00	0.54	0.38	3.38	0.23	0.38	3.38	0.85
B3	2.15	0.54	1.77	1.08	0.00	0.46	0.31	3.08	0.00	0.92	0.92
B4	3.00	1.23	2.00	1.62	1.46	0.00	1.15	1.54	3.00	0.77	1.77
B5	2.62	3.85	2.38	0.54	1.15	0.08	0.00	0.46	0.85	0.92	0.62
B6	2.62	1.77	2.77	0.85	0.15	0.00	2.38	0.00	0.38	1.15	0.31
B7	3.15	2.77	3.46	2.85	0.23	0.08	2.77	0.00	0.00	3.08	0.38
C1	1.46	3.54	0.62	0.00	0.00	0.15	0.62	0.00	0.00	0.00	0.00
D1	2.62	1.38	2.69	2.23	2.38	0.08	2.38	1.31	2.85	1.92	0.00

Normalized direct relation matrix

Effect Cause	A1	A2	B1	B2	B3	B4	B5	B6	B7	C1	D1
A1	0.00	0.03	0.01	0.02	0.00	0.02	0.14	0.00	0.00	0.02	0.01
A2	0.02	0.00	0.03	0.09	0.01	0.01	0.01	0.00	0.00	0.02	0.00
B1	0.17	0.10	0.00	0.06	0.02	0.01	0.15	0.03	0.02	0.03	0.00
B2	0.16	0.14	0.17	0.00	0.03	0.02	0.17	0.01	0.02	0.17	0.04
B3	0.11	0.03	0.09	0.05	0.00	0.00	0.02	0.02	0.16	0.00	0.05
B4	0.15	0.06	0.10	0.08	0.07	0.00	0.06	0.08	0.15	0.04	0.09
B5	0.13	0.19	0.12	0.03	0.06	0.00	0.00	0.02	0.04	0.05	0.03
B6	0.13	0.09	0.14	0.04	0.01	0.00	0.12	0.00	0.02	0.06	0.02
B7	0.16	0.14	0.17	0.14	0.01	0.00	0.14	0.00	0.00	0.16	0.02
C1	0.07	0.18	0.03	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00
D1	0.13	0.07	0.14	0.11	0.12	0.00	0.12	0.07	0.14	0.10	0.00

Cronbach's alpha value for DEMATEL procedure

Number of items	110
Sum of item variances	64.75
Variances of total score	1324.39
Cronbach's alpha value	0.96

List of surveyed health facilities name with their given code

S.N	HF name	Description	Given code
1	Debretabor hospital	Referral hospital	RH-1
2	Debretabor health center	Health center	HC-4
3	Lewaye health center	Health center	HC-5
4	Woreta health center	Health center	HC-6
5	Licha health center	Health center	HC-7
6	Anbesamie health center	Health center	HC-8
7	Hamusit health center	Health center	HC-9
8	Alember health center	Health center	HC-10
9	Adisszemen health center	Health center	HC-11
10	Adisszemen hospital	Primary hospital	PH-2
11	Agat health center	Health center	HC-12
12	Yifag health center	Health center	HC-13
13	Ebinat health center	Health center	HC-14
14	Estie health center	Health center	HC-15
15	Mekaneyesus hospital	Health center	PH-3
16	Aribgebia health center	Health center	HC-16
17	Adada health center	Health center	HC-17
18	Mahidere-Mariam health center	Health center	HC-18

DECLARATION

I, the undersigned agree to accept responsibility for the scientific, ethical and technical conduct of the research project and for provision of required progress reports as per terms and conditions of the research.

Principal investigator: Zewdu Tessema (B.Pharm)

E-mail: zewdutessema1@gmail.com

Phone: +251-918320931

Signature _____ Date _____

Approval of advisors

1. Eskinder Eshetu (PhD)

E-mail: eskinder.eshetu@aau.edu.et

Signature _____ Date _____

2. Mr. Tesfaye Tsigu (MSc)

E-mail: ttsigu@unicef.org

Signature _____ Date _____

Addis Ababa, Ethiopia

October, 2022

በ ፋርማሲ ት/ቤት
የኢትዮጵያ ሪፐብሊክ ኮምቴ

አዲስ አበባ ዩኒቨርሲቲ
Addis Ababa University

School of Pharmacy
Ethical Review Committee



ቀን
Date January 03, 2022

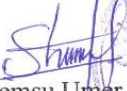
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Ref. No. ERB/SOP/390/14/2021

To: Zewdu Tessema
School of Pharmacy

Re: Ethical Clearance

It is to be recalled that you submitted a research proposal entitled “**Assessment of Health Commodities Inventory Management Performance and Challenges in South Gondar Zone Public Health Facilities, Amhara Region, Ethiopia: A Comprehensive Approach**”. The committee thoroughly reviewed the proposal based on its operational guidelines and found that it fulfills all the ethical requirements stipulated in the guidelines. This is, therefore, to inform you that the proposal is ethically approved for implementation.

With best regards,


Shemsu Umer (PhD)
Chairperson, ERC
School of Pharmacy
College of Health Sciences
Addis Ababa University

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ቁጥር:-አከ.ኢ.ጤ/ም/ቴ/ሸ/1/1218
_Ref. No:
ቀን:- 02/05/2014ዓ/ም
Date:- -----

ለደብረ ታቦር ኮምፕሪዬንሲቭ ከፕሻላይዝና ሆስፒታል

ለአዲስ ዘመን የመጀመሪያ ደረጃ ሆስፒታል

ለመካነ እየሱስ የመጀመሪያ ደረጃ ሆስፒታል

ለአንዳቤት የመጀመሪያ ደረጃ ሆስፒታል

ለወገዳ የመጀመሪያ ደረጃ ሆስፒታል

ለአብናት የመጀመሪያ ደረጃ ሆስፒታል

ለዶ/ር አምባቸው መታሰቢያ የመጀመሪያ ደረጃ ሆስፒታል

ለደቡብ ጎንደር ዞን ጤና መምሪያ

ባሉበት

ጉዳዩ:- ትብብር እንዲደረግላቸው ስለመጠየቅ

ተማሪ ዘወዱ ተሰማ በአዲስ አበባ ዩኒቨርሲቲ የ2ኛ ዲግሪ ተማሪ ሲሆኑ “Assesments of health commodities Inventory management performance and challenges in south Gondar Zone Public health facilities ” በሚል ርዕስ በሆስፒታላችሁ/በዞናችሁ ስር ጥናት ለማከናወን የጥናቱ ንድፈ ሀሳብ በአዲስ አበባ ዩኒቨርሲቲ ፋሚሊ ት/ት ክፍል የምርምር ስነ-ምግባር ገምጋሚ ኮሚቴ ታይቶ የፀደቀ ስለሆነ አስፈላጊው ትብብር እና ድጋፍ እንዲደረግላቸው ስንጠይቅ ምስጋናችንን በማስቀደም ነው። በመጨረሻም ጥናቱ ሲጠናቀቅ ውጤቱ ለጤና ተቋማት ጥቅም ላይ ለማዋልና ለመከታተል እንችል ዘንድ ቅጅ ለጤና ምርምርና ልማት ዳይሬክቶሬት እንዲቀርብ ጥናቱን ለማያከናውነው በድን በግልባጭ እናሳውቃለን።



“ለሕብረተሰብ ጤና ልማት እንትጋ”

(Handwritten signature)
ታይ ገዳጃ
Taye Tadege
የሕብረተሰብ ጤና ምርምርና
ክፍሉን ማሻሻል
የደብረተሰብ ጤና

ግልባጭ//

→ ለዘወዱ ተሰማ