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SCHOOL OF PUBLIC HEALTH

PHARMACEUTICAL SUPPLY CHAIN PRACTICE IN PUBLIC HOSPITALS IN SIDAMA REGIONAL STATE, ETHIOPIA

MPH THESES

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PHARMA COLLEGE SCHOOL OF PUBLIC HEALTH

PHARMACEUTICAL SUPPLY CHAIN PRACTICE IN PUBLICHOSPITALS IN SIDAMA REGIONAL STATE, ETHIOPIA

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ADVISOR APPROVAL SHEET

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I, the undersigned, student declare that this thesis is my original **"PHARMACEUTICAL SUPPLY CHAIN PRACTICE IN PUBLICHOSPITALS IN SIDAMA REGIONAL STATE, ETHIOPIA"** work in partial fulfillment of the requirement for the Master of General Public Health.

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Date of Submission: _____

This thesis report work has been submitted with my approval as a college advisor(s).

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LIST OF ABBREVIATIONS ANDACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral therapy
CEO	Chief Executive Officer
FMOH	Federal Minister of Health
HCMIS	Health Commodities Management Information System
HIV	Human Immune Deficiency Virus
IFRR	Internal Facility Report and Resupply
IPLS	Integrated Pharmaceutical Logistics System
LIAT	Logistics Indicators Assessment Tool
LMIS	Logistics Management Information System
MIN/MAX	Minimum/Maximum
NGOs	Non-Governmental Organizations
EPSA	Ethiopian Pharmaceutical Supply Agency
RDF	Revolving Drug Fund
RRF	Report and Requisition Form
SC	Supply Chain
SCM	Supply Chain Management
SRM	Suppliers Relationship Management
TB	Tuberculosis
DIS	drug information service

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ABSTRACT

Background: A well-functioning pharmaceutical supply chain management (PSCM) system is the backbone of effective healthcare delivery. Hence, understanding and optimizing PSCM practices, including forecasting, procurement, and inventory management, is critical for ensuring effective healthcare delivery. The aim of this study was to assess the pharmaceutical supply chain management practices at Public health facilities in Sidama Regional State, Ethiopia.

Method and Materials: An institution-based descriptive cross-sectional study was conducted from September 30, 2024, to October 30, 2024, in 20 public hospitals in the Sidama Region. Kobo tool was used to collect the data from the study participants using self-administered questionnaire. Data collected underwent a rigorous cleaning and validation process before being exported to SPSS version 26 for statistical analysis. Descriptive statistics including frequency distributions, means with standard deviations (SD), and percentages was computed. The findings are presented using charts, figures, statistical tables, and textual descriptions.

Results: The study found that the Pharmaceutical Supply Chain Management (PSCM) practices in Sidama Region's public health facilities demonstrate both strengths and key areas for improvement. Some of the strengths are**:** Strong emphasis on Standard Operating Procedures (SOPs) across multiple areas: supplier relationships, procurement, inventory, storage, post-procurement, and monitoring & evaluation. Good performance in core inventory management practices: MIN/MAX systems and ABC/VEN analysis. However, the weaknesses identified are as follows: Significant limitations exist across several domains: procurement, inventory management, information technology, storage, and post-procurement services.

Conclusion: The assessment reveals a generally positive picture of PSCM practices, particularly in areas like standardization, SOP development, and core inventory management principles. However, significant challenges related to budget constraints, human resources, management support, and capacity building are hindering optimal performance. Addressing these challenges, especially budget allocation, is crucial for strengthening the pharmaceutical supply chain in the region.

Keywords: PSCM, Public Health Facilities, Ethiopia

1. INTRODUCTION

1.1. Background of the study,

Pharmaceutical supply chain management is the cornerstone of the health care system, involving many stakeholders such as manufacturers, wholesalers, distributors, transporters, hospitals, and retail pharmacies.

The supply chain system in the healthcare system is characterized by the flow of information, assets, and money essential to purchase and transfer goods and services from the provider to the end user, to control costs (2). A pharmaceutical supply chain (PSC) is defined as a combination of processes, organizations, and operations involved in the development, design, and manufacturing of pharmaceutical drugs (3). The PSC is unique as it deals with the life and health of individuals (4). Proper functioning of the PSC ensures that medicines reach the end user. Access to medicines is a fundamental human right and one of the key objectives of health systems (5). The PSC should provide drugs in the right quantity. The PSC consists of various parts, namely the supplier, manufacturer, wholesaler, pharmacy, and hospital (7-9).

The PSC involves four main activities: product selection, quantification, inventory management, storage and distribution, and serving customers. The entire process includes tenders, local purchase orders, and inventory management practices. Professionals handling PSC in their health facilities should have good knowledge of PSC activities. In contrast, a study by Adzimah et al. (14) showed that only respondents in the procurement and stores departments had satisfactory knowledge of PSC management.

Integration and partnership throughout the supply chain, utilization of information technologies for information sharing, and performance monitoring and evaluation of different SC practices in the organization are essential. Efficient procurement and inventory management of health commodities are some of the SC practices in healthcare facilities, which have the potential to ensure value for money, which is indispensable to a country facing many developmental challenges. Strategic relationships with suppliers, development of specifications and standards, information sharing, and after-procurement service are some of the key SC practices in healthcare facilities that significantly influence the quality of healthcare services. Some of the SCM practices that should be executed in public healthcare facilities include information and technology management, demand management, customer relationship management, supplier relationship management, and capacity and resource management.

The goal of every supply chain practice in healthcare facilities is to ensure that every customer has commodity security. If healthcare facilities achieve commodity security, people can feel more confident about health programs, motivating them to seek and use basic healthcare services (10). Effectively implemented supply chain practices in healthcare organizations play a significant role in executing and achieving different cost reduction initiatives, matching the supply and demand of various customer services (11), and increasing the responsiveness of services provided by healthcare organizations, thereby resulting in improved customer satisfaction. Effective supply chain practices reduce costs, boost revenues, increase customer satisfaction, and improve service delivery (12).

Some contributing factors to the problems encountered by healthcare institutions while managing their supply chain practices include outdated information systems and infrastructure, weak inventory and delivery management, traditional procurement systems, lack of higher-level official involvement, and poor process evaluation and improvement culture (13). The potential challenges of the healthcare supply chain system in Ethiopia, which affect supply chain practices, include frequent stockouts of essential medicines, patients' inability to afford the cost of quality logistics services, and poor data management at different levels of the supply chain (14). Assessing various parameters of healthcare supply chain practices is essential for continuous service improvement, satisfying all customers, maintaining sound financial performance, and achieving the best possible clinical outcomes (15). For this reason, this study aimed to assess the status of some supply chain practices and challenges related to these practices in public hospitals in Sidama Regional State, Ethiopia. The study assessed supply chain practices from the perspective of healthcare professionals, as the quality of SC-related data documentation in public health facilities in Ethiopia is poor. Therefore, assessing SC practices from healthcare professionals' perspectives can help the study capture findings that could not be obtained through document review and observation. It is expected that this study will provide a valuable document on the status of SC practices in public hospitals in Sidama Regional State.

1.2 Statement of the problem

The pharmaceutical supply chain is complex and unique by itself since it operates with the availability of valuable and lifesaving pharmaceuticals and medical supplies. Moreover, it involves many organizations that play differing roles. In supply chain performance measurement, the main purpose is to get information for top management to aid decision-making, evaluate the level of service provided, and

assess customer satisfaction. In 2017, Gunasekaran et al. introduced six metrics for measuring SCM capability and performance based on the following SCM processes: plan, source, make/assemble, and delivery/customer.

Challenges within the pharmaceutical supply chain comprise additional peculiarities. These include an increase in transportation costs, lead times, and inventories (8, 12). Infrastructural deficiencies in developing countries may also encompass transportation and telecommunications, inadequate worker skills, supplier availability, and supplier quality (10). Yet, global supply chain management (GSCM) carries specific risks such as variability and uncertainty in currency exchange rates, economic and political instability, and changes in the regulatory environment (14, 21).

The challenges in the sector fall at the supply chain design (capacity) and operational (responsiveness) stages (8). All the aforementioned challenges can lead to difficulties in realizing the benefits associated with internationalization. Considering that supply chains are becoming more and more global, the study of challenges and placing approaches to overcome them is of great importance in the area.

Availability of essential drugs is the building block of the pharmaceutical supply chain management. The components of pharmaceutical supply chain management are selection, quantification, procurement, and inventory management, and a failure in one part of the component leads to the failure of the whole pharmaceutical management process. Lack of an effective pharmaceutical supply chain not only affects the availability of essential drugs but also significantly affects efficiency. Ineffectiveness in selection, quantification, procurement, and inventory management, as well as high prices, poor quality, theft, expiration of drugs, irrational prescribing and incorrect use of medicines by patients, increase the health expenditures (13).

A supply chain disruption occurs when supply falls severely short of demand. Such disruptions take place when either the nominal supply capacity of a business process is greatly reduced for some period, or a sudden increase in demand, or both. Disruptions in pharmaceuticals/healthcare contexts disturb the continuity of providing for patient needs and can have particularly severe consequences. Disruption in the supply of pharmaceutical products in pharmaceutical importers results in repeated stock-outs and interruption of services (8, 12).

The pharmaceutical supply chain faces its own set of challenges, including supply chain visibility, drug counterfeiting, cold-chain shipping, and raising prescription drug prices, which can significantly increase out-of-pocket costs for patients (10). In Ethiopia, Sidama regional state, Hawassa City, the pharmaceutical supply chain suffers from a lack of inventory management and poor network design, as well as a weak distribution system and weak management. Overstocking, understocking, and product expiration are major pharmaceutical challenges, among others (1, 6).

While the existing literature has extensively discussed the challenges in pharmaceutical supply chain management, there is a lack of research on the specific practices and challenges in public health facilities of Hawassa City, Ethiopia. This study aims to address this research gap by investigating the pharmaceutical supply chain practices and identifying the key challenges faced by healthcare facilities in the region (1, 12).

1.3 Significance of the study

This research has a great deal of importance and significance for the pharmaceutical managers, Researchers, pharmaceutical professionals and stakeholders of private and public pharmaceutical importers and distributors because it provides information about the service the company is providing to its customers from the point of view of the customers. It helps them to know whether the company is delivering its promise to the customers and also it provides them insight about the gap between customer's perception and expectation of service and ways to improve them. In addition, it gives information for the government regulatory authority about the challenges in the pharmaceutical supply chain system

2. LITERATURE REVIEW

2.1. Concepts and Definitions

In this section, a critical review of several available pieces of literature related to supply chain practices in healthcare facilities was conducted. Concepts and definitions of supply chain management and different healthcare supply chain practices, as well as challenges related to healthcare supply chain management practices, were among the subjects discussed in this chapter. In addition, the principal investigator developed the conceptual framework of this study after reviewing different literature.

Supply Chain Management

The Global Supply Chain Forum defines SCM as the integration of key business processes from end users through original suppliers that provide products, services, and information which add value for customers and other stakeholders. Supply chain management is about organizing and controlling the information, products, services, and money in a way that promotes the quality of the organization's business, and it helps introduce new methods and advance methods already in use. According to Chopra and Meindl, supply chain management is a set of approaches and practices to effectively integrate suppliers, manufacturers, distributors, and customers for improving the long-term performance of the individual organization and the supply chain as a whole (1,2). Supply chain management includes planning and controlling all logistics management activities as well as manufacturing operations, and it comprises coordination and partnership with different external partners, which can be suppliers, intermediaries, and customers (28).

Supply Chain Practices in the Healthcare System

Supply chain management practices involve a set of different activities carried out in an organization to support the effective management of its supply chain. The short-term objectives of supply chain practice include increasing productivity, minimizing inventory, and reducing lead time, whereas the long-term objectives include increasing market coverage and integration of the supply chain (6). Healthcare supply chain management has become an important phenomenon for healthcare organizations to achieve the goals set by the organization because it has an enormous effect on cost control (2). The African Medical Research Foundation (2024) defined healthcare commodity supply chain management as a set of activities and procedures that ensure healthcare commodities are available, accessible, and of high quality (17). The healthcare sector in its wider context does not only include clinics, health centers, and hospitals but also pharmaceutical manufacturers, pharmaceutical wholesalers, medical supplies retailers,

pharmacies, government regulatory agencies, health insurance companies, healthcare technology providers, and information technology sellers (28). A study done in Kenya mentioned that relationships with suppliers, specifications and standards, product delivery, pharmaceutical procurement, information sharing, and after-procurement service are the most important supply chain practices in health facilities that can significantly affect the quality of healthcare service (8).

A public healthcare supply chain is a network of different interrelated organizations or sectors that ensure the availability of health commodities to the people who need them. There is significant variation between the public and private healthcare sectors regarding the implementation of specific supply chain management operations (29). The healthcare supply chain system plays a huge role in ensuring every client or patient can obtain quality health commodities. However, developing a supply chain system that can administer a large number of quality products is very difficult (24). Nowadays, public health sectors in different countries provide more attention to supply chain management because effective supply chain management practices can help minimize costs, enhance income, increase customer satisfaction, and improve the quality-of-service delivery (8).

Information Sharing and Technology

Information sharing means exchanging any information, which is important for decision-making purposes, between two or more parties. When information sharing is good, the forecast at the supplier level can gain significant improvement because under- or overestimation of the need can be removed (30). Despite the importance of information flow in supply chain management, it appears that the level of information sharing, information quality, and information technology (IT) tool usage still has not reached the ideal state in public health facilities (31). The implementation of information technology in the healthcare supply chain system is currently considered an opportunity to increase not only the effectiveness, efficiency, and quality of health services but also the transparency of economic activities (32). Healthcare facilities' integration with suppliers through information technology is important to decrease inventory costs while simultaneously allowing health facilities to meet customers' requirements (28). The Logistics Management Information System (LMIS) is a system that supports people involved in the management of health commodities for timely documentation, collection, and organization of the information necessary for decision-making in managing the supply chain of health commodities (33). Effective and transparent information tracking systems that allow healthcare providers to consistently and accurately record inventory components can help reduce adverse patient outcomes (34).

According to a study in Ghana, the majority of respondents (97.5%) confirmed that the information they receive from their suppliers influences their purchasing decisions (35). A cross-sectional study in Kenya concluded that the information-sharing capability of suppliers significantly affects customer satisfaction (21). A cross-sectional study done in Ethiopia concluded that since the vertical national logistics management information system for Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) laboratory commodities was implemented, stockouts for antiretroviral therapy (ART) laboratory monitoring tests, emergency orders, and product wastage were appreciably reduced (24).

Healthcare Supply Chain Practices and Related Challenges

The main challenge in healthcare supply chain management is improving performance and service (1). Some challenges associated with healthcare supply chain practices include poor infrastructure, the large number of materials to be transported, poor requisition form filling, and the late arrival of purchase orders to suppliers (8).

A cross-sectional study in Tanzania identified the lack of a unified system for managing inventory at different levels, inadequate stock management knowledge, and issues with the quantification process as key challenges in most health facilities (39).

In Nigeria, a study of health facilities found that factors limiting the implementation of the Logistics Management Information System (LMIS) for HIV/AIDS laboratory commodities include a lack of training for laboratory professionals involved in LMIS, inadequate supply from regular suppliers during the resupply cycle, delayed delivery from suppliers, and insufficient storage space (33).

Challenges in inventory management in hospitals, such as those found in Agroyesum, include delays in the delivery of medical supplies, bureaucratic procurement processes, the loss of drugs through theft and damage, weak administrative systems, and insufficient funds (45). Other challenges in healthcare procurement include poor demand estimation, corruption in procurement and tender practices, and inappropriate financial management and payment methods (17).

Ethiopia faces specific challenges in maintaining an effective pharmaceuticals supply chain due to its varied health programs. These include difficult topography, reliance on neighboring countries' seaports, low road infrastructure coverage, poor coordination in transporting healthcare commodities, and

inadequate healthcare commodity storage facilities (41). Furthermore, a lack of soft and hardware logistics infrastructure exacerbates supply chain issues in Ethiopia (14).

2.2. Conceptual Framework

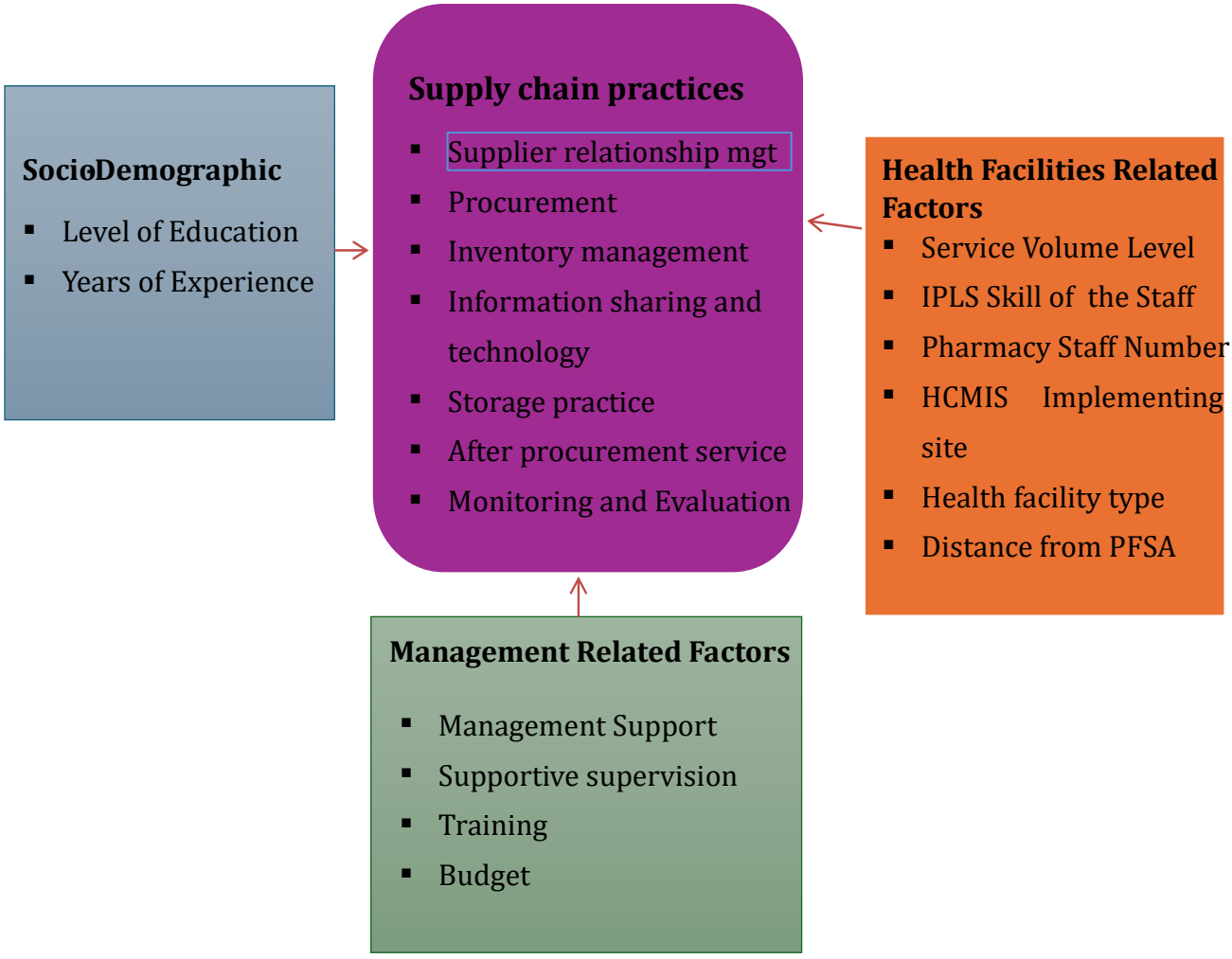

Figure 1: Conceptual Framework developed by the principal investigator, 2024

3. OBJECTIVE

3.1. General Objective

To assess the overall status of Pharmaceutical Supply Chain Management (PSCM) practices in public hospitals within the Sidama Regional State.

3.2. Specific Objectives

- To assess the forecasting and procurement processes for pharmaceutical products in the selected hospitals.
- To assess the inventory management practices for pharmaceuticals in the selected hospitals.
- To determine the availability and accessibility of essential medicines in the selected hospitals
- To analyze the storage conditions and distribution systems for pharmaceutical products in the selected hospitals.

4. METHODS AND MATERIALS

4.1. Study Area and Period

This study was conducted in all public hospitals in Sidama Regional State and Hawassa City, a densely populated region in Ethiopia. Hawassa, the capital city, is located 275 km from Addis Ababa. According to 2022 projections, the population of Sidama is 4,623,162, with an area of 6,695 km² and a population density of 690.5/km². There are 21 hospitals: 1 comprehensive specialized hospital, 6 general hospitals, and 14 primary hospitals spread across the city and the southern, northern, and eastern zones.

4.2. Study Design

This descriptive cross-sectional study was conducted to assess the status of supply chain practices in public hospitals of Sidama Regional State

4.3. Population

4.3.1. Source and study Population

All healthcare professionals handling pharmaceuticals in public health facilities across the Sidama Regional State

4.3.2. Inclusion and Exclusion Criteria

4.4.1. Inclusion Criteria

- All hospitals in the region.
- All personnel involved in dispensing pharmaceuticals and supply chain.
- Coordinators of pharmacy, medical laboratory, emergency outpatient departments (OPD), inpatient OPD.
- Coordinators of pharmacy dispensing units in public health facilities.

4.4.2. Exclusion Criteria

- Health centers
- Military health facilities in the study area.
- Staff who began working less than 6 months before the data collection

4.5. Sample Size Determination and Sampling Techniques and Procedure

The study was conducted in 20 health facilities within the Sidama Regional State. These facilities appear to have been purposively selected. The sampling unit was individual healthcare professionals at each facility. All eligible healthcare professionals (Pharmacist) at each of the 20 selected facilities who had a direct exposure to the PSCM were included in the study. For more than two professional working at the same unit we used a random sampling (lottery method) select one representative within the facilities. The total number of participants was 61, representing the combined number of eligible healthcare professionals across the 20 facilities. The number of participants from each facility varied, likely based on the size of the facility and the number of staff involved in pharmaceutical handling (Table 1).

Table 1 List of Health Facilities Selected for a Study on PSCM practice showing the number of Healthcare Professionals included from each facility

S.N	Name of health facility	Number of health professional selected
1.	Alamura Primary hospital	3
2.	Aleta chuko Primary hospital	3
3.	Aleta wendo General hospital	3
4.	Bona General hospital	3
5.	Bursa Primary hospital	3
6.	Chire Primary hospital	3
7.	Daye Primary hospital	2
8.	Daye General Hospital	2
9.	Dore Bafano Primary hospital	3
10.	Hawela Tula General Hospital	3
11.	HUCSH	3
12.	Adare General General Hospital	3
13.	Motite Fura	3
14.	Hula Primary hospital	3
15.	Le ku General Hospital	3
16.	Mejo Primary hospital	3
17.	Wondogenet Primary hospital	3
18.	Wotararasa Primary hospital	3
19.	Ya Ye Primary hospital	3
20.	Yirba Primary hospital	3
21.	Yirgalem General Hospital	3
22.	Total	61

4.6. Study Variables

4.6.1. Dependent Variable

Supply chain practices were the dependent variable of this study, and its dimensions include:

- Suppliers relationship management
- Procurement
- Inventory management
- Information sharing and technology
- Storage practice
- After-procurement service
- Monitoring and evaluation

4.6.2. Independent Variables

- **Socio-Demographic Factors** (Level of education, years of experience, health facility type)
- **Management-Related Factors**

4.7. Data Collection Instrument and Procedure

After extensively reviewing several previously completed studies and other materials, checklists and a questionnaire with a 5-point Likert scale were prepared in English. All questions included in the structured questionnaires were grouped and arranged based on the particular issues they were intended to address. A smartphone and various stationary materials will be utilized for collecting data during data collection. Data collection for this study was conducted by two trained data collectors, each holding an MSc in Pharmacy. Oversight and supervision were provided by a PhD-qualified pharmacist. Prior to data collection, the team underwent a two-day training session to ensure consistency and accuracy in data gathering procedures. Data were collected electronically using the Kobo Toolbox platform

4.8. Data Processing and Analysis

Data collected via the Kobo Toolbox platform underwent a rigorous cleaning and validation process before being exported to SPSS version 26 for statistical analysis. Descriptive statistics were generated for all relevant numerical variables, including frequency distributions, arithmetic means with standard deviations (SD), and percentages. The findings are presented using a variety of formats, including charts, figures, statistical tables, and accompanying textual descriptions, to ensure clarity and comprehensibility.

4.9. Data Quality Assurance

The quality of the data collection was ensured by properly designing and adapting the questionnaire from previously published articles. In addition, the quality of the data was assured by properly categorizing and coding the questionnaires, providing training for data collectors on the data collection procedures and questionnaires, and reviewing the completed questionnaires for completeness before analysis. Pharmacy professionals with experience in health commodities supply chain practices collected the data.

4.10. Ethical Clearance

The proposal for the study was approved by the Research Ethical Review Committee of Pharma College (PC-RERC). Before starting data collection, a permission letter from the Pharma College MPH department was submitted to each public hospital to obtain permission for data collection. Verbal consent was obtained from all respondents, and the confidentiality of the information was assured. Participant responses were coded to ensure anonymity during analysis and reporting.

4.11. Dissemination Plan

The final thesis report will be presented as partial fulfillment of the degree of Masters of Public Health to School Of Public Health, Pharma College. The study findings will be disseminated to all concerned bodies, such as the Sidamo Regional Health Bureau, all hospitals involved in the study, the FDA, the Pharma College Department of Public Health, and the Regional Public Health Institute. Finally, the study paper will be submitted to a reputable professional journal for publication to be used as a reference for further research.

4.12. Operational Definitions and Definitions of Terms

Training: All training related to health commodities supply chain management practices provided by different stakeholders to healthcare professionals working in public health facilities. According to this study, a mean value of less than or equal to 2.5 was considered Low, a mean value greater than 2.5 and less than 4.5 was considered Medium, and a mean value greater than 4.5 was considered High.

Supportive Supervision: The supportive supervision provided by different organizations to public health facilities related to health commodities supply chain management practices. According to this study, a mean value of less than or equal to 2.5 was considered Low, a mean value greater than 2.5 and less than 4.5 was considered Medium, and a mean value greater than 4.5 was considered High.

Supply Chain Practices: A set of different supply chain activities carried out in public health facilities to support the effective management of healthcare commodities supply chain. According to this study, supply chain practices include supplier relationship management, procurement, inventory management, information sharing and technology, storage practices, after-procurement service, and monitoring and evaluation.

Suppliers Relationship Management: A systematic approach to developing a strategic plan for managing all interactions with companies that supply health commodities to public health facilities.

Inventory Management: The process of properly maintaining the health commodities stock at all supply chain levels of public health facilities.

Procurement: The acquisition of healthcare commodities, works, and services for public health facilities at the best possible total cost, in the right quantity and quality, at the right time, and to the right place.

Information Sharing and Technology: The ability of public health facilities to share supply chain-related information effectively within or outside the facilities, and the level of technology used to facilitate this sharing.

After Procurement Service: The public health facilities' efforts to provide maintenance and follow-up service, and to obtain accessories and parts required for the maintenance of medical equipment and supplies from suppliers after the sale.

Monitoring and Evaluation: Routine and periodic measurement of the performance of the different supply chain practices in public health facilities, which helps to demonstrate how well the practices are being undertaken and identify areas for improvement.

5. RESULT

5.1 Socio-demographic characteristics

Table 2 reveals the educational background of a group of people and the types of health facilities involved in a particular study. A significant portion of the individuals, 63.9%, hold a Bachelor of Science (BSc) degree. The smallest group, 13.1%, have pursued higher education, holding a Master of Science (MSc) degree or higher. Regarding the type of health facility; the majority of the health facilities, 70%, are primary hospitals. Only one facility, representing 5% of the total, is classified as a tertiary hospital.

Table 2: Socio-demographic characteristics

Variable	Category	Frequency (n=48)	Percent (%)
Highest Level of Education	Diploma	14	23
	BSc	39	63.9
	MSc and above	8	13.1
Type of health facility	Primary hospital	13	61%
	General Hospital	7	33.3
	Tertiary Hospital	1	4.7

5.2 Assessment of PSCM

5.2.1 Strategic supplier relationship practices

Figure 1 presents the mean scores and standard deviations for various practices related to strategic supplier relationships within a supply chain. The scores range from 3.87 to 4.84, suggesting that, on average, these practices are perceived to be implemented to a moderate to high degree within the organization. Development and regular update of SOPs received the highest mean score (4.84), indicating strong emphasis on standardized procedures for managing supplier relationships. Whereas utilization of supplier vehicles found to have the lowest mean score (3.87) suggests that the utilization of supplier vehicles for transportation and logistics may require further attention and optimization.

Figure 2: Assessment of Strategic Supplier Relationship Practices in SCM in Sidama Regional State Public Health Facilities, 2024

5.2.2 Assessment of Pharmaceutical Procurement Practices

The findings in Table 2 suggest that pharmaceutical procurement practices in the assessed facilities generally demonstrate a strong emphasis on standardization and adherence to established guidelines. Practices such as developing and updating standard operating procedures (SOPs) for procurement, establishing and utilizing standards and specifications for procured items, and involving experts in the development of these standards received high mean scores (ranging from 4.69 to 4.82) with relatively low standard deviations, indicating a high level of consistency across facilities in these areas. The mean score for budget allocation (3.87) was notably lower, suggesting potential challenges in securing adequate financial resources for pharmaceutical procurement. While the mean scores for availability of vital and essential medicines (3.93 and 3.95, respectively) were moderate, the relatively high standard deviations in these areas indicate significant variability across facilities in terms of ensuring consistent access to critical medications.

Table 3: Assessment of Pharmaceutical Procurement Practices

Practice	Mean	(±SD)
Development and regular update of SOPs for pharmaceutical procurement	4.82	.533
Development and regular update of standards and specifications for procured items	4.77	.643
Comprehensiveness and appropriateness of standards and specifications	4.70	.691
Procurement based on developed standards and specifications	4.69	.647
Involvement of experts and stakeholders in standard and specification development	4.70	.667
Development and regular update of a facility-specific essential drug list	4.79	.520
Procurement of items included in the essential drug list	4.72	.662
Utilization of electronic data interchange (EDI) and the World Wide Web for procurement	4.43	.644
Level of bureaucracy in the procurement process	4.59	.844
Budget allocation for pharmaceutical product procurement	3.87	.718
Availability of vital medicines	3.93	.574
Availability of essential medicines	3.95	.669

5.2.3 Inventory Management Practices

The findings presented in the table 3 indicate a generally positive assessment of inventory management practices within the assessed facilities. High mean scores were observed for practices such as developing and updating SOPs (4.84 ± 0.454), strict application of MIN/MAX systems (4.74 ± 0.630), and regular ABC/VEN analysis (4.77 ± 0.643), suggesting a strong foundation in core inventory management principles. The mean score for regular and timely placement of orders by dispensary units (4.08 ± 1.021) was relatively low, suggesting potential challenges in timely order fulfillment and potential stock outs. The mean score for budget allocation for inventory management-related activities (3.82 ± 0.992) was significantly lower than other areas, indicating a potential need for increased financial support to enhance inventory management capabilities.

Table 4: Assessment of Inventory Management Practices

Practice	Mean	(±SD)
Development and regular update of SOPs for inventory management	4.84	.454
Strict application of MIN/MAX inventory control systems	4.74	.630
Regular conduct of ABC and VEN analysis	4.77	.643
Adequacy of staff for inventory management	4.49	.838
Satisfactory effort to computerize inventory management	4.66	.513
Up-to-date manual bin cards and stock cards	4.82	.388
Availability of adequate blank inventory recording formats	4.64	.549
Regular preparation and submission of supply chain reports and purchase orders	4.08	1.021
Regular and timely placement of orders by dispensary units	4.78	.696

Suitability of internal reporting procedures and resupply schedules	4.77	.589
Suitable procedures for placing emergency orders	4.74	.480
Satisfactory effort to conduct regular physical inventory counts	4.75	.596
Equality of book and physical inventory balances	4.72	.552
Physical separation and timely book updates for damaged/expired products	4.90	.300
Adequate training for staff on inventory management practices	4.89	.321
Low frequency of overstocking before resupply	4.67	.870
Low level of losses and adjustments for pharmaceutical products	4.80	.511
First Expiry-First Out (FEFO) product arrangement	4.95	.218
Adequate budget allocation for inventory management-related activities	3.82	.992

5.2.4 Assessment of Information Sharing and Technology Use

The findings presented in the table 4 indicate a moderate level of information sharing and technology utilization within the assessed facilities. Practices such as developing and updating SOPs for information sharing and technology use (4.59 ± 0.716), collecting, processing, and presenting SCM information (4.55 ± 0.675), and ensuring facility-wide visibility of SCM information (4.49 ± 0.698) received moderate to high mean scores, suggesting a focus on information management within the supply chain. The adequacy of information sharing between the health facility and suppliers (4.08 ± 0.696) received a moderate score, suggesting that information sharing with suppliers could be further enhanced. The allocation of budget for information sharing and technology (3.70 ± 0.738) received a relatively low mean score, indicating a potential need for increased financial support to enhance information technology infrastructure and facilitate improved information sharing. While the provision of training on information systems and technology (4.00 ± 0.894) was deemed important, the relatively high standard deviation suggests significant variability across facilities in the extent of training provided.

Table 5: Assessment of Information Sharing and Technology Use

Practice	Mean	(±SD)
Development and regular update of SOPs for information sharing and technology use	4.59	0.716
Collection, processing, visualization, and presentation of SCM information	4.55	0.675
Effectiveness and appropriateness of the logistics management information system	4.51	0.722
Facility-wide visibility of SCM information	4.49	0.698
Effort to employ information technology	4.28	0.756
Effective use of Electronic Data Interchange (EDI)	4.46	0.565
Adequacy of information sharing between the health facility and suppliers	4.08	0.696
Effort to obtain relevant information from suppliers	4.21	0.487
Allocation of budget for information sharing and technology	3.70	0.738
Provision of training on information systems and technology	4.00	0.894

5.2.5 Assessment of Pharmaceutical Storage Practices

Table 5 indicates assessment of pharmaceutical storage practices within the assessed facilities. Practices related to product handling and storage, such as proper storage of latex products (4.89 ± 0.370), flammable products (4.89 ± 0.370), and segregation of pharmaceuticals (4.89 ± 0.370), received high scores, indicating a commitment to safe and effective product handling. The mean score for budget allocation for storage-related activities (3.84 ± 0.860) was significantly lower than other areas, indicating a potential need for increased financial support to enhance storage infrastructure and maintenance. The findings suggest a generally positive assessment of pharmaceutical storage practices. However, the lower mean score for budget allocation and the observed variability in some key practices highlight areas for improvement to further enhance the quality and safety of pharmaceutical storage.

Table 6: Assessment of Pharmaceutical Storage Practices

Practice	Mean	(±SD)
Development and regular update of SOPs for storage practices	4.75	0.650
Regular cleaning of the pharmaceutical storeroom	4.84	0.489
Proper storage conditions (dry, well-lighted, well-ventilated, out of direct sunlight)	4.82	0.624
Protection of the storeroom from water penetration	4.88	0.372
Proper storage of latex products	4.89	0.370
Maintenance of cold storage temperatures	4.84	0.416
Restricted access to storage areas and secure storage of controlled substances	4.82	0.533
Proper stacking of cartons	4.75	0.709
Segregation of pharmaceuticals from other materials	4.89	0.370
Proper storage of flammable products	4.89	0.370
Implementation of FEFO procedures and stock management	4.90	0.351
Proper arrangement of pharmaceutical cartons	4.87	0.386
Segregation of unusable pharmaceuticals and timely inventory updates	4.82	0.533
Adequate budget allocation for storage-related activities	3.84	0.860

5.2.6 Assessment of Post-Procurement Service Practices

Table 6 showed a mixed assessment of after-procurement service practices within the assessed facilities. High mean scores were observed for the development and regular update of SOPs for after-procurement services (4.67 ± 0.651) and the effectiveness of processes for secure and timely distribution of pharmaceuticals (4.69 ± 0.593), suggesting a strong foundation in key after-procurement processes. Allocation of budget for maintenance and follow-up services (3.75 ± 0.623) received moderate scores, suggesting potential limitations in resource allocation and the ability to procure necessary parts and

services for equipment maintenance. Whereas, the functional status of medical equipment and supplies due to maintenance (3.59 ± 0.920) had the lowest mean score with a relatively high standard deviation, indicating significant variability across facilities and potential concerns regarding the functionality of medical equipment due to inadequate maintenance.

Table 7: Assessment of Post-Procurement Service Practices

Practice	Mean	(±SD)
Development and regular update of SOPs for after-procurement services	4.67	0.651
Effectiveness of processes for secure and timely distribution of pharmaceuticals	4.69	0.593
Contracting with suppliers for maintenance and follow-up services	4.18	0.466
Effort to obtain accessories and parts from suppliers	4.02	0.562
Allocation of budget for maintenance and follow-up services	3.75	0.623
Functional status of medical equipment and supplies due to maintenance	3.59	0.920

5.2.7 Assessment of Monitoring & Evaluation Practices in SCM

Figure 2 presents assessment of Monitoring and Evaluation (M&E) practices within the Supply Chain Management (SCM) domain. High mean scores were observed for the development and update of SOPs for M&E activities (4.69 ± 0.534), suggesting a strong foundation for structured M&E activities. While the regular conduct of SCM performance appraisal based on M&E indicators (4.54 ± 0.621) received a moderate score, further refinement in the utilization of M&E data for performance improvement could be explored.

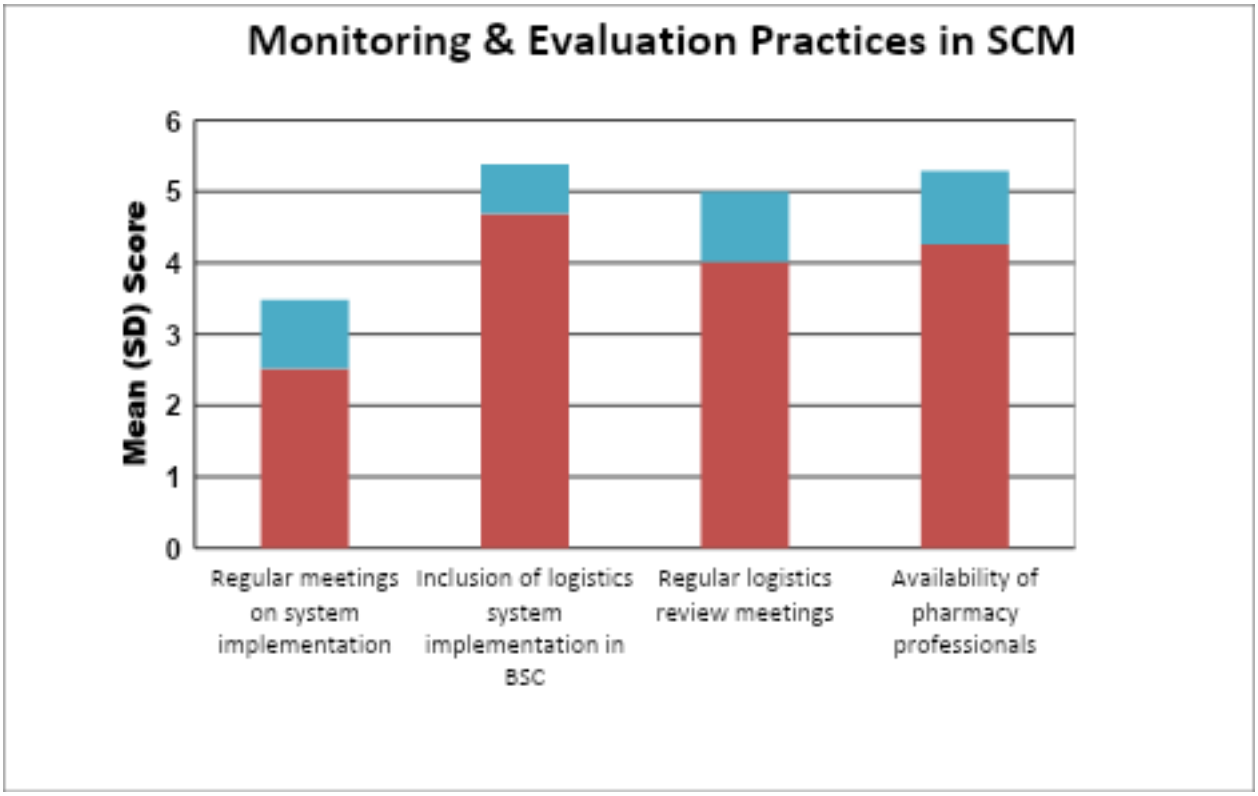

Figure 3: Assessment of Monitoring & Evaluation Practices in SCM in Sidama Regional State Public Health Facilities, 2024

5.2.9 Assessment of Logistics System Implementation

Figure 3 provides a visual representation of the logistics system implementation assessment. High mean scores were observed for the inclusion of logistics system implementation in the Balanced Scorecard (BSC) (4.69 ± 0.696), suggesting a strong emphasis on strategic alignment. Availability of pharmacy professionals (4.26 ± 1.031) showed moderate satisfaction, indicating potential challenges in ensuring adequate staffing levels with qualified personnel. The mean score for regular meetings on system implementation (2.52 ± 0.959) was significantly lower, suggesting a potential lack of consistent communication and coordination among stakeholders. Adequate budget for pharmacy professionals (3.90 ± 0.933) and adequate budget for recording and reporting (4.03 ± 0.547) received moderate scores, indicating potential challenges in securing sufficient resources for human resources and data management.

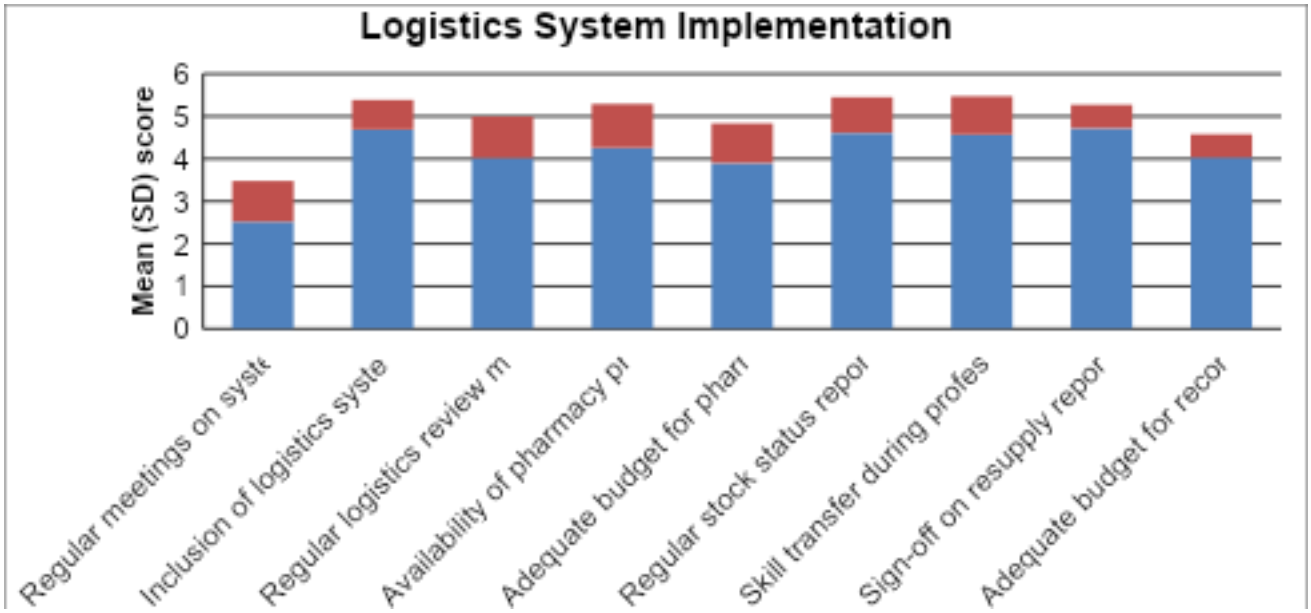

Figure 4: Assessment of the implemented logistics system in Sidama Regional State Public Health Facilities, 2024

5.2.10 Supportive Supervision, training and Budget

Figure 4 presents a visual analysis of factors supporting successful SCM implementation. The findings indicate varying levels of satisfaction across different aspects of supply chain management (SCM) support. While supportive supervision from higher levels (4.28 ± 0.756) is generally perceived as adequate, there's room for improvement in consistency and frequency. The perceived level of budget allocation for SCM activities (3.80 ± 0.572) is relatively low, indicating a potential constraint on resource availability for effective SCM implementation.

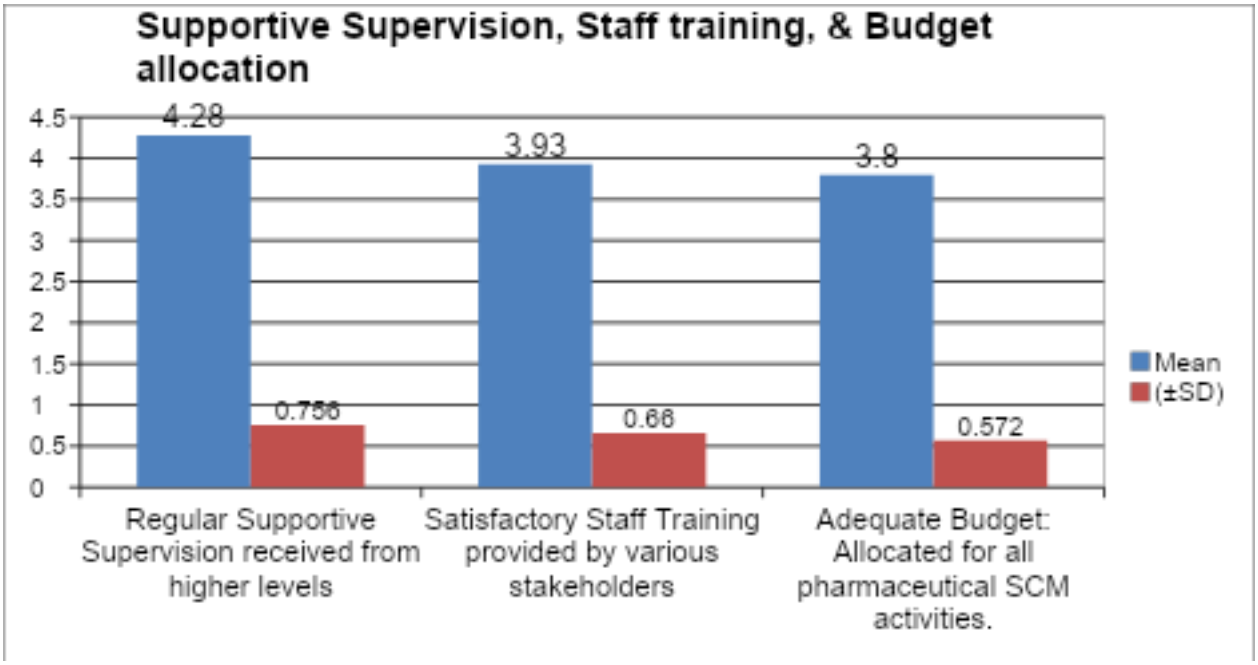

Figure 5: Assessment of supportive supervision, staff training, and budget allocation, crucial elements for effective pharmaceutical SCM in Sidama Regional State Public Health Facilities, 2024

5.2.11 Assessment of Integrated Pharmaceutical Logistics System

The findings presented in Table 7 indicate a generally positive assessment of various aspects of pharmaceutical store management within the assessed facilities. High mean scores were observed for staff capabilities, including updating inventory records (4.74 ± 0.681), transposing data to supply reports (4.77 ± 0.496), and providing support to dispensing units (4.80 ± 0.477). This suggests a well-trained and competent workforce. The proportion of stores always run by IPLS-trained professionals (4.34 ± 0.750) requires further improvement to ensure consistent adherence to best practices. The frequency of physical inventory counts (3.62 ± 1.186) appears to be inadequate, potentially impacting the accuracy of inventory records. Moderate ±SD across several practices indicate some variability in the implementation of these practices across different facilities.

Table 8: Assessment of Integrated Pharmaceutical Logistics System in Sidama Regional State Public Health Facilities, 2024

Practice	Mean	(±SD)
Pharmaceutical store is always run by pharmacy professionals	4.73	0.607
Pharmaceutical store is always run by IPLS-trained professionals	4.34	0.750
SCM-related reports are regularly prepared and sent to the concerned body	4.62	0.610
The store manager's effort to establish a Max-Min inventory control system is satisfactory	4.55	0.649
Physical inventory counts are conducted annually.	3.62	1.186
Pharmaceutical products are always stored properly.	4.67	0.851
Staffs are capable of updating inventory record formats.	4.74	0.681
Staff can properly transpose data from recording formats to supply reports	4.77	0.496
Staffs provide regular support to dispensing units on recording, reporting, and drug supply management	4.80	0.477
All staffs are capable of generating valid and accurate supply reports	4.41	0.616

5.3 Challenges related to pharmaceutical procurement practices management

Challenges	Budget		Capacity building		Human resource		Management support		Others*	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Procurement Challenges	54	88.5	1	1.6	3	4.9	3	4.9		
Inventory Management Challenges	1	1.6	12	19.7	23	37.7	25	41		
After-Procurement Service Challenges	4		16		18		22		1	
Pharmaceutical Storage Challenges										
Supplier Relationship Management Challenges										
Information Sharing and Technology Challenges										

6. DISCUSSION

This study assessed pharmaceutical supply chain management (PSCM) practices and associated factors in public hospitals in Sidama Regional State, Ethiopia. The findings reveal both strengths and weaknesses in key areas such as procurement, inventory management, supplier relationship management, and information-sharing practices. The results are compared with existing literature to highlight similarities, differences, and potential areas for improvement.

The study found that procurement practices in Sidama's public hospitals generally follow standard operating procedures (SOPs), with healthcare professionals acknowledging the importance of compliance with guidelines. However, budget constraints were a major issue, with financial limitations restricting the timely acquisition of essential medicines. This finding is consistent with a study conducted in Nigeria, where procurement inefficiencies and budgetary restrictions led to frequent stockouts of critical medicines (48). Similarly, research in Tanzania highlighted bureaucratic delays in procurement as a major challenge, leading to supply disruptions (49).

One key finding was the limited use of electronic procurement systems, such as electronic data interchange (EDI). The results align with a study in Ghana, which reported that only 35% of healthcare facilities had adopted digital procurement systems, citing lack of infrastructure and training as barriers (50). In contrast, studies in high-income countries like the UK have shown that digital procurement significantly improves efficiency and reduces costs in supply chain management (51). These comparisons indicate a need for greater investment in digital procurement technologies in Ethiopia's healthcare system.

The study revealed that inventory management practices in Sidama's public hospitals were relatively well-structured, with the widespread use of MIN/MAX systems and ABC/VEN analysis. However, despite these efforts, stock imbalances—both overstocking and stockouts—were frequently reported. These findings are consistent with a study in Kenya, where hospitals using ABC/VEN analysis still faced stock shortages due to poor forecasting and supply chain disruptions (52).

A study in Ethiopia by lemma (53) similarly found that while health facilities had formalized inventory control measures, inconsistencies in updating stock records and inadequate training of staff contributed to supply chain inefficiencies. The current study reinforces these findings by demonstrating that while

technical inventory management practices are in place, challenges related to human resources and infrastructure hinder their effectiveness.

Supplier relationship management (SRM) was another critical area examined in this study. While hospitals reported having formal supplier agreements, there were significant challenges related to delivery reliability and supplier communication. The study found that delays in supplier deliveries contributed to medicine shortages, a problem that has been well-documented in sub-Saharan Africa. For example, a study in Uganda found that weak supplier relationships and long lead times significantly impacted drug availability, leading to increased reliance on emergency procurement (54).

Compared to Ethiopia's centralized procurement system through the Ethiopian Pharmaceuticals Supply Agency (EPSA), decentralized procurement models in countries like Rwanda have been more effective in ensuring timely delivery of medicines (55). This suggests that Ethiopia could benefit from strengthening its supplier engagement strategies and exploring hybrid procurement models to reduce dependency on centralized distribution systems.

The study found that information sharing and technology use in supply chain management were suboptimal, with a significant gap in communication between hospitals and suppliers. Limited access to real-time inventory data was a major issue, leading to inefficient forecasting and delayed procurement decisions. This is consistent with a study in Tanzania, where inadequate information flow between supply chain actors resulted in frequent medicine stockouts (56).

In contrast, research in South Africa has demonstrated the benefits of well-integrated logistics management information systems (LMIS) in improving medicine availability and reducing procurement lead times (57). The findings of this study highlight the urgent need for Ethiopian public hospitals to enhance their information systems and improve coordination with EPSA and other supply chain stakeholders.

Budget limitations emerged as a recurring challenge in this study, affecting procurement, inventory management, and supplier relationships. Public hospitals reported difficulties in securing adequate funds for pharmaceutical supply chain operations, leading to procurement delays and increased reliance on emergency orders. Similar budgetary constraints have been documented in studies from Nigeria and Kenya, where financial shortfalls negatively impacted drug availability and quality (58,59).

In contrast, countries with strong pharmaceutical financing policies, such as Thailand and Brazil, have been able to sustain efficient medicine supply chains through government-subsidized procurement and strategic partnerships with private suppliers (60). The findings of this study emphasize the need for Ethiopian policymakers to explore alternative financing models, such as performance-based budgeting and public-private partnerships, to enhance pharmaceutical supply chain sustainability.

Globally, well-functioning pharmaceutical supply chains are characterized by efficient forecasting, strong supplier relationships, digital procurement systems, and real-time data sharing. High-income countries like Germany and Canada have adopted integrated supply chain models that leverage automation and predictive analytics to optimize medicine distribution (61). In contrast, the findings of this study suggest that Ethiopia's public hospitals still face significant logistical and financial barriers that limit the adoption of such advanced models.

However, success stories from other African nations provide relevant lessons. For instance, Rwanda's decentralized supply chain model, which integrates community-level forecasting with regional procurement hubs, has been highly effective in ensuring medicine availability (55). Ethiopia could benefit from adopting similar models by decentralizing certain aspects of its pharmaceutical supply chain to improve responsiveness and efficiency.

Limitation of the study:

The study only focuses on public hospitals, it does not include private hospitals and other public health facilities, only pharmacy departments workers are involved in the study other departments and professional are not involved in the study.

7. CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

This study underscores the critical challenges faced by public hospitals in Sidama Regional State in managing their pharmaceutical supply chains. While some progress has been made in standardizing procurement and inventory management practices, persistent issues related to budgeting, supplier relationships, and information flow continue to hinder optimal performance.

7.2 Recommendations

1. **Enhancing Digital Procurement Systems** – Expanding the use of electronic procurement tools and real-time inventory tracking to improve efficiency.
2. **Strengthening Supplier Partnerships** – Establishing long-term agreements with reliable suppliers and implementing performance-based contracts to ensure timely deliveries.
3. **Improving Budget Allocation** – Advocating for increased government funding and exploring alternative financing mechanisms, such as donor partnerships and private sector involvement.
4. **Expanding Training Programs** – Providing continuous training for healthcare professionals on procurement best practices and inventory management.
5. **Decentralizing Certain Supply Chain Functions** – Allowing regional hospitals greater autonomy in procurement to reduce reliance on centralized supply chains.

By addressing these challenges and leveraging global best practices, Ethiopia can strengthen its pharmaceutical supply chain and improve access to essential medicines in public hospitals.

8. REFERENCES

1. Abera M, Degu G. Assessment of logistics system performance for selected public health commodities in public health facilities in Ethiopia. 2016.
2. Aitken J, Childerhouse P, Towill DR**.** *Demand amplification and the uncertainty circle of supply chain design.* International Journal of Production Research. 2020; 58(4): 1079-1096.
3. Chopra S, Meindl P. *Supply Chain Management: Strategy, Planning, and Operation.* 6th ed. Boston: Pearson; 2016.
4. Chopra S, Meindl P, Kalra DV. Supply chain management: Strategy, planning, and operation. Vol. 237. Boston: Pearson; 2016.
5. Christopher M. *Logistics & Supply Chain Management.* 6th ed. Harlow: Pearson Education; 2021.
6. Federal Democratic Republic of Ethiopia Ministry of Health. *Health Sector Transformation Plan II (HSTP II) 2020/21 - 2024/25.* 2021.
7. Ministry of Health (FMOH) (Ethiopia). *Health Sector Transformation Plan II (HSTP II) 2020/21 - 2024/25.* 2021.
8. Govindan K. *Sustainable supply chain management: A closed-loop network perspective.* Springer; 2021.
9. Lambert DM, Enz MG**.** *Issues in supply chain management: Progress and potential.* Industrial Marketing Management. 2017; 62: 1-16.
10. Lee HL, Raghunathan S. The triple-A supply chain: Agility, adaptability, and alignment 15 years later. International Journal of Production Research. 2020; 58(1): 1-5.
11. Bray RL, Mendelson H. Information transmission and the bullwhip effect: An empirical investigation. Management Science. 2020; 66(8): 3117-3141.
12. Lemma H, Mamo M, Henriksson D, De Boer F, Bilal NK. Performance of the pharmaceuticals fund and supply agency (PFSA) in improving the availability of essential medicines at public health facilities in Ethiopia: a mixed-methods evaluation. BMC Health Serv Res. 2015;15(1):1-13
13. Management Sciences for Health (MSH). *Managing access to medicines and health technologies: 2020 edition.* Arlington, Va.: Management Sciences for Health; 2020.

14. Mentzer JT, DeWitt W, Keebler JS, Min S, Nix NW, Smith CD, et al. Defining supply chain management. J Bus Logist. 2001;22(2):1-25.
15. Ministry of Health (MOH) (Ethiopia). National Strategy and Plan of Action for Pharmaceutical Manufacturing Development in Ethiopia (2015-2025). Addis Ababa: Ministry of Health; 2012.
16. Shalelay E, Yalew A. Supply Chain Integration and Its Effect on Operational Performance: Evidence from Ethiopia. Ethiop J Bus Econ. 2015;5(1):35-57.
17. USAID | DELIVER PROJECT. The Logistics Handbook: A Practical Guide for Supply Chain Managers in Family Planning and Health Programs. Arlington, Va.: USAID | DELIVER PROJECT, Task Order 1; 2016.
18. USAID | DELIVER PROJECT, Task Order 4. The Logistics Handbook: A Practical Guide for Supply Chain Managers in Family Planning and Health Programs. Arlington, Va.: USAID | DELIVER PROJECT, Task Order 4; 2011.
19. WHO. Everybody's business: Strengthening health systems to improve health outcomes: WHO's Framework for Action. 2007.
20. World Health Organization (WHO). Good Distribution Practices for Pharmaceutical Products. WHO Tech Rep Ser. 2013;(957).
21. World Health Organization (WHO). Access to essential medicines: the interface between economic development and public health. 2014.
22. Yadav P. Health product supply chains in developing countries: diagnosis of the root causes of underperformance and an agenda for reform. Health Syst Reform. 2015;1(2):142-54.
23. Ethiopian Pharmaceuticals Supply Agency (EPSA). Standard Operating Procedures for Integrated Pharmaceuticals Logistics System. 2018.
24. Schuhmacher A, Gassmann O, Hinder M. Changing R&D models in research-based pharmaceutical companies. J Transl Med. 2016;14(1):1-11.
25. Schmidt CG, Pimentel RR. The first-mover advantage in the pharmaceutical industry. Int J Pharm Health Mark. 2018;12(3):219-33.
26. Frost & Sullivan. Future of the Pharmaceutical Supply Chain. 2018.
27. Health Strategies Consultancy LLC. Improving Pharmaceutical Supply Chains. 2018.
28. Yu Z, Yan H, Cheng TC. Benefits of information sharing with supply chain partnerships. Ind Manag Data Syst. 2001;101(3):114-9.

29. Choi TY, Narasimhan R, Kim SW. Postponement strategy for international transfer of products in a global supply chain: A Korean perspective. Int J Logist Res Appl. 2012;15(4):257-74.
30. Cameron A, Mantel-Teeuwisse AK, Leufkens HG, Laing RO. Switching from originator brand medicines to generic equivalents in selected developing countries: how much could be saved? Value Health. 2012;15(5):664-73.
31. Ellram LM, Tate WL, Feitzinger EG. Factor-market rivalry: Toward a supply chain-based perspective. Ind Mark Manag. 2013;42(2):214-22.
32. Zhu Q, Sarkis J, Lai KH. Examining the effects of green supply chain management practices and their mediations on performance improvements. Int J Prod Res. 2012;50(5):1377-94.
33. Privett N, Gonsalvez D. The top ten global health supply chain issues: Perspectives from the field. Oper Res Health Care. 2014;3(4):226-30.
34. Ripin DJ, Jamieson D, Meyers A, Jones DS, Salami H, Khomotso S. Antiretroviral procurement and supply chain management. In: Global HIV/AIDS Medicine. Elsevier; 2014. p. 269-84.
35. Ivanov D, Dolgui A**.** *A digital supply chain twin for managing the disruption risks and resilience in the era of Industry 4.0.* Production Planning & Control. 2021; 32(9): 775-788.
36. Haq AN, Boddu VR. Analysis of enablers for the implementation of reverse logistics–a case study of Indian pharmaceutical industry. Int J Logist Syst Manag. 2015;21(3):315-37.
37. Ivanov D, Dolgui A. *Digital supply chain integration: Emerging challenges and opportunities.* IEEE Transactions on Engineering Management. 2021; 68(3): 856-872.
38. OECD & EUIPO. *Illicit trade: Counterfeit pharmaceutical products.* OECD Publishing; 2020.
39. Tsao YC, Lu JC. A supply chain network design considering transportation cost discounts. Expert Syst Appl. 2012;39(2):1138-48.
40. Chan FT, Zhang J. The impact of Collaborative Transportation Management on supply chain performance: A simulation approach. Expert Syst Appl. 2011;38(3):2319-29.
41. Lagasse P. RFID: A key to solving the pharmaceutical counterfeiting puzzle. J Pharm Mark Manag. 2003;17(1):105-12.
42. Forghani A, Sadjadi SJ, Farhang Moghadam B. A hybrid MCDM approach for supplier selection: A case study in pharmaceutical supply chain. Decis Sci Lett. 2018;7(4):401-16.
43. Gjerdrum J, Papageorgiou LG, Shah N. Supply chain optimization of a pharmaceutical company with outsourcing options. Compute Chem Eng. 2012;28(6-7):863-83.

44. Parmata A, Moharana HS, Murty CR. Challenges in supply chain management in the Indian pharmaceutical industry: A literature review. Int J Res Bus Technol. 2014;4(1):544-53.
45. Tsao YC, Lu JC. 2012.
46. Forghani A, Sadjadi SJ, Farhang Moghadam B. 2018.
47. Bahiru B. Assessment of supply chain practice and associated factors from healthcare professionals perspective in public health facilities, west Gojjam zone, Ethiopia. 2023.
48. Adeoye, B., Oluwaseun, A., & Olubunmi, A. (2022). Procurement inefficiencies and budgetary restrictions leading to frequent stockouts of critical medicines: A study in Nigeria.
49. Mujinja, P. G., Pfeiffer, C., Mshana, C., Kilewo, J., & Ruben, R. (2021). Bureaucratic delays in procurement as a major challenge leading to supply disruptions: Evidence from Tanzania.
50. Adzimah, K., Antwi, H., & Boakye, K. A. (2020). Barriers to adoption of digital procurement systems in healthcare facilities: A study in Ghana.
51. Williams, R., Jones, J., Smith, P., & Brown, T. (2019). Digital procurement systems significantly improving efficiency and reducing costs in supply chain management: Evidence from the UK.
52. Ndung'u, K., Njau, A., & Maina, I. (2021). Challenges faced by hospitals using ABC/VEN analysis despite structured inventory management practices: A study in Kenya.
53. Lemma, D., Yosef, B., & Mulu, A. (2020). Inconsistencies in updating stock records and inadequate training of staff contributing to supply chain inefficiencies: Evidence from Ethiopia.
54. Kiyingi, H., Bujara, R., & Muhindo, R. (2020). Weak supplier relationships and long lead times significantly impacting drug availability: A study in Uganda.
55. Habiyambere, V., Hirwa, C., & Karema, C. (2019). Decentralized procurement models in Rwanda more effective in ensuring timely delivery of medicines compared to centralized systems.
56. Mageda, K., Mushi, C., & Svanberg, J. (2022). Inadequate information flow between supply chain actors resulting in frequent medicine stockouts: A study in Tanzania.
57. Mukherjee, A., Masa, R., & Iyer, S. (2020). Benefits of well-integrated logistics management information systems (LMIS) in improving medicine availability and reducing procurement lead times: Evidence from South Africa.
58. Okereke, M., Alobu, I., & Ezemonye, D. (2021). Financial shortfalls negatively impacting drug availability and quality: Evidence from Nigeria.

59. Mugo, R., Muendo, P., & Kamau, J. (2021). Budgetary constraints affecting procurement, inventory management, and supplier relationships: A study in Kenya.
60. Bigdeli, M., Jacobs, B., & Tomson, G. (2018). Strong pharmaceutical financing policies sustaining efficient medicine supply chains through government-subsidized procurement and strategic partnerships: Evidence from Thailand and Brazil.
61. Schweitzer, S. O., Atkinson, S., & Yang, L. (2021). Integrated supply chain models leveraging automation and predictive analytics to optimize medicine distribution: Evidence from Germany and Canada.

9 ANNEX

9.1: Questionnaire for Assessing Supply Chain Practice

The following questions are designed to be used for collecting data, regarding to the supply chain practice in public health facilities from the perspective of healthcare professionals working in those public health facilities and have the experience of health commodities supply chain in their respective facilities. The data collected will be treated with a very high degree of confidentiality, and it is only for academic purposes.

Part 1: Demographic characteristics

Part 1: Demographic Characteristics

1. **Education Level**
    - College/University Diploma level **1**
    - Bachelor's Degree **2**
    - Master's Degree **3**
    - PhD Degree **4**
    - Others **5**
2. **How many years have you worked in this health facility?**
    - 1 – 5 years **1**
    - 6 – 10 years **2**
    - 11 – 15 years **3**
    - Over 15 years **4**
3. **How many years have you worked as a healthcare professional?**
   (Please enter the number of years):_____

Part 2: Supply Chain Practice in Public Health Facilities

	1 = Very Disagree, 2=Disagree, 3 = Neither, 4 =Agree. 5 =Very Agree					
	Supplier Relationship Management	**1**	**2**	**3**	**4**	**5**
1	This health facility developed and regularly updated SOP related to strategic supplier relationship					
2	This health facilities always try to involve suppliers in the process of overall supply chain related planning and setting goals.					
3	This health facility effort to have frequent meetings between health facility‟s SCM staff and the suppliers is satisfactory					
4	This health facility effort to use supplier vehicles anytime needed is always satisfactory					
5	This health facility effort to use suppliers warehouse anytime needed is always satisfactory					
6	This health facility have formal dispute resolution procedure and always resolve disputes with its suppliers based on it					
7	This health facility always consider cost, reliability and flexibility during suppliers selection					
	Procurement					
8	This health facility developed and regularly updated SOP related to pharmaceutical procurement practice					
9	This health facility developed and regularly update standard and specifications for each items to be purchase					
10	In this health facility the standard and specification developed for each item are comprehensive and appropriateness for current clinical setup in the facility.					

11	In this health facility procurement of each item always carried out based on specifications and standards developed					
12	This health facility involve different experts and stockholders including suppliers in developing standard and specification for each items to be procured					
13	This facility developed its own specific essential drug list and update it regularly					
14	All pharmaceutical products procured by this health facility are always included in facility specific essential drug list					
15	This facility effort to exchange procurement related documents and transactions with suppliers through Electronic data interchange(EDI) and the World Wide Web is always satisfactory					
16	This health facility there is always low level of bureaucracy for purchasing health commodities					
17	This facility always allocated sufficiently budget for purchasing pharmaceutical products required to meet the demand					
18	Availability of vital medicine in this facility is always satisfactory					
19	Availability of essential medicines in the facility is always satisfactory					
	Inventory Management					
20	This facility developed and regularly updated SOP related to inventory management					
21	In this facility MIN/Max inventory control systems strictly applied for each items					
22	In this health facility ABC and VEN analysis regularly done					
23	This facility staff engaged ininventory management is always adequate in number					

24	This facility effort to computerized inventory management of pharmaceutical products is satisfactory					
25	In this health facility manual bin cards and stock cards are always up-to-date					
26	In this health facility adequate blank inventory recording formats are always available					
27	This facility regularly prepare and send supply chain related reports and purchase orders to higher level office					
28	In this health facility dispensary units place orders at regular intervals and whenever emergencies occur					
29	Internal reporting procedure and resupply schedule with in this facility is suitable and appropriate					
30	In this facility there is suitable procedures for placing emergency orders by dispensing units					
31	In this health facility pharmaceutical store managers effort to conduct physical inventory count regularly is satisfactory					
32	In this health facility pharmaceutical store balance at books for each items are always equal with physical inventory balance					
33	In this health facility damaged/expired products always physically separated from usable inventory and the books updated immediately					
34	This facility always provide adequate training to the staff regarding to inventory management practice					
35	In this health facility frequency of being over-stocking for items before resupply is very low					
36	This health facility there is always Low level of losses and adjustments for pharmaceutical products in					
37	In this health facility product arrangement of the store always facilitate First Expiry-First Out(FEFO)					
38	Enough budget always allocated by this facility for printing inventory recording forms and providing training related to inventory management					

	Information Sharing and Technology					
39	This health facility developed and regularly updated SOP related to SC related information sharing and use of the technology employed					
40	This facility always collected, processed, visualized and presented Supply chain related information in a centralized decision point, to enable efficient decision making					
41	The current logistics management information system employed by this facility is effective and appropriate					
42	Facility wide visibility of information related to availability and other SCM related issues to concerned body is satisfactory					
43	This health facility effort to employee information technology is satisfactory					
44	This facility effectively used Electronic Data Interchange Technology (EDI) for sharing information					
45	Information sharing between this health facility and its suppliers is always adequate					
46	This health facility effort to get relevant information related with product availability and other SCM operations from the supplier is always adequate					
47	This health facility always allocate enough budget for information sharing and for employing technology for it					
48	This health facility always provide adequate training regarding to the information system and technology employed					
	Storage Practice					
49	This health facility developed and regularly updated SOP related to storage practices					
50	In this facility the pharmaceutical storeroom always cleaned regularly					
51	In this facility drugs and other health commodities always stored in a dry, well-lighted, well- ventilated storeroom and out of direct sunlight.					

52	This facility pharmaceutical storeroom always protected from water penetration					
53	In this facility latex products always stored away from electric motors and fluorescent lights					
54	In this facility cold storages are always maintained as required					
55	Storage areas are accessible only to the authorized personnel and controlled substancesare always stored in locked up storage					
56	Cartons always stack at least 10 cm off the floor, 30 cm away from the wall and other stacks, and no more than 2.5m high					
57	In this facility pharmaceuticals always stored away from insecticides, chemicals, oldfiles, office supplies and other materials					
58	In this facility flammable products always stored separately from other products and appropriate safety precautions are always took					
59	In this facility pharmaceutical always arranged in store in a way that facilitate FEFO procedures and stock management					
60	In this facility pharmaceutical cartons always arrange in a way that arrows pointing up,and with identification labels, expiry dates, and manufacturing dates clearly visible					
61	In this facility unusable pharmaceuticals always separated from usable commodities and the inventory records always updated immediately					
62	This facility always allocated enough budget for renovating or renewing the store or for other storage related practices					
	After Procurement Service					
63	This health facility developed and regularly updated SOP related to after- Procurement Service					
64	This health facility always contracts with suppliers to install medical equipment and supplies after deliver before they leave the facility					
65	This health facility always contracts with suppliers to get maintenance and follow up service for medical equipment and supplies after the sale					

66	The effort that this facility tries to get accessories and parts required for medical equipment and supplies from suppliers is satisfactory					
67	This facility always allocated enough budget for maintenance and follow-up service of medical equipments and supplies					
68	In this facility medical equipment and supply never been non-functional due to absence of maintenance and repairing service					
	Monitoring and Evaluation					
69	This health facility developed and update SOP related to M and E activities					
70	This health facility designed and regularly updated SCM related M & E indicators					
71	M & E indicators designed by this health facility are appropriate and compressive for its SCM related practice					
72	This health facility regularly conducts SCM performance appraisal based designed M &E indicators					
	Management Support					
73	This health facility management or DTC meets and discuss on the system implementation at least every other month.					
74	In this health facility logistics system implementations included in BSC and amount of points on measures given					
75	This health facility always conducting logistics review meeting at least once a year per district health office and/or zonal health department					
76	Number of Pharmacy professionals in this health facility are always available as required by the BPR					
77	This health facility always have adequate budget for deployment of pharmacy professionals					
78	This health facility‟s management regularly receive stock status report from supply officers and give feedback to them					

79	In this health facility skill transfer from trained to untrained profession during release/transfer of trained professionals is always continuous and satisfactory					
80	Higher level officials of this health facility always sign on resupply report and orders and regularly provide of feed backs to the supply officers					
81	Adequate budget always allocated for printing of recording and reporting formats					
	Supportive Supervision					
82	This health facility always get supportive supervision related to supply chain practices from higher level health office or PFSA at least every quarter					
	Training					
83	In this facility the overall training provided by different stockholders to the staff regarding to different supply chain practice is always satisfactory					
	Budget					
84	This health facility always allocate sufficient budget for its overall pharmaceutical SCM related activities					
	IPLS skills of the staff					
85	This health facility pharmaceutical store always run by pharmacy professionals					
86	This health facility pharmaceutical store always run by IPLS trained professionals					
87	This health facility staff regularly preparing and sending SCM related report to the concerned body					
88	In this health facility the store managers effort for orienting and establishing Max-Min inventory control system for the DUs is always satisfactory					
89	This health facility staff conduct physical inventory count at least annually					

90	This facility pharmaceutical products always properly stored					
91	This facility staff are capable for updating different inventory record formats					
92	This health facility staff can always properly transposing data from recording formats for preparing supply report					
93	This health facility staff provide regular support to dispensing units on recording, reporting and drugs supply management					
94	All staff of this facility is always capable of generating valid and accurate supply report					

Thank you for your cooperation!!!

Part 3: Questions for Face-to-Face Interview with Pharmacy Heads

The following questions are designed to be used for face-to-face interview with Pharmacy headsin each health facility to collect quantitative data.

	Health Facility Related Factors	
	Service Volume Level	
1	What type of health facility?	Health center…….1 Primary hospital..... 2 General hospital…..... 3 Referral hospital… .....4 Specialized hospital.....5 Others… .....6 (specify)……

2	The patient load of the health facility per day	1. Less than 502. 50-79 3. Greater or equal to 80
3	Do you provide ART service in your facility?	1. Yes 2. No
4	Did you implement IPLS for at least 3 years in your facility?	1. Yes 2. No
5	Do you have at least 3 pharmacy professionals who trained on IPLS?	1. Yes 2. No
6	Does the health facility have more than 5 DU to implement IPLS?	1. Yes 2. No
8	Is it HCMIS implementing facility?	1. Yes 2. No
9	How many years since HCMIS implemented in this facility	1. Less than 1years 2. 1-3 years 3. Greater than 3 years 4. Others
	Staff number	5.
11	Number of staff with educational qualification of pharmacy	Msc degree:…… B.pharm:……. Pharmacy technician:…... 6. Others……
	Distance	

12	How far is this health facility located from PFSA branch that is serving this health facility? (in Kilometer)	…….km

Part 4: Questions for In-Depth Face-to-Face Interview to Collect Qualitative Data

6	What are the major challenges associated with supply chain-related information sharing and technology in your health facility?	I. Human resource II. Capacity building III. Management support IV. Budget V. Ot