COLLEGE OF HEALTH SCIENCE

SCHOOL OF PHARMACY

DEPARTMENT OF PHARMACEUTICS AND SOCIAL PHARMACY

Warehousing and Inventory Management Performance and Associated Factors after HCMIS Implementation in TikurAnbessa Specialized Hospital

BY: GetahunTefera(B.Pharm)

A thesis proposal to be submitted to Addis Ababa University, College of Health Science, School of Pharmacy, Department of Pharmaceutics and Social Pharmacy for the partial fulfillment of the requirements for Master's Degree in Health Supply Chain Management

November, 2018

Addis Ababa

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ACKNOWLEDGMENT

I take this opportunity to express my deepest gratitude, respect and appreciation for Dr. Teferi Gedif (B.pharm, MPH, PhD), Dr.Bruck Messele (B.pharm, MSc, PhD), Mr.Dawit Teshome (B.pharm, MSc), and Mr. Alemayehu Adenew (B.pharm, MSc) for their continuous guidance and encouragement throughout this proposal development.

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ACRONYMS

EDI	Electronic Data Exchange
EFY	Ethiopia Fiscal Year
EPFSA	Ethiopia Pharmaceutical Fund Supply Agency
GRV	Goods Receiving Voucher
HCMIS	Health Commodities Management Information System
MMIS	Material Management Information System
QM	Quality Management
RDF	Revolving Drug Fund
SC	Supply Chain
SCI	Supply Chain Innovation
SCM	Supply Chain Management
SKUs	Stock Keeping Units
SoP	School of Pharmacy
SPSS	Statistical Package for Social Science
TASH	TikurAnbessaSpecialized Hospital

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LIST OF FIGURE

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LIST OF TABLES

created with nitroPDF professional
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TABLE OF CONTENTS

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SUMMARY

Background: The provision of complete health care necessitates the availability of safe, effective and affordable drugs and related supplies of the required quality, in adequate quantity at all times. To meet this need TikurAnbessa Specialized Hospital, Pharmacy Service Directorate strives to restructure relentlessly, and consider innovation of supply chain process. Technological software implementation called Health Commodities Management Information System in the warehouse in 2009 E.C. is among them. Despite those encouraging progresses, evidence reveals frequent stock depletions and shortages of health commodities at the service delivery point.

Objectives:To assess warehousing and inventory management performance and associated factors after Health Commodities Management Information System implementation in TikurA nbessa Specialized Hospital.

Methods: A mixed method research design using quantitative and qualitative methods will be used in this study. For the quantitative part,facility based retrospective method will be used to survey data like, items and quantity ordered and/ received, cost and quantity of items expired or damaged, cost of the products, and number of days to process the orders on medication store for Revolving Drug Fund and program medicinesfor the years, Nehase,1,2007 –Sene ,30,2008 E.C/August,7,2015-July,7,2016G.C/before,andNehase,1,2009–Sene,30,2010E.C/August,7,2017-July,7,2018 G.C/ after implementation of Health Commodities Management Information System using standardized data collection tools.A Delphi technique will be used to selectmedicines which indicated pharmaceutical supply chain performance of the Hospital. Data from Health Commodities Management Information System, Internal Facility Requisition Report, Disposal Report, Bin card and Good Receiving Voucher (Model 19), Model 22 will be used to collect quantitative data.Qualitative data collection tool will be used to assess the related factors which affect the performance of warehousing and inventory management using in-depth interview method with key informants, purposively selected from TikurAnbessa Specialized Hospital. The data collection and analysis will be conducted from December, 2018 – March, 2018. The collected quantitative data will be entered and analyzed using Microsoft excel and SPSS version 20 computer software while the qualitative data will be analyzed manually.

Budget: The total budget required to conduct the study is **35,673.75 ETB**.

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Key words: Health Commodities Management Information System, Implementation, Inventory management, Performance, TikurAnbessaSpecilized Hospital, Warehousing management.

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1. INTRODUCTION

1.1 Background

Inventory management is the heart of the medicine supply system. It comprises the activities related to ordering, receiving, storing, distributing, issuing, reordering of pharmaceuticals and accounting for stocks. All these activities are tracked with appropriate documentation, thus good record-keeping is critical. An inventory control system informs health facilities when to order or issue, how much to order or issue, and how to maintain an appropriate stock level of all products. Generally a good inventory control system result in minimized inventory investment, appropriatecustomer service level,balanced supply and demand, minimized ordering cost and holding cost; also preservation of inventory control system (Mursyid, 2013).While poor inventory management leads to waste of financial resources, overstock of pharmaceuticals, shortage of essential drugs, and a decrease in the quality of patient care. Supply chain inventory management is focused on end-customer demand and aims at improving customer service while lowering relevant cost (Kwangyeol, 2012).Inventory management has a significant role in the supply chain and among various SCM issues; it is a greater extent relevant to the entire supply chain. It has been recognizes as one of the most important functions that has huge impact on the overall performance (George, 2010). Studies performed in the past as well as more recent research suggest that inventory costs in the health care sector are substantial and are estimated to be between 10% and 18% of net revenues (Jarett, 1998). At the same time, hospitals are forced to increase their internal service performance and it is also for this reason why a strong focus on inventory management has become paramount in many hospitals nowadays. It will be of no surprise, therefore, that a large number of hospitals have started with projects in the area of inventory management in order to reduce costs and improve service levels. In addition high capital is tied up in inventory due to the growing volumes and variety of physical goods carried by hospitals, and thus an increasing number of SKUs (Lanckzweirt, 2010).Therefore inventory management constitutes the key lever to realize efficiency improvements (e.g. reduce costs, waste and the risk of product obsolescence) while satisfying healthcare service levels (Volland,2016).

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Warehouse management comprises the physical movement of a stock in to, through, or out of a warehouse. The primary purpose of a warehouse is to receive, hold and dispatch pharmaceuticals. It ensures the physical integrity and safety of products and their packing, throughout the various storage facilities, until they are dispensed to clients. Regardless of storage facility size- from a small health center to a central warehouse-the main operational activities for storage are very similar which include receiving, put away, storage, and packing, and shipping. Warehouse management can be assessed and monitored for productivity, timeliness, use of resource, and safety. They all influence cost and service.

(Camp, Kneedler, Pfister, Reeves, 2014)provide several strategies to improve the healthcare supply chain performance, such as the degree of standardization, inventory control, waste reduction, data analysis and improved physician preference card management, all of them required aSupply chain innovation (SCI) which isdefined as a change (incremental or radical) within the supply chain network, supply chain technology, or supply chain processes (or combinations of these) that can take place in a company function, within a company, in an industry or in a supply chain in order to enhance new value creation for the stakeholders (Arlbjørn,2011).Itcombines developments in information and related technologies with new logistic and marketing procedures to improve operational efficiency and enhance service effectiveness (Bello et al. 2004). Information technology and technological innovations enable decision-making throughout the supply chain, improve productivity, lower costs and improve patient safety (Rossetti M, 2012).The material Management Information System (MMIS) typically supports inventory management (e.g. inventory on hand, order quantity, storage locations, etc.). The adoption and use of innovative technological solutions for solving business problems have been arguably slow within the healthcare industry (Herzlinger, 2006). However, Since the 90s, the health care sector has changed rapidly. Due to increased competition, a growing influence of patients and a stronger necessity to deliver health services in a more efficient and effective way, many health care organizations have started projects in the area of service quality, clinical pathways, information systems and patient logistics, and innovative supply chain strategies (Stock *et al*., 2007; Mahmoud and Rice, 1998).

The logistical performance (e.g. fill rate, supply chain cost) should be evaluated for various levels of cost in order to take advantage of technological advances (Liliane, 2018). Performance indicators for warehousing and inventory management pointed out from Quality(service level

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availability, stock out, Inventory visibility), Time (Replenishment time), Financial (Inventory cost Value of stock, stock wastage), and Productivity (Inventory turnover)perspective (Liliane, 2018).

1.2. Health commodities management information systems

The health commodity management information system (HCMIS) in Ethiopia is an open source, custom software solution; it was developed in Ethiopia for the country's health commodity supply chain. First developed and deployed in 2009 to manage inventories in health facility pharmaceutical stores.It was adapted in 2010 for thePharmaceuticals Fund and Supply Agency (PFSA) to use in its network of distributionhubs. The USAID | DELIVER PROJECT developed and implemented the HCMIS; a coreteam of local programmers continues to support the system's evolution, and the teamprovides help desk services for user and administrator support. USAID has providedmost of the funding for the HCMIS; additional support from the Bill & Melinda GatesFoundation helped the programmers adapt the system for vaccine management. As of 2015, the HCMIS plat form has been implemented in more than 500 health facilitiesthe entire PFSA network of the central stores and 11 hubsand 18 regional cold rooms for vaccines (eLMIS selection Guide, 2015).

The HCMIS Facility contains the essential data required to manage and account for all health commodities managed by facilities, including donated items and the commodities purchased with the Revolving Drug Fund (RDF). Analytical tools provide users and managers with reports on cost, price only (value per batch to determine charge to the patient), as well as value of inventory, expiries, and near expiries. The HCMIS Facility also manages transactions for issuing commodities to dispensing units within the facility, capturing consumption, stock balance, and losses and adjustments to calculate issue quantity. All the data are aggregated into a single Report and Requisition Form (RRF) that facilities can generate electronically and use to order from Pharmaceutical Fund Supply Agency.

HCMIS has not yet reached its full potential. HCMIS facility, a desktop module, is not linked in real-time to the HCMIS warehouse, so real-time data visibility at the facility level is a target for the future. This future state depends more on internet access and reliability than on any weakness in the HCMIS architecture, which was built in SQL (special purpose programming language) (eLMIS selection Guide, 2015). With internetaccess, facilities can email their RRFs to their designated PFSA hub, but the lack of enablinglaws for electronic signatures

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also results in duplicative efforts; to commit funds for RDFcommodities, emailed RRFs must be printed and signed, and they must be sent to PFSAwith payment. The lack of internet infrastructure for linking the HCMIS facility with PFSA'sHCMIS warehouse also makes updates to commodity lists and pricing harder and preventsfacilities from checking PFSA's availability of items before ordering (eLMIS selection Guide, 2015).

HCMIS is helping health facilities to improve commodity management, datavisibility, and overall performance. Users with various backgrounds—ranging fromthose with limited computing experience to advanced users and experts can useHCMIS due to its user-friendly interface. Since HCMIS facility gives facility managers visibility to every health commodity in theirstore, including donated items and the commodities purchased with the RDF, managerscan now provide stakeholders with instant information regarding all expiries, costs, and inventory. Users and managers can react quicker to changes in inventory and makemore informed decisions about which products and how much of those products areneeded to bring any facility up to adequate stock quantities, reducing the number and length of stock outs.

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1.3 Statement of the problem

In a hospital, the consequence of a stock-out is far more severe (e.g. endanger patient's life) compared to other industries where a stock-out typically results in lost revenue (Toba S, 2008). One of the biggest challenges in healthcare supply chain management is balancing costs with the right amount of inventory to sustain quality and timely patient care (Abukhousa E, 2014).Inventory management impacts the bottom line as it ensures cost containment, supply chain efficiencies and customer satisfaction (Camp, Kneedler, Pfister, Reeves, 2014). However, logistics managers lack quantifiable data regarding supply consumption, inventory levels, product duplication and procedure costs to notify the key stakeholders of the financial, clinical and operational impact of supply chain practices. The hospital decision makers must consider many elements such as costs, service levels, storage space, product availability, product expiration dates, etc. in order to control stocking levels at all times both in the central warehouse and at point-of-care locations (e.g. operating rooms, wards, etc.). New technologies and automation can point to new supply chain capabilities and help health care providers overcome the biggest inventory and distribution management barriers of product variability, charge capture inaccuracies, complicated workflows, etc. (cardinal heath,2015) Furthermore, there is a growing need for technologies that provide end-to-end supply chain visibility, resulting in lower inventory and cost, improved patient service, improved tracking, shorter delivery times, and lean and proactive supply chain partners (Dittmann,2015). In contrary on the study conducted at India's biggest retail company, which has developed expertise in Supply Chain Management of consumer product categories such as Fashion, Food and General Merchandise, warehouses with manually run had a high cycle time process of 773 minutes(Ramaa.A,2012). The study also pointed the receipt of order; pickingand dispatching were tedious to carry out in a manually operated warehouse.

Even though there is no study conducted on the performance of inventory management and warehousing during manual service management using key performance indicators in TASH, the burden of using manual method were paramount. Because of there is high amount of processed order lines and amount of stock keeping units, in this nationwide, specialized teaching hospital.To tackle these challenges, and to increase efficiency and effectiveness TikurAnbessa specialized hospital(TASH) involved in supply chain innovation. Because such challenge requires a reliable, agile, scalable supply chain with the capacity to adapt timely and efficiently

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to different types of requirements (Quinn, 2010).Among supply chain innovation TASH adopted is, technological software called HCMIS in 2009 E.C.to enhance flow of products and information, and which is related with the use of information technology facilitated information sharing between parties (Martin,2000). It is also agreed that information exchange capabilities are a positive antecedent for successful supply chain innovation too (Santanu,2011). New technologies and automation can help healthcare providers overcome the biggest inventory and distribution management barriers of product variability, inaccuracies, and complicated workflows (Liliane,2018).

Despite those encouraging progresses, evidence reveals frequent stock depletions and shortages of Health commodities at the service delivery point in TASH. The focus of this research project, therefore, will be to understand systematically how HCMIS acts as a transformative technology to address cost, safety, and quality problems in this ever-important health care industry. To narrow our scope, this research focuses on the use of HCMIS within a bounded set of activities and work processes in the healthcare industry. Namely, we will focus on warehousing and inventory management processes that support the delivery of a particular type of healthcare service.

To achieve the intended objectives, this study will answers to the following questions:Does automation of logistic information management system result in improved warehousing and inventory management performance? Andwhat are associated factors affecting the performance of warehousing and inventory management?

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1.4 Significance of the study

The primary target of this study is to assess warehousing and inventory management performance after HCMIS implementation in Addis Ababa University College of Health Science TikurAnbessaSpecialized Hospital. Therefore there was a need to conduct this research in order to determine the magnitude of performance improvement through the use of key performance indicators, and qualitatively for related factors affecting performance. Findings from this study will help to formulate strategic plans that will help to maximize the performance of warehousing and inventory management, and continuous innovation in hospital supply chain. The findings will also help to find out how innovations are critical for better organizational performance. To researchers and academia the study will also form a basis for interested researchers, scholars and supply chain management practitioners to research on and add to the body of knowledge on SCM and innovation management.

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2. LITERATURE REVIEW

2.1. Medical supply logistics

Medical supply logistics encompasses purchasing, materials planning and scheduling, inventory control, material handling and physical distribution of medical supplies, and supporting services. Medical supply logistics involves both inter-facility (between locations) and intra-facility (within the facility) management of the flow of supplies and resources to enable patient care. Many different functions are utilized during this process, including information systems, warehousing, inventory, packaging, and transportation. Medical supply materials management is critical in ensuring the safety, availability, and affordability of supplies. A critical component of ensuring patient safety is ensuring that the right supplies are used on the right patients at the right time. The first responsibility of a health care materials manager is to ensure that the products purchased for clinical use are of good quality. This involves ensuring that the product's safety and clinical effectiveness are considered in addition to the cost. The building of a team of clinicians and logistics professionals to evaluate and select appropriate items for inclusion in the procurement functions of the provider is critical to the success of this process. Besides ensuring that the right products are used within the system (given safety and effectiveness), materials management must ensure that the items are properly stored and controlled(Manuel D., 2012). Among various SCM issues, inventory management is a greater extent relevant to the entire supply chain. Inventory management has been recognizes as one of the most important functions that has huge impact on their overall performance (George, 2010). Supply chain inventory management is focused on end-customer demand and aims at improving customer service while lowering relevant cost (Kwangyeol, 2012).

2.2 Hospital pharmacy supply chain

Hospitals are complex organization providing a multitude of service to patient, physicians and staff. These services include pharmacy, laboratory, surgery, dietary, linen, housekeeping, administration and others. Moreover, each area has specific and often unique material and supply need (Chuleeporn, 2010). The hospital product line consists of high cost and low cost items as well as perishable and durable goods that are consumed in large and small. Pharmaceutical components characterize as a large amount of hospital's operating expenses. Several researchers pointed out that inventory costs in the healthcare sector are substantial and are estimated between

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10% and 18% of total revenues (Peter, 2012). Any measures to control expenditures in this area can have significant impacts on the overall efficiency of the organization. Hospital supply chain, in terms of pharmaceutical products is providing the supplies of medicine for the patients and it's critical in ensuring high standard care (Noorfa, 2009).

2.3. Supply chain innovation

According to Rogers (2003), an innovation is defined as, an idea, practice, or object that is perceived as new by an individual or other unit of adoption. As such, nearly any contemporary idea, practice, or product that an organization wishes to adopt and employ for the purpose of obtaining gains in performance can be thought of as an innovation. For example, electronic data interchange (EDI) is an information technology used to exchange data across organizations and therefore it can be regarded as a technological innovation (Rogers, 1995). In addition, ideas such as cross-docking, containerization, and even green reverse logistics are technological innovations that have been discussed in the supply chain literature (Hazen et al., 2011). Although supply chain innovations take on many forms and functions, most innovations are intended to achieve the same objective- enhancing organizational effectiveness through improved performance. The complete incorporation of a SCM innovation into the organization is desired by any firm seeking to realize the anticipated benefits of an adopted innovation. Firms look to adopt supply chain innovations in hopes of realizing a variety of positive outcomes, such as to increase productivity and attain higher service levels without expending more resources (Mashelkar, 2010). Supply chain innovation has been regarded as a success factor for organizational performance. According to Byrnes, (2004) supply chain innovation provides tools to improve organizational processes needed for effective SCM through seamless interactions with suppliers, manufacturers, distributors and customers. Thus, supply chain innovation allows reduction in cost and lead time, and the development of flexibility for dealing with rapid changes in the business environment (Shih et al., 2009). The interacting content element of the SCI is found by comparing and contrasting frequently used SCM frameworks. SCM is concerned with the management of relationships in business networks and deals with both intra- and inter-organizational business processes. Furthermore, implementing supply chain technology has an explicit usage in the SCI contributions, while also mentioned in the SCM frameworks. Thus, the three interacting content elements of SCI are Supply chain business processes, Supply chain network structure, and Supply chain technology.

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2.4. Warehousing and inventory management performance measurement

Within healthcare organizations, the main goal of inventory management is to reduce the costs associated with supplies without sacrificing the quality of patient care (Rossetti, 2012).The financial performance indicators (e.g. inventory holding cost, value of stock, average response cost, etc.) identify the supply chain cost drivers and help move toward a more efficiently managed supply chain (Aronovich D.,2010) . The inventory costs are estimated to be between 10% and 18% of net revenues (Jarret, 1998). Epstein and Dexter (Epstein, 2000) categorize the inventory costs into five types of costs: ordering, shipping, purchasing, storage and opportunity costs. In addition, one should also con- sider the cost of not having the items in stock when needed (i.e. stock-out cost). Stock-out costs are difficult to measure given its high variability. Therefore prevention of stock-out is handled via a service level constraint that is dependent on the item criticality, which is a measure of the consequences of a stock-out (Gebicki, 2013; Guerrero, 2014). The reordering and storage costs as well as the risks of stock-outs should be taken into account when determining the inventory turnover rate.

The majority of literature is devoted to inventory management systems that reduce inventory levels in order to achieve the main objective of cost reduction. Sole cost cutting objectives, however, do not suffice since patient's satisfaction is influenced by the perceived quality of care and prices. Hospital managers need to balance inventory levels by trading-offbetween quality metrics (e.g. service level, timely treatment, meeting professional standards, etc.) and costs (De Vries J. 2011). Nachtmann and Pohl (Nachtmann H. ,2009) , Aronovich et al. (Aronovich D, 2010)and Hoeur and Kritchanchai (Hoeur S. , 2015) develop aset ofperformance measures to monitor the quality of its inventory activities, including inventory visibility, inventory availability, stock-out rates, inventory accuracy rate, stock wastage due to expiration or dam- age, etc. Supply availability is a crucial factor in a healthcare logistics system's ability to support patient care processes (VilaParrish AR, .2013).

Supeekit et al. (Supeekit T, .2015) and Supeekit, Somboonwiwat and Kritchanchai (SupeekitT, 2016) explore four supply chain performance criteria of cost, time, reliability and productivity to evaluate internal hospital supply chain performance.The inventory management system of public health pharmaceutical supply systems can be monitored and evaluated periodically using standard performance indictors to measure how effectively the inventory is being managed, some

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of the commonly used indicators that are considered as a tools to measure inventory management performance are order fill rate, line fill rate, inventory accuracy rate, percentage of stock wasted due to expiration or damage, value of unusable stock as percentage of total inventory value, inventory turnover rate, percentage of facilities stocked according to plan, and other additional indicators like, invoice accuracy, inventory holding cost, order entry accuracy. The performance monitoring of warehouse activities can be approached internally and externally. Interanly,warehouse management can be assessed and monitored for productivity,timeliness,use of resources, and safety they all influence cost and service. Externally, measurement focuses on satisfying customers, including indicators of quality and length of lead time. Some customer service-specific performance indicators include order turnaround time, documentation quality, and order completeness.

2.5. Supply chain innovation and performance

In today‘s complex world, supply chain operations are going through profound structural changes. More and more companies rely on an intricate web of partners worldwide to carry out the elaborate processes of planning, sourcing, manufacturing and distributing their products. These companies are being challenged with increasingly shorter product cycles, varying customer demand, and heightened global competition. Pressures are further exacerbated as companies are forced to deliver products to customers nearly on demand, while adhering to regulatory compliance requirements and meeting financial performance objectives. A Supply Chain Innovation (SCI) is defined as a change (incremental or radical) within the supply chain network, supply chain technology, or supply chain processes (or combinations of these) that can take place in a company function, within a company, in an industry or in a supply chain in order to enhance new value creation for the stakeholders (Arlbjørn, de Haas &Munksgaard, 2011). According to Lee (2011), supply chain (SC) innovation helps organizations achieve efficiency and quality management practices for new customer value creation, which is expected to result in improved organizational performance. In his study to examine the effects of innovation leadership, SC innovation, SC efficiency, and QM practices on organizational performance in the health care organization he found that there is positive relationships between process improvement and IT application as part of SC innovation; and SC efficiency and QM practices. In addition, the results showed the effect of operational improvement as a result of SC efficiency and QM practices on organizational performance.

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2.6. Conceptual framework

The conceptual model in Figure 2.1 indicates the relationship between supply chain innovation and organizational performance. According to Kahn (2000), supply chain innovation plays a key role in developing products and services that fulfill customers‘ needs and values .On one hand, if an organization focuses on value creation for customers, it can do so through customer acquisition, satisfaction, and loyalty (Kahn, 2000). On the other hand, if an organization provides its products and services by a delivery system, it must improve its SC processes through innovation to continuously search for customers' needs and values (Flint et al., 2005). Supply chain innovation influences organizational performance with intervening effect from increased data visibility, information sharing, and facilitated order entry and generating report.

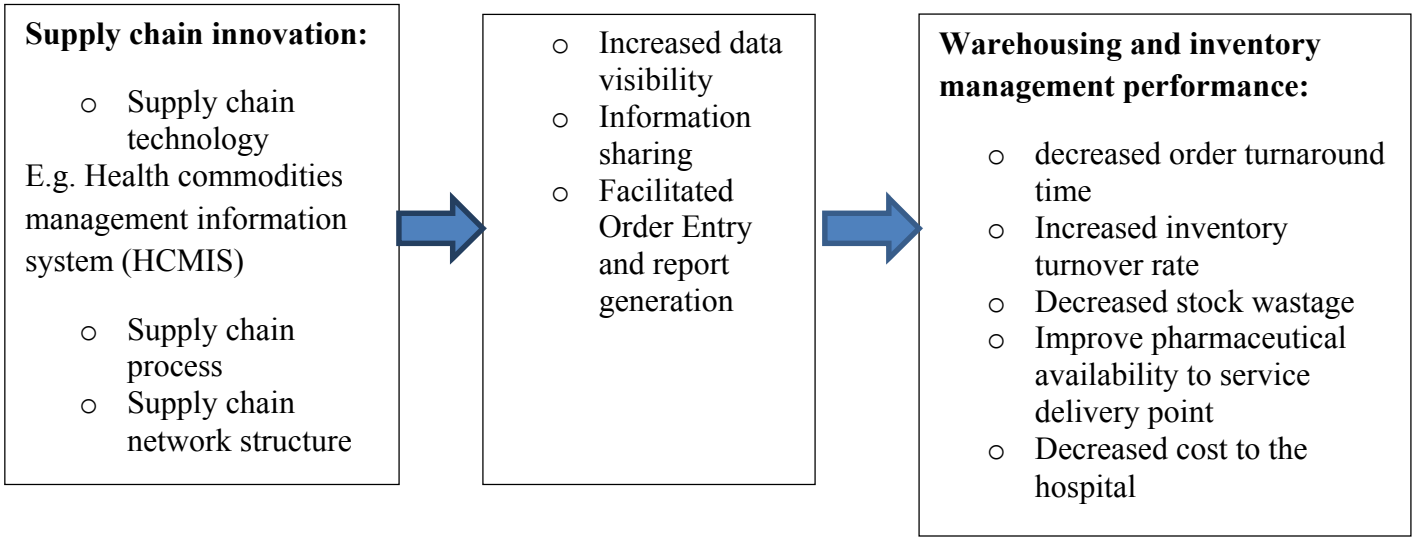

Fig.1. conceptual model

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3. OBJECTIVE

3.1 General objective

To assess warehousing and inventory management performance and associated factors after HCMIS implementation in TASH.

3.2 Specific objectives

- To assess warehousing management performance before and after HCMIS implementation in the warehouse.
- To assess inventory management performance before and after HCMIS implementation in TASH.
- To identify associated factors affecting warehousing and inventory management performance of TASH.

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4. METHODS

4.1Study setting

The study will be conducted at medication warehouse of TikurAnbessa Specialized Hospital, which was established in1972 G.C. It is the largest teaching hospital affiliated with College of Health Science, Addis Ababa University and serves as a training center for undergraduate and postgraduate medical, pharmacy, and other health science students. It is also an institution where specialized comprehensive and clinical services that are not available in other public or private institutions are rendered to the whole nation. The hospital has around 465 physicians,76 pharmacists,992 nurses, and 115 other health care professionals dedicated to provide health care services.it is also has 950 administrative and support staff (college of health sciences human resource management,2018). The different departments, faculty members and residents, under specialty training in school of medicine provide patient care in the hospital. In addition, almost all regional and federal hospitals in Addis Ababa use this hospital as referral unit and training site. The hospital served more than 500,000 patients per year in its 20 outpatient specialty clinics, inpatient and emergency departments. For all of the services rendered by TASH, the pharmaceuticals, including medical equipment,are supplied through pharmacy service director, which is organized into six case teamand;more than 13 pharmacy outlets.Recently TASH implemented the national auditable pharmaceutical transaction service (APTS) to make transparent and accountable process, and automate the warehouse with HCMIS software to make the logistic management information system visible and increase service effectiveness since 2009 E.C. The warehouse is structured into medication, and supplies store, which supply needs from each pharmacy unit, other departments in the hospital, and catchment health setting around TASH.

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4.2 Study period

The data collection and analysis will be conducted- from December/2018- March/2018.

4.3. Study design

A mixed method research design that involves retrospective facility based quantitative survey and qualitative in-depth interview method will be usedto assess warehousing and inventory management performance in TASH.

4.4 Population

4.4.1. Source population

All health commodities found in TASH warehouse and all documents that were used to manage the pharmaceuticals supply chain are the source data for quantitative method.

4.4.2. Study population

All RDF; and program medicines, found inthe warehouse will be the study population for quantitative method.

4.5. Sample size and sampling procedure

From among 626 both RDF medicines (523) and program medicines (103) flows in the hospital currently,medicationsindicated pharmaceutical supply chain performance in terms of service coverage, and cost of the hospital will be sampled by using Delphi technique, a technique which is a structured communication technique or method, originally developed as a systematic, interactive forecasting method which relies on a panel of experts; through the use of ABC/VEN analysis, where V class and E class (vital and essential items) which is categorized under A,B, and C class (high,medium, and low value items respectively) will be included under study during a panel of experts with pharmacy service Director, store managers, and case team leaders of pharmacy service.200 medications Purposive sampling method will be applied for qualitative method to sample the former and current pharmacy Directorate Directors, store managers, drug supply management case team leaders, and pharmacy service case team leaders and coordinators of TASH organized in Amharic version by principal investigator.

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4.6. Inclusion and exclusion Criteria for Pharmaceuticals

Pharmaceuticals i.e., medicine, that are purchased by hospital and program pharmaceuticals and the document used to manage them will be included, Whereaspharmaceuticals acquired through aid, laboratory reagents and consumable medical supplies and equipmentwill be excluded from this study.

4.7. Inclusion and exclusion Criteria for Professionals

Both the former and current pharmacy professionals who are working with managing and coordinating the pharmacy service of TASH included in the study, whereas otherpharmacy professionals working in hospital will be excluded from this study.

4.6 Study variables

Dependent Variable

- Order fill rate
- Line fill rate
- Stock wastage
- Wastage rate
- Inventory turnover rate
- Order turnaround time

Independent Variable

- HCMIS software

4.7. Data collection procedures

After ethical approval and support letter obtained, a one year each (Nehase,1,2007 – Sene ,30,2008 E.C/August,7,2015-July,7,2016 G.C/ before HCMIS and, Nehase,1,2009 -Sene,30,2010 E.C/August,7,2017- July,7,2018 G.C/ after HCMIS implementation) Data like, items and quantity ordered and/ received, cost and quantity of items expired or damaged, cost of the products, and number of days to process the orders will be abstracted from HCMIS, IFRR, RRF, Disposal Report, Bin Card, and GRV (Model 19),Model 22using standardized Ethiopian PFSA pharmaceutical supply chain management system monitoring and evaluationquantitative data collection tools to analyze the performance using order fill rate, line fill rate, wastage rate, stock wastage, inventory turnover rate, and order turnaround time indicators. The data will be collected

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by 8 trained and recruited Pharmacist in TASH.The related factors which affect the performance of warehousing and inventory management will be gathered by using qualitative data collection tool through semi-structured in-depth interview with potential key informantsby principal investigator in their office secured from noise at suitable time with clear summary description of the interview guide. Audio recording with tape-recorder and field notes will be taken properly.

4.9. Data processing and analysis

After the quantitative data is collected, it will be entered and analyzed using MS Excel and Statistical Package for Social Sciences (SPSS) version 20 computer software. Simple descriptive statistics such as frequency, percentage, and proportion, will be determined. To test the association between HCMIS and each indicator a multivariate statistical analysis will be applied. Correlation between indicators will be analyzed using Pearson correlation coefficient. Paired T-test will be analyzed to test for two dependent sample means. The qualitative data will be analyzedin close consultation with the advisor and co-advisor manually using thematic analysis method.

4.8. Data quality assurance

The quantitative data collection tool used is standardized Ethiopian PFSA pharmaceutical supply chain management system monitoring and evaluationdata abstraction tool will be used; training and briefing will be done to data collectors by investigator. Data completeness and consistency will be checked by the investigator. The Principal investigator will discuss with the project advisor and co-advisor on regular basis and review the collected data for completeness. The collected data will be summarized on the same day of the data collection. Data cleaning and editing will be taken on regular basis electronically.Forqualitative data collection tool(semi-structured interview Guide) will be developed by investigatorwho had taken training in collaboration with area expert opinion and content review through literatureand pretested to 5% similar study setting prior to the data collection by investigator to assess clarity, flow, validity understandability, consistency, and reliability. The qualitative data will be recorded with audio recorder, translated from Amharic to English, and transcribed in collaboration with advisor and co-advisor.

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4.10. Ethical considerations

Ethical approval will be obtained from the ethics review committee of School of Pharmacy, College of Health Science, Addis Ababa University and support letter written from department of Pharmaceutics and Social Pharmacy to hospital management. Written informed consent will be requested from participants involved in semi-structured in-depth interview.

4.11. Operationaldefinition

Order fill rate: is the percentage of all pharmacy dispensary orders placed to a medication store over a period of time that are filled correctly in terms of items and quantities of those items.

Line fill rate:is the percentage of all items ordered by a dispensary unit to a medication store over a period of time that are filled correctly in terms of quantities requested of those items.

Stock wastage:is the percentage of stock for an item that is unusable because of expiration or damage during a period of one year to the total quantity of that item received during a year plus the quantity of that items found during the beginning period of the year.

Stock wastage rate: is the portion of stock found to be unusable over a given period of time as a percentage of the total inventory value (the value of the items found during the beginning period of the year plus the value of the items received during the year in review).

Inventory turnover rate:is the total value of items distributed divided by the average value of the inventory (average of beginning and ending inventory value) managed for that itemduring over a given time period.

Order turnaround time:is the average amount of time it takes for a warehouse (medication store) to fill an order from the date the order is received by the warehouse until the date the order is shipped to the dispensary unit, usually recorded in days.

Data source: EPFSA pharmaceutical supply chain management system monitoring and evaluation manual, April, 2017.

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5. WORK PLAN

Table.1 Work plan for a study on assessment of warehousing and inventory management performance after HCMIS implementation in TASH, Addis Ababa Ethiopia.

S.No.	Tasks to be performed	Period 2018/2019	Assigned personnel	Time (days required)
1.	Topic selection	Aug. – Sept. 2018	PI*	20 days
2.	Proposal writing	Sept. 2018	PI	30 days
3.	Approval of the proposal	Oct. 2018	PI	50 days
4.	Securing Ethical clearance	Nov. 2018	PI	10 days
5.	Securing fund	Dec. 2018	PI	10 days
6.	Pretest, review data collection instrument	Dec. 2018	PI	5 days
7.	Data collection	Dec. 2018	PI and data collectors	30 days
8.	Data entry and clearing	Jan. 2019	PI	20 days
9.	Data analysis and write up	Feb. 2019	PI	25 days
10.	Submission of the first draft of proposal to advisor for comment	Mar.2019	PI	1 days
11.	Inclusion of feedback and comments	Mar 2019	PI	15 days
12.	Thesis defense	Mar. 2019	PI	1 days
13.	Submission of final report	Mar. 2019	PI	10 days

* Principal investigator

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6. BUDGET

Table.2 Budget break down for the study of assessment of warehousing and inventory management performanceafter HCMIS implementation in TASH, Addis Ababa Ethiopia, and 2018 G.C.

S.No.	Budget category	Unit cost	Multiplying factor	Total cost(ETB)
1.	**Personnel**	**Daily wage**	**No.of staff *No. of working days**	
	Data collectors	100 birr/day	8*30	24,000
	Supervisor	100 birr/day	1*30	3000
Sub Total (1)				27,000
2.	**Supplies**	**Cost per item**	**Number**	**Total cost**
	Pen	5 birr	15	75
	Tape recorder	2500 birr	1	2500
	Notebook	20 birr	15	300
	Flash (USB) 8 GB	400 birr	1	400
	Telephone / mobile card	100	15	1500
	Internet subscription	400	2	800
	Printing &binding	200	5	1000
Sub Total (2)				6575
3.	**Training and briefing**	**Cost per item**	**Number of person-work days**	**Total cost**
		50 birr/day/person	8*1	400
Sub Total (2)				400
4.	**Total**	**Subtotal (1+2+3)**		**33,975**
5.	**Contingency (5%)**	**5% of the total cost**		**1698.75**
6.	**Grand total**	**Total +contingency**		**35,673.75**

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7. PLAN FOR DISSEMINATION OF THE RESULT

The result will be presented to Addis Ababa University, College of Health Science, School of Pharmacy and the document will be disseminated to the hospital management. In addition, the result will be disseminated through presenting the finding at different meetings, and workshops to the university communities and researcher, as well as publishing in scientific journal, and disseminating through different sites like research gate.

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9. APPENDICESS

9.1 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 warehousing and inventory management Performanceafter HCMIS implementation in TikurAnbessaspecialized Hospital:*

Your organization has been selected to form part of the study. I will be very grateful if you would spare sometime from your busy schedule, to respond to the semi-structured interview Guidequestions prepared in Amharic version.

Your response will be treated with uttermost confidentiality. The findings of this research may be availed to you upon completion of the research if you so request.

Your assistance and co-operation will be highly appreciated.

Yours faithfully,

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9.2 Appendix I

Interview guide for key informants (Pharmacy Directorate Directors, Drug supply case team leaders, each pharmacy unit Coordinators, Store managers, and pharmacy case team leaders)

Part 1: Biographical details.

1. What is your Profession _____
2. Age in year_____
3. Sex: Male ☐ Female ☐
4. What is the highest level of education have you attained?
    a. College education ☐
    b. Undergraduate degree ☐
    c. Master's Degree ☐
    d. Doctorate ☐
    e. Others (Indicate) _____
5. Position you hold in the organization _____
6. Number of years you have worked in the organization _____

Part II

1. How do you assess warehousing management of TASH before and after HCMIS?
    a. Probe 1: what conditions facilitated warehousing management before and after HCMIS innovation?
    b. Probe 2: what barriers have you encountered after HCMIS innovation?
    c. Probe 3: what is your recommendation for system improvement?
2. How do you assess inventory management of TASH before and after HCMIS?
    a. Probe 1: what conditions facilitated inventory management before and after HCMIS innovation?
    b. Probe 2: what barriers have you encountered after HCMIS?
    c. Probe 3: what is your recommendation for system improvement?
3. Do you have anything to add to this interview regarding this topic?

Thank you very much!

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Table.3 Each indicators data calculation format

Criteria	Indicators	Formula	Before HCMIS	After HCMIS	Data source
Coverage (Service delivery)	Order fill rate	$\frac{-}{} * 100$			IFRR,BC,Model 22,HCMIS
	Line fill rate	$\frac{}{} * 100$			IFRR,Model 22, HCMIS
Cost	wastage rate due to expiration, and damage	$\frac{h}{+ \quad h}$			Disposal report, Model 19, HCMIS
	Stock Wastage due to expiration, and damage	$\frac{h}{} * 100$			Disposal report, Model 19, HCMIS
	Inventory Turnover Rate	$\frac{\textit{Total value of items distributed}}{\textit{Average value of inventory}}$			Model 19,Model 22, HCMIS
Time	Order turnaround time	$\frac{h}{}$			IFRR,Model 22, HCMIS

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Table.4 Each indicators supply chain function, description, and issues and/ consideration when using indicators

SC function	Indicator	Indicator description	Issues/consideration when using the indicator
Inventory management performance	Order fill rate	The percentage of items ordered that are actually received. This can be used to measure individual products or for an entire order.	Measures the supplying facility ability to fill requests for resupply correctly. May reflect on issues in inventory management, picking, and shipping procedures.
	Line fill rate	The percentage of all items ordered by a customers from a distribution source over a period of time that are filled correctly in terms of quantities requested of those items.	Measure the percentage of items ordered that are actually received to determine whether an order is filled in the correct quantities with the correct products. Used to measure individual products(line fill rate) or for an entire order
	Stock wastage	The percentage of counted stock for an item that is unusable because of expiration or damage	Measure warehousing management practices such as FEFO and avoiding product damage. Provides an important but incomplete picture of wastage because it does not incorporate wastage caused by loss.
	Inventory turnover rate	The number of times the inventory turns over(is replaced) in a given time	Shipping invoices and requisition and/ issues vouchers provide the required cost data. Higher ratios indicate lower average inventory levels

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		period, as a ratio	(and thus lower holding costs).High performing facilities should range anywhere from 6-12 on this indicator.
Warehousing performance	Order turnaround time	The average amount of time it takes for a warehouse to fill an order from the date the order is received by the warehouse until the date the order is shipped to the customer. Usually recorded in day	Measure the efficiency with which requests are processed because it measure only the time between when the request was received by the distribution source and the time the order was actually shipped.

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Table.5 Data abstraction format

S.No	Indicators	Required Data
1.	Order fill rate	✚ quantity of items ordered and/received with in a period ✚ Total quantity of items ordered with in a period
2.	Line fill rate	✚ Number of line items filled as requested ✚ Total number of lines with in a period
3.	Wastage rate	✚ Cost and quantity of products expired and damage ✚ Cost of beginning and received products during the period
4.	Stock wastage	✚ Quantity of product expired and damaged ✚ Quantity of usable and unusable stock during the period
5.	Inventory turnover rate	✚ Total Cost of products within a period ✚ Cost of beginning and ending inventory within a period
6.	Order turnaround time	✚ Sum of the number of days to process all orders ✚ Total number of orders processed within a period

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