ANALYSIS OF MEDICAL EQUIPMENT SUPPLY CHAIN MANAGEMENT OF PUBLIC HOSPITALS UNDER THE ADDIS ABABA REGIONAL HEALTH BUREAU

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This is to certify that the thesis is prepared by Addisu Getie, entitled,Analysis of medical equipment supply chain management in public hospitals under AARHB, in partial fulfilment of the requirements for Masters of Arts in Logistics and Supply chain Management with the regulation of the university.

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DECLARATION

I, Addisu Getie, hereby declare that this thesis entitled, Analysis of medical equipment supply chain management in public hospitals under AARHB, is my original work and that sources of materials used in this thesis have been duly acknowledged. I seriously declare that this thesis is not submitted to any other institution anywhere for an academic degree, diploma, or certificate.

Name: Addisu GetieSignature……Date.....

Letter of Certification

This is to certify that Addisu Getie has carried out his thesis on the topic entitled:Analysis of medical equipment supply chain management in public hospitals under AARHB.This work is original in nature and suitable for the award of Masters of Arts (MA) in Logistics and Supply chain Management.

Shiferaw Miteku (PH.D.)

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Addisu Getie

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ABBREVIATIONA AND ACRONYMS

WHO: World Health Organization

MDE: Medical devices and equipment

SCM: Supply Chain Management

AARHB: Addis Ababa Regional Health Bureau

HSTP: Health Sector Transformation plan

EFMHACA: Ethiopian Food medicine, health care administration and control Authority

MOH: Ministry of Health

PFSA: Pharmaceuticals Fund and Supply Agency

ABSTRACT

Medical equipment are essential for a functioning health system. Medical equipment in particular are crucial in the prevention, diagnosis, and treatment of illness and disease, as well as patient rehabilitation. The objective of this study is to analyse the medical equipment supply chain management of public hospitals under Addis Ababa Regional Health Bureau. Both quantitative and qualitative approaches are used in an explanatory and descriptive research design. A total of 339 samples were taken from 2231 population. Across sectional data was collected using Simple random sampling and purposive sampling methods for quantitative and qualitative data collection respectively. Structured questionnaires and open ended interview questions are used as a tool for data collection. The data were analysed using both descriptive and inferential statistical tools. Moreover, the result was described using mean, frequency and standard deviation, and the researcher was also applied parametric statistical test (correlations, and regression analysis (Simple, multiple)) to interpret and analyze the data, using Statistical Package for Social Science version 21.The findings showed that the efficiency of medical equipment supply chain management in public hospitals is found to be strongly affected by the procurement, inventory, transportation and warehouse management practices. Majority of respondents disagree for having good procurement, inventory, transportation and warehouse management in public hospitals under Addis Ababa Regional Health Bureau. From the overall findings we can conclude that medical equipment supply chain management practices of public hospitals under Addis Ababa Regional Health Bureau is inefficient which will contribute for not giving quality health service. This is mainly due to poor practices in the procurement, inventory, transportation and warehouse management. From the findings of the study 44.5 percent of the variance in efficiency of medical equipment supply chain was explained by the variance of explanatory variables, while the rest 55.5 percent was contributed by other factors that were not included in the model. Hence it is recommended that Federal Ministry of Health should work for improving of medical equipment supply chain management practices of facilities such as to prepare updated medical equipment list nationally and at each level of the facility, to develop health commodities procurement policy. Addis Ababa regional health bureau together with hospital management and staffs should give attention and work cooperatively to improve the practices of medical equipment supply chain management of hospitals.

Key words: *Medical, Equipment, Health service, Supply, Chain, Management, Efficiency*

CHAPTER ONE: INTRODUCTION

Managing stock effectively is important for any organization, running a hospital is no exception because without enough stock, services to patients will come to a halt. The efficient operation of any organization demands a planned flow of materials to service its activities. This can be successful when the organization holds stock of materials it uses. Therefore this research paper dealt mainly about analysis of Medical Equipment Supply Chain Management in Public Hospitals, Under AARHB. Moreover this introductory part includes background of the study, statement of the problem, research objectives and questions, scope of the study significance and expected limitations of the study.

1.1 Background of the study

Supply chain management is managing a series of activities for any product from point of origin to point of consumption. Most of the time the most forgotten but valuable part of any institution especially in developing countries is supply chain management. Institutions focus within their four walls to give a solution to problems they face in profit making or in giving service but for sustainable solutions and to maximize their competitive advantage they need to see the whole physical and information flows throughout the supply chain channel. Generally speaking Supply Chain Management includes number of main processes to achieve integration. Supply chain management processes include Customer service management process, Procurement process, Product development and commercialization, Manufacturing flow management process, Physical distribution, Outsourcing/partnerships, Performance measurement and Warehousing management. Healthcare supply chain management is the regulation of the flow of medical goods and services from manufacturer to patient (Kerly L,*et al*.2001).

The healthcare supply chain starts at the medical product manufacturer where items are produced and sent to a distribution centre. Depending on the type of product, hospitals can

either purchase inventory directly through the manufacturer or distributor, or the transaction can be conducted through a group purchasing organization, which establishes a purchasing contract with the manufacturer on behalf of the hospital.

Medical products are then sent to the healthcare organization, where the goods are stocked into inventory for providers and patients. The organization ensures that providers are not left without essential medical products and patients have access to potentially lifesaving tools.

An efficient supply chain safeguards the significant financial investments on the procurement of health products by donors and country governments .Estimates on donor-financed health products alone range from $7 - 10 billion dollars per year procured for low- and middle-income countries (LMIC) (WHO, 2014).

Health technologies are essential for a functioning health system. Medical equipments in particular are crucial in the prevention, diagnosis, and treatment of illness and disease, as well as patient rehabilitation.

In May 2007, the Sixtieth World Health Assembly expressed concern about the waste of resources resulting from inappropriate investments in health technologies in particular, medical equipments that do not meet high priority needs, are incompatible with existing infrastructures, are irrationally or incorrectly used, or do not function efficiently (WHO, 2014).

A strategic objective in the World Health Organization (WHO) plan for 2008–2013 is to ensure improved access, quality and use of medical products including medical equipments, thereby recognizing medical equipment as a tool to provide health care and improve the health of people (WHO, 2014).

The absence of safe, effective and well-functioning medical equipment impairs health service provision, leads to poor patient outcomes and poses substantial health system and national security risks.

Health systems throughout the world whether in developed or developing countries, are struggling with the challenge of how to manage health-care delivery in conditions of resource constraint. Lack of working equipment has a devastating effect on healthcare in

resource-poor settings. It is often said that most of the medical equipment in the developing world is broken with estimates ranging up to ninety six percent are out of service. More than fifty percent of the laboratory and medical equipment in resource-poor settings are not in service (Bryce C, Cline K, 2013).

Management of medical equipment in high-resource settings is not a simple task either. A single hospital can have thousands of medical equipment, with various models of the same type .Hence the need for greater standardization, which would not only simplify the use, repair, and servicing of multiple devices but also the integration of several devices used in a single system or network. Lack of standardization is clearly a barrier to using medical equipment (WHO, 2014).

The World Bank estimated that over fifty percent of medical equipment in developing countries is not maintained and is out of order: Developing countries could obtain greater returns on their investments in medical devices if they would pay greater attention to ensuring adequate recurrent budget, training of operators and staff and the introduction of good management practices. However, poor use of medical equipment in low-resource settings is sometimes a consequence of the lack infrastructure roads, electrical power, landline and mobile telephones, Internet connectivity essential for medical equipments to be used to their full potential (WHO, 2014).

In addition, low-income countries often lack not only the funds, but also the experience required to create and run an efficient medical equipment management system. Efficient procurement, utilization, inventory management, repair and maintenance, and other requisites for proper utilization of medical equipment, is difficult without a qualified person to manage a medical equipment management system. Until such systems are in place, the major barriers to using medical equipment will persist. A combination of inadequate planning and inadequate financial resources could explain that seventy five percent of district hospitals in developing countries had no access to the oxygen needed to operate lifesaving ventilators and of those that did, most had only enough for about three months In addition to the policy choices at health ministry level, appropriate management of medical equipment is also the responsibility of the managers of individual health-care facilities, heads of department, biomedical engineers, physicians, and nursing staff (WHO, 2014).

In Ethiopia, lack of proper management of medical equipment has limited the capacity of health institutions to deliver adequate health care. It is estimated that only about sixty one percent of medical equipment found in Ethiopian public hospitals and other health facilities are functional at any one time. Medical equipment management defines organization and coordination of activities that ensure the successful management of equipment related to patient care in a health facility (Beyene,*et al* .2016).

1.2 Statement of the problem

The annual performance report of AARHB for HSTP at 2016/2017 describes the implementation status and addresses the fifteen Strategic Objectives of the health sector. One of them is to improve supply chain and logistics management. The strategic objectives are drawn from the gaps identified in the sector, so this study will be an input to meet this strategic objective.

The healthcare sector is facing major challenges nowadays. Healthcare providers and institutions are under an increasing pressure to deal with a number of inefficiencies, in order to achieve an optimum balance between improvements in quality healthcare services and cost effectiveness. Supply chain costs can account for over one quarter of a hospital's operating budget, while the healthcare industry could significantly improve its ability to deliver quality healthcare products and services to consumers and save as much as $11 billion. Many authors (Towill, and Christopher 2005; Schneller and Smeltzer, 2006, de Vries, 2011; Min, 2012), have pointed out that saving opportunities are not currently exploited by organizations due to supply chain inefficiencies, such as ineffective inventory control and materials management, inadequate purchasing orders, and distortion of information flows involved in the transport and delivery of supplies to the healthcare providers (Matopoulos and Michailidou, 2013).

Medical equipment supply chain is unique from the supply chain management of other medical and non-medical goods and services in developing nations of the world. Even though over ninety five percent of medical equipment in developing world hospitals are imported and it seems appropriate to sell the same equipment used in developed nations to the developing world hospitals, WHO estimates that seventy percent of medical equipment

coming from the most developed nations does not work when they reach in developing nation hospitals, ninety six percent are not working just 5 years after and thirty nine percent never worked due to lack of training, manuals or accessories. As part of the developing world Ethiopia, particularly Addis Ababa health bureau, has such challenges. This study fills the gap in the supply chain management to save the scarce resources we have (WHO, 2014).

Developing countries have very limited resources for procurement of medical equipments. Usually, the scarcest resources they do have are not used in appropriate and optimal ways.Deciding which healthcare technologies to procure, and how to procure them, becomes a recurring policy dilemma in a climate of austerity. In an environment of budget constraints, innovative or high-value technologies can be marginalized. This can lead to an exaggerated focus on commodity purchasing, whereas outcome-based purchasing should be the aim. This study aims to offer recommendations to equip healthcare system stakeholders with detail analysis that support smarter procurement (K.Diaconu, Yen C, Carole.C.2017).

Transparency International, a global civil society organization set up to combat .corruption, ranks procurement of drugs and medical equipment fourth on a list of seven processes that carry a high risk of corruption. Experts interviewed by this organization alleged that health ministry officials and hospital administrators inflate the cost of medical equipment in collusion with private suppliers and share the non-reported difference, which can be as much as five times the true cost. Large public health care programmes in the United States lose five to ten percent of their budget through this form of overpayment (WHO, 2014). The study assessed the presence and transparency of procurement procedures and policy.

Inventory management is the heart of pharmaceutical system and poor management will lead to wastage of financial resources, shortages of essential medicines, essential medical equipment and supplies, average of others resulting in expiration and deadline in quality health care (USAID, 2012). Due to this, in most public hospitals patients are always turned away due to lack of essential drugs and functional medical equipment. This study will focus on bridging the existing problems in inventory management practices and performance of public hospitals at AARHB.

The storage of medical equipment should be carried out in buildings that have been built for or adapted this purpose. Buildings should be built to the standard to keep the medical equipment safe and protected. There should be enough space and premises. Significant numbers of medical equipment are not functional when they tested to be installed (WHO, 2014).One of the factors contributing to this is poor warehouse management practice. So, this study will assess the warehouse management practices of hospitals under AARHB as per the standard set by FMHACHA.

Medical equipment is heavy and costly to transport. In addition almost all of the medical equipment in use in Ethiopia is imported because we have no manufacturing plant for medical equipment. With medical equipment costs and device complexity rising, as a developing nation we don't have adequate and to the standard infrastructure for transportation. So, this study will assess the current transportation challenges for medical equipment and show possible solutions for AARHB and MOH.

A study done by Beyene (Beyene,*et al* .2016) in Jimma referral hospital on medical equipment focuses on utilization ,there is also a study on other pharmaceuticals specifically Anti-retroviral drugs supply chain management and different systems applied to the supply chain management system (IPLS)(Tilahun A, *et al*,2016*).*As to the knowledge of the researcher, there is no published study done on the supply chain management of medical equipment in Ethiopian hospitals in general, and in hospitals of Addis Ababa in particular. Therefore, this study was designed to analyse the four major practices that affect efficiency of medical equipment supply chain management in public hospitals under AARHB.

1.3 Objective

1.3.1 General objective

To analyse the practices that affect the efficiency of medical equipment supply chain management of public hospitals in AARHB.

1.3.2 Specific objectives:

- To assess the medical equipment procurement practices (Planning, forecasting etc.) of public hospitals under AARHB.
- To examine inventory management practices of medical equipment's in public hospitals under AARHB.
- To assess the storage systems (warehouse management practices) of medical equipment's in public hospitals under AARHB.
- To assess the transportation management systems used for medical equipment in public hospitals under AARHB.
- To examine the effect of procurement, inventory, transportation, warehouse management practices of medical equipment on efficiency of medical equipment supply chain management.
- To identify challenges of medical equipment supply chain management in public hospitals under AARHB.

1.4 Research questions

1.4.1 Research questions

- How is medical equipment procurement being practiced at hospitals under the AARHB?
- How is medical equipment inventory managed at public hospitals under AARHB?
- What are the warehouse management practices for medical equipment's administered at AARHB?
- How is medical equipment transportation system managed at AARHB?
- To what extent procurement, inventory, transportation, warehouse management practices of medical equipments affect efficiency of medical equipment supply chain management.

- What are the challenges that affect medical equipment supply chain management in public Hospitals under AARHB?

1.5 Scope of the study

This study was conducted on analysis of Medical Equipment Supply Chain Management in public Hospitals under AARHB. Geographically it is limited only on Public Hospitals Case of Addis Ababa City administration, excludes private sectors. Moreover, there are 11 public hospitals in Addis Ababa, but this study will be employed only on 6 public hospitals under Addis Ababa city administration. Supply chain management in healthcare have many dimensions but in this study the focus is on the four main areas. These are procurement, inventory, transportation and warehouse management (Dawling P.2011).

1.6 Significance of the study

International Healthcare systems are under increasing pressure to reduce waste, eliminate unnecessary costs while improving the quality and consistency of the care they provide to patient. For this reason, Healthcare logistics / supply chain management is receiving high attention at National and International level from practitioners and academics (Elmuti *et al.*, 2013).

Understanding, the prospects of Medical Equipment Supply Chain Management Practices in Public Hospitals has been academic as well as policy relevance. That is, it is likely to contribute to the body of knowledge by bringing empirical evidences of practices in An Assessment of Medical Equipment Supply Chain Management Practices in Public Hospitals and associate with those in the academia. Likewise, since Medical Equipment Supply Chain Management Practices in Public Hospitals is recent phenomenon worldwide as well as in Ethiopia, and no further study on this had been conducted so far, the findings of this study might contribute to minimize the existing problems.

This study would be significant to AARHB to understand the existing gaps in medical equipment supply chain management, so that they would develop improvement plans in the supply chain of medical equipment, by this the service given would be improved in quality and quantity by the availability of modern and appropriate medical equipment which in turn improve patient satisfaction and suffer.

Specifically, doing research on Assessment of Medical Equipment Supply Chain Management Practices in Public Hospitals has its own contribution for the researcher as well as different groups of the society and for the government policy makers on the subject. It would also serve as a base for further wider research in future. Thus, the information provided in the study would be useful to researchers who might want to undertake further research into the area of Medical Equipment Supply Chain Management Practices in Public Hospitals.

1.7 Limitation of the Study

The study focuses only on facilities; it doesn't thoroughly assess other actors in the supply chain. A longer time and enough resources would have helped to unearth more findings especially with other healthcare institutions in other regions of the country.

Regarding results obtained as to the knowledge of the researcher there is no empirical data or standard for the practices assessed which makes it difficult to discuss based on standard deviations of results obtained.

1.8 Definition of terms/ Operational Terms

Health technology: The application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of life.

Medical equipment: Medical devices requiring calibration, maintenance, repair, user training, and decommissioning activities usually managed by clinical engineers. In this study it also includes any article, instrument, apparatus or machine that is used in the prevention, diagnosis or treatment of illness or disease, or for detecting, measuring, restoring, correcting or modifying the structure or function of the body for some health purpose. Medical equipment is used for the specific purposes of diagnosis and treatment of disease or rehabilitation following disease or injury; it can be used either alone or in combination with any accessory, consumable, or other piece of medical equipment. Medical equipment excludes implantable, disposable or single-use medical devices.

1.9 Organization of the study

This study covered five chapters, chapter one provides overview of the study which includes; introduction of the study, background information the study, statement of the problem, objectives of the research, research questions, significance of the study, scope of the study, limitation of the study, description of the study area , and definition of key terms.

Chapter two focuses on literature review which is divided into two parts that is theoretical literature review based on theories and concepts and empirical studies done by other researchers within and outside Ethiopia. Conceptual frame works and research gaps were also addressed.

Chapter three is concerned mainly with research methodology which includes; research design, study area, target population, sample size and sampling design, data collection methods, measurements, reliability and validity of measurement, as well as method of data analysis. Chapter four is concerned with data presentation, analysis and discussion of findings. Finally chapter five deals about Summary, conclusions, and recommendations related to this research.

CHAPTER TWO: RELATED LITERATURE REVIEW

This chapter reviews relevant literature on Assessment of Medical Equipment Supply Chain Management Practices in Public Hospitals. In detail, it captures the meaning and concept of medical equipment, importance of medical equipment supply chain management in public hospitals, supply chain management techniques as well as the broad concept of supply chain management. Ware house management, medical equipment preventive techniques', utilization and transportation and disposal systems are also part of this chapter. Finally conceptual framework and research gap are included.

2.1 Theoretical literature review

2.1.1 Definition and Concept of Supply chain management

Supply Chain (SC) and Supply Chain Management (SCM) terms were introduced for the first time in the middle of 1980s and later became more widespread in the 1990s. The concept of supply chains and supply chain management is a relatively recent managerial principle. The term supply chain also describes the network of suppliers, distributors and consumers. It also includes transportation between the supplier and the consumer, as well as the final consumer, thus the environmental effects of researching, developing, manufacturing, storing, transporting, and using a product, as well as disposing of the product waste, must be considered (Messelbeck and Whaley, 1999, 42). The field has evolved from a number of sources including purchasing, marketing (distribution channels), logistics, and operations management. The issues include management of inventory, customer-supplier relationships, delivery time, product development and purchasing. According to Handfield and Nichols (1999), a supply chain encompasses all activities associated with the flow and transformation of goods from raw materials (extraction), through the end user, as well as associated information flows, material and information flow both up and down the supply chain. Chopra and Meindl (2001), state that a supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves.

Supply chain management is a specialized form of strategic management. It must become a major part of business strategy. Supply chain management is the area of management that will attempt to be sure that the customer's needs will be able to be met and you will have a reason to be in business. The supply chain management strategy should be covered in the large umbrella of the vision statement for the organization. There are different models for the supply chain management (Felea and Albastroiu, 2013).

There are different theories of supply chain management, some are resource based view theory, principal agent theory, and transaction cost analysis.

Resource based view explains firms actively exchange resources in their operation. The theory deals with competitive advantages related to the firm's possession of heterogeneous resources (financial, physical, human, technological, organization, and reputations) and capabilities (Prahalad and Hamel, 1990).

SCM and related strategies are crucially important to the success of a company. This is because the cost and quality of goods and services sold are directly related to the cost and quality of goods and services purchased. Therefore, supply chain policies such as procurement and supplier selection have an important role in the SCM (Hartley and Choi, 1996; Degraeve*et al*. 2000).

Forty to Seventy per cent of medical equipment in low- and middle-income countries are broken, unused or unfit for purpose; this impairs service delivery to patients and results in lost resources. Undiscerning procurement processes are at the heart of this issue. Indiscriminate procurement methods, a mismatch in technology design and demand, high costs as well as deployment, maintenance and human resource training challenges all contribute towards this issue .Low- and middle-income countries (LMICs) particularly lack the regulatory authorities, or biomedical engineering capacity, to advise on what MDEs are suitable for use in harsh deployment settings: i.e. facilities with high temperature, fluctuating electricity or no clean water supply. The problem is compounded by a mismatch in MDE supply: manufacturers are located and attuned to users in lucrative high-income markets. Installation, preventive and corrective maintenance services and user training programs are also traditionally absent in LMICs, leading to unsafe device handling practices

with potentially harmful consequences for patients (e.g. in cases of misdiagnosis due to mis-calibration or infection propagation due to device re-use) (Diaconu*et al*.,(2017).

According to Beyene, *et al*(2016) the report of a case study in Jimma Zone Hospitals, South west Ethiopia; The way of purchasing of medical equipment in which devices were being purchased with bids that requested cheap price; attitude of staffs in taking care of the equipment; limited capacity to purchase quality devices with reasonable price; being dependent on donation; lack/absence of spare-parts for donated medical devices; mismatch between demand and supply (number of staff and supply); inappropriate utilization and/or over-utilization of devices, misuse or intentionally disabling medical equipment; lack of training while medical devices installed; taking responsibility to operate machines without appropriate training; being not available in the market; power interruption, lack of maintenance staff; insufficient or no motivation for professionals; absence of standard to monitor devices; absence of structure which allow to recruit bio-medical engineers for district hospitals; less sense of accountability and staff work overload were among the reasons mentioned by the participants that affect availability of and proper utilization of devices.

2.1.2 Medical equipment procurement procedures practice in public hospitals

Procurement is the act of finding, acquiring, buying goods, services or works from an external source, after via a tendering or competitive bidding process. The process is used to ensure the buyer receives good, services or works at the best possible price, when aspects such as quality, quantity, time and location are compared (Stephen B., Helen W., 2011).

Central procurement of medical equipment is challenging. Competing interests of clinical staff preferences, innovation, more specialisation and changing clinical practice influence the types of medical equipment that hospitals use. Tenders require longer lead times, more consultation and increasingly complex negotiation and management (Lamberts D.2008).

An effective procurement process ensures the availability of the right Medicals in the right quantities, available at right time for the right patient and at the right prices and at recognizable standards of quality (Cheng, 2007).

A qualitative study done on Effects of procurement practices on quality of medical device or service received across four countries shows that in Mexico price of medical equipments is often the ultimate criteria in selection and contracting phase of procurement. The study indicates that many stakeholders thought this detrimental to clinicians, clinical procedures and outcomes. For them, this focus on buying at the lowest price was the root of the problem. This study also shows the purchase demand is regrouped at regional and sometimes national level by ministry of health to increase the purchase power which makes the procurement process more bureaucratic. On the other hand European countries like Switzerland procurement is entirely left to hospitals (Myriam L,*et al*.,2016).

2.1.3 Inventory management practice in public hospitals

In order to optimize the inventory control and reduce the material handling costs of pharmaceutical products, it is necessary to manage the Supply Chain following an integrated perspective, capable to overcome boundaries between professional specializations and organizations involved in the materials flow from warehouses to wards.

According to Okwaro, Fredrick, Iravo, Mike, Berut, Zipporah (2017), effective inventory flow management in supply chains is one of the key factors for success. The challenge in managing inventory is to balance the supply of inventory with demand. A company would ideally want to have enough inventories to satisfy the demands of its customers- no lost sales due to inventory stock-outs. On the other hand, the company does not want to have too much inventory staying on hand because of the cost of carrying inventory. Enough but not too much is the ultimate objective. Inventory management efficiency is ever the means of conducting public sector around the world and it facilitate continued flow of production.

According to Min and Zhou (2002), institutions should follow the following steps in order to have an effective inventory management system: develop a mathematical model which describes the behavior of inventory; design and adopt an optimal inventory policy with respect to the firm’s mathematical model; develop a computerized information processing system that

will provide information on the current inventory levels; use the current inventory levels information to apply the optimal inventory policy to replenish existing inventory levels. In addition, the theory of inventory and production considers and uses the following measures: ordering costs, shortage costs, holding costs, salvage costs, discount rates, and revenues.

A stock diffusion theory was pioneered by Braglia, Gabbrielli and Zammori (2013) with an intention to derive the probability distribution of the stock consumption and that of the reorder time. These authors further explained that the importance of stock diffusion theory is to assess and evaluate the required inventory levels in theory and practice. There are three considerations of the stock diffusion theory: storage space required; how quickly inventory is sold or used; and how to avoid inventory from becoming outdated before it is used. These considerations can prevent shortages and wasteful spending. In addition, the stock diffusion theory has been confirmed to lower inventory level and has a direct impact on cost savings emanating from storage costs including stock insurance premiums (Nzuza, 2015).

The three main activities in the inventory management include initial data collection which is listing of all equipments in the facility (in the store plus those in service giving areas). The second is information update which is updating the equipment inventory whenever there is any change in information for any inventory item. The third main component is annual audit/review on which the responsible department performs review of all the information about equipment inventory (WHO, 2011).

2.1.4 Transport in the supply chain

Transport is part of the economic activity, which is associated with an increase in the degree of satisfaction of people and businesses by changing the geographical location of goods and people. Transport - means of satisfying needs through transportation of goods and passengers. Transportation - one of the key logistics functions associated with moving goods vehicle on a particular technology in the supply chain, consisting of logistics operations and functions, including forwarding, cargo handling, packaging, and transfer of ownership of the goods, risk insurance, customs procedures, and so on. From an economic point of view, transport is one of the defining elements of the production process. The production and use of goods, there are two limiting factors, the time factor and the spatial factor (Kondratjev, 2015).

The time factor is that the product produced today may only be required after a certain period. Solve this problem by storing. The content of the spatial factor is that the producers and consumers of goods are rarely found in one place, and some distance from each other. Linking production and consumer, transport allows expanding the boundaries of production. Transport itself becomes gradually because the spatial factor - the development of transport and transport technology allows you to build further away from the production sites of consumption goods. Under market conditions, transport is always profitable (Kondratjev, 2015).

Movement of goods a change of location, subject to the principle of efficiency, this process should be economically justified, since the movement of goods spent money, time and environmental resources. Transportation requires financial re-sources - in the form of internal costs for transportation of goods own rolling stock, and external costs for this purpose commercial or public transport. Thus, function defines the main transport its goal - delivery of goods to their destination as quickly as possible, cheaper, and with the least damage to the environment. It is also necessary to minimize the loss and damage of goods transported while fulfilling customer requirements for timely delivery and to provide information about the goods in transit (Kondratjev, 2015).

A study done in Kenya shows that instead of trying to own and operate government fleet of trucks they have contracted a third party transport providers to distribute stock from central to health facilities. Depending on the geography, overall economic situation, maturity of the transport market and structuring of the price and service level contracts, a third party logistics provider can offer better service at rates comparable to the full loaded cost of owning and operating a government fleet (Parashant Y. 2015).

2.1.5 Warehouse in supply chain

Warehousing and storage is an act of storing and assorting the finished goods so as to create maximum time utility at minimum cost .Storage systems are essential elements of logistics systems. They allow you to overcome the temporal, spatial, quantitative and qualitative mismatch between the availability and demand for materials in the production, sale and consumption.

A study done in 2011 in south Sudan on pharmaceutical logistics reveals that many facilities 75% has a separate store assigned for but with inadequate space and many facilities do not adhere to the proper guidelines, many facilities (89%) do not have storage maintaining equipments like thermometer, ventilator, humidity checker even they do not have adequate shelving and storage cabinets (Dick M.*et al*.2011).

2.1.6 Challenges of medical equipment supply chain management practices

According to Henry Q. *et al* (2012) the main challenges that affect supply chain management include: Politics which is explained by the support of the government by promoting when importing and development of different policies which support and promote supply chain management; technology especially for communication and documentation, it also allows suppliers, manufacturers, distributors, retailers, and customers to reduce lead time, paperwork, and other unnecessary activities; Economy(budget availability) is also a challenge to procure and access materials in addition to technology.

Management support is the main facility specific factor which affects supply chain management. It determines the structure, relative man power, and time and resource allocation. The commitment is very important than other internal factors make supply chain responsive because their decision and strategies put effect on hole supply chain (Khizer H. *et al* 2012).

2.1.7 Medical equipment supply chain management efficiency

Efficiency according to Beamon (1998) is the measurement of how well the resources expended are utilized. In general, it describes the extent to which time, effort or cost is well used for the intended task or purpose. It is often used with the specific purpose of relaying the capability of a specific application of effort to produce a specific outcome effectively with a minimum amount or quantity of waste, expense, or unnecessary effort.

Supply chain efficiency is how well the resources are utilized in the Supply chain. The most efficient Supply chain has the lowest possible cost and at the same time meets the customer's expectations on service quality like delivery precision and lead-time (Pettersson, 2008)

According to Goonatilake (1990) and De Meyer et al. (1989) Supply chain is efficient when the hospital avails medical equipment and service at low cost and high quality.

2.2 Empirical Literature review

According to the WHO (2010), currently eighty six percent of the world's population spends $6 per capita on medical equipment as compared to the $290 per capita spent by developed countries.

The study by Chow and Heaver (1994) on drug supply logistic cost reveals that the logistics activities stress around 46% of an average hospital's operational budget; more precisely logistics costs may be split as follows: 27% for the cost of supplies, 4% for time spent by clinical staff on logistics tasks, and 15% for employees assigned to logistics duties (Chow G., and Heaver T.1994).

In a research done on medical equipment's, the most common problem mentioned was a lack of spare parts fifty seven percent, followed by lack of operating and/or service manuals thirty two percent and issues with consumables, either lacking or expired twenty one percent. Not one organization reported that they had received spare parts for every piece of donated equipment. In addition to the lack of spare parts; there was also a distinct lack of support material such as manuals and consumables provided by the donor organizations (Bradley *et al.*, 2016).

Many types of equipment have been procured without a clear medical equipment management plan of how to maintain them to ensure functionality, safety, accuracy and durability. For example, a recent study conducted in an eastern Mediterranean country showed that from 1996 to 2004 the amount the government spent on repairs of medical equipments was more than 2.5 times the amount it would have needed to maintain the

equipment by adopting standard annual inspections and management of maintenance contracts (WHO, 2014).

This lack of medical device oversight has resulted in unregulated donations of devices of questionable quality and utility. The same WHO study found that only forty two percent of countries recommended technical specifications of medical devices to support procurement or donations. Only fifteen percent of countries adhere to WHO guidelines regarding donations, twenty six have developed their own national guidelines and fifty eight percent have no guidelines for donations (Lustick and Zaman, 2011).

The public hospital sector uses a central procurement agency that puts contracts in place for procurement of high volume, commonly used goods and services. These contracts cover about twenty three per cent of total hospital procurement. For the rest hospitals can buy locally, subject to the conditions of the central procurement contracts and policies.Across Victoria, hospitals and health services purchase equipment, services and goods in excess of $750 million per year**.** These items are supplied by more than 2 000 individual vendors and cover in excess of 30 000 items (DR PEARSON, 2011).

Procurement policies and practices in the four public hospitals audited are variable, with instances of poor practice and insufficient transparency. This requires attention because hospitals self-managed procurement accounts for around 77 per cent of the $1.6 billion spent by the sector in 2010–11.The department spent around $145 million funding medical equipment replacement across public hospitals since 2007–08.In addition, a 2009 department review of medical equipment replacement needed in hospitals found around $240 million of medical equipment due for replacement after2010–11 (DR PEARSON, 2011).

There are four types of costs associated with inventory in pharmacy practice: acquisition costs, procurement costs, carrying costs, and shortage costs .Acquisition cost is the net amount of money the pharmacy pays for the products. Procurement costs are costs associated with purchasing the products, which include placing and receiving orders, stocking and paying invoices. Carrying costs refer to costs associated with product storage, which also include costs incurred as a result of crises (Ali, 2011).

ABC Analysis is an inventory control technique in which inventory items are classified into three groups according to their value. Group A: High value items. These are 15-20 percent of the items that account for seventy five percent of the total inventory value (Budget). Items in this category should be monitored regularly. Group B: Medium value items. These are 10-20 percent of the items that account for approximately 20 percent of total value (Budget) and the last which is 60 to 80 percent of items and accounts 5 to 10 percent of budget (Ethiopian FMOH, 2017).

Transport is generally the largest single component of logistics costs. Based on BTRE (2001), Australian gross value added of the transport and storage sector was $34,496 million in 1999-2000, which was 5.6% of GDP.

2.3 Conceptual framework of the study

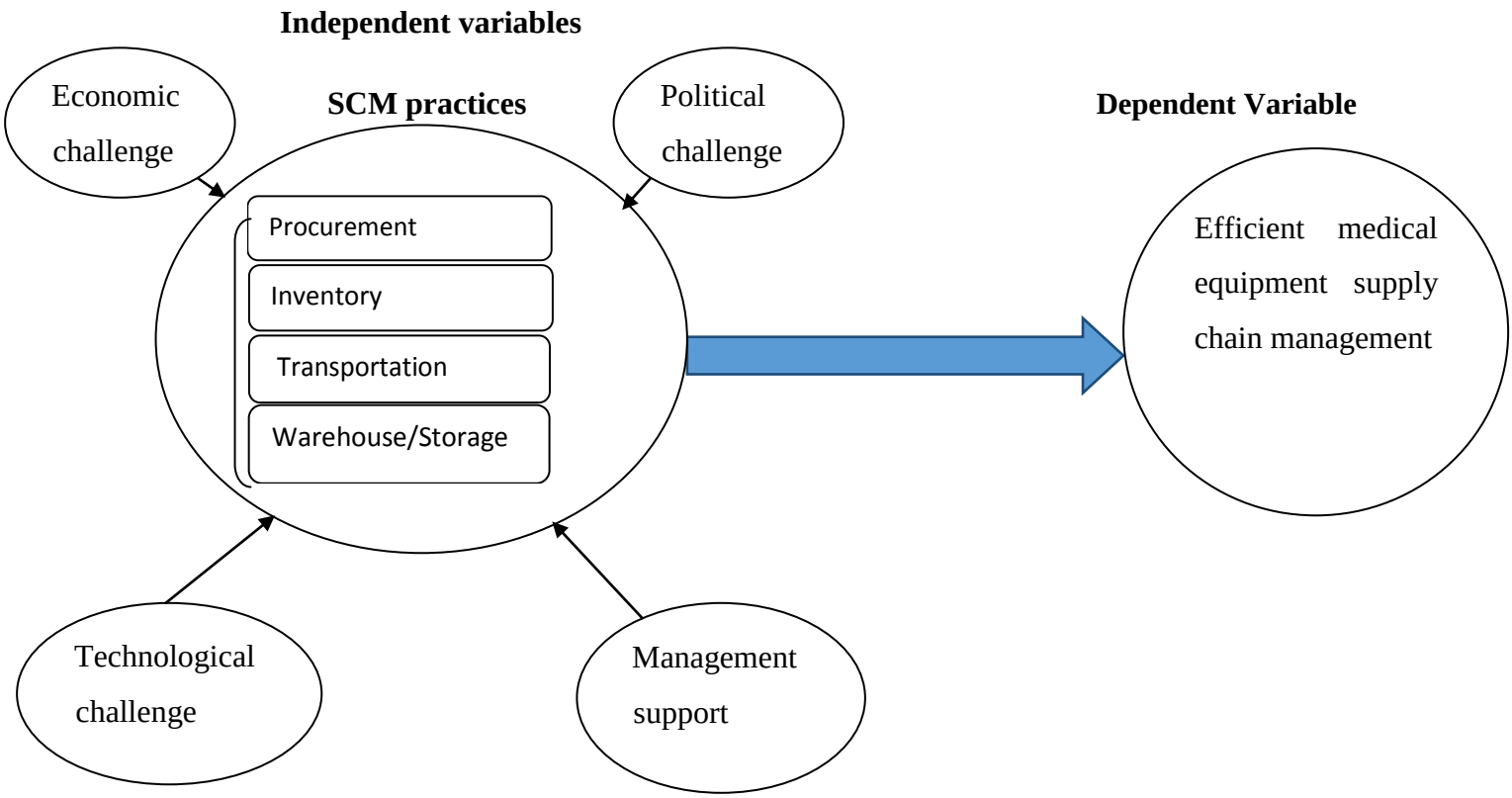


Fig 1: Conceptual framework (self depicted)

2.4 Identified literature gap

Various studies reviewed previously WHO (2014), Diaconu *et al*. (2017), Beyene *et al*. (2016), Dick M.*et al*.(2011) have not adequately indicated extensively the role played by supply chain management in improving the healthcare service in Ethiopia. These studies done on medical equipment are from the point of the manufacturer; they didn't explore challenges of the supply chain practice for medical devices from the facility perspective There is no published paper done in Ethiopia and specifically in Addis Ababa on medical equipment supply chain management.

Most Studies done on medical equipment Beyene *et al.* (2016), WHO (2010), Chow and Heaver (1994) address only one component of the supply chain which makes it difficult to fully understand and recommend the challenges in the medical equipment supply chain management. Medical equipment supply chain management has adversely affected the health sector in Ethiopia and contributed to poor performance. There is therefore great need to investigate further to get a solution.

To the knowledge of the researcher there is no study that have been comprehensively been done on challenges that affect medical equipment supply chain management in the health sector, in particular in Addis Ababa city administration and hence this study intend to fill these gaps.

CHAPTER THREE: METHDOLOGY OF THE STUDY

The types of data used and the methods to be employed to assess medical equipment supply chain management at public hospitals in Addis Ababa regional health bureau had been be dealt in this chapter. To do so issues of the research approach, research design, sampling design, source of data, methods of data interpretation and analysis and interpretation of data including validity, reliability and ethical considerations were addressed.

3.1 Description of the Study Area

The study was conducted in Addis Ababa, the capital city Of Ethiopia. The study was done at the six public hospitals under Addis Ababa city Administration health beauro namely; Yekatit 12 ,Zewditu memorial, Ras desta Damitew, Minillik II, Gandi memorial ,Tirunesh Bejing.

3.2 Research Approach

The Researcher employed both quantitative and qualitative study approaches to analyse medical equipment supply chain management in public hospitals under Addis Ababa city administration. The combination of this approach had had more effect in addressing the data and information in a holistic manner, where the qualitative approach supported the results obtained quantitatively.

3.3 Research Design

Both explanatory and descriptive research design were employed to identify any causal links between variables and to assess different practices of medical equipment supply chain management respectively.

Regarding the time dimension it was cross sectional (a point in time) data was collected, for qualitative part of the study in-depth interview was undertaken with key players in the medical supply management system.

3.4 Sampling Design

The populations of the study are healthcare givers in the six public hospitals under AABH due to the fact that the individual and collaborative work of those professionals has a hand on the medical supply chain management.

3.4.1 Study Population

To conduct the research study target population in general were all pharmacists, store managers, biomedical engineers, laboratory technicians, medical directors, diagnostics technicians (Radiologists), nurses who participate in selection, procurement, inventory management, transportation, warehouse management of medical equipment in public hospitals of Addis Ababa. The total number of Pharmacists, Nurses, Laboratory technicians, biomedical engineers, Radiologists (technicians) is 2231 in the 6 hospitals under AARHB.

3.4.2 Sampling frame

This research would have a sampling frame of pharmacists, store managers, biomedical engineers, laboratory technicians, medical directors, diagnostics technicians (Radiologists), and nurses.

3.4.3 Sampling size

In this study, the suitable formula used by the researcher is Yamane's formula of sample size with an error 5% and with confidence coefficient of 95% (Yamane, 1967)), the calculation has been presented as follows.

Therefore formula used by: Yamane

$n = N/(1+Ne^2)$, Where;

n= estimated sample size,

N = population size, and

e = Margin of error

Table 1: Total number of study population in hospitals under AARHB

Study population	RasDesta	Zewditu	Yekatit	Minillik	Tirunesh Beijing	Ghandi memorial	Total
Medical Directors	1	1	1	1	1	1	**6**
Pharmacist/druggist	31	28	35	31	33	17	**175**
Nurse professional/clinical	248	398	350	300	260	285	**1841**
Laboratory technologist/technician	31	38	34	24	18	16	**161**
Biomedical engineer/technicians	2	5	5	4	3	2	**21**
Radiologists/technicians	9	5	5	2	3	3	**27**
Total	322	475	430	362	318	324	**2231**

Total study population in the six hospitals under AARHB (Obtained From respective HR departments of Hospitals)

n = 2231/ (1+2231(.0.05) (0.05))

n = 339 being the total number of samples, 48 samples were taken purposively, taking 8 from each hospital. The rest 291 were selected proportionally from each hospital and respective departments. To know the sample size of each category, the researcher had used proportion coefficients as follows:

291/2183=13.3%

Table 2: Description of sampling frame

Sampling frame	Number of population	Number of sample size (13.3%)	Data collection tools	Sampling techniques
Ras Desta	**314**	**42**	Closed ended Questionnaire	Simple random
Zewditu	**467**	**62**		
Yekatit	**422**	**56**		
Menilik	**354**	**47**		
Tirunesh Bejing	**310**	**42**		
Ghandi Memorial	**316**	**42**		
Sub- total	**2183**	**291**		
Department heads and medical directors	**48**	**48**	Unstructured and structured Questionnaire	Purposive
Total	**2231**	**339**		

Sampling frame	RasDesta	Zewditu	Yekatit	Minillik	Tirunesh Beijing	Ghandi memorial	Total
Pharmacist/druggist	4	3	4	4	4	2	21
Nurse professional/clinical	33	53	46	40	35	38	245
Laboratory technologist/technician	4	5	4	3	3	2	21
Biomedical engineer/technicians	0	1	1	0	0	0	2
Radiologists/technician	1	0	1	0	0	0	2
Total	42	62	56	47	42	42	291

For qualitative interview respondents were selected purposely from employees. The researcher had taken 8 employees from each process unit. Therefore, total numbers of interviewees were 48, including the medical directors.

3.5 Sampling Technique

To undertake this research the researcher had used both probability and non probability sampling techniques. The rationale to use both types of sampling technique was because of the characteristics of the respondent to be used in this research.

The probability sampling technique had been used to select respondents randomly from the target population. The researcher tried to take samples from each category using simple random sampling technique (lottery method). Because, this technique is important to each element of the population have an equal chance of being in the selected sample and also it is easy to implement and free from subjectivity or personal errors.

For qualitative interview respondents were selected purposely from each hospital (medical directors or deputy directors, Pharmacy heads, Procurement officers from Pharmacy, medical equipment store managers, and biomedical engineering department head ,Diagnostic (radiology) head, laboratory head) were included. Therefore, total numbers of interviewee were forty eight.

3.6 Source of Data

Both primary and secondary sources of data were used to meet the objectives of this research.

3.6.1 Primary Data

Primary data were collected using closed ended questionnaires and through open ended interview guidelines.

3.6.2 Secondary Data

Secondary data were gathered from books, proclamations, research works, reports, manuals, journal articles and internets.

3.7 Data Collection procedure

The researcher used both primary and secondary data collection methods. The Primary data collection method includes questionnaires, interviews and personal observation; whereas secondary data were obtained from various documents such as books, Journals, files and other written reports. In this study, Likert scale questionnaires were adopted from different artciles. Likert scale Alen Bryaman (2012) is a psychological measurement device that is used to gauge attitudes, values, and opinion. The instrument was given to 339 health professionals. Questionnaires were designed using a 5-point scale of strongly agrees coded as 5; agree coded as 4; neutral coded as 3 (which is the middle value of the response); disagree coded as 2, and strongly disagree coded as 1. Moreover, each variable has its own, multiple numbers of questionnaires and aggregated to average to examine the effect of intervening variable and dependent variable. In addition, face to face interview was applied based on interview guidelines with key department heads for the study.

Table 3 Variables and measurement items

Variable/ Factor	**Measurement Items**	**Adopted From**

Variable/ Factor	Measurement Items	Adopted From
Procurement practices	Items are Procured and delivered timely, purchase is based on procurement plan, follow up system for forecasted quantity, good ethical Purchasing practice which contributes for the availabilities of items, VEN/ABC analysis methods are used, maintaining good relationship with suppliers for the timely delivery of items	(Chen et al., 2004); (Krause et al., 2007); (Li et al., 2006) (D R Pearson.2011)
Inventory management practice	Medicines are listed and appropriately documented in the Essential drug list; Availability of Physical inventory is done at least ones per year; availability of list of all medical equipments; Electronic inventory management system is well implemented for proper management of stock; Overall inventory management level of the organization.	(Monicah *etal*.,2013) (Ali, A. K. 2011) (Chen *et al.*, 2004);
Warehouse storage practices	Special storage area for cold chain items; Enough Storage space is Enough to store items; functionalities of Storage equipment; Storage equipment are regularly checked for compliance; Measures in place to ensure pharmaceuticals don't wasted and expired; Existing SOPs that are followed to ensure proper storage	(Prajogo *etal*, 2012); (Monicah *etal*.,2013) (Chen *et al*., 2004)

Variable/ Factor	Measurement Items	Adopted From
Transportation practice	Availability of enough vehicles for transportation: availability of enough vehicles to meet demand for delivery of procured goods; delivery is done within recommended timelines;	(Monicah *etal.*,2013) (Kondratjev,J.2015)
SCM efficiency	Minimum cost of purchased materials; assuring quality of purchased materials; Volume and mix flexibility, on-time delivery of ordered materials to meet customer satisfaction;	(Sanchez-Rodriguez 2009); (Verecke and Muylle,2006); (Prajogo *et. Al*, 2012) (Chen J. 1997)

3.8 Data Analysis Techniques and Presentation

3.8.1 Method of Data Analysis

To analyze data both descriptive and inferential statistics were applied. In order to find answers to the specific objectives, descriptive statistical tool was used to analyze the effect of independent variables on dependent variable, using ratio, mean, and standard deviation. According to Zaidaton and Bagheri (2009), the mean score below 3.39 is considered as low;the mean score from 3.4 up to 3.79 is considered as moderate and the mean score above 3.8 is considered high.

While, inferential statistics such as correlations, and regressions (simple and multiple), were used to find out if there exist significant effect between the determinant factors constructed as the independent variable with efficiency of medical equipment supply chain management constructed as the outcome variable.

3.8.2 Methods of Data Presentation

The result of descriptive statistics was presented by using the tools such as tables, percentages, averages, and charts. Whereas the inferential statistics analysis results were also presented using tables based on the output of SPPSS version 21.

3.9 Model Specification

For valid hypothesis testing and to make data available for reliable results, the test of the assumption of regression model is required. Accordingly, the study had gone through the most critical regression diagnostic tests consisting of, interval/continuous, normality, multi-co linearity, independence observation, linearity and model specification accordingly.

3.9.1 Variable description and model specification for medical equipment supply chain management efficiency

Dependent variable- A variable that we think is an effect or outcome. In this research efficiency of medical equipment supply chain management was a dependent variable, because the value of this variable depends on the cause (independent variables).

Independent variable- A variable that we think is a cause is known as explanatory or predictor (because its value does not depend on any other variables). Hence independent variables were procurement, inventory management, and warehouse and transportation system.

Generally, the model that applied in the analysis provides the extent to which the independent variables affect dependent variable and presented in equation (1) as follows:

$EFF = \beta_0 + + \beta_1 PRO + \beta_2 INV + \beta_3 WARE + \beta_4 TRAN + \varepsilon$ …..……. (1)

Where:

EFF = efficiency of medical equipment supply chain management (dependent variable here)

Independent variables

PRO = Procurement

INV = Inventory

WARE = Warehouse

TRAN=Transportation

ε=error term, which captures other variables not included in the model that affects the dependent variable

β_0 =constant term or slope of the dependent variable

β_1, β_2, $\beta 3$, β_4, estimate regression coefficients: Procurement, Inventory, Warehouse and Transportation respectively.

3.10 Validity and reliability test

3.10.1 Validity Test

Validity refers to the extent to which an instrument can measure what it ought to measure (Kothari,).Research instrument validity is the quality attributed to a proposition or a measure of the degree to which they conform to established knowledge or truth. An attitude scale is considered valid, for example, to the degree to which its results conform to other measures of possession of the attitude. It therefore refers to the extent to which an instrument asks the right questions in terms of accuracy. Here, the research instruments had been in use before by other researchers for other similar studies and they were found to be valid instruments by the researchers. To test validity of the questionnaire, conducted a pilot study with 5 persons from each departments were conducted. The five persons were given to complete the questionnaire and the researcher was available to assist. Moreover the researcher discussed with friends and colleagues to give comment on the format and wording of the questionnaire.

3.10.2 Reliability Test

As proposed by Nunnally (1978), The Cronbach's alpha coefficient was within the acceptable level of reliability of 0.70 for scale acceptability. Table 4, shows the alpha scores for all the variables.

As per the result below , the data were collected from 305 respondents and 24 item scales were assessed using the Cronbach alpha technique. The scale produced an alpha of 75.6 %, which is above the standard threshold level. Therefore the questionnaires were reliable.

Table 4: Cronbach's Alpha Reliability Statistics

Variables	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
All variables entered	.756	.791	24

Source: Survey result, 2018

3.11 Ethical Considerations

In this study the researcher was ethical enough. The dignity, right and secrecy of individuals and institutions were respected. The researcher clarified the reasons and objectives of undertaking this research to respondents. The respondents had known and were assured as nothing would happen on their right and security.

At the beginning of the survey, the enumerators were trained and instructed to explain the purpose of the research to the respondents and to request their verbal consent before conducting the questionnaire. An attempt was also made to ensure the confidentiality of the information that respondents were going to provide and their freedom of terminating the questionnaire /interview at any point and skipping any questions that they would not wish to respond to. Lastly, respondents were also informed that any data they provided would be kept confidential as the analysis is made without mentioning names and the information they provided was not to be used for anything, other than research purpose**.** All other sources of data and ideas were fully acknowledged.

CHAPTER FOUR: RESULTS, DISCUSSIONS AND INTERPRETATION

4.1 Introduction

The main objective of the study was to analyze medical equipment supply chain management of public hospitals under the Addis Ababa regional health bureau.

Accordingly, the research questions, and the hypotheses forwarded was based on objectives that have been already discussed in chapter one. Thus, to answer the research questions and test the hypotheses posed in the study, data have been collected and analyzed with both descriptive and inferential statistics.

Here, the primary data were in the form of structured Likert scale, and collected through self-administered questionnaire. The questionnaire was self-administered to the 339 respondents, of which 305 answered all questions as required. Therefore, the response rate is 90 % percent. Moreover, eight employees from each hospital were interviewed.

This chapter is about the presentation of the data analysis, results and discussion of the findings of the study. Here, the chapter begins by presenting the characteristics of the samples and their responses to the study with the help of descriptive statistics. Therefore, the chapter presents the general background of the respondents of the study with frequency tables so that readers could have some understanding about the characteristics of the study sample. Having discussed on the above-mentioned aspects, the chapter includes detailed discussions on the data analysis results with the help of inferential statistics (correlations, and multiple regressions). As such, the formulated hypotheses of the study have been tested, using inferential statistics. Here, the study findings were presented with the help of statistical tables, and figures. Finally, chapter ends with the discussions and interpretations of the study results based on the research questions and hypotheses.

4.2 Demographic Characteristics of Respondents

Demographic information shows the characteristics of the units in the sample. The researcher used to establish general information of respondents, which forms the basis under the interpretation are made. This part includes the analysis of general background information of respondents based on gender, age, educational level, and income level of respondents.

4.2.1 Sex of Respondents

The researcher sought to find out the gender of the persons filling the questionnaire, and hence was indicated below.

Table 5: Sex Distribution of Respondents

SEX	Frequency	Percent
Male	170	55.7
Female	135	44.3
Total	305	100.0

Source: Survey Data, 2018

The findings indicate that majority of the respondents 170 who filled the questionnaires were male representing 55.7%, where as to 135 or 44.3 % of them being female. The researcher was interested in establishing the age bracket of the respondents.

4.2.2 Age Distribution of Respondents

The researcher was interested in establishing the age bracket of the respondents. Table (4), below, indicates the age distribution of respondents. This information is necessary to enable the researcher to know whether the respondents are young or older people.

Table 6: Age Distribution of Respondents

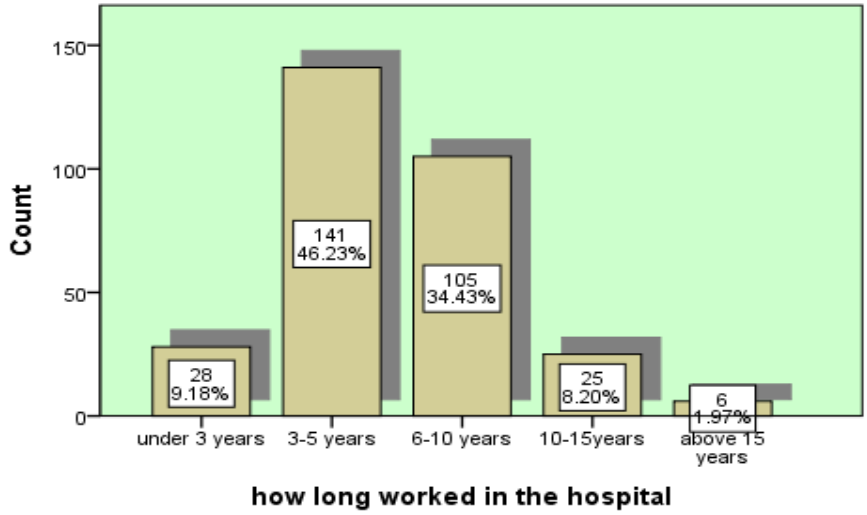
Age	Frequency	Percent
20-30	152	49.8
31-40	138	45.2
above 40 years	15	4.9
Total	305	100.0

Source: field Survey, 2018

The study found out that the majority of the respondents were in the age bracket of 20-30 years. In addition, 138 (45.2%) were in the age bracket of 31-40 years. Coincidentally, the study findings indicate that 15 were above 40 years of age.

4.2.3 Work Experience of respondents

Figure 1: work experience of respondents



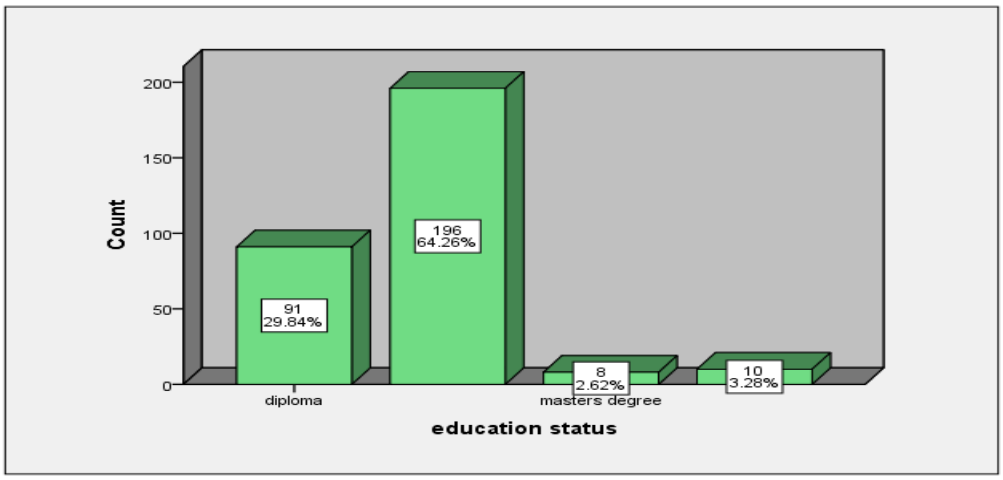
Source: field Survey, 2018

Furthermore, it is evident from the Fig. 1 that most of the respondents 141 (46.2%) had work experience of between 3-5 years, while 105 (34.43%) of the employees have served the respective offices for 6-10years.Moreover, 28 (9.18%) were under 3 years and 6 (1.97%) were at age of above 15 years. It is the researcher's belief that these combinations of respondents were good enough in finding the real information, since medical equipment supply chain management was executed at each level of experience, which gave the opportunity to them in reflecting their opinion on medical equipment supply chain management achievement and have a clear understanding on the current practices public hospitals.

4.2.4 Educational level of respondents

This part includes the analysis of general background information of respondents based on educational level.

Figure 2: Educational Level of Respondents

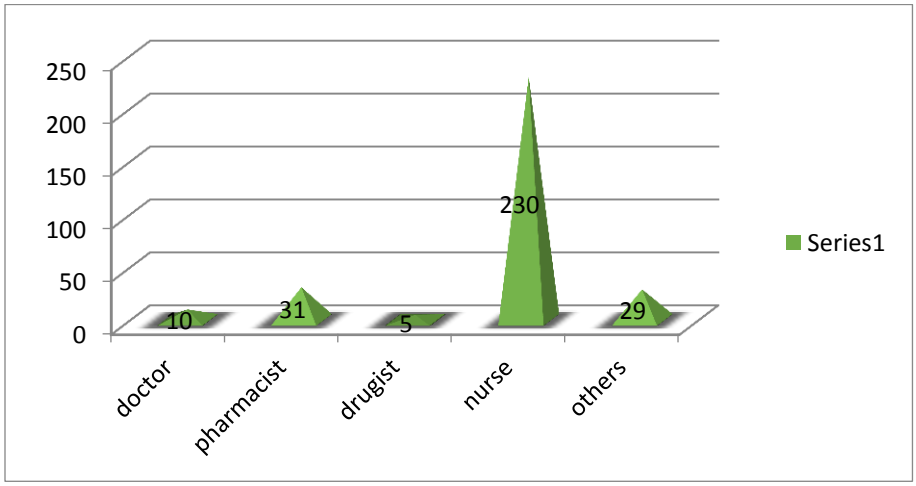


Source: Survey Data, 2018

As indicated in Fig 2, more than half of respondents (64.26%) have first degree while 29.8 % of respondents were diploma holders and 2.62 % were master's degree holders. The rest (3.26 %) were specialists. This indicates that respondents have a good understanding of the questions about the study.

4.2.5 Professional Background of Respondents

Figure 3**:** Professional Background of Respondents



Source: field Survey, 2018

As it is presented in the Fig. 3 above, majority of the respondents 230 (75.4%) were nurses. while 31 (10.2 %) are Pharmacist, and 10(3.3 %) were also doctors. 5 (1.64%) were also druggists. The remaining 29 (9.5%) are other staffs. This may assure that the respondents are the right persons to provide information pertaining to the topic investigated.

In general the characteristics of respondents' show the study is represented by those are educated and experienced in judgment of the questionnaires as well as the subject matter. As the result, it is the researcher's opinion that the subject area is well interpreted by respondents those helping to capture the feeling of all representative staffs that assure the accurate data have been predetermined from the respondents.

4.3 Descriptive Statistics on analysis of Medical Equipment Supply Chain Management

Descriptive statistics are brief descriptive coefficients that summarize a given data set, which can be either a representation of the entire or sample population. Descriptive statistics are broken down into measures of central tendency and measures of variability (spread). The editing and coding phase was followed by descriptive analysis of the sample. Participants were asked about efficiency of medical equipment supply chain management. Data for the survey study were collected from the target by means of self- administered questionnaire. 24 close ended questionnaires were used so that, the variables can be averaged to measure the degree of their agreement or the disagreement of the respondents, moreover open ended questionnaires and interview were used to triangulate the entire study.

4.3.1 Procurement practices of Medical Equipment

Table 7: Summary of responses on Procurement of medical equipments

	Procurement of Medical equipment		1(SD)	2(D)	3(N)	4(AG)	5(SA)	Mean	SDV
1	Medical equipment requested and delivered timely	Frequency	172	122	4	6	1	1.50	0.66
		%	56.4	40	1.3	2	0.3		
2	The facility have good working relation with suppliers	Frequency	217	86	0	1	1	1.30	0.52
		%	71.1	28.2	0	0.3	0.3		
3	There is ABC/VEN classification of medical equipment for procurement and budget allocation	Frequency	155	142	0	6	2	1.55	0.67
		%	50.8	46.6	0	2	0.7		
4	Local suppliers' services are satisfactory to the facility	Frequency	217	79	4	5	0	1.33	0.59
		%	71.1	25.9	1.3	1.6	0		
5	Procurement is being processed based on procurement plan	Frequency	197	97	6	5	0	1.41	0.62
		%	64.6	31.8	2	1.6	0		
6	There is appropriate forecasting & follow up to procure efficiently and effectively	Frequency	194	96	11	4	0	1.43	0.63
		%	63.6	31.5	3.6	1.3	0		
	Total Composite mean							1.42	0.62

Sources: Field survey, 2018

1 = strongly disagree(SD); 2 = disagree(D); 3 = Neutral(N); 4 = agree(A); and 5 = strongly agree(SA).

As shown in the above table 5, respondents were asked whether Medical equipment requested and delivered timely or not. In this regard majority 294 (96.4%) respondents assured that there was no timely request and delivery of medical equipment in their respective organization**.**

Respondents were also asked to give their opinion whether the facility have good working relation with suppliers or not. In this regard 303 (99.4%) of respondents strongly disagreed

about the existence good working relation with suppliers, while 2 (0.6%) respondents were replied positively.

Respondents in the interview assure that their main supplier to medical equipments is PFSA, but 99.4 % disagree for having good relationship with the agency.

Having good Supplier-buyer relationship, emphasizes that suppliers have an important impact on the overall performance and/or competitiveness of organizations, not only through minimizing costs, but also through joint product, service and process development, as well as continuously improving quality across all supply chain levels (Lamberts D.2008). By concentrating on establishing and developing long term relationships the costs of initial set up for large contracts with deals taking many months to complete can be offset, with both parties actively looking to avoid any unnecessary costs which may arise from retendering, re negotiating or being forced to exit an existing contract early.

Respondents in the interview explain that *"We have agreements with PFSA to procure for credit and to pay when we can in the working physical year, but the agreement is only about the payment issues. It doesn't have any article which explains about maintenance of medical equipments. The agency may have an agreement with the company but we don't have information what their agreement is on installation, training, and maintenance. Because of this we are in trouble to fix when our equipments impaired to give service, we will communicate PFSA, and sometimes agents of the company but it depends on their goodwill to fix the problem as fast as we need. This is mainly because we don't have clear direct agreement with the agents of the company and also with PFSA"*

An important phenomenon related to buyer-supplier relationships is that many buyers are developing single source suppliers because of the pressure to increase quality, reduce inventory, develop just in time systems, and decrease time to market .The ultimate goal in developing these capabilities is to reduce costs (David T.Willison.1995).

Though it is a good idea to establish a single source supplier, it has also bad consequences if the supplier is not potentially fit. The researcher believes that PFSA is not potentially fit to answer the demands of hospitals.

Hospitals under AARHB do not have good relationships with their main supplier PFSA and also with other suppliers. This will contribute to have low quality and high cost medical equipments. Due to lose buyer-supplier relationships minor impairments will also be difficult to fix (due to lack of adequate training by professionals, and lack of experts) and contribute to service interruptions and financial expenses to fix or buy new medical equipments.

Pertaining to existence of ABC/VEN classification of medical equipment for procurement and budget allocation, the majority of respondents 297 (97.2%) replied that there was no ABC/VEN classification of medical equipment for procurement and budget allocation.

Moreover; respondents were asked whether local suppliers' services are satisfactory to the facility in their respective organizations. In this case, almost all respondents 296(97.1%) assured that local suppliers' services were not satisfactory to the facility.

The respondents were asked about the existence of procurement plan and is being processed based on procurement plan.Almost all 294 (96.4%) of respondents strongly disagreed about the issue, whereas 11 (3.6%) of respondents were replied positively.

Respondents were also asked to give their opinion whether there is appropriate forecasting & follow up to procurement efficiently and effectively. In this regard 290 (96.1%) of respondents strongly disagreed and disagreed about the existenceappropriate forecasting &follow up to procurement efficiently and effectively, while 11 (3.6%) respondents were neutral and 4 (1.3%) were agreed about the existence of appropriate forecasting and existence of follow up to procurementefficiently and effectively.

As explained from interviewee with pharmacy head and those assigned to follow the procurement, the major problem for not procuring quality equipments is the procurement policy of the government which uses price as the major criteria for procurement. This is a similar challenge with the practice in Mexico as shown below.

In Mexico, price of medical equipments is often the ultimate criteria in selection and contracting phase of procurement. The study indicates that many stakeholders thought this detrimental to clinicians, clinical procedures and outcomes. For them, this focus on buying at the lowest price was the root of the problem (Myriam L, *et al.*, 2016).

As explained by interviewees on the procedure to select supplier, it's mandatory by the government low to purchase from PFSA without comparing with other suppliers on any criteria; hospitals are allowed to buy from other suppliers if it is out of stock from PFSA.*"We will buy from PFSA even those products having higher prices when compared to other suppliers"* but as most respondents explained by interview they believe that since PFSA is expected to cover the demand of the country as a whole most medical equipments requested are not available. They explained also that there is a delay even more than years to buy medical equipments from PFSA after making order and paying 60% of the total payment. Due to this they prefer to use private suppliers for procurement if the equipment is not available from PFSA. This is in line with the study in Mexico on which the purchase demand is regrouped at regional and sometimes national level by ministry of health to increase the purchase power which makes the procurement process more bureaucratic. On the other hand European countries like Switzerland procurement is entirely left to hospitals (Myriam L, *et al*., 2016).

The interviewee raise their concern about forecasting as *"There is annual forecasting done based on the specification and item list of the main governmental supplier PFSA, but it's only on paper, we didn't procure what we forecast and the agency also used the forecasted data as an input to procure not as a request to be procured*". This happens mainly due to the input or data used for forecasting is poor because they don't have appropriate inventory management system which would produce data for forecasting demand.

4.3.2 Inventory management of Medical Equipment

Table 6: summary of responses on inventory management

	Inventory management of medical equipments	%	SDA	D	N	A	SA	mean	SDV
1	Medical equipment acceptance SOP are Available and clearily defined	Freq.	148	149	4	4	0	1.55	0.59
		%	48.5	48.9	1.3	1.3	0		
2	All medical equpments available in the facility are listed and appropraitly documented	Freq.	141	148	4	11	1	1.63	0.72
		%	46.2	48.5	1.3	3.6	0.3		
3	The medical equipment management committee is well functional to manage the inventory	Freq.	111	170	3	20	1	1.79	0.79
		%	36.4	55.7	1	6.6	0.3		
4	Poor record keeping(Bin card, stock card, model 19, model 22)	Freq.	58	125	9	112	1	2.58	1.18
		%	19	41	3	36.7	0.3		

	Inventory management of medical equipments	%	SDA	D	N	A	SA	mean	SDV
5	Electronic inventory management system is well implemented	Freq.	36	238	12	19	0	2.05	0.63
		%	11.8	78	3.9	6.2	0		
6	Manual inventory management system is well implemented	Freq.	63	32	8	175	26	3.23	1.34
		%	20.7	10.5	2.6	57.7	8.5		
7	Physical inventory is done quarterly	Freq.	158	124	7	9	6	1.62	0.84
		%	52.1	40.7	2.3	3	2		
	Total composite mean							2.06	0.87

Sources: Field survey, 2018

1 = strongly disagree(SD); 2 = disagree(D); 3 = no answer(N); 4 = agree(A); and 5 = strongly agree(SA).

From the table above there is respondent agreement level on each variable regarding analysis of medical equipment supply chain management in hospitals of AARHB. Accordingly, Most of the respondents were not strongly agree for most variables. For example no respondents strongly agree with the statement of "Medical equipment acceptance SOP is Available and clearly defined, electronic inventory management system is well implemented".

Respondents answer explain on interview that all hospitals under the study there is electronic inventory management system which is called HCMIS (health commodity management information system) a data base by the support of partners but the data base is use for medications and supplies. In our finding 89.8% did not agree for having electronic data management system for medical equipments. Electronic data management system helps to improve information flow and decision making across the supply chain. It enhances information content, accuracy, ease data management to overcome problems encountered in public sector supply chains (Prashant Y. 2015).

A frequency of 48.5 % strongly disagrees and 48.9 % disagree for having a clearly defined medical equipment acceptance standard operating procedure. 46.2 strongly disagree and 48.5 % disagree that all medical equipment available are listed and appropriately documented. 92.1 % of the respondents disagree that the medical equipment management committee is well functional to help in managing the inventory.78 % agree that electronic inventory management system is not well implemented.

From the table we understand that most respondents were disagreed and strongly disagreed on the statements listed in this category. But most (66.2%) agreed that manual inventory management system is well implemented.

From the interview all hospital pharmacy departments replied as if they have physical inventory at least once per year but the inventory is limited to medical equipments in the store .Medical equipments which are giving service are not included in the inventory. This shows that medical equipments in the facility are not all recorded and managed appropriately. This is against the WHO recommendation; in order to have effective inventory management system; the inventory should be updated whenever there is any change in or addition of information and during annual audits and reviews. The three main activities in the inventory management include initial data collection which is listing of all equipments in the facility (in the store plus those in service giving areas). The second is information update which is updating the equipment inventory whenever there is any change in information for any inventory item. The third main component is annual audit/review on which the responsible department performs review of all the information about equipment inventory (WHO, 2011).

It is critical to know the rate at which medical equipments are being consumed (to predict the service year of large medical equipments) at each hospital in order to create resupply processes that can guarantee the highest level of service and minimize service interruptions. But practically in hospitals under the study, there is no adequate information about medical equipments in the service giving units. One interviewee confirms this “We made annual inventory of store on June 30, every year and report the items with quantity, batch number and expiry date if they have .This finding is indeed in line with Currently in most countries there are no processes by which information about consumption is systematically captured. Often information on stock outs is captured through surveys which fulfill an important objective for evaluation but do not provide continuous information feedback that is required for supply chain planning. in the absence of periodic stock out and consumption information, supply chain planning is conducted based on estimates from outdated assumptions (Prashant Y.)

4.3.3 Transportation management practices of medical equipments

Table 8: summary of responses on transportation management practices of medical equipment

	Transportation		SDA	DA	N	A	SA	mean	SDV
1	There are enough Vehicles for transportation of medical equipment	Frequency	209	88	2	4	2	1.37	0.64
		%	68.5	28.9	0.7	1.3	0.7		
2	Delivery is done within recommended timelines	Frequency	178	122	3	2	0	1.44	0.56
		%	58.4	40.0	1.0	0.7	0		
3	Safety of medical equipment is protected as required during transportation	Frequency	181	114	8	1	1	1.45	0.60
		%	59.3	37.4	2.6	0.3	0.3		
4	Transportation practices of medical equipment are satisfactory	Frequency	201	98	3	2	1	1.37	0.58
		%	65.9	32.1	1.0	0.7	0.3		
	Total composite mean							1.41	0.59

Sources: Field survey, 2018

1 = strongly disagree(SD); 2 = disagree(D); 3 = no answer(N); 4 = agree(A); and 5 = strongly agree(SA).

A frequency of 209 **(**68.5 %) of the respondents strongly disagreed for having enough vehicles for transportation of medical equipment. 54.8% disagree on delivery is done within recommended timelines .In addition 59.3% disagree on that Safety of medical equipment is protected as required during transportation. Finally 65.9% of respondents strongly disagree on the statement 'transportation practices of medical equipment are satisfactory'.

Respondents were asked to indicate their view on questions about transportation management in their hospital. In this regard, the survey outcome reveals that nearest to strongly disagreed points (1.45).This indicates the transportation management is very poor in hospitals of AARHB.

Lack of public sector transport is a key barrier for medical equipment supply chain. The availability of vehicles is often limited due to lack of budget, poor maintenance and inappropriate use. The interviewee explains that they have shortage of vehicles even for ambulance service. They are giving solution to their problems by negotiation with the supplier and rent of car for specific transportation. Against to the finding a study done in Kenya shows that instead of trying to own and operate government fleet of trucks they have contracted a third party transport providers to distribute stock from central to health facilities. Depending on the geography, overall economic situation, maturity of the transport market and structuring of the price and service level contracts, a third party logistics provider can offer better service at rates comparable to the full loaded cost of owning and operating a government fleet (Parashant Y. 2015).

4.3.4 Warehouse management practices of medical Equipment

Table 9: summary of responses on warehouse management

	Warehouse practice on Medical Equipment Supply Chain Management		SDA	DA	N	A	SA	mean	SDV
1	Appropriate storage space is available within the facility	Freq.	212	85	1	5	2	1.36	0.65
		%	69.5	27.9	0.3	1.6	0.7		
2	Storage equipment are Fully functional	Freq.	75	184	4	40	2	2.05	0.92
		%	24.6	60.3	1.3	13.1	0.7		
3	Storage equipment are regularly checked for compliance	Freq.	78	188	4	32	3	2.00	0.88
		%	25.6	61.6	1.3	10.5	1.0		
4	Existing SOPs that are followed to ensure proper storage	Freq.	207	83	5	4	6	1.42	0.77
		%	67.9	27.2	1.6	1.3	2.0		
	Total composite mean							1.71	0.81

Sources: Field survey, 2018

1 = strongly disagree(SD); 2 = disagree(D); 3 = no answer(N); 4 = agree(A); and 5 = strongly agree(SA).

A frequency of 69.5% of respondents strongly disagree that appropriate storage space is available within the facility and 60.3% of the respondents disagree storage equipment are fully functional. 61.6% of respondents disagree on storage equipment are regularly checked for compliance.67.9% of respondents strongly disagree on the presence of SOPs to be followed to ensure proper storage

In line with this study a study done in 2011 in south Sudan on pharmaceutical logistics reveals that many facilities 75% has a separate store assigned for but with inadequate space and many facilities do not adhere to the proper guidelines, many facilities (89%) do not have storage maintaining equipments like thermometer, ventilator, humidity checker even they do not have adequate shelving and storage cabinets (Dick M.*et al*.2011).

As we can see from the mean value of the respondent's response, among four warehouse management measurement items, all the measurement items were below disagreed points as shown in the table. This implies that warehouse management in hospitals of AARHB is poor or contribute a lot to make the medical equipment supply chain management inefficient.

4.3.5 Challenges of medical equipment supply chain management

A frequency of 230(75.4%) of respondents strongly agree that lack of technologies like different SCM software's affects procurement and 225(73.8 %) strongly agree that lack of technologies affect inventory management. While 155(50.8 %) disagree the effect of technology on warehouse and 182(59.7%) strongly disagree its effect on transportation management.

A frequency of 213(69.8%) of respondents strongly agree that lack of updated and appropriate policies and procedures of the government affect procurement on the other hand a frequency of 209(68.5%) disagree on the effect of lack of updated and appropriate policies and procedures of the government on inventory management, 164(53.8%) disagree its effect on storage practice, 179 (58.7%) disagree its effect on transportation management.

Majority of the respondents 97.1% agree that lack of enough budgets affects procurement.95.1% of respondents agree that lack of budget affects warehouse management and 97.7% agree that lack of budget affects transportation management. On the other hand 64% of respondents disagree that lack of enough budget affects inventory management.

Regarding the little support from top management towards improving supply chain management the mean value shows that respondents strongly agree (mean 4.5) to procurement and agree (mean 4.4) to inventory management, storage and transportation management. This is in line with Khizer *et al* (2012) which strongly explain the effect of top management support (because of their decisions and strategies) to the overall efficiency of supply chain.

Regarding the challenges of medical equipment supply chain management the interviewee explains that *"Supply chain management is a huge department which needs multidisciplinary team participation. But almost all activities in supply chain management in hospitals of AARHB are vested on pharmacy department. In addition even from the pharmacy department it is not a case team with coordinator and members whose primary duty is to work on supply chain. The participation of different departments in different activities of the supply chain is too low*".

Biomedical engineers in the interviewee explains that *'the challenge in medical equipment supply chain management starts at procurement, they didn't involve us in setting specifications due to this some medical equipment are not working from the begging due to different reasons ,some impaired when they start to use due to inappropriate electric power, most equipment become out of use due to careless handling by professionals, and lack of preventive maintenance, overload above the capacity of the equipment, and we engineers do not have enough trainings to do preventive maintenance for most and to fix when impaired".*

no	Challenges		Procurement practice					Inventory management					Warehouse and storage practice					Transportation practice				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	Lack of technologies like different SCM software's affects	Feq.	4	5	3	63	230	4	10	2	64	225	128	155	3	11	8	182	101	4	9	9
		%	1.3	1.6	1.0	20.7	75.4	1.3	3.3	0.7	21	73.8	42	50.8	1	3.6	2.6	59.7	33.1	1.3	3	3
		Mean	4.67					4.63					1.74					1.56				
		S.dv	0.71					0.78					0.86					0.89				
2	Lack of Updated and appropriate Policies and procedures of the government	Feq.	0	5	4	83	213	66	209	5	15	10	121	164	6	10	4	179	108	7	6	5
		%	0	1.6	1.3	27.2	69.8	21.6	68.5	1.6	4.9	3.3	39.7	53.8	2	3.3	1.3	58.7	35.4	2.3	2	1.6
		Mean	4.65					1.99					1.73					1.52				
		S.dv	0.59					0.85					0.77					.78				
4	Lack of enough budget	Feq.	1	4	4	64	232	35	160	6	64	40	4	6	5	117	173	0	3	4	141	157
		%	0.3	1.3	1.3	21.0	76.1	11.5	52.5	2	21	13.1	1.3	2	1.6	38.4	56.7	0	1	1.3	46.2	51.5
		Mean	4.7					2.72					4.47					4.48				
		S dv	0.59					1.28					0.75					0.58				
5	There is little support from top management towards improving	Feq.	0	11	7	80	207	6	12	5	109	173	3	8	7	126	161	1	10	3	143	148
		%	0	3.6	2.3	26.2	67.9	2	3.9	1.6	35.7	56.7	1	2.6	2.3	41.3	52.8	0.3	3.3	1	46.9	48.5
		Mean	4.58					4.4					4.4					4.4				
		Sdv	0.71					0.87					0.75					0.71				

Table 10: summary of challenges on medical equipment supply chain management

1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree **Source:Survey result,2018**

4.3.6 Efficiency of medical equipment supply chain management

The efficiency of medical equipment supply chain management was the dependent variable being measured. The mean value for the statement "The total cost of medical equipment supply chain management is low" is 1.42 which shows that almost all of the respondents strongly disagree for low cost supply chain management.

In line with our finding a quantitative study done in Ghana on estimating the cost of logistics shows that the transportation costs at the hospital level are both very high and much higher than they should be (20%); Storage is the largest cost (70%) for the supply system and should be a target for cost reduction. Procurement also costs very high (10%).A study by Huff R, *et al* (2002) revealed that these three dimensions are the major determinants of supply chain cost.

The mean value for the statement "medical equipment procured at enough quantity (volume and mix)" is 1.5 which shows respondents disagree for having enough quantity medical equipments. With respect to quality the mean value 1.62 shows that the quality of medical equipments procured are not good. The mean value of all measurements shows that there is no efficient and effective supply chain management in hospitals of AARHB.

The study shows that our Supply chain cost is high which is in line with the study by Chow and Heaver (1994) on drug supply logistic cost reveals that the logistics activities stress around 46% of an average hospital's operational budget; more precisely logistics costs may be split as follows: 27% for the cost of supplies, 4% for time spent by clinical staff on logistics tasks, and 15% for employees assigned to logistics duties (Chow G., and Heaver T.1994).

Table 11: efficiency of medical equipment supply chain management

	Efficiency		SDA	DA	N	A	SA	mean	SDV
1	Total cost of medical equipment supply chain management is low	Freq.	207	83	5	4	6	1.42	0.77
		%	67.9	27.2	1.6	1.3	2		
2	Medical equipment procurement is of enough quantity(volume and mix)	Freq.	179	111	4	9	2	1.5	0.73
		%	58.7	36.4	1.3	3	0.7		
3	Medical equipment procured are of high quality	Freq.	159	124	7	9	6	1.6	0.84
		%	52.1	40.7	2.3	3	2		
	Total composite mean							1.50	0.78

1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

Source: Survey result, 2018

4.4 Advanced Data Analyses

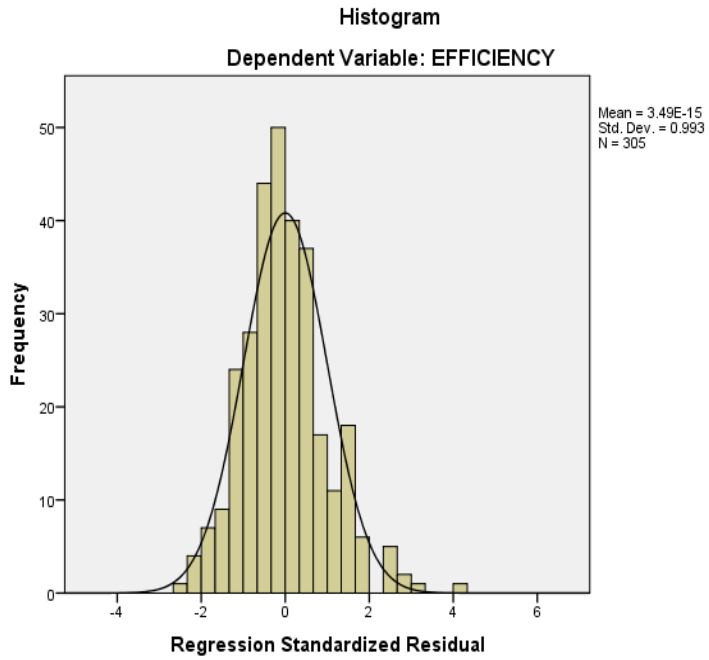
4.4.1 Test of Assumptions

Parametric inferential tests are carried out on data that follow certain parameters: the data should be normal, data should be at least in interval/continuous level, independent samples, and furthermore, the samples should not be multi-collinear, and linearity assumptions should be fulfilled. Reliability and validity tests were also have been checked. Unless these assumptions are fulfilled, it cannot be possible to go forward. Instead it needs to go to searching other testing mechanisms such as non- parametric statistical methods. Hence before conducting such tests this criterion should be assured and the tested variables revealed that all assumptions were almost fulfilled.

4.1.1.1 Normality Test/ Test for Normal Errors

When we take the analysis data in inferential statistics like multiple regressions the value should be in a normal distribution across the samples. This means errors are normally distributed and that a plot of the value of the residuals will approximate a normal curve (Kothari, 2004).After completing the model and the parameters, the results indicate that they fitted a model and the model assumptions bias needs to be checked. This is done in three ways: the histogram, the normal probability plot and the Zresid vs. Zpred scatter plot. The best way to evaluate how far the used data are from a Gaussian (normal) is to look at a graph and see if the distribution grossly deviates from a bell-shaped normal distribution. the histogram looks symmetric and the normal p-p plot showed fairly consistent with that of the line and the residuals are normally distributed. Therefore, according to these findings this assumption was fulfilled (see the following graph).

Figure 4: Model Assumptions of Histograms



Source: Survey result, 2018

4.1.1.2 Test of Multi-Co Linearity

Multi-co linearity means that there is a linear relationship between the explanatory variables which may cause the regression model biased (Kothari, 2004).

In order to examine the possible degree of multi-Co linearity among the explanatory variables, Variance Inflation Factor (VIF) technique is also employed to detect the problem. Theoretically, a VIF greater than 10 suggest that the concerned variable is multi-collinear with others in the model and may need to be excluded from the model (Robert B. Burns and Richard A. Burns, 2008). But in the case of this study, the VIF result of SPSS output in Table 14, below(multiple regression analysis section) Indicated that, as none of the VIFs is excessively high, (it is between1.045and 1.388), suggests that there is no perfect or strong Co- linearity between the explanatory variables. So this assumption is fulfilled.

4.1.1.3 Test for Interval Level/ Continuous Scale Data

To robustness of parametric statistical analysis, data should be measured by continuous interval level (Kothari, 2004). The researcher was used a five level Likert scale to measure each variable. Then each variable consists of the sum of many items averaged to give the mean score. Since the data were created by calculating a composite score of mean from multiple items than a single mean for procurement, inventory, warehouse, and transportation. Therefore a series of multiple items was averaged and used to test dependent, and independents, meaning, numbers can be added, subtracted, multiplied and divided. Hence these assumptions were fulfilled.

4.1.1.4 Independence Observation

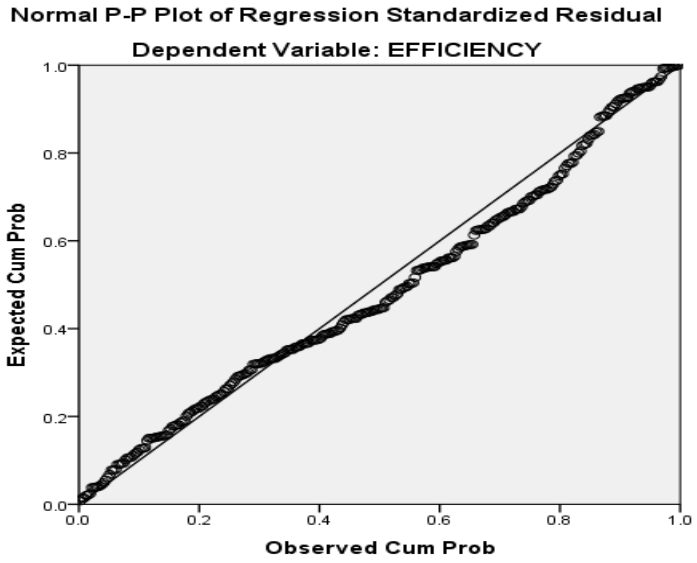
Two observations are independent if the occurrence of one observation provides no information about the occurrence of the other observation. In other words, it is the correlation between errors. The independence observations are tested by Durbin-Watson coefficient (Robert B. Burns and Richard A. Burns, 2008). The test statistic coefficient should be between 1.5 and 2.5, which mean residual are uncorrelated. As indicated in table 13 below (multiple regression, ANOVA table), the Durbin-Watson coefficient was 1.544. Therefore, this assumption is fulfilled.

4.1.1.5 Test of linearity

Simple linear regression is based on finding the straight line on a scatter graph that fits the scatter points best, i.e. as closely possible (Robert B. Burns and Richard A. Burns, 2008). Regression procedures assume that the dispersion of points is linear. Where the amount of scatter around the line varies markedly at different points and forms a pattern, then the use

of regression is questionable. As we can see from the output graph below, the regression line sloping from bottom right to top left, which indicates a positive relationship between the dependent and independent variables. Moreover; The P-P plots look like a diagonal line; dots lie almost exactly along the diagonal line. Therefore, this assumption is fulfilled

Figure 5: Model Assumptions of linearity



Source: Survey result

4.1.2 Correlation Analysis between Independents and dependent Variable

Correlation analysis was performed to obtain initial insight into the directionality and significance of relations among the variables of independents with efficiency. This study employs the Pearson correlation which measures the linear association between two metric variables (Robert B., Richard A.2008).The test also indicates the strength of a relationship between variables with a value that can range from -1.00 to 1.00; when 0 indicates no relationship, -1.00 indicates a negative correlation, and 1.00 indicates a perfect positive correlation (Pallant, 2010). For the rest of the values is a small correlation for value 0.1 to 0.29, medium correlation of 0.3 to 0.49, high correlation for 0.50 to 1.0 (Pallant, 2010).

The correlation between efficiency of medical equipment supply chain management with procurement, as it was indicated in the table below showed there exist positive medium correlation between (r=.415 and p (.000) <0.05)).

On the other hand, the correlation between efficiency of medical equipment supply chain management with inventory was small and positive correlation (r= .249and p=0.000).This shows that a change in efficiency with inventory changed in the same direction. In addition, the relationship between efficiency of medical equipment supply chain management with transportation management is statistically significant at a p value of (0.000) with highly and positively correlated (.599). Besides this the correlation between efficiency of medical and warehouse was medium and positive (0.451).

Generally, all variables were correlated positively with efficiency, even though their correlation strength varies from highly correlated (transportation) to low correlation (inventory).

Table 12: Correlation Matrix between Variables

		PROCUREMENT	INVENTORY	TRANSPORT	WAREHOUSE	EFFICIENCY
PROCUREMENT	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	305				
INVENTORY	Pearson Correlation	.105	1			
	Sig. (2-tailed)	.067				
	N	305	305			
TRANSPORT	Pearson Correlation	.387**	.205**	1		
	Sig. (2-tailed)	.000	.000			
	N	305	305	305		
WAREHOUSE	Pearson Correlation	.256**	.102	.419**	1	
	Sig. (2-tailed)	.000	.075	.000		
	N	305	305	305	305	
EFFICIENCY	Pearson Correlation	.415**	.249**	.599**	.451**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	305	305	305	305	305
**. Correlation is significant at the 0.01 level (2-tailed).						

Source: Survey result, 2018

4.1.3 Regression Analysis

4.1.3.1 Multiple Regression Analysis of medical equipment supply chain management

Cohen *et al* (2011) argues that there are some assumptions that need to be met in order to make sure that the regression model has a strong fit. This study as indicated above, data met these assumptions as follows: the measurements are from a probability-based sample, data are collected by Likert scale which is considered as interval, there are no extreme outliers, there is an approximate linear relationship between the dependent variable and the independent variables, the dependent variable is approximately normally distributed and data values are independent of each other, there is no multi co linearity between variables.

Regression analysis was conducted to know by how much the independent variable explains the dependent variable and to see the significance of each variable. A standard multiple regression was performed between overall efficiency of medical equipment supply chain management as the dependent variable and procurement, inventory, transportation, and warehouse as independent variables.

As clearly indicated in methodology part, the regression equation took the following form:

$Y= \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \varepsilon$

Where,

Y = Efficiency (EFF)

$\beta0$ = constant term

$\beta1, \beta2, \beta3, \beta4,$ = estimated coefficients

X1 = Procurement (PRO)

X2 = inventory (INV)

X3 = Transportation (TRAN)

X4= warehouse (WARE)

In the model, $\beta0$ = the constant term while the coefficients were used to measure the sensitivity of the dependent variable (Y) to a unit change in the predictor variables. ε is the error term which captures the unexplained variations in the model.

The SPSS output of regression result is divided into three panels. The top sub table summarizes the model summary to the regression, the middle sub table discussed ANOVA, indicates the overall significance. Moreover, the third gives information about each regression coefficient. The results were illustrated in table 14 below.

Table 13: model summary (a) independent variables as predictors to efficiency of medical equipment supply chain management

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.673[a]	.452	.445	.42243	1.544

Source: Survey result 2018

Table 14: ANOVA (b) independent variables as predictors to efficiency of medical equipment supply chain management

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	44.205	4	11.051	61.929	.000[b]
	Residual	53.534	300	.178		
	Total	97.739	304			
a. dependent variable: efficiency						
b. predictors: (constant), warehouse, inventory, procurement, transport						

Source: Survey result, 2018

Based on the model summary and ANOVA table the researcher had found the following findings.

I. The Fit of the Regression Model

As indicated above in both tables 13 and 14 the fit of the regression model can be evaluated by two things: the Model Summary table and ANOVA table. The model summary table provides the R, R2, adjusted R2, and the standard error of the estimate, which can help in determining how successful the model is in predicting the outcome (Cohen *et al* 2011). R can be considered as one measure of the quality of the prediction of the dependent variable relationship of the independent variables. However R square tends to somewhat over-estimate the success of the model when applied to the real world, so an adjusted R square value is calculated which takes into account the number of variable in the model and the number of observations our model is based on. The adjusted R square value gives the most

useful measure of the success the model. The adjusted R square is medium indeed (0.445), indicating that 44.5 % of the variance in the dependent variable is explained by the independent variables, which is medium. As Cohen *et al* (2011) highlight, there is medium fit for the model.

Similarly to the above table, the analysis of variance is highly statistically significant (0.000) at the 5 % level of significance and F ratio is 61.929, demonstrating that the relationship between the independent and dependent variables is strong. In conclusion and from the above results, both the Model Summary table and ANOVA table show a significant fit of the data overall and prove that the model enhances our capability to expect the dependent variable.

The sub table 15 random effect estimation regression result below shows that, coefficient intercept (B) is 0.391. This means, when all explanatory variables took a value of zero, the average value EFF would take 0.391 units and statistically significant at the 5 % level of significance (P=0.013).

Table 15: Independent variables as predictors of efficiency of medical equipment supply chain management

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.391	.157		2.490	.013		
	PROC	.325	.081	.187	4.004	.000	.839	1.192
	INVEN	.166	.059	.123	2.816	.005	.957	1.045
	TRANS	.542	.066	.410	8.153	.000	.721	1.388
	WARE	.199	.043	.218	4.601	.000	.814	1.229

Source: Survey result, 2018

As shown above, the effect of procurement on efficiency of medical equipment supply chain management is significant (t =4.004, p = 0.000 < 0.05). The raw score regression coefficient

or slope (β1) is displayed in SPSS under β as the second line and is .187. This means for every one unit rise (1 unit procurement) in β, efficiency (the outcome) rise by 0.187.

When we see the effect of inventory management with efficiency of medical equipment supply chain management as presented in model 1, above revealed the presence of a positive and significant direct effect between inventory management and efficiency (t =2.816, p = 0.005<0.05). It shows that there is a statically significant relationship between inventory management and efficiency of medical equipment supply chain management of public hospitals. Moreover, the slope (β1) =0.123 indicates that when inventory management increases by one unit, efficiency of medical equipment supply chain management of public hospitals increases by 0.123 units.

Table 15 reveals that the effect of transportation system on efficiency of medical equipment supply chain management was significant (t =8.153, p = 0.000 < 0.05).In addition, the slope (β1) =.410 indicates that when transportation management increases by one unit, efficiency of medical equipment supply chain management of public hospitals increases by .410 units.

Table 15 reveals that the effect of Warehouse management on the efficiency of medical equipment supply chain management in public hospitals of AARHB was significant (t =4.601, p = 0.000 > 0.05)..

In addition, from model 1 results we understand that for every one unit increase in warehouse management, the efficiency of medical equipment supply chain management in public hospitals of AARHB increases by .218 times.

Generally, the effect of the four independent variables was significant and the overall regression model expressed by the following box:

Efficiency (units) =o.391+0.187 (procurement) + 0.123 (Inventory) + .410 (Transportation) +0 .218 (ware house management).

Medical equipment supply chain efficiency is a function of procurement, inventory, transportation and warehouse management. When improve these practices, we will improve the total supply chain efficiency. The conclusions of the study will be presented in the next chapter.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of findings

The main objective of the study was to made analysis of medical equipment supply chain management of public hospitals under AARHB. Quantitative and qualitative study was conducted in explanatory research design using structured questionnaire and interviews. The practice of the procurement, inventory, transportation and warehouse management of medical equipments in hospitals was assessed and their effect on efficiency of supply chain management of medical equipments was evaluated in the paper.

The findings indicate that majority of the respondents 170 who filled the questionnaires were male representing 55.7%, where as to 135 or 44.3 % of them being female. The descriptive analysis of procurement practice shows that majority of the respondents disagree (composite mean 1.42) for having good procurement practices in their respective hospitals. Based on further analysis the effect of procurement on efficiency of medical equipment supply chain management is significant ($t = 4.004$, $p = 0.000 < 0.05$).

Respondents also disagree (composite mean 2) for having good inventory management practices in their respective hospitals , in addition the effect of inventory management practices on efficiency of medical equipment supply chain management is found to be small and positive correlation ($r = .249$and $p=0.000$).

The composite mean value for transportation management, warehouse management assessment questions is 1.41, 1.71 respectively which shows majority of the respondents disagrees for having good transportation practices and warehouse management systems. Results from correlation analysis shows that transportation management is statistically significant at a p value of (0.000) with highly and positively correlated (.599). Besides this the correlation between efficiency of medical equipment supply chain management and warehouse was medium and positive (0.451).

Regarding challenges of supply chain management practices there are lack of software technologies, political factors such as lack of updated policies which affects significantly

procurement of medical equipments, lack of enough budgets for buying medical equipments which has negative impact on procurement, inventory, transportation and warehouse management of medical equipments. Top management gives less attention to procurement, inventory, transportation and warehouse management which contribute for inefficiency in medical equipment supply chain management.

The finding reveals that the composite mean value measuring efficiency of medical equipment supply chain management is 1.5 which shows the presence of high cost for medical equipment supply chain management, having small quantity and type of medical equipments and with low quality. This indicates for having inefficient supply chain management of medical equipments which is caused by poor procurement, inventory, transportation and warehouse management of medical equipments. The advanced analysis shows this all variables have significant effects on the efficiency of medical equipment supply chain management.

5.2 Conclusions

The medical equipment procurement practice in public hospitals under AARHB is not based on appropriate forecasting and is not processed by procurement plan. There is annual forecasting done based on the specification and item list of the main governmental supplier PFSA, but it's only on paper they didn't procure what they forecast and the agency also used the forecasted data as an input to procure not as a request to be procured. Due to this medical equipment are not requested and delivered timely. The ABC/VEN reconciliation is not applicable for budget allocation. Procurement of medical equipment is usually done when the existing medical equipment stops to function or when new services are started.

The comprehensive list of medical equipment which found in the service delivery units is not available; the inventory management is more limited to those equipment in the store. There is a good practice cold HCMIS (health commodity management information system) which is limited to medications and supplies. In all hospitals there is no electronic inventory management system for medical equipment which makes the total quality and accuracy of data more difficult. The annual physical inventory system is limited to those equipment in the store and the manual inventory management tool content doesn't have any information about the status of the medical equipment.

There are no enough vehicles for facilitation of medical equipment transportation. The available small and old vehicles are not capable of medical equipment transportation. There is a good habit of these hospitals to work with negotiation with suppliers to solve this problem.

Unavailability of enough and standardized warehouse is a great challenge for medical equipment supply chain management in these hospitals. In addition most respondents agreed for either not having the storage maintaining equipment or not regular checkup of their functionality. This is also contributed by the absence of standard operating procedure for storage management.

Regarding challenges of medical equipment supply chain management almost all respondents agree (mean value 4.44) the little support from the management adversely affects procurement, inventory, transportation and warehouse management of medical equipment.

Lack of technology strongly affects procurement and inventory highly than transportation and warehouse management. Absence of updated government policies affects procurement (4.65 mean values) but not other dimensions of supply chain (procurement, inventory, warehouse and transportation).

Lack of enough budgets has a higher effect on procurement, transportation and warehouse (mean values 4.7, 4.47, 4.48 respectively) but respondents disagree its effect on inventory management (mean value 2.27).

We can understand from the results medical equipments procured without appropriate forecasting (most of the time in emergency not to interrupt the service), due to lack of appropriate timing to request, and policy that helps to include quality in addition to price the supply chain is inefficient for not having enough types and quantity of equipment though it invests high cost for the whole process.

From the correlation analysis we found that all variables were correlated positively with efficiency of medical equipment supply chain management, even though their correlation strength varies from highly correlated (transportation) to low correlation (inventory).

According to the findings the overall effects of model summary about Analysis of medical equipment supply chain management showed that 44.5 % of the variance in efficiency of medical equipment supply chain was explained by the variance of explanatory variables, while the rest 55.5 % was contributed by other factors that were not included in the model.

5.3 Recommendations

As we have seen in the result and conclusion of the study there is inefficient medical equipment supply chain management which contributes to have poor healthcare service delivery and low patient satisfaction.

As this study proved that unavailability of medical equipment list in hospitals under study hospitals shall work with the ministry of health to review and prepare updated medical equipment list nationally and at each level of the facility. The list also shall be distributed to each health facility to have standardized and appropriate quality medical equipment.

The study also shows that the procurement policy of the country is not customized for health commodities. Health commodities including medical equipment are procured based on the procurement guideline developed for non-health commodities. Hospitals shall work with the ministry of health to develop health commodities procurement policy.

In addition it needs to strengthen its follow up system on having standardized procurement, inventory management, warehouse and transpiration management system in hospitals.

AARHB should help hospitals in developing standard operating procedures for accepting procured medical equipments and should work hard on improving the forecasting needs to process procurement based on procurement plan. The Bureau should enforce hospitals to have the comprehensive list of medical equipments not only storage area but also those who are in the service giving units. Almost in all hospitals the storage space is not sufficient and also to the standard, the great challenge which affects this from all challenges assessed is not having enough budget and some also says space, So, the office needs to work on finding budget sources to help in building standardized storage area rather than giving spaces built for other purpose.

I recommend AARHB to strengthen supply chain management by directing hospitals to have a separate case team established for supply chain management.

Hospitals included under the study should establish a case team who technically follow all medical equipment procurement, inventory, warehouse and transportation. They should develop standard operating procedures for medical equipment acceptance. Procurement should be based on appropriate forecasting and procurement plan. Unlike other pharmaceuticals there is no enough stock for medical equipment, due to this procurement of medical equipments is always done when the existing equipment stops to function, this leads to service interruption in most hospitals. So, hospitals are recommended to have safety stock and develop the habit of predicting the status of medical equipment and processing procurement before it stops to function.

Hospitals should have a master list of all medical equipments available in their store and in service giving areas; this is better to be done together with biomedical engineers to include information about the status of medical equipments. As per the WHO recommendation each time when there is a change in the list and status it should be updated and especially in annual inventory.

The hospital management should give more attention to medical equipment procurement, inventory, transportation and warehouse management because without appropriate medical equipment we cannot give even basic lifesaving services.

All stakeholders who are involved in the medical equipment supply chain are highly recommended to develop a software to manage the medical equipment supply chain from procurement to the service giving units, the data base in addition to the basic parameters in medication and supply software shall better to include parameters which show the status of medical equipment and possible safe years of service.

AARHB and hospital management should strengthen multidisciplinary team participation in procurement, inventory management and other areas of the medical equipment supply chain management. There is Drug Therapeutic Committee and medical equipment committee in structure but both are not functional as required. AARHB need to strengthen the monitoring

and evaluation of the functionality of these teams. The hospital management together with AARHB should establish separate case teams for pharmaceuticals supply chain management under the pharmacy directorate.

Hospitals shall work together with universities and partners on arranging trainings of medical equipment maintenance. Ministry of education should revise the curriculum/or the quality of education given for biomedical engineers to include more practical attachments than the existing. Nurses and other users of medical equipment should be trained adequately before they are involved in using medical equipment.

5.4 Suggesting for Further Research

Several limitations of this study may be noted. As identified and explained in the background theory of this study, there are many factors that affect medical equipment supply chain management. But, the current study has used only four independent variables into account. Based on the findings, the statistical model in this study explained 44.5% of the variation in predicting efficiency of medical equipment supply chain management. The implication is that other factors that explain 55.5 % of the variation in efficiency of medical equipment supply chain management were not accounted in this study.

Therefore, further research should be conducted to account for other factors. Moreover, further study needs to be done on the same topic, but covering a different location other than AARHB so as to determine whether there exist some variance in the findings.

The researcher identifies other areas for further research and intervention, The first is that the finding from open ended questions shows that there is a great gap in appropriate utilization of medical equipments, secondly a study by David T.Willison (1995) indicated that the sole sourcing of suppliers is preferable to increase quality, reduce inventory, and decrease time to market .However, in contradict to the above finding this study proved that, the presence of sole supplier seems to be the cause for experiencing inefficient medical equipment supply chain management in hospitals of AARHB. Hence, Further study is

recommended to find the practical advantages/disadvantages of exercising mainly sole supplier based medical equipment procurement in Ethiopia (PFSA).

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