EFFECT OF COLD CHAIN MANAGEMENT PRACTICE ON AVAILABILTY OF VACCINES : THE CASE OF HEALTH CENTERS OF DIRE DAWA REGIONAL HEALTH BUREAU

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THESIS SUBMITTED TO THE SCHOOL OF POST GRADUATE STUDIES OF DIRE DAWA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTER OF LOGISTIC AND SUPPLY CHAIN MANAGEMENT.

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DECLARATION

I, Tewodros Tafere, announce this research paper entitled “Effect of cold chain management practices on availability of vaccines: The case of health centers under Dire Dawa city administration health bureau” is my own and I dare to say original research work that has not been produced by others in any other universities for any other requirements in any form. To this end, I acknowledged all sources of information that I used to produce the study appropriately and I would say perfectly.

TEWODROS TAFERE; ________________________ ________________________

Signature Date

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Final Thesis Approval Sheet

Board of Examiners and Advisor

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Title of the Thesis: EFFECT OF COLD CHAIN MANAGEMENT PRACTICE ON AVAILABILTY OF VACCINES : THE CASE OF HEALTH CENTERS OF DIRE DAWA REGIONAL HEALTH BUREAU We, the undersigned, members of the Board of Examiners, have read the thesis and evaluated the final open defense of the candidate. The Thesis is written for partial fulfillment of the requirements for the degree of Master of Art in Logistics and Supply Chain Management

This is, therefore, to certify that the thesis has been (put √ mark):

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Abstract

This research was designed to assess the effect of cold chain management practices on availability of vaccines: the case of health centers under Dire Dawa city administration health bureau. The study used a quantitative methodology with explanatory study design to generate answers to the research questions. Primary data were collected through questionnaire from cold chain responsible personnel in selected health centers. To determine the sample size for selecting health centers the researcher employed a sample determination formula developed by Cochran in 1963. In order to select the respondents, the study used probability sampling method specifically simple random sampling. Accordingly, an aggregate of 16 respondents were selected and participated in this study. Data collected through questionnaire were analyzed using descriptive statistics such as frequency and mean. The findings of the study revealed that all the components of cold chain management practices and also availability of vaccines were rated average on information system.. In order to improve the availability of vaccines in the health centers the researcher recommend to FMOH and other concerning bodies to focus on all distribution and storage practices. Among the recommendations, using electronic databases such as Health Commodities Management Information System (HCMIS), accelerating the transition of vaccine supply chain responsibility from the Federal Ministry of Health to the Pharmaceuticals Fund and Supply Agency, purchasing more cold chain equipment's are some to mention. On top of that, the researcher recommend others to conduct similar research by expanding their scope to include private and other governmental health facilities and also to find out actual vaccine wastage.

Key words: cold chain, vaccine, availability

TABEL OF CONTENT

List of Tables

List of Figure

List of acronyms

FMOH- Federal ministry of health

MDVP -Multi-Dose Vial Policy

MOH- Ministry of Health

PFSA- Pharmaceuticals Fund & Supply Agency

UNICEF- United Nations Children's Fund

VVM - Vaccine Vial Monitors

CHAPTER ONE:

1.INTRODUCTION

1.1. Background of the Study

Vaccination is the intervention used to prevent or eradicate childhood diseases. It is the most cost-effective health intervention. A set of practice guidelines for different service levels were created by the World Health Organization (WHO), which include vaccine monitoring, immunization techniques, cold chain management and reporting systems(WHO1998). Cold chain is system for storing and transporting vaccines in a potent state (within an acceptable temperature range) from the manufacturer to users (WHO).Throughout the chain, primary health care providers must have adequate knowledge to manage the cold chain (Shah J, Agarwal M, PatelShah J,2015). The cold chain guidelines recommend the following: the vaccine storage should be maintained in the temperature range of 2–8 °C, the use of minimum/maximum thermometers, temperature charts, and the shake test Hanjeet K LM, Sinniah M, Schnur1996).

All vaccines are sensitive biological substances that progressively lose their potency (i.e. their ability to give protection against disease). This loss of potency is much faster when the vaccine is exposed to temperatures outside the recommended storage range. Once vaccine potency has been lost, returning the vaccine to correct storage condition cannot restore its potency. Any loss of potency is permanent and irreversible. Thus, storage and transportation of vaccines at the correct recommended temperature conditions is vitally important in order that full vaccine potency is retained up to the moment of administration.

A vaccine is a biological preparation that improves immunity to a particular disease. The agent stimulates the body's immune system to recognize the agent as foreign, destroy it, and remember it, so that the immune system can more easily recognize and destroy any of these microorganisms that it later encounters (WHO, 2015b). Vaccines need specialized storage because of the very sensitive nature of these biological products. As a result, the type of equipment used for storing vaccines needs to be specialized according to different temperature zones, and the service level of storage. Most vaccines need to be stored in a temperature controlled environment (either in a freezer or a refrigerator) all the time; improper storage temperatures reduce vaccine potency and result in recipients not being protected against diseases (Lala & VVM, 2003). Appropriate cold storage equipment is an essential prerequisite in order to ensure the quality of vaccines administered to the population. Many vaccines lose their effectiveness if they're exposed to extreme heat or freezing conditions. Excessive heat, cold, or light exposure can damage vaccines, resulting in reduced potency.

Once potency is lost, it cannot be restored (CDC, 2014). Eventually, if the cold chain is not properly maintained, potency will be lost, and the vaccines become useless.

The vaccine cold chain is a temperature controlled environment used to maintain and distribute vaccines in optimal condition. A proper cold chain is a temperature controlled supply chain that includes all equipment and procedures used in the transport and storage and handling of vaccines from the time of manufacture to administration of the vaccine (CDC, 2014). According to World health organization (WHO) cold chain is a system of storing and transporting vaccine at the recommended temperature range from the point of manufacture to point of use (Immunization & Biologicals, 2004). The cold chain relies on three main elements well-trained personnel, reliable transportation and storage equipment and efficient management procedures. The cold chain begins with the cold storage unit at the manufacturing plant, extends through transport of vaccine to the distributor, then delivery and storage at the provider facility, and ends with administration of vaccine to the patient. Appropriate storage conditions must be maintained at every link in the cold chain (CDC, 2014)

Vaccine supply chain management has received increasing attention in recent years as both a priority and a challenge for many countries (Lydon, Raubenheimer, Arnot-Krüger, & Zaffran, 2015).Vaccination is one of the methods that have been proven effective in preventing the transmission of infectious diseases and hence reduction of infant and child mortality rate in the world. It is one of the most cost-effective health investments, estimated to avert between 2 and 3 million deaths globally each year, with proven strategies that make it accessible to even the most hard-to-reach and vulnerable populations(Matthias, Robertson, Garrison, Newland, & Nelson, 2007). To be effective, however, a number of elements in a vaccination program need to be implemented properly, including cold chain management, vaccine management, logistics management, and waste management. Failure to properly implement these can reduce the level of protection that is expected from a vaccination program (WHO, 2008). Therefore, the availability of a proper cold chain and vaccine and logistics management system from the vaccine manufacturer to the end user, and follow-up after the vaccination program is finished must ensured. Without vaccines as well as safe and effective distribution systems and delivery practices, disease would become more rampant and the public health and the community would be overburdened with treatment costs and deaths particularly in children. The national Immunization program in Ethiopia was launched in 1980. At the national level, the maternal and child health directorate of the Ministry of Health (MOH) coordinates the program (MOH, 2012). Existing Country Context for Vaccine Distribution shows Cold Chain system for vaccines and other cold storage requires health commodities consists of five levels, following the Federal ministry of health (FMOH) administrative structures the current vaccine cold chain system incorporate Ethiopian Pharmaceuticals & Supply Agency (EPSA) , Regional health bureaus, Zonal health divisions , woreda health offices and health facilities.

1.2. Statement of the Problem

With few exceptions, vaccine supply and logistics systems around the world are unable to keep pace with growing immunization programs (WHO, 2014a). According to WHO less than 25% of countries are operating at even a minimum standard within the criteria of maintenance, stock management and distribution. Furthermore, only 29% of countries are meeting minimum standards for temperature control. In 2011 2.8 million Vaccine doses ware lost in five countries due to cold chain failures (WHO, 2014c). WHO and the United Nations Children's Fund (UNICEF) have estimated overall wastage rates in developing countries of around 50% (Lloyd, 1999). Total cost of vaccine per fully immunized child in a developing country is $38.75/31.64 (WHO, 2014c). Ethiopia has a population of 3 million children which means 116 million USD (2 billion birr) is spend on vaccines each year (FMOH, 2013). A huge amount of money is allocated both by partners and the government of Ethiopia for the procurement of vaccines each year. In Ethiopia, even though, there are no significant problems in the availability of vaccines at national level weak vaccine stock and inventory management has been noted at regional and service delivery levels (FMOH, 2015). The vaccine distribution system in Ethiopia comprises several distribution steps with average of five levels of inventory holding points that are considered unnecessary (FMOH, 2013; WHO, 2014c). This kind of system is likely to result in vaccine wastage and expired vaccine, and that led to overstocks at some distribution points. Each transfer in a complex supply chain processes could increases the risk of bottlenecks or breakdowns (Kaufmann, Miller, & Cheyne, 2011). A study done in immunization centers of Ethiopia revealed that 32.8% of the health institutions used to collect vaccines at intervals longer than a month. Vaccine storage in the refrigerator was observed to be improper in 73.4% of the functioning 64 centers and Lack of technicians for refrigerator maintenance was reported by 61.2% of the institutions (Berhane & Demissie, 2000). According to the national cold chain equipment inventories carried out in 2013, About 38% of the refrigerators/freezers at health facility level and 36% of refrigerators/freezers at administrative level (woreda to region) were not functional (FMOH, 2015). In addition, inventory control and vaccine wastage are not traceable due to lack of a reporting system (JSI, 2015a). The same study from the immunization centers of Ethiopia shows that a complete record of the vaccines stock was observed only in 59.4% of the health institutions (Berhane & Demissie, 2000). Although, studies are indicating that such poor management of vaccines could result in overstocking of vaccines at central level while sub national cold rooms are not storing adequate vaccines, there is no study that shows the availability of vaccines in the health facilities in Ethiopia (Kaufmann et al., 2011; WHO, 2014c).

There were gaps in following the cold chain management principles such as use of FEFO principle, recording damaged vaccine, recording temperature twice daily, and recording VVM status for each vaccine. Also, there was a gap in using requisition form for reporting and ordering vaccine. the majority of the health facilities did not have a separate room for vaccine storage. Their storage capacities were insufficient to accommodate all vaccines and its consumable supplies, even though all storage area had secured windows and doors. Infrastructures were not fulfilled in room to handle the vaccine properly. This inappropriate handling of the vaccine has a negative effect on its potency. the availability of the power sources and an alternative source were not sufficient. The number of health facilities using electricity as their primary power source predominates but the major challenge of this type of power supply was an irregularity in the power supply. Availability of necessary spare parts and conducting cold room maintenance were very low(Hewan Adam Bogale, Abebe Feyissa Amhare2019). Thus this research was assess the management of vaccine in order to analyze its effect on the availability of vaccines in service delivery level.

1.3. Research Questions

Based on the previous statement of research problem, the following main research questions was formulated

1. How the current vaccine cold chain management practices in Governmental health centers of Dire Dawa does looks like?

2. How much available are vaccines in governmental health centers of Dire Dawa?

3. How vaccine cold chain management practices influence the availability of vaccines in governmental health centers of Dire Dawa?

1.4. Objectives

1.4.1. General Objective:-

The general objective of the research is to assess the Effect of vaccines cold chain management practices on the availability of vaccines in health centers under Dire Dawa city administration health bureau.

1.4.2. Specific Objectives:-

- To assess the effect of technical capacity of health centers under Dire Dawa city administration health bureau on availability of vaccines.
- To assess the effect of information system of health centers under Dire Dawa city administration health bureau on availability of vaccines.
- To assess the effect of Storage system and facilities of health centers under Dire Dawa city administration health bureau on availability of vaccines.
- To assess the effect of distribution system of governmental health centers on availability of vaccine

1.5. Significance of the Study

This study will recognize the impact of vacine cold chain the board on the accessibility of immunizations in well being places under Dire Dawa city organization well being department. The discoveries and suggestions of the review will be valuable for administrative specialists by way of planning rules and implementation of cold chain norms for consistence. The review will contribute accommodating data to the accessible writing on immunization Distribution framework and its capacity rehearses. The review was contribute significant data for neighborhood wellbeing strategy creators, EPI, medical care suppliers, benefactors and all partners engaged with cold chain drugs to really plan, oversee and direct the dispersion framework and capacity practices of Vaccines in Dire Dawa. At last, the examination brings to the front inquiries to uncover holes that would require further examination.

1.6.Scope of the Study

The researcher has limited the study on the effect of cold chain management practice on availabilty of vaccines : in case of health centers under dire dawa regional health bureau. The organizations that was be address for the study are 17 Health facilities Which is 2 hospitals and 15 health centers The study was focused on effect of cold chain management practice on availabilty of vaccines and also a two years experience from 2019-2021 G.C/ was covered under this study.

1.7. Organization of the Study

This proposal was critically examine determinants of Available of vaccine. It has structured into three chapters. Each chapter has its own subunits. The first chapter outlines the introductory part including background of the study, statement of the problem, general and specific objectives of the study, scope of the study and the significance of the study. This chapter also raises questions that was answer by the study. The second and third chapters cover the literature review and theoretical frameworks of Available of vaccine with the latter dealing about the methodology used for the study. The fourth chapter devoted to the presentation, analysis and discussion of data and the last chapter consisted of the summary, conclusion and recommendations of the study.

CHAPTER TWO

LITRATURE REVIEW

This chapter reviews pertinent writing on the key regions that the review covers. This section presents the hypothetical underpinnings of the review. With an emphasis on the goals and hypothetical edges of this review, the part audits related and contemporary writing on the idea of the cold chain and accessibility of immunization. An endeavor has likewise made to give a feature on Worldwide viewpoint of immunization dispersion and the executives lastly the antibody cold chain the executives in Ethiopia. The part looks at different examination studies and reports done locally (Ethiopia), provincially (Africa) and all around the world. Verifiable viewpoints and the theoretical system of the review are tended to in this part.

2.1. The cold chain in vaccine supply chain management

A cold chain is a temperature-controlled supply chain. An unbroken cold chain is an uninterrupted series of storage and distribution activities which maintain a given temperature range. It is the integrated system of equipment- (e.g., cold rooms, shipping containers, refrigerators, and vehicles), procedures, records, and activities used to handle, store, transport, distribute and monitor temperature sensitive products. It is used to help extend and ensure the shelf life of products such as fresh agricultural produce, seafood, frozen food, photographic film, chemicals and pharmaceutical drugs (Kohli, 2008). Cold chains are common in the food and pharmaceutical industries and also in some chemical shipments. Many biological substances deteriorate when exposed to heat, sunlight, or fluorescent light. When transporting and storing such biological substances, it is imperative to control environmental conditions, ensuring that exposure to potentially damaging environmental factors is minimized. One common temperature range for a cold chain in pharmaceutical industries is 2 to 8 °C. But the specific temperature (and time at temperature) tolerances depend on the actual product. This is also the recommended temperature range by WHO for the cold chain system of transporting and storing vaccines (Health & Council, 2008).

The system used to keep and distribute vaccines in good condition is called the cold chain. The cold chain has three main components: transport and storage equipment, trained personnel, and efficient management procedures. All three elements must combine to ensure safe vaccine transport and storage. The cold chain begins with the cold storage unit at the vaccine manufacturing plant, extends through the transfer of vaccine to the distributor and then to the provider's office, and ends with the administration of the vaccine to the patient. Proper storage temperatures must be maintained at every link in the chain. Excess heat or cold will reduce their potency, increasing the risk that recipients will not be protected against vaccine preventable diseases. To ensure the optimal potency of vaccines, careful attention is needed in handling practices at all levels of the cold chain (Afsar & Kartoğlu, 2006; Association, 2007). Choosing the right cold chain equipment is strategically important; as such choices can facilitate changes in delivery routes and frequencies, which in turn could have an effect on vaccination schedules and strategies. Make the decision on what type of cold-chain equipment to use on detailed knowledge of the local situation. The first question to ask is whether or not reliable electricity is available. If it is available, whether from a grid or a generator, various types of electric refrigerator can be used, provided they are of known reliability. In areas with an electricity supply of 8 or more hours during a 24-hour period (whether the source is grid and/or generator), the ice-lined compression refrigerator is highly suitable because it has a holdover time of 24 hours at +43 °C ambient temperature; it can therefore prevent vaccines from damage during power interruptions or regular outages (WHO, 2008). According to WHO, in any temperature-controlled rooms, cold rooms, freezer rooms, refrigerators and freezers used to store vaccine air temperature and Humidity monitoring systems and devices should be installed. Electronic sensors should be accurate to ± 0.5 °C and ± 5% relative humidity or better. Sensors should be located in areas where the greatest variability in temperature is expected to occur within the qualified storage volume and they should be positioned so as to be minimally affected by transient events such as door opening (WHO, 2011).

2.2. Association between vaccine cold chain management and availability of vaccine

WHO recommends the range of temperatures for storing and transporting vaccine should be on the basis of data supplied by manufacturers. Each vaccine has its own specific storage 10 requirements so it is extremely important to know how long, and at what temperature, each vaccine can be stored. All vaccines can be stored at positive temperatures (between +2 °C and +8 °C). However, only some vaccines can be stored at negative temperatures (between -15 °C and - 25 °C) (WHO, 2008). Vaccines are delicate biological substances that can become less effective or destroyed if they are not stored and transported properly. Literatures suggest that vaccines could be destroyed or become less effective if they are allowed to get too hot, frozen, or exposed to direct sunlight or fluorescent light (Common wealth of Australia, 2013; Kartoglu & Milstien, 2014)

2.2.1. Freezing

Freezing is the most common reason for vaccine damage. Freezing of vaccine refers to situation whereby vaccines stored at or below 0°C of temperature for type of vaccines which need to be stored in refrigerator temperature range of +2 °C and +8 °C. Vaccine damage at temperature of 0°C is common although it may not appear frozen (Common wealth of Australia, 2013). Because the original problem with the cold chain was keeping the vaccines cold enough, most of the training efforts for the effective management of cold chain were directed at keeping the vaccine cold enough. But researches are reveling that vaccines are more sensitive to freezing than they are to heat (Kartoglu & Milstien, 2014). For example, according to the product information sheets inactivated polio vaccine, diphtheria-tetanus-pertussis vaccine (DTP), diphtheria and tetanus toxoids vaccine, hepatitis B vaccine (HepB), and tetanus toxoid vaccine (TT) are seriously damaged at temperatures less than 0°C. A study in Indonesia that monitored the temperature of HepB vaccine shipped from the manufacturer to the provider found that 75% of vaccine shipments were being frozen (C. M. Nelson et al., 2004). Studies involving site visits show that 15% of refrigeration units had temperatures of 34°F (1°C) or lower (Bell, Hogue, Manning, & Kendal, 2001; Gazmararian et al., 2002).

2.2.2. Allowed to get too hot

When vaccines are exposed to repeated episodes of heat the loss of vaccine potency is cumulative and cannot be reversed (Common wealth of Australia, 2013). The transport and storage of vaccines at temperatures higher than 8°C have been reported in the United States and Australia. In the United States, a temperature study was conducted of refrigerators used to store 11 vaccines in medical clinics. Thermometers were used to measure the minimum and maximum temperatures for a 24-hour period. The results indicated that 59% reached temperatures higher than the acceptable range, and 93% were both higher and lower than the acceptable range (Miller & Harris, 1994; Woodyard, Woodyard, & Alto, 1995) A study in Bolivia that monitored the temperature of DTP-HepB-Haemophilus influenza type B vaccine throughout its transportation from the national warehouse to 11 communities in 3 provinces reported that 7 of the 11 routes from provincial to district warehouses had a temperature higher than 8°C (C. Nelson et al., 2007)

2.2.3. Exposed to direct sunlight or fluorescent light

Vaccines and cold chin equipment should be placed in such a way in the room that they are not exposed to sunlight any time during the day. Exposure to sunlight will lead to increase in core temperature of the cold chain equipment, which would break the cold chain by causing an increase in the temperature of the vaccines (Naik, Rupani, & Bansal, 2013). There have been a number of reports demonstrating an association between vaccine quality and appropriate vaccine transport and storage. In Nigeria, the potency of oral polio vaccine (OPV) as well as vaccines for measles and yellow fever was found to decrease below international standards when they were transported from the national warehouse to health facilities (Acu, Adedeji, Esan, & Odusanya, 1996). Diphtheria toxoid containing vaccines may change their appearance and lose potency when frozen due to freezing destroying the gel structure of the adjuvant and could be destroyed in three to five hours if exposed to 60°C (Kartoğlu, 2012). An estimated 17% to 37% of providers expose vaccines to improper storage temperatures (Bell et al., 2001) WHO estimates that in some countries, 50% of all vaccine doses are wasted either before or after a vial is opened (WHO, 2005). Most closed-vial vaccine wastage can be attributed to supply chain issues including accidental freezing, expiry, vaccine vial monitor indication, breakage, theft, and loss(Guichard et al., 2010; WHO, 2005) . Loss of vaccine potency due to improper storage conditions is a costly mistake. Patients receiving vaccine with decreased potency caused by improper storage conditions may not be fully protected against the vaccine preventable disease. Unless these supply chain issues are solved, vaccine wastage will continue to consume much needed vaccine and unnecessarily inflate the cost of vaccination programs

2.3.1. Information system

Many countries do not have reliable data about past vaccine usage or accurate projections of target population and their locations. National vaccine forecasting is done using population estimates, birth rates, infant mortality rates, vaccine waste rates, and prior year estimates of usage(Kaufmann et al., 2011). Because census data are typically only brought up to date every ten years, even in the best organized developing countries, the combination of inaccurate estimates means that incorrect vaccine forecasts are replicated year after year. Unnecessary incountry logistical burdens and expense are the result when too much or too little vaccine is ordered as a result of the inaccuracies. Inaccurate or outdated census counts, population migrations, and unforeseen changes in birth rates all contribute to the problem. Local health managers may try to counteract these by head counts but they introduce their own biases, including inflation of numbers to ensure adequate amounts of vaccines and deflation to make coverage rates look high (FMOH, 2013). There is considerable lack of coordination between those people and organizations that finance and procure vaccines for shipment to developing countries and those supply-chain managers and storekeepers responsible for receiving and distributing the shipments. Financing and procurement stakeholders have limited knowledge of the constraints faced by vaccine officials in developing countries. Supply-chain planners and managers are rarely consulted or involved in the plans that ultimately produce incoming vaccine shipments (Kaufmann et al., 2011).

2.3.2.Technical capacity

Training supply chain personnel is usually focused narrowly on specific activities, such as storekeeping, maintaining cold-chain records, and providing security for commodities, rather than the higher order planning, analysis, and performance management skills needed by supply chain managers. studies done in different countries show that inadequate knowledge and practices exist regarding cold chain management in primary health care facilities (de Timóteo Mavimbe & Bjune, 2007). Those who manage the supply chain must be given higher status and a seat at the planning table, so managers can advise on logistical road blocks and how to overcome them. People involved in transportation and supply of vaccines need to be trained and have knowledge of cold chain and how to handle breakage of cold chain. Without pre-requisite knowledge of how to handle vaccines being transported can seriously affect the vaccine potency which in turn can result in wastage of vaccines and thus, increase in their price. Cold chain equipment requires installation and maintenance, which necessitates the availability of properly trained technicians, replacement parts, a system to monitor equipment performance, and the capability to rapidly respond to breakdowns and failures. Although existing supply chains should already have maintenance plans in place, recent cold chain assessments reveal consistent deficiencies in this area (PATH., 2008). Developing, procuring, supplying, and maintaining shipment and storage materials, including appropriate vehicles, refrigerators, and cold boxes, is an ongoing challenge

2.3.3. Storage and Transportation

When multiple vaccines become available and are added to existing vaccine regimens, storage and delivery capacity in many countries can quickly be overwhelmed. Donor support of in country transportation needs is often limited. The ability in country to analyze and plan efficient transportation routes, develop and operate transportation schedules and networks, or procure and maintain the right vehicles to meet transport needs is often lacking. Some countries lack skills, funding, and equipment to handle incoming shipments, maintain what limited equipment they do have, or overcome institutional barriers to effectively use and share needed vehicles and equipment among programs (Kaufmann et al., 2011

2.4. The vaccine supply chain and logistics in Ethiopia

The Federal Ministry of Health has been working to ensure an efficient and high performing healthcare supply chain that will ensure equitable access to affordable medicines for all Ethiopians. In past years, significant progress has been made, although various challenges remain an inadequate supply of quality and affordable essential pharmaceuticals, poor storage conditions, and weak stock management resulted in high levels of waste and stockouts. The Expanded Program on Immunization started in Ethiopia in 1980 with the aim of reducing mortality and morbidity of children and mothers from vaccine preventable diseases. During the inception of EPI the objective was to increase immunization coverage by 100 % annually but this target has not been realized even after three decades. Immunization services are being rendered

in most of the health facilities and in outreach and mobile services for the community residing beyond 5KM from the static health facilities. In the routine EPI program the traditional six antigens are being given in both the public and private services. Starting in 2007, pentavalent formulation, DPT-HepB-Hib was introduced into the routine immunization program thus increasing the number of total antigens given to infants to eight (DPT-HepB-Hib, BCG, OPV and measles). In addition, 10 valent pneumococcal vaccine was introduced in the October 2011 and increased the total number of antigens in the routine immunization programme to nine. Rota (FMOH, 2013). For years, staff at the regional, woreda, and health facility staff collected vaccine supplies from the level above. The journey from the facility to the warehouse can take a day or longer on tough-to-navigate roads, and trips were frequently made more than once a month to ensure sufficient supply of vaccine when mothers arrived with their infants. Now, Ethiopian Pharmaceuticals Supply Agency (EPSA) is delivering vaccines from the central cold room to their regional hubs, and then to the zones and/or woreda (district) level using refrigerated trucks. Distributing vaccines to numerous sites presents a logistical challenge. system have been responsible for picking up vaccine supplies from warehouses and transporting them back to their locations using cold boxes or vaccine carriers to maintain a safe temperature. Vaccines were distributed through a complex supply chain involving no fewer than six levels. Starting in 2014, the responsibility for the routine vaccine supply chain began transitioning from the FMOH to the EPSA, an autonomous FMOH agency responsible for the entire essential medicine supply chain. This shift consolidated the national vaccine supply chain with the supply chain for essential medicines and vaccines used for campaigns, creating potential efficiencies but also bringing new challenges. EPSA was managing distribution of vaccine for campaigns before the vaccine transition. By May 2015, three of the 14 Hubs began to manage vaccine for routine immunization as well. The hubs now receive vaccines in refrigerated trucks each quarter, and are delivering vaccines to lower levels of the system (JSI, 2015a).

2.5. Cold chain equipment in Ethiopia

National level cold chain equipment inventories were carried In Ethiopia with the objective of identifying the status of cold chain equipment in the country. The 2002 inventory shows that 35% of equipment was not functional, 83% of the functional equipments were aged 10 and above 14% of the functional equipments were sub-standard equipment. By the end of 2004, there was only one cold room of about 75 meter cube in internal volume. By the end of 2005, there were five regional cold rooms in three regions of the country, with a total 150 meter cube internal volume. By mid-June 2006, nine additional cold rooms were provided at different regions of the country. A cold room was provided in Tigray, Nekemt, Bahir Dar, Awassa, Dukem, Dire Dawa and Afar. The 2013 inventory result revels 20,660 refrigerators/freezers were available at different level of health structure (health post, clinic, health center and hospital, woreda, zone and region). About 62% of the refrigerators/freezers at health facility level and 64% of refrigerators/freezers at administrative level (woreda to region) were functional during the inventory (FMOH, 2015). Studies indicate that there is a real weakness in the cold chain system in Ethiopia, which could compromise the potency of the vaccines and the general quality of the immunization services (Berhane & Demissie, 2000; FMOH, 2013, 2015). A study done in urban and rural health centers of Ethiopia showed that 32.8% of the health institutions used to collect vaccines at intervals longer than a month. Completely melted ice packs during transportation of vaccines were encountered by only three (4.5%) centers. A complete record of the vaccines stock and up-todate refrigerator temperature records taken twice a day were observed in 38 (59.4%) and 37 (57.8%) of the 64 functional immunization centers, respectively. In four of the rural centers, there was no thermometer to regulate the temperature of the refrigerator, and among those found having any, seven were reading outside the recommended temperature of 0 to +8°C for vaccine holding refrigerators. Vaccine storage in the refrigerator was observed to be improper in 47 (73.4%) of the functioning 64 centers (Berhane & Demissie, 2000). Today's vaccine management is becoming more complicated, as national immunization programmes prepare to provide protection against 2.5 times as many diseases, administer three times as many doses per person, store and transport four times more vaccine volume per fully immunized person, increase six-fold the spending on vaccines to fully immunize one person and serve a global target population size that has doubled. It is clear that immunization programmes in developing countries such as Ethiopia face severe challenges (WHO, 2014c). Vaccine management is a major challenge currently of concern within Ethiopia. As the FMOH highlighted a number of areas improved significantly, such as vaccine arrival, cold storage, vaccine vial monitor use, and proper use of multi-dose open vial policy. However, it also identified continued gaps in vaccine wastage control, stock management, effective vaccine delivery, and vaccine storage temperature. The high level of vaccine wastage, and poor utilization of available policies and equipment such as VVM (Vaccine

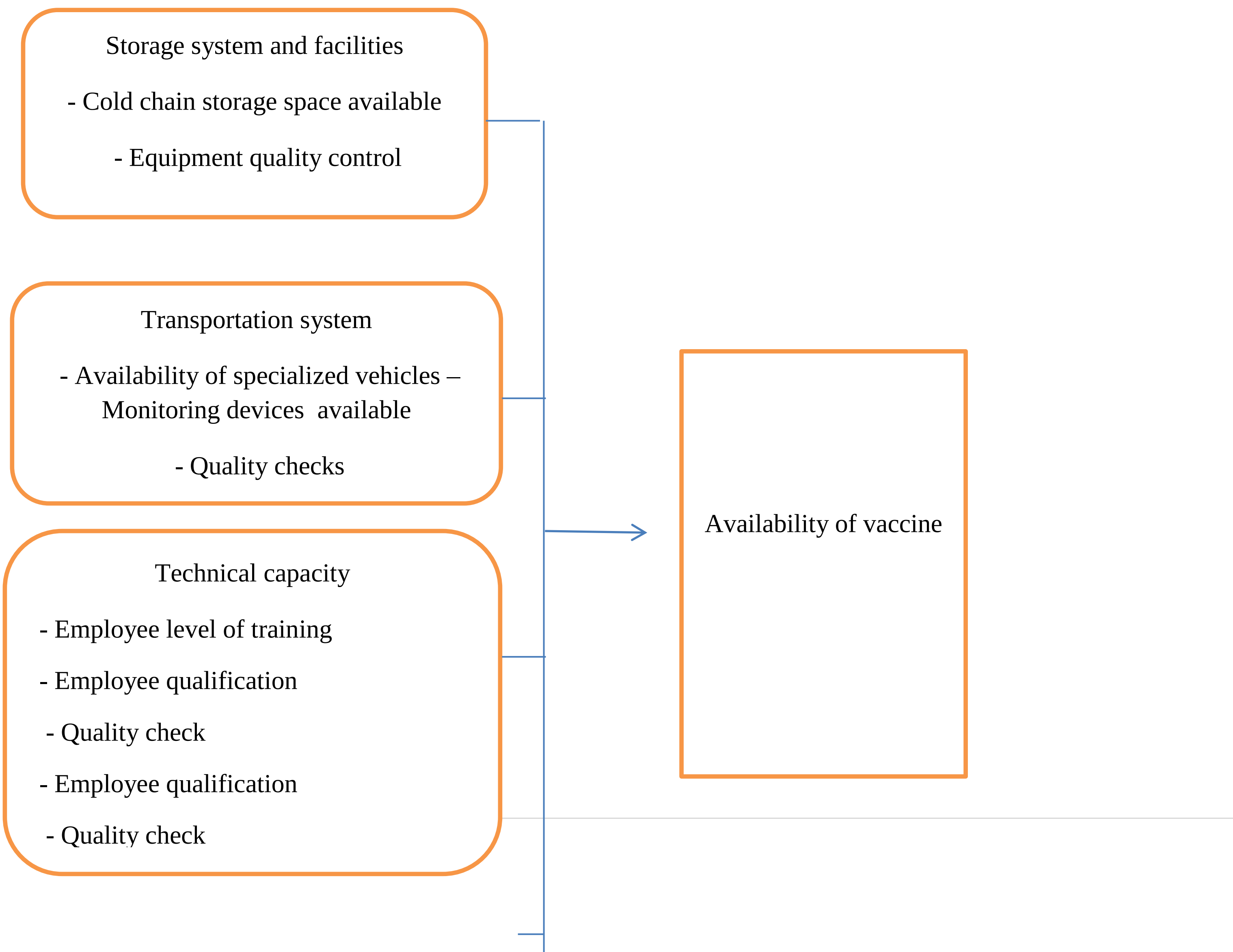
Vial Monitors), and/or MDVP (Multi-Dose Vial Policy) have also highlighted the need for better vaccine management practices. Adverse events due to inappropriate vaccine distribution practices are, partly, also believed to effect negatively on vaccine management (FMOH, 2013). Immunization is well accepted as one of the most cost-effective of all health interventions. In most of the prior work this important constraint is either neglected or not given much importance while generating the optimized supply route. In advent of new and improved vaccines introduced daily, the logistics systems must be strengthened and optimized.

2.6.Availability of vaccine in health facilities

As (Adida, Dey, & Mamani, 2013) mentioned the two main reasons of why it is difficult to reach optimum level of vaccine coverage are emergence of operational issues on the supply side and negative network effects on consumption side. These two reasons are needed to be dealt with to achieve the optimized solution for vaccine supply. There are many constraints which need to be considered in vaccine distribution planning, like (Zaffran et al., 2013) mentioned some current issues include: Effect of vaccine schedules and presentations on cold chain volume requirements, vaccine transporting with maintain cold chain, immunization related information systems, technical capacity for vaccine supply chain and Vaccine cost and wastage. These issues need to be addressed in order to keep logistic systems with pace with growing immunization programs. According to the researchers from the World Health Organization WHO and PATH, the vaccine volume requirements compared to the available capacity exceeds by 25 percent (PATH., 2008).

As Hewan Adam Bogale, Abebe Feyissa Amhare study conducted on Gojam zone of Amhara region There were gaps in following the cold chain management principles such as use of FEFO principle, recording damaged vaccine, recording temperature twice daily, and recording VVM status for each vaccine. Also, there was a gap in using requisition form for reporting and ordering vaccine. the majority of the health facilities did not have a separate room for vaccine storage. Their storage capacities were insufficient to accommodate all vaccines and its consumable supplies, even though all storage area had secured windows and doors. Infrastructures were not fulfilled in room to handle the vaccine properly. This inappropriate handling of the vaccine has a negative effect on its potency. the availability of the power sources and an alternative source were not sufficient. The number of health facilities using electricity as their primary power source predominates but the major challenge of this type of power supply was an irregularity in the power supply. Availability of necessary spare parts and conducting cold room maintenance were very low.

2.7. Conceptual framework



Information system

- Inventory control

- Information flow

CHAPTER THREE:

METHODOLOGY

This chapter deals how the research was conducted to achieve the objectives of the study. It consists of the research design, method of data collection, sampling design, data collection instrument and method of data analysis.

3.1. Research Design

descriptive study design was used to collect data on relevant variables.

3.2. Study Setting

The Study was conducted in Dire Dawa. Dire Dawa is one of the city of Ethiopia. with a population of 341,834 according to the 2007 population census out of which the urban population was 233,224 and that of the rural population, 108,610. Out of the total population in the Administration, men population comprises the majority (50.2 %.). While, female constitute the remaining 49.8%. (CSA, 2007). According to Dire Dawa City Administration Health Bureau there are 17 health Facilities which are 2 Hospitals and 15 Health Centers

3.3. Sample Design

3.3.1. Population

A population can be defined as all people or items (unit of analysis) with the characteristics that one wishes to study. The unit of analysis may be a person, individual, organization, country, object, or any other entity that researchers wish to draw scientific inferences about (Clark ,Kelley, Brown, & Sitzia, 2003). Accordingly, the population of this research consists of all public health centers in Dire Dawa.

3.3.2.Sample Size

To determine the sample size for selecting health centers in this study the researcher employed a sample determination formula developed by Cochran in 1963.

$$\mathbf{n} = Z^2\, pq/\,_{e}2 \quad = \quad Z^2 \ast \mathbf{p(1\text{-}p)}/_{e}2$$

Where n0 is the sample size, Z^2 is the abscissa of the normal curve that cuts off an area α at the tails (1 – α) equals the desired confidence level, e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is 1-p.

Therefore in this research n= 1.962 * (0.5)*(0.5) = 384.16~385

(0.05)2

Since the population is small then the sample size can be reduced slightly. This is because a given sample size provides proportionately more information for a small population than for a large population. The sample size (n) can be adjusted using the following formula.

n = 385/ (1+ ((385-1)/17)) = 16.32~16

Therefore, using the formula, the sample size of the study with 95 confidence level and 0.5 level of variability is calculated to be 16

3.3.3. Sampling Technique

Probability sampling (or representative sampling) is most commonly associated with survey based research strategies where you need to make inferences from your sample about a population to answer research question(s) or to meet the research objectives (Saunders, 2011). For that reason, simple random sampling was used to select samples from the study population. After determining sample size, was used a random number table to get the random numbers for the selected participants list of this research. The sampling frame (complete list of all of 17 health centers) was found from Dire Dawa City administration Health Bureau. According to random number table the research was select 16 health centers from the list to be included in this study

3.4. Sources and tools for data collection

Data was collected from vaccines in-charges personnel or vaccination focal person. For the study, questionnaire is used as the research instrument. The questionnaire consists of 3 parts with five point Likert scale and is divided into 4 parts as follows: The first part of the questionnaire is the demographic information of the respondents. Queries about personal information of the sample such as gender, age, education and profession were included. The second part of the questionnaire is cold chain management practices of the health centers questions about storage distribution, information systems and the technical capacity of the health centers regarding cold chain management were included in this part. In the third part, questions about the availability of vaccine in the health centers were included.

3.5. Procedures of data collection

The procedure for the data that was collected using questionnaires is, first the respondents was communicated to get their consent. Once their consent is obtained, the prepared questionnaires was distributed to each participant by appreciating their participation and devoting their precious time for the research. Finally, questionnaires was collected by checking the completeness of the data.

3.6. Pre-testing of tools

All information gathering instruments ought to be pretested to check the ease of use of the information assembled. An examination instrument ought to be tried on a pilot test of individuals from the objective populace. This interaction was permit the scientist to distinguish whether respondents comprehend the questions and guidelines, and whether the significance of inquiries is no different for all respondents. Where shut questions are utilized, steering was feature whether adequate reaction classes are accessible, and whether any inquiries are efficiently missed by respondents (Kelley et al.,2003). Pretest is of fundamental significance, Hence, for this review, the information assortment apparatus was pretested at 1 distinct focuses which won't be remembered for the example. This assiste the 5 researcher to check the clarity, validity, ambiguity and readability of the statements and questions and to get a feedback on leading questions and to know the time that is needed to complete the questionnaire. Through conducting the pilot, the researcher spotted some vocabularies which were difficult to the participants and recognized as they were somehow vague. Data collecting tools was modify accordingly upon completing the pre test.

3.7. Reliability and Validity

The purpose of this stage is to describe on the reliability of the measuring tools employed in this research. This is important because reliability shows whether or not an instrument's measures are free from errors, thus yielding reliable outcomes. The most common technique used in the literature to assess the scale's reliability and stability is use of the Chronbach Alpha Statistics, which identifies to what extent items hang together as one set. Low Chronbach alpha values mean the items do not capture the same construct, but high values of Chronbach Alpha indicates the items very well measure and reflect the construct. Ideally , Chronbach Alpha should be over 0.70 to produce a reliable scale (Burns & Burns, 2008). Accordingly, internal reliability of a 8 item scale was assessed by using the Cronbach alpha technique.

Tabel 1 Reliability Statistics

Variables	No. of Items	Cronbach's Alpha
Storage System	10	.745
Distribution System	9	.906
Technical Capacity	9	.837
Information System	8	.848
Avialabilty of Vaccine	4	.715

3.8. Method of Data Analysis

The data of this study was analyze by computer through package software (SPSS: Statistical Package for Social Sciences), version 22.

Statistical methods employed were:

- The demographic background information of the respondents was analyzed and presented using descriptive statistics in form of frequency and percentage.
- To assess the cold chain management practices and availability of vaccines measures of descriptive statistics in form of Mean and Standard Deviation was used.
- The scoring of questionnaire was analyzed by using five-points rating scale or five– Likert scales.

3.9. Ethical clearance

Any survey should be conducted in an ethical manner and one that accords with best research practice. Two important ethical issues to adhere to when conducting a survey are confidentiality and informed consent (Kelley et al., 2003). In this study Permission was seen from each regional health offices. The regional health offices was wrote support letter for health centers that are included in the study. Consent was seen from participants before enrolling them into the study. The information that was collect from this research project was kept confidential.

CHAPTER FOUR:

DATA PRESENTATION, ANALYSIS AND DISCUSSION

This chapter presents the data analysis, the research findings (results) and based on the results the researcher gives some interpretation of the results. This chapter includes the general characteristics or the demographic profile presented by descriptive statistics. As an aside, correlation analysis is used to indicate the relationship between the variables. Finally, the results of multiple regression was presented in order to estimate the value of availability of vaccine from independent variables and analyzed here in this chapter.

4.1. Response rate

A total of 16 questionnaires were administered to governmental health centers in Dire Dawa, out of which all 16 were completely filled and returned.

4.2. Demographic characteristics of the participants

The study sought to determine the general characteristics or the demographic profile of the study participants' by using five variables that were exhibited in table 2, and they were analyzed in frequency statistics accordingly.

Table 2: **Demographic characteristics of study participants**

Variables	Response items	Frequency	Percentage
Gender	Male	4	25
	Female	12	75
	Total	16	100
Age	< 25 years	2	12.5

	25-44 years	14	87.5
	45-54 years	0	0
	>45 years	-	-
	Total	16	100
Educational background	Certificate	-	-
	Diploma	5	31.3
	First degree	11	68.7
	MSc/MA degree	-	-
	Total	16	100
Profession	Pharmacist	0	0
	Health officer	0	0
	Nurse	16	100
	Other	0	0
	Total	16	100
Experience in current job	1-5 Years	12	75
	6-10 Years	4	25
	11-15 Years	-	-
	Over 15 Years	-	-
	Total	16	100

Table 1 indicates that 4 (25%) of the respondents were male while 12 (75%) were female. This simply indicates that the dominance of females in managing vaccines in the health centers.

As indicated in the same table, the age range of the majority respondents were between 25 to 44 years, which occupied 14(87.5 %).The respondents who were under 25 years old were accounted for the second place which took 2(12.5%). No respondent on The remaining age Category.

The majority 12 (75%) had experience of 1 to 5 years. 4 (25%) of the respondents had 6 to 10 years of experience. Unfortunately there was no respondent who has 11 and more years of experience in this job. But in general the data implies the respondents had a reasonable experience in their job which enables them to evaluate the vaccine cold chain management and availability of vaccines in the health centers.

From the given 16 respondents, 11 (68.7%) and 5 (31.3%) have had First degree and diploma respectively. All 16 (100%) of them were nurses. From these data, it is possible to conclude that most of the respondents have the required understanding of the objective of the study in general and the items of the questionnaire in particular which definitely can be taken as a positive factor towards the quality of the study.

4.3. Descriptive statistics

Respondents were asked to rate the cold chain management and availability of vaccines in the health centers on a five-point likert type scale ranging from 1 being strongly disagree to 5 strongly agree. The mean statistical value approaching were based on the following assumptions: if the mean value is between [0 to 1.5) this implies the respondents strongly disagreed, if the mean value is between [1.50 to 2.50) it indicates the respondents disagreed, the mean value between [2.50 to 3.50) indicates the respondents were neutral, the mean value between [3.50 to 4.50) implies the respondents agreed and a mean value 4.50 and above shows the respondents strongly agreed (Burns & Burns, 2008). Accordingly, the mean scores have been computed for all components of the independent variables and the dependent variable by equally weighting the mean scores of all the items under each dimension. The average mean results together with their respective variables was separately presented, analyzed and interpreted as follows

4.3.1.**Storage system**

Table 3 Mean scores of distribution system

	N	Mean	Std. Deviation
Special storage area available for vaccines in the health facility.	16	4.7500	.57735
There is enough vaccine storage space.	16	4.7500	.44721

The vaccines are stacked properly inside the refrigerator	16	4.7500	.44721
Storage equipment's are fully functional.	16	4.5625	.72744
There is different storage equipment for different kinds of vaccines.	16	3.6875	.79320
Storage equipment's are regularly checked for compliance.	16	3.7500	.77460
SOPs are available to ensure proper vaccine storage.	16	4.4375	.72744
Existing SOPs are followed to ensure proper storage.	16	4.3125	.79320
There is any type of temperature monitoring devices in use.	16	4.9375	.25000
Temperature record readings remains between 2-8Oc	16	4.9375	.25000
Storage System	16	4.4875	.33838

Table 2 illustrates that the respondents agreed on having different storage equipment for different kinds of vaccines in their health center (mean=3.68,s.d=0.79,) Storage equipment's are regularly checked for compliance respectively (mean=3.75 s.d=0.77), Existing SOPs are followed to ensure proper storage(mean=4.31 s.d=0.79), SOPs are available to ensure proper vaccine storage(mean=4.43 s.d=0.727), They Strongly agreed on availability of Special storage area for vaccines (mean=4.75, s.d=0.57), There is enough vaccine storage space. (mean=4.75, s.d=0.447). There is any type of temperature monitoring devices in use. (mean=4.9375, s.d=0.25).Temperature record readings remains between 2-8oC (mean=4.9375, s.d=0.25). The respondents preferred to stay Strongl agreed on the other questions asked about the storage system.

From this study, it was possible to determine that the storage condition of vaccines in the health centers of Dire Dawa is excellent to ensure safety and availability of cold chain items.

4.3.2 **Distribution system**

Table 4: Mean scores of distribution system

Descriptive Statistics			
	N	Mean	Std. Deviation
There are special vehicles for transportation of cold chain items.	16	4.3125	1.13835
There are enough Containers to meet demand for distribution.	16	4.3125	1.01448
Appropriate mode of transportation is used	16	4.4375	.96393
There is temperature monitoring system during transportation.	16	3.7500	1.18322
Temperature readings remain between 2-8oCduring transportation.	16	3.6875	1.01448
Vaccine collection schedule time table is available.	16	4.6250	.88506
Delivery is done within recommended timelines.	16	3.9375	.85391
SOPs are available to ensure proper transport conditions.	16	4.1875	.91059
SOPs are followed to ensure proper transport conditions.	16	3.8125	.75000
Distribution	16	4.118	.73867

Table 3 indicates that, the respondents agreed on availability of special vehicles for transportation of vaccines (mean=4.3125, s.d=1.138), enough container for transportation of vaccine (mean=4.3125, s.d=1.014), Temperature readings remain between 2-8oCduring transportation (mean=3.6875, s.d=1.014 SOPs are available to ensure proper transport condition (mean=4.1875, s.d=.91059) and SOPs are followed to ensure proper transport conditions (mean=3.8125, s.d=.75000), Delivery is done within recommended timelines (mean=3.937, s.d=0.8539).In contrast, the respondents strongly agreed on Vaccine collection schedule time table is available (mean=4.625, s.d=0.885),. The respondents were agreed on the other questions asked about the distribution system of vaccines.

On average the respondents were agreed to having proper distribution systems. This means there is a chance of cold chain items being damage during transportation Proper transportation condition should be used to transport cold chain products and be fitted with monitoring devices.

4.3.3 Technical capacity

Table 5: Mean score of technical capacity

Descriptive Statistics

	N	Mean	Std. Deviation
Staffs who handle cold chain items are specifically trained.	16	4.8125	.54391
Enough training provided for the staff on vaccine distribution system.	16	4.1875	.75000
There are enough employees to handle maintenance of equipment	16	3.6250	.88506
Enough employees to handle the demand.	16	3.6875	.87321
Equipment are regularly checked and serviced to avoid breakdown and ensure compliance.	16	3.5625	.72744
There is enough equipment to handle demand.	16	3.6250	.71880
There is reliable electric power supply.	16	4.1250	.88506
There is a power backup to ensure constant power supply for equipment.	16	3.8125	.91059
Quality checks are done to ensure compliance with cold chain supply regulations.	16	3.8750	.71880
Technical	16	3.92	.51913

Table 5 illustrates that the Mean respondents were agreed on all question , There are enough employees to handle maintenance of equipment's (mean=3.6250, s.d=.54391), There are enough employees to handle the demand (mean=3.6875, s.d=.87321) and There is a power backup to ensure constant power supply for equipment. (mean=3.8125, s.d=.91059). As we can see from the table above the respondents were neutral on other questions.

This means that the technically capacity of health centers in Dire Dawa in terms of employee competence in monitoring storage and transport conditions as well as on quality checks , calibration of equipment, handling of the systems, is good but not sufficient to handle cold chain items.

4.3.4 Information system

Table 6: mean score of information system

Descriptive Statistics

	N	Mean	Std. Deviation
The facility has proper vaccine forecasting.	16	3.8750	.95743
Consumption reports are regularly prepared and reported to the appropriate organization.	16	4.3750	.71880
Vaccine stock balance and physical count of sample vaccine are equal.	16	3.8750	.88506
Vaccine requisition forms are used for ordering vaccine.	16	4.8125	.40311
SOPs are available to ensure proper Information system.	16	4.3750	.80623
SOPs are followed to ensure proper Information system.	16	4.0625	.77190
There is adequate inventory control system in the health facility	16	4.2500	.57735
Vaccine wastage reports are regularly prepared and reported to the appropriate organization	16	4.6875	.47871
Information System	**16**	**4.289**	**.50357**

Based on table 5, the respondents agreed on all statements about the information system except Vaccine requisition forms are used for ordering vaccine (mean=3.8750, s.d=0.885), Vaccine wastage reports are regularly prepared and reported to the appropriate organization. (mean=4.6875, s.d=.47871) to which they were Strongly agree.

The study reveals that information system practiced are agreeable in the health centers. Proper information system along the cold chain system is crucial in ensuring availability of vaccines (WHO, 2014c

4.3.5 Availability of vaccines

Table 7: mean score of availability of vaccines

Descriptive Statistics

	N	Mean	Std. Deviation
There is adequate quantity of vaccine for the supply period	16	4.0625	.92871
There is adequate buffer stock of vaccine for the supply period	16	3.9375	.92871
There is no stock out vaccine for the supply period	16	3.6250	1.14746
There is no over stock of vaccine for the supply period	16	3.2500	.77460
Availability of Vaccine	16	3.718	.70045

The above table shows that the respondents agreed on there is adequate quantity of vaccine for the supply period (mean=4.0625,s.d=.92871), There is adequate buffer stock of vaccine for the supply period (mean=3.9375,s.d=.92871), is no stock out vaccine for the supply period mean=3.6250,s.d=1.14746). and they were neutral on There is no over stock of vaccine for the supply period (mean=3.2500,s.d=.77460). On average the respondents were Agreed on availability of vaccine in their health centers

4.6 **Discussion**

This part presents detailed discussions pertaining to the research study. The results of the present study are discussed in line with the basic questions raised in chapter one. It also provides possible explanations for the results presented on the above.

on this study, it was possible to determine that vaccines are being stored carefully to ensure optimal potency. Vaccines should be stored at all times, beginning at the factory where they are manufactured and at every stage until the moment they are given to children and mothers. Excess heat or cold will reduce the vaccine potency (strength), increasing the risk that vaccines will be discarded. The storage condition of vaccines in the health centers of Dire Dawa is Good to ensure safety and availability of cold chain items. Control of storage conditions and temperature is essential in maintaining the quality of cold chain items and in helping to protect patients from sub-standard or ineffective medicines that may result from inadequate storage control (WHO, 2015a). The respondents in this study Strongly agreed on availability of Special storage area for vaccines in their health facility, they agreed on There is different storage equipment for different kinds of vaccines and Storage equipment's are regularly checked for compliance. This result is Similar to a study done in Addis Ababa, which revealed that, Standard vaccine refrigerators were not found in most of the healthcare centers visited but assessment of good arrangement practices of vaccines revealed that only half of all visited healthcare facilities and stores had not good arrangement practices (Tiya, 2012). A study from Pakistan reported that vaccine Storage facilities had massive over stacking and improper placement of products (USAID| Deliver project, 2015). Therefore, even if the vaccines were potent on arrival at the health institutions, their potency could easily be compromised because of lack of proper monitoring of the storage system. Vaccines should be stored carefully between+2ºC and +8ºC at all times, from the factory where they are manufactured until they are used in order to increase availability of vaccines and to maximize the resulting efficacy of immunization as observed in this study and others elsewhere (Njuguna et al., 2015; Zaffran et al., 2013).

The distribution of vaccines from the EPSA vaccine stores to health centers was on as recommended.. Simultaneously SOPs are available to ensure proper transport conditions but non perfectly SOPs are followed to ensure proper transport conditions. Similar study conducted in Coast region, Tanzania shows that the main cause of delay in delivery of vaccines to the health centers was shortage or lack of transport to distribute the vaccine. As it is indicted in similar study lack of reliable transport at district level contributes to shortage of vaccines at health facility level (Makuru, 2012)). Lack of means of transport from districts level to lower level could result in healthcare workers using public transport to transport vaccine carrier to their facilities. This is dangerous as public transport take long time and the temperature in the carrier may change because of the length of the time. Training is a very important constraint which needs to be considered to improve the vaccine distribution plan. People involved in transportation and supply of vaccines need to be trained and have knowledge of cold chain and how to handle breakage of cold chain. Without pre-requisite knowledge of how to handle vaccines being transported can seriously affect the vaccine potency which in turn can result in wastage of vaccines and thus, increase in their price (Immunization & Biologicals, 2004).

In the present study the respondents claimed that the training provided for the staff on vaccine cold chain management was good. The other in this study was capacity of employees to handle the demand and maintenance of equipment's. This result is supported by other studies done in different countries. In Tanzania, a study showed that in the last 3 years of the study majority of respondents were not attended any training on storage, distribution and handling procedures of vaccines (Makuru, 2012). A study done on cold chain management knowledge and practices in primary health care facilities in Niassa, Mozambique indicated that 60% of the health workers had no pre- service training in vaccine storage and handling (de Timóteo Mavimbe & Bjune, 2007). According to study done on pharmaceutical distributors in Nairobi County 41% of respondents have absolutely no special training in cold chain (Njuguna et al., 2015). This means that most organizations are not technically capable to handle cold chain items and ensure their safety. (Samant et al., 2007) showed generator facility in 65% of public health centers .This is in contrast to the present study, where the respondents agreed on having backup to ensure constant power supply for equipment's in their health centers. Results were reported from India where Vaccine Cold Chain in Urban Health Centers of Western India shows that only 30% of the health centers had either a working inverter or a generator (Naik et al., 2013). Respondents in the present study were neutral on having their cold chain equipment checked and serviced to avoid breakdown this comparatively a better result when compared to results reported from Kenya where 52% of the respondents strongly disagree on this issue (Njuguna et al., 2015). It was positive point to note that the respondents agreed on almost all items of the information system. Unlike the findings in this study effective Vaccine Management (EVM) Analysis done by WHO in 75 countries revealed that with a few exceptions, information systems are weak at each level in each region. The same study illustrates more than a third of vaccine storage facilities do not monitor vaccine wastage(WHO, 2014b).

Information systems were found on good in the health centers under dire dawa . Various weaknesses on Information systems have been underlined from other studies as a major risk factor associated with limited availability of vaccines (Kaufmann et al., 2011).Some key interventions including constant supervision, training of professionals in charge, promoting access to existing guidelines and making available cold chain tools have been identified to reduce these gaps **(**WHO, 2014c)

CHAPTER FIVE:

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary

In this study, the researcher looked for the cold chain management practice and availability of vaccines in governmental health centers in Dire Dawa. The study also indicated the relationship that exists between cold chain management practice and availability of vaccines. In order to achieve these objectives, data were collected from the cold chain responsible personnel in the health centers.

From the demographic characteristics of respondents', the majorities (75%) were female participants and the remaining (25%) was male. Besides, age range of the majority respondents were between 26 to 34 years, which occupied 14(87.5 %). In cognizant to their educational level, the participants had a minimum of diploma and it is possible to say they are/were educated. Coming to profession and work experience of the respondents, they had adequate of both which reasonably increase the validity (as a whole the quality) of this research.

In descriptive statistics the results show that the respondents Neutral on Information system. On the other hand the respondents preferred to stay Agreed on the Storage system, transportation system and technical capacity of the health centers.

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5.2. Conclusion

In this study, the major determinant factors identified were cold chain management practices based on cold chain responsible personals' response which comprises of four components;

storage system distribution system, technical capacity and information system. Besides, their effect on the availability of vaccines was studied. Three main research questions were developed and addressed in this research.

Unfortunately, all the components of cold chain management practices were rated good. In other words, cold chain management practices in the health centers were Good in ensuring the availability of vaccines.

Based on the analysis made on availability of vaccines in the health centers, respondents were good in rating the availability of vaccines in their health centers. This good but doesn't guarantee the service is in line with the recommendation of guidelines and could hinder the immunization services and have continuity of the health centers.based on the findings of the study it will not be unwise to conclude that Information system in the cold chain management should be improved so as to bring a change in the availability of vaccines in the health centers.

5.3. Recommendations

Based on the findings of the study, the researcher suggested the following points as plausible commendations which if adopted would lead to efficient and effective cold chain management

Storage conditions for cold chain items Have good and it have to be improve so that the safety of vaccines is guaranteed in having fully functional and enough storage facilities. FMOH Need to strengthen supportive supervision at lower healthcare facilities delivery site so as to improve proper vaccine storage., Staffs who handle cold chain items should strictly follow SOP’S.

The transport systems for cold chain items need to be improved so that the safety of cold chain items is guaranteed in having fully functional and enough vehicles for transport of cold chain items. The transition of vaccine supply chain responsibility from the Federal Ministry of Health to the Pharmaceuticals Fund and Supply Agency should be facilitated since it was found to bring huge benefit in Dire dawa hub where the transition took place (JSI, 2015b

One of the major challenges identified was erratic power supply. FMOH should ensure that all health facilities need to have adequate contingencies for light offs. Special training is required for all personnel involved in cold chain sensitivity of cold chain items and hence improves their understanding and competency in handling cold chain pharmaceuticals to ensure their safety. All equipment’s also need to be properly calibrated and up to standard as recommended by regulatory bodies. SOPs in place should be updated and strictly followed since; one of the challenges identified was the poor adherence and implementation. WHO cold chain management systems (GDP, GSP, etc) could also be adopted in order to adhere to some standard as recommended by regulatory bodies.

This study indicates the information system in the management of cold chain is considerable. It will be further strengthen if the Standard operating procedures would be followed. Taking lesson from, FMOH, donors and EPSA should work together to implement a better information system in Dire Dawa through electronic databases such as Health Commodities Management Information System (HCMIS).

Reference

Acu, F., Adedeji, A., Esan, J., & Odusanya, O. (1996). Live viral vaccine potency: an index for assessing the cold chain system. Public health, 110(6), 325-330.

Adida, E., Dey, D., & Mamani, H. (2013). Operational issues and network effects in vaccine markets. European Journal of Operational Research, 231(2), 414-427.

Afsar, A., & Kartoğlu, Ü. (2006). Vaccine stock management: Guidelines for immunization and vaccine store managers. Geneva: World Health Organization.

Association, P. D. (2007). Guidance for temperature-controlled medicinal products: maintaining the quality of temperature-sensitive medicinal products through the transportation environment. PDA journal of pharmaceutical science and technology/PDA, 61(2 Suppl TR 39),

. Bell, K. N., Hogue, C. J., Manning, C., & Kendal, A. P. (2001). Risk factors for improper vaccine storage and handling in private provider offices. Pediatrics, 107(6), e100-e100.

Belsey, M. J., de Lima, B., Pavlou, A. K., & Savopoulos, J. W. (2006). Influenza vaccines. Nature Reviews Drug Discovery, 5(3), 183-184.

Berhane, Y., & Demissie, M. (2000). Cold chain status at immunisation centres in Ethiopia. East African medical journal, 77(9).

Blue, L. (2008). Why Don't Adults Get Vaccinated. Time, January, 24. BoFED, A. A. (2009). Socio-Economic Profile of Addis Ababa For the Year 2004 E.C/2011/12G.C Policy Study and Analysis Sub Process.

Burns, R., & Burns, R. (2008). Business Research Methods and Statistics Using SPSS: SAGE Publications Ltd.

CDC. (2014). Vaccine Storage& Handling Toolkit May 2014 Retrieved Jan27, 2016, from http://www.cdc.gov/vaccines/recs/storage/toolkit/

CommonwealthofAustralia. (2013). National Vaccine Storage Guidelines: Strive for 5.

David Wolking, U. D. O. H. I. a. t. P. O. H. C. (2013). PREDICT One Health Consortium 2013. Guide for Implementing a Cold Chain for Safe Sample Transport and Storage. Retrieved Jan 27, 2016, from http://www.vetmed.ucdavis.edu/ohi/predict/PREDICT_Publications.cfm#Protocols

de Timóteo Mavimbe, J. C., & Bjune, G. (2007). Cold chain management: knowledge and practices in primary health care facilities in Niassa, Mozambique. Ethiopian Journal of Health Development, 21(2), 130-135.

Deo, S., & Corbett, C. J. (2009). Cournot competition under yield uncertainty: The case of the US influenza vaccine market. Manufacturing & Service Operations Management, 11(4), 563-576.

FMOH. (2013). Vaccine Management Training Manual for EPI Coordinators and Focal Persons.

FMOH. (2015). Ethiopia national expanded programme on comprehensive multi year plan 2016 - 2020. Gazmararian, J. A., Oster, N. V., Green, D. C., Schuessler, L., Howell, K., Davis, J., . . . Warburton, S. W. (2002). Vaccine storage practices in primary care physician offices: assessment and intervention. American journal of preventive medicine, 23(4), 246-253.

Guichard, S., Hymbaugh, K., Burkholder, B., Diorditsa, S., Navarro, C., Ahmed, S., & Rahman, M. M. (2010). Vaccine wastage in Bangladesh. Vaccine, 28(3), 858-863.

Health, N., & Council, M. R. (2008). The Australian immunisation handbook: NHMRC. Immunization, W. D. o., & Biologicals. (2004

Immunization in practice: A practical guide for health staff: World Health Organization.

JSI. (2015a). From Supply Chain Analysis to Action: Delivering Vaccines in Ethiopia.

JSI. (2015b). Transition.

Kartoğlu, Ü. (2012). Temperature sensitivity of the diphtheria containing vaccines.

Kartoglu, U., & Milstien, J. (2014). Tools and approaches to ensure quality of vaccines throughout the cold chain. Expert review of vaccines, 13(7), 843-854

Katz, M. L., & Shapiro, C. (1985). Network externalities, competition, and compatibility. The American economic review, 75(3), 424-440.

Kaufmann, J. R., Miller, R., & Cheyne, J. (2011). Vaccine supply chains need to be better funded and strengthened, or lives will be at risk. Health Affairs, 30(6), 1113-1121.

Kelley, K., Clark, B., Brown, V., & Sitzia, J. (2003). Good practice in the conduct and reporting of survey research. International Journal for Quality in Health Care, 15(3), 261-266. Kohli, P. (2008). Fruits and Vegetables Post-Harvest Care: The Basics. PDF). CrossTree technovisors. Kothari, C. R. (2004). Research methodology: Methods and techniques: New Age International. Lala, K. R., & VVM, V. V. M. (2003). Thermostability of Vaccines Mrudula K.

Lala. Indian pediatrics, 40, 311-319.

Lloyd, J. (1999). Technologies for vaccine delivery in the 21^ st century: A white paper of WHO, UNICEF, USAID and PATH: WHO/ATT/TECHNET. 99.

Lydon, P., Raubenheimer, T., Arnot-Krüger, M., & Zaffran, M. (2015). Outsourcing vaccine logistics to the private sector: The evidence and lessons learned from the Western Cape Province in South-Africa. Vaccine.

Makuru, M. (2012). Assessement of vaccines distribution system in public healthcare facilities in coast region, Tanzania Degree of Master of Science.

Matthias, D. M., Robertson, J., Garrison, M. M., Newland, S., & Nelson, C. (2007). Freezing temperatures in the vaccine cold chain: a systematic literature review. Vaccine, 25(20), 3980-3986.

Maurice, J. M., & Davey, S. (2009). State of the World's Vaccines and Immunization: World Health Organization.

Miller, N., & Harris, M. (1994). Are childhood immunization programmes in Australia at risk? Investigation of the cold chain in the Northern Territory. Bulletin of the World Health Organization, 72(3), 401.

MOH. (2012). Immunization Retrieved Feb,4, 2016, from http://www.moh.gov.et/immunizatio

Mugenda, M., & Mugenda, A. (2003). Research Methods in Education: Quantitative and Qualitative Approach, Nairobi: Acts press.

Naik, A. K., Rupani, M. P., & Bansal, R. (2013). Evaluation of vaccine cold chain in urban health centers of municipal corporation of surat city, Western India. International journal of preventive medicine, 4(12), 1395.

Nelson, C., Froes, P., Van Dyck, A. M., Chavarría, J., Boda, E., Coca, A., . . . Lima, H. (2007). Monitoring temperatures in the vaccine cold chain in Bolivia. Vaccine, 25(3), 433-437.

Nelson, C. M., Wibisono, H., Purwanto, H., Mansyur, I., Moniaga, V., & Widjaya, A. (2004). Hepatitis B vaccine freezing in the Indonesian cold chain: evidence and solutions. Bulletin of the World Health Organization, 82(2), 99-105.

Njuguna, M. W., Mairura, C. J., & Ombui, K. (2015). Influence of Cold Chain Supply Logistics on the Safety of Vaccines. A Case of Pharmaceutical Distributors in Nairobi County. Okwo-Bele, D. J.-M. (2015). Together we can close the immunization gap Retrieved Jan,19, 2016, from http://www.who.int/mediacentre/commentaries/vaccine-preventablediseases/en/ PATH. (2008). Landscape Analysis Analysis of EVSM Indicators.

Samant, Y., Lanjewar, H., Parker, D., Block, L., Tomar, G. S., & Stein, B. (2007). Evaluation of the cold-chain for oral polio vaccine in a rural district of India. Public health reports, 112-121. Saunders, M. N. (2011). Research methods for business students, 5/e: Pearson Education India.

Taylor, J. (2001). Recommendations on the control and monitoring of storage and transportation temperatures of medicinal products. THE PHARMACEUTICAL JOURNAL, 267(28), 128-131. USAID|Deliverproject. (2015). EPI Reforms at the Federal Stores: Optimizing Supply Chain Practices for Better Governance and Accountability. Arlington.

WHO. (2005). Monitoring vaccine wastage at country level: Guidelines for programme managers.

WHO. (2008). Training for Mid-Level Managers: Cold Chain, Vaccines and Safe-Injection Equipment Management. Geneva (Switzerland): WHO.

WHO. (2011). Technical Report Series 961. Annex 9: Model guidance for the storage and transport of time- and temperature-sensitive pharmaceutical products.

WHO. (2014a). 2014 assessment report of the global vaccine action plan strategic advisory group of experts on immunization .

WHO. (2014b). Effective Vaccine Management (EVM) Global Data Analysis 2010-2013

WHO. (2014c). Immunization supply chain and logistics - a neglected but essential system for national immunization programmes. Geneva, Switzerland.

WHO. (2015a). How to monitor temperatures in the vaccine supply chain.

WHO. (2015b). Vaccines Retrieved Jan,27, 2016, from http://www.who.int/topics/vaccines/en/ Woodyard, E., Woodyard, L., & Alto, W. A. (1995). Vaccine storage in the physician's office: a community study. The Journal of the American Board of Family Practice, 8(2), 91-94.

Yadav, P., Stapleton, O., & Van Wassenhove, L. (2013). Learning from coca-cola. Stanford Soc Innov Rev, Winter.

Zaffran, M., Vandelaer, J., Kristensen, D., Melgaard, B., Yadav, P., Antwi-Agyei, K., & Lasher, H. (2013). The imperative for stronger vaccine supply and logistics systems. Vaccine, 31, B73-B80.

Appendix 1 :Consent form

DIRE DAWA UNIVERSITY SCHOOL OF COMMERCE DEPARTMENT OF LOGISTICS AND SUPPLY CHAIN MANAGEMEN

Greetings!

My name is Tewodros Tafere. I am conducting a study on the effect of cold chain distribution system on the vaccine availability in governmental health centers for the partial fulfillment of master's degree in logistics and supply chain management in Dire Dawa University, School of commerce. The information that will be collect from this research project will be kept confidential. Taking part in this study you will contribute towards alleviating the problem of poor vaccines distribution system and availability. If you are willing to participate in our project, you need to understand and sign the Consent form. Then, you will be asked to give your response to the data collectors. If you have any question you can contact following individual and you may ask at any time you want.

Tewodros Tafere Tsigie: Dire Dawa University

Tel: +251 913- 054044

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E-mail: tewodrostafere222@gmail.com

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Name Signature Date

Appendix 2: **Questionnaire**

Questionnaire on Effect of cold chain distribution system on availability of vaccine

Questionnaire No:________________ Date: ________________________________

PART1: Demographic characteristics of respondents

The general attributes of respondents (i.e. you) are given below. Please tick (□) in the box that exactly expresses you.

1. Gender:

□ Male □ Female

2. Age:

□ <25yrs □ 25-44yrs □ 45-54yrs □ >54yrs

3. Educational Background :

□ Certificate □ Diploma □ BA/Bsc □ BA/Msc
Other Specify______________________

4. Experience in the job:

□ <1yr □ 1-3yrs □ 4-6yrs □ 7-8yrs □ > 9 yrs

5. Professional of in-charge/coordinator/ immunization focal person of the facility cold chain

□ Pharmacist □ Health ofifcer □ Nurse/midwife other
Specify _____

6. How many years have you been employed in this Health Facility?

□ 1-5 Years □ 6-10 Years □ 11-15 Years □ Over 15 Years

Part two: vaccine distribution system

Please rate to what extent you agree on the following vaccine distribution system components are applicable to your organization. The scale below will be applicable: 1 – Strongly disagree 2 – Disagree3- Neither agree nor disagree 4- Agree 5 – Strongly agree

No	Storage system and facility	1	2	3	4	5
1	Special storage area available for vaccines in the health facility.					
2	There is enough vaccine storage space.					
3	The vaccines are stacked properly inside the refrigerator					
4	Storage equipment's are fully functional.					
5	There is different storage equipment for different kinds of vaccines.					
6	Storage equipment's are regularly checked for compliance.					
7	SOPs are available to ensure proper vaccine storage.					
8	Existing SOPs are followed to ensure proper storage.					
9	There is any type of temperature monitoring devices in use.					
10	Temperature record readings remains between $2\text{-}8^oC$					
No	Transportation system	1	2	3	4	5
1	There are special vehicles for transportation of cold chain items.					

2	There are enough Containers to meet demand for distribution.					
3	Appropriate mode of transportation is used					
4	There is temperature monitoring system during transportation.					
5	Temperature readings remain between 2-8^{o}Cduring transportation.					
6	Vaccine collection schedule time table is available.					
7	Delivery is done within recommended timelines.					
8	SOPs are available to ensure proper transport conditions.					
9	SOPs are followed to ensure proper transport conditions.					
No	Technical capacity	1	2	3	4	5
1	Staffs who handle cold chain items are specifically trained.					
2	Enough training provided for the staff on vaccine distribution system.					
3	There are enough employees to handle maintenance of equipment's.					
4	Enough employees to handle the demand.					
5	Equipment are regularly checked and serviced to avoid breakdown and ensure compliance.					
6	There is enough equipment to handle demand.					

7	There is reliable electric power supply.					
8	There is a power backup to ensure constant power supply for equipment.					
9	Quality checks are done to ensure compliance with cold chain supply regulations.					
No	Information system	1	2	3	4	5
1	The facility has proper vaccine forecasting.					
2	Consumption reports are regularly prepared and reported to the appropriate organization.					
3	Vaccine stock balance and physical count of sample vaccine are equal.					
4	Vaccine requisition forms are used for ordering vaccine.					
5	SOPs are available to ensure proper Information system.					
6	SOPs are followed to ensure proper Information system.					
7	There is adequate inventory control system in the health facility					
8	Vaccine wastage reports are regularly prepared and reported to the appropriate organization					

Part three: Availability of vaccine

No	Availability of vaccine	1	2	3	4	5
1	There is adequate quantity of vaccine for the supply period					
2	There is adequate buffer stock of vaccine for the supply period					
3	There is no stock out vaccine for the supply period					
4	There is no over stock of vaccine for the supply period					

THIS IS THE END. THANK YOU FOR YOUR VALUABLE INPUT AND KIND COOPERATION. YOUR KIND PARTICIPATION IS MUCH APPRECIATED. THANK YOU AGAIN