ASSESSING EFFICIENT COLD CHAIN MANAGEMENT PRACTICES IN THE HEALTH SECTOR AND ITS IMPACT ON SERVICE DELIVERY IN GHANA: A STUDY OF KOMFO ANOKYE TEACHING HOSPITAL, KUMASI

By

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DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no materials previously published or written by another person nor material by which to a substantial extent has been accepted for the award of any other degree or diploma at the Kwame Nkrumah University of Science and Technology, or any other educational institution, except where due acknowledgement is made in this thesis.

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DEDICATION

To my father and mother and my wonderful family. Thank you all.

ABSTRACT

The purpose of this study was to assess efficient cold chain management practices in the health sector and its impact on service delivery in Ghana. The objectives of the study were: to identify the existing cold chain practice in the Ghanaian healthcare sector; to evaluate the challenges associated with the cold chain delivery system in the Ghanaian healthcare sector; and to determine cold chain delivery system and its impacts on the healthcare service delivery. The study adopted the quantitative research approach. First, a comprehensive review of the literature was carried out to identify variables that were compounded to form structured questionnaires. A survey was then conducted using the questionnaires among healthcare professionals in the Komfo Anokye Teaching Hospital in the Ashanti regions in Ghana. Sixty-two (62) healthcare professionals participated in the survey, whose responses were analyzed mean scores and the one-sample t-test. The study's findings revealed a moderate level of practice of cold chain management in Ghana, whereas the use of fridge tags or functional thermometers, presence of emergency power supply, use of appropriate refrigeration (storage) equipment, use of requisition forms for ordering and reporting, and storage of products at required temperatures mainly were practised. The findings also indicated that trained personnel, reliable transportation, reliable storage and efficient management are essential for efficient cold chain management. Efficient cold chain management has a significant impact on healthcare service delivery. Notwithstanding, the significant challenges to efficient cold chain practice in the Ghanaian healthcare sector include lack of modern technology or optimal equipment, inadequate financing, lack of reliable transportation, erratic electric power supply, and transportation delays. The study provides empirical evidence regarding the efficient cold chain management practice and its impact on service delivery in a developing country such as Ghana. This would guide healthcare professionals and institutions, and the government to implement strategies necessary to improve cold chain practice in the Ghanaian healthcare sector.

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CHAPTER ONE

INTRODUCTION

1.1 Background of The Study

Disease prevention in the last century has been the greatest public health success through vaccination efforts intensified globally by numerous corporations, governments and researchers to improve and manage vaccines at hand as well as develop new ones (Bankole et al., 2010). According to de Timóteo Mavimbe and Bjune (2007), efficient conservation of vaccines at hand right from its manufacture through administration requires an adequate cold chain system, conformity with standards and effective management. Vaccines are characterised by Ogboghodo et al. (2017) as highly thermo-sensitive substances which have a fixed shelf life that lose viability over time. As new, more expensive vaccines are introduced, prevention of vaccine potency during storage and handling is increasingly becoming important (Bankole et al., 2010). These vaccines are biological products that slowly become inactive with time and must be kept within appropriate temperature ranges right from manufacturers to those receiving them (Yakum et al., 2015).

It is estimated that vaccinations have prevented 26 million cases of childhood disease in the United States (Pfizer, 2019). Vaccine-preventable diseases (VPDs) are responsible for nearly 20% of the 8.8 million deaths/year among children under-5 years (Praveen, 2015). In Nigeria, children under the age of five die from VPDs as a result of poor routine immunization performance, which can be attributed to logistics and supply chain infrastructure issues, failure of the cold chain and insufficient knowledge among health workers regarding cold chain management (Federal Ministry of Health, 2013). The burden of VPDs in Africa,

including Ghana cannot be over emphasized. Although vaccination coverage seems to be on the increase, reports have shown that the prevalence of VPDs has not reduced especially in Africa as reported by the World Health Organisation (WHO) that, more than 30 million children under five still suffer from VPDs annually (Rao et al., 2012; WHO, 2020).

Due to the COVID-19 pandemic, a largely concealed issue in healthcare delivery (i.e., the cold chain requirement for most biologic medications and vaccines) was brought to light (Yu et al., 2021). From the time of manufacture through the time of administration/distribution, vaccines are kept in a potent form (within a safe temperature range) through a cold chain. (Mugharbel and Al Wakeel, 2009). WHO defined cold chain as "a set of rules and procedures that ensure the proper storage and distribution of vaccines to health services from the national to the local level interconnected with refrigeration equipment that allows vaccines to be stored at recommended temperatures to maintain their potency" (WHO, 2021). However, it is worthy of note that cold chain delivery in healthcare does not cover only vaccines but other healthcare products that need to be preserved. Thus, the definition by FedEx is an end-to-end system of storing and transporting vaccines or healthcare products at desired temperatures from the point of manufacture to the point of use (FedEx, 2020). It is required of primary health care providers throughout the chain to have adequate knowledge to manage the cold chain (Shah et al., 2015). Higher vaccination coverage necessitates efficient cold chain management systems that can keep vaccines at the proper temperatures and distribute them efficiently (Asamoah et al., 2021). An efficient vaccine supply chain system has been proven to be one of the essential components of any immunization program, as it guarantees that vaccines reach recipients in their most potent form (Chiodini, 2014). Also, necessary vaccines need to be available and of good quality for a successful vaccine delivery system.

Only when potent and efficacious vaccines are administered can successful immunisation be actualized (Ogboghodo et al., 2018).

For efficient cold chain management, WHO has developed a set of practice guidelines for different service levels, including vaccination practices, vaccine monitoring, cold chain management, and reporting systems (WHO, 2004). The Ghana Health Service (GHS) and the Ministry of Health (MoH) have collaborated to create immunization guidelines that incorporate the cold chain delivery system (MoH, 2016). However, Bogale et al. (2019) believe that a cold chain delivery system is vulnerable, particularly in tropical nations with inconsistent power supplies and underdeveloped facilities for its maintenance. Against this backdrop, this study seeks to assess cold chain delivery in the Ghanaian health sector and its impact on healthcare service delivery.

1.2 Statement of the Problem

As the global healthcare sector is continuously undergoing tremendous changes and facing new challenges, such as the outbreak of the Corona Virus disrupting every aspect of human's life, vaccine development became a worldwide priority (Izikki et al., 2021). However, according to Izikki et al. (2021), after securing the manufacturing of the COVID-19 vaccine, the main challenge remains to transport and distribute the vaccines securely and wastage free. Furthermore, although technological advancements have improved the cold chain, logistical and transportation operations remain the main issue (Castelein et al., 2020). Hence, the many challenges faced by COVID-19 vaccine logistics in developing countries (Izikki et al., 2021).

Inadequate knowledge of health workers of cold chain management could lead to improper handling of vaccines, resulting in altering the potency of vaccines or even failing to recognise

that vaccine potency has been compromised (Ogboghodo et al., 2018). Thus, it may lead to inadvertent administration of sub-potent vaccines, which increases the risk that beneficiaries are not fully protected from disease (de Timóteo Mavimbe and Bjune, 2007). The consequence of this will be the administration of non-potent vaccines to people with the tendency for re-emergence of those diseases thought to be under control, causing a rise in morbidity and mortality rate (Bankole et al., 2010). Despite the fact that healthcare professionals (HPs) have received training, evidence reveals that skills, knowledge, attitudes, and non-adherence to cold chain management standards exist, negatively impacting the efficient administration of the cold chain delivery system (Bogale et al., 2019). As a result of this lack of understanding, the cold chain management system could collapse, which could harm the quality of the vaccines to be delivered (Asamoah et al., 2021).

According to WHO, up to 50% of vaccines are thrown away each year due to a lack of temperature control and logistics to maintain an unbroken cold chain. At the scale of COVID-19, this wastage rate could waste up to a billion vaccines, representing a staggering wasted investment even if valued at a non-profit cost of around $10 for each vaccine (United Nations Environment Programme (UNEP), 2020). A total of 2.8 million doses of vaccinations were lost in 2011 owing to cold chain problems in five countries, according the World Health Organization (WHO, 2014). Similar to this, report from the Centre for Disease Control and Prevention (CDC) suggests that Disposable vaccines amount to 300 million pounds every year owing to poor storage and distribution practices worldwide (Praveen, 2015). Due to a lack of proper cold chain management, vaccines that are both costly and in short supply end up being wasted (Ogboghodo et al., 2017). Cold-chain logistics expenditures for biopharmaceutical goods alone in 2017 exceeded $13 billion globally, with damage estimates ranging from 20% to 40% before the goods reach the end-user (Logmore, 2019).

The overall amount of pharmaceutical losses worldwide is enormous because of this steady increase in spending.

In Ghana, the Expanded Programme on Immunization (EPI) is tasked with cold chain activities. Even with this programme, there is still limited evidence on the knowledge, attitudes, and challenges of healthcare providers in Ghana about the management of the cold chain and the level of compliance of health facilities (Agyekum, 2012; Diamenu et al., 2015; Osei et al., 2019). There was only a minor correlation between knowledge of cold chain management and attitudes toward it, according to Asamoah et al. (2021). This finding suggests that knowledge of cold chain management does not necessarily impact attitudes toward it, and vice versa. Additionally, their study revealed that cold chain management supporting facilities in the Ghanaian healthcare sector are less than the highest standard or quality, presenting several challenges that impede healthcare providers' capacity to effectively manage the vaccine cold chain system. From this, it can be concluded that the cold chain delivery system in the Ghanaian healthcare sector is very poor. Therefore, an investigation into the cold chain delivery system in Ghana's healthcare sector is being conducted. In Ghana, studies conducted on cold chain delivery in the healthcare sector have primarily focused on effective vaccine management, knowledge, attitudes and practices of healthcare providers in cold chain management, as well as the challenges faced by the cold chain delivery system (Osei et al., 2019; Asamoah et al., 2021). Nonetheless, these studies failed to assess how cold chain impacts healthcare service delivery. This presents a significant gap in literature this study sought to fill.

1.3 Objectives of the Study

This research aimed to assess efficient cold chain management practices in the health sector and their impact on service delivery in Ghana.

1.4 Research Questions

To achieve the aim as mentioned above, the following objectives were set;

1. To identify the existing cold chain practice in the Ghanaian healthcare sector.
2. To evaluate the challenges associated with the cold chain delivery system in the Ghanaian healthcare sector.
3. To determine the effect of cold chain delivery system on healthcare service delivery.

1.5 Significance of the Study

Perhaps the most basic question that this study must address is: "Why is there a need for a cold chain delivery system?" With the current global health crisis caused by the COVID-19 pandemic and the absence of vaccine manufacturing centres, especially in African nations like Ghana, research into cold chain delivery systems is becoming increasingly important to ensure safe and effective vaccine administration. A study on Ghana's healthcare sector's cold chain delivery system would not be necessary if vaccines could avert infections or medical supplies were not so sensitive to environmental factors like heat.

The significance of this research lies in its assessment of the cold chain delivery in the Ghanaian healthcare sector and its impact on healthcare service. It is envisaged that the findings of the study would lead the activities of various healthcare sector stakeholders by providing useful information about the current state of cold chain delivery in the Ghanaian healthcare sector, cold chain delivery impact in healthcare, the challenges encountered, and steps that may be taken to enhance it.

1.6 Overview of the Methodology

The quantitative research approach was adopted for this study. In research design, there are options of choosing either a quantitative or qualitative approach to collect and analyze data (Ajayi, 2017). The choice of a certain method is dependent on the study intent, the nature and the information available for the research (Naoum, 2002; Baiden, 2006). Quantitative research is the systematic collection of numerical data and applying statistical, mathematical, or computational approaches to investigate phenomena (Adedoyin, 2020). The quantitative approach to research is appropriate where the researcher has some population information. In the effort to realise the study's objectives, the research methodology was steered across three phases. An extensive review of pertinent literature was conducted in the first phase to reveal the available literature on the subject area.

The literature review was sought from articles, journals, unpublished thesis and books. Attained variables from the review were then be compounded to develop a questionnaire. Following this, a survey of structured questionnaires employing both closed and open-ended questions was conducted to gather the relevant data as the second phase. The final stage of the research methodology focused on how the data collected will be analysed. Healthcare professionals constituted the targeted population, from which a sample was drawn using the purposive and convenience sampling techniques. The purposive sampling technique involves using the researcher’s discretion to select a sample that, per his understanding, possesses the knowledge and expertise needed to provide the requisite information for the study (Greener, 2008). According to Teddlie and Yu (2007), the convenience sampling technique also aids in obtaining readily available samples for the study. Data gathered from the survey was coded

and fed into the Statistical Package for Social Sciences (SPSS) and analysed using Mean score ranking and the One-sample t-test.

1.7 Scope of the Study

This study focused on assessing cold chain delivery in the Ghanaian health sector and its impact on service delivery. This study involved healthcare professionals who have lines of influence in cold chain management or are working on a cold chain site. Geographically, the study's scope was limited to the Ashanti region of Ghana. This region was selected because it has the highest number of health facilities compared to the other regions, representing 530 out of 2857 identified health facilities in Ghana, according to Statista (2021).

1.8 Organization of the Thesis

The research has been categorized into five main chapters as follows:

Chapter one deals with the introduction covering the background of the study, statement of the problem, aim and objectives, research questions, the scope of the study, the methodology to be adopted, the significance of the study, as well as the organization of the study.

Chapter two provides a review of previous studies to assess the current cold chain system in Ghanaian healthcare sector.

Chapter three shows the methodology to be used in this research to achieve its stated objectives. It gives a profile of the selected area to be studied and describes the sources of data and methods of data collection and analysis.

Chapter four presents and discusses the results from the analysis of the data.

The last chapter which is chapter five provides a brief of the entire research, the findings and conclusion of the study as well as recommendations for the way forward.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discusses relevant literature on cold chain ma in the general, global and Ghanaian healthcare sector. It began with an overview of the global healthcare sector, trailed by healthcare in their Ghanaian context. It then discussed the cold chain delivery system in the general healthcare and Ghanaian context, identifying some cold chain practices. It also examines some challenges faced in the cold chain delivery system in the Ghanaian healthcare sector. It further identifies some of the various impacts the cold chain delivery system has on healthcare service delivery. This chapter then ended by identifying some measures to improve cold chain delivery system in the Ghanaian healthcare sector.

2.2 Conceptual Review

2.2.1 Supply Chain

In its most basic form, a supply chain is the series of events and procedures that transport a product from dirt to dirt, sometimes literally. It refers to various activities that have existed since the birth of business (Blanchard, 2021). Blanchard (2021), in other terms, asserts that a supply chain runs from the initial supplier or source to the final client/consumer (ibid). According to Izikki et al. (2021), a supply chain is a network that connects a corporation with its suppliers to manufacture and deliver a specific product to the consumer. Various tasks, individuals, organizations, data, and assets are all part of this network. This implies that the supply chain encompasses all the stages of getting a product or service from its initial condition (manufacturer) to its final destination (consumer). According to Izikki et al. (2021),

supply chains are now complex due to demanding client requirements regarding quality, time, and sustainability as the industrial and business world continuously undergoes tremendous changes and faces new difficulties.

Supply chain management was coined in the early 1980s, when transportation, distribution, and materials management merged into a single term (Blanchard, 2021). It was conceived by Keith Oliver, a Booz Allen consultant, and first appeared in print in 1982. The book Competitive Advantage, by Harvard professor Michael Porter, was published in 1985 and explained how a company might become more successful by carefully analyzing the five primary processes that make up its supply chain.

1. Inbound logistics: This refers to the actions involved in receiving, storing, and dispersing product inputs (material handling, warehousing, inventory control, transportation scheduling, and returns to suppliers).

2. Operations: This refers to the actions involved in changing raw materials into finished goods (machining, packaging, assembly, equipment maintenance, testing, printing, and facility operations).

3. Outbound logistics: These are the actions involved in gathering, storing, and physically distributing commodities to customers (finished goods warehousing, material handling, freight delivery, order processing, and scheduling).

4. Sales and marketing: In the context of a supply chain, these activities entice and enable purchasers to acquire a product (advertising, promotions, sales force, quoting, channel selection, channel relations, and pricing).

5. Service: This refers to the activities involved in providing service to improve or maintain the product's value (installation, repair, training, parts supply, and product adjustment).

2.2.2 Cold Chain

The cold chain constitutes a small part of the supply chain; it is mainly used for frozen goods, medical supplies, and delicate items, including meat, medications, ice cream, and fish. Cold chain, according to Bishara (2006), is a type of supply chain that ensures the preservation of a wide range of perishable items or products being pharmaceutical, agricultural and chemical from deterioration, inappropriate temperature, humidity, light, or specific pollutants to preserve them refrigerated, chilled, and fresh. Similarly, Zhang et al. (2018) refer to cold chain as a systematic logistics program in a supply chain where temperature-responsive goods are always supplied and kept in a cold environment throughout the overall process, such as storage, manufacturing, transit, dissemination, and marketing, to ensure product safety and quality, speedy delivery, and reduced logistics wear and tear. According to Bamakan et al. (2021), a cold chain is a type of supply chain with controlled temperature right from the production stage to the stages of transportation, storage, distribution processes, and delivery to the end-user. The cold chains can be defined as “the equipment, processes and information management used to protect chilled and frozen [cargo, in which] the transport phases (i.e., loading, unloading, handling, and storage) play a fundamental role” (Castelein et al., 2020). The cold chain is a particular category of supply chains that stands out from other types of supply chains by demanding requirements and regulations that involve mainly perishable and temperature exigent products (Dong et al., 2021). According to the Grand View Research, the cold chain characterised the cold chain industry as a prosperous industry with a global growth rate increasing its market value to be over 15% from 2019 to 2025 (Grand View Research 2019).

In delivering products to consumers using a cold chain delivery system, the characteristics of the products decide the evaluation and control systems required to maintain the freshness and quality of the product throughout its delivery to the end-user (Bamakan et al., 2021). Temperature monitoring is important throughout the cold chain process to ensure the safety and quality of cold chain products, as stated by Xiao et al. (2019). Bamakan et al. (2021) state that to build a cold chain, one must know the product's nature and characteristics. For products that have a short lifespan and require particular storage, distribution and sale facilities, the development of Cold Chain Management (CCM) was a natural progression in supply chain management (Shih and Wang, 2016). Perishable goods, such as dairy and drinks, flowers and ornamental plants, fresh agricultural items, and pharmaceuticals, can all be divided into four groups based on findings from the cold chain sector (Bamakan et al., 2021).

The cold chain is an essential part of the food products supply chain in foods and perishable products. There are higher risks of food waste, higher expenses, and frequently health-related hazards in this cold chain category, which entail a high social cost if expired foods end out on the market (Bamakan et al., 2021). Managing the issues connected with the cold chain system from "farm to fork" requires a smart cold chain (Tsai and Pawar 2018). Inefficiencies in this cold chain segment could result in post-harvest food, which is a major problem in densely inhabited areas (Cerchione et al., 2018). Because of the great distances between greenhouses and markets, cold chain logistics for flowers and ornamental plants is critical, and it involves three stages: (i) from growers to wholesalers, (ii) from wholesalers to retailers, and (iii) from retailers to customers (Babalola et al., 2011). The most crucial aspect of fresh agricultural cold chains is freshness (Bamakan et al., 2021). Several studies have focused on the significance of the last mile, including the final delivery of items to clients, which is one of

the most expensive aspects of the supply chain, according to Hsiao et al. (2018). Pharmaceutical items are typically carried in cold packets organized in pallets in the healthcare sector, specifically the pharmaceutical industry (Babalola and colleagues, 2011).

2.2.3 Cold Chain Delivery System In The Healthcare Sector

The cold pharmaceutical chain and the healthcare supply chain are associated with the supply chain of medicines within pharmaceutical companies, hospitals, health centres, and pharmacies (Bamakan et al., 2021). Cold chain's importance in healthcare cannot be overemphasized mainly due to the worldwide priority of the conception of a vaccine in the fight against Corona Virus (COVID-19), disrupting every aspect of man's life (Izikki et al., 2021). Disease prevention in the last century has been the most significant public health success through global intensified vaccination efforts by numerous corporations, governments and researchers to improve and manage vaccines at hand and develop new ones (Bankole et al., 2010). After securing the manufacturing of the COVID-19 vaccine, according to Izikki et al. (2021), secure vaccine transportation and distribution-free from wastage remains the main challenge. The greatest public health success chalked in the last century by the healthcare sector in terms of disease prevention, according to Bankole et al. (2010), was made possible by an efficient vaccine supply chain system (cold chain) in vaccinations programs (Chiodini, 2014).

Cold chain in healthcare, according to the WHO, "is a set of rules and procedures that ensure the proper storage and distribution of vaccines to health services from the national to the local level interconnected with refrigeration equipment that allows vaccines to be stored at recommended temperatures to maintain their potency" (WHO, 2021). However, the cold chain in healthcare delivery covers vaccines. It is an end-to-end system of storing and

transporting vaccines or healthcare products at desired temperatures from the point of manufacture to the point of use (FedEx, 2020). Therefore, according to Asamoah et al. (2021), increased vaccination coverage necessitates quality cold chain management systems that assure the efficient distribution of cost-effective vaccines stored at the proper temperatures.

The increased vaccination coverage benefited from the cold chain delivery system in the healthcare sector has reportedly prevented an estimate of 26 million cases of childhood disease in the United States (Pfizer, 2019). Although with the breakthrough of the cold chain system in healthcare, it is faced with many challenges such as erratic electric power supply, inadequate financing, lack of adequate implementation systems, insufficient cold chain capacity, lack of trained personnel, inadequate storage facilities, poor information, communication and consumption data (Ashok et al., 2017; Oli et al., 2016; Lakew et al., 2015; Rogie et al., 2013; WHO, 2006).

2.2.3.1 Cold Chain Practice in the Ghanaian Healthcare Sector

As part of the larger healthcare ecosystem, a well-functioning and efficient public health supply chain ensures that high-quality medicines and medical supplies are readily available when and where they are required in the right quantities and conditions (USAID, 2020). Cold chain activities within the Ghanaian healthcare sector are guided by the Expanded Programme on Immunization (EPI) (Asamoah et al., 2021). This programme has proved to be a foundation in the Primary Health Care (PHC) strategy (Osei et al., 2019). The Government of Ghana, in her efforts through the Ministry of Health to increase the COVID-19 vaccination coverage rate, secured 1.2 million Pfizer/BioNTech vaccines through the COVAX initiative in July this year ensured that the necessary cold chain for these vaccines would be ready by

procuring 58 ultra-low temperature vaccine freezers, 50 regular vaccine fridges, 3000 Ice pack freezers, and 300 cold boxes (Medical Systems, 2021).

According to CDC (2021), Well-trained personnel is one of the three major required elements for cold chain management to be efficient. Without adequate knowledge and understanding of the cold chain delivery system by health professionals, even with all the requisite logistical support and management systems in place, the cold chain delivery system is doomed to fail. There is good understanding of cold chain management among healthcare workers in Ghana, according to a study by Asamoah et al. (2021), which assessed the knowledge of healthcare professionals in a district on vaccine handling and transportation and storage. However, the study revealed a fragile relationship between knowledge and attitude, implying a higher knowledge will not guarantee a good attitude towards cold chain management even though a positive relationship exists between behaviour and knowledge (Aman et al., 2012).

Moreover, the study by Asamoah et al. (2021) revealed various cold chain management practices such as cold chain policies and guidelines to check practices, proper cold chain inventory, training of personnel, etc., to be infrequent in healthcare facilities. Additionally, the Ghanaian healthcare cold chain is inferior in terms of infrastructure such as functional cold chain equipment, adequate storage space, the layout of a storage facility, etc. Management of vaccines relies on both infrastructure and best standards and practices for cold chain management in order to be effective (Azira et al., 2013), despite the importance of cold chain management in guaranteeing the public of vaccination safety and potency (Asamoah et al., 2021).

Rogers et al. (2010a) indicate that all cold chain refrigerators at the district level are preferred to maintain a temperature of +2° C to +8° C as the optimal temperature range for the storage of vaccines at the district and subdistrict level. Most healthcare institutions had their vaccines

in good condition, which is reassuring; nevertheless, there is also a cause for concern because the vaccine VVMs in the refrigerators were not attached to all the vaccines, which is a problem. The fridge tags in most of the facilities were working, while some did not have one at all (ibid).

When it came to keeping vaccines cold, an earlier study in India by Krishnappa (2014) found that most health facilities had ice-lined refrigerators, deep freezers, and working thermometers. In Ghana, the capacity of national cold chain activities appears to be sufficient for both positive and negative storage, according to the WHO and UNICEF. However, regional and district disparities remain due to a lack of cold chain storage capacity (WHO/UNICEF, 2016).

It was discovered by Asamoah et al. (2021) in their study that none of the healthcare facilities studied had a contingency plan in place for equipment. The Public Health Unit of Ontario says a contingency plan helps facilities identify resources for risk-reduction actions (Public Health Unit Ontario, 2013). Since there is the chance that vaccines could be wasted in the event of a breakdown in the cold chain system, it is important to be prepared.

2.2.4 Efficient Cold Chain Practice (Eccp)

Due to the significant growth in customer demand for refrigerated and frozen food and medicinal items, efficient cold chain management has gotten a lot of attention in the logistics business (Kim et al., 2012). The four sections of the cold chain are typically cold storage, cold processing, cold transport and distribution, and ultimately cold commerce (Zhang, 2018). Fresh food, dairy goods, vaccinations, blood, and other sensitive products are examples of the cold chain (sensitive products). Some items, such as fish pieces, need tough and rigorous meat processing, warehousing, and transportation, according to (Yan and Lee, 2009; Mohan et al. 2014). For efficient cold chain management, some factors need to be

considered: well-trained employees or personnel, reliable transportation, reliable storage equipment, and efficient management methods (CDC, 2021; Ogboghodo et al., 2017; Rogers et al., 2010a, 2010b). The above implies that a cold chain practice shall and cannot be termed as efficient if one of these components is missing or inadequate. One must have well-trained workers and reliable storage and temperature monitoring equipment for a cold chain's pharmaceutical inventory to be successful (Feyisa et al., 2021). Ojo et al. (2019) indicated that efficient management of a cold chain delivery constitutes the essential backbone of successful national vaccination or immunization programmes.

Similarly, according to Joshi et al. (2009), the key to avoiding avoidable losses and protecting the bottom line is efficient cold chain practice. In the health sector, storing vaccines outside the required temperature range, improperly monitoring temperatures to maintain vaccines safely, using improper storage containers or wrong locations inside a refrigerator, equipment failure, and inadequately training personnel constitute vaccine cold chain violations (CDC, 2009a). In addition, Feyisa et al. (2021) identified the challenge of nonadherence to good storage practices, shortage of service providers at some public health facilities and poor storage conditions of vaccines on transit as critical issues affecting cold chain management. From the above realities, the four components of an efficient cold chain practice or management are analysed below to indicate their roles in ensuring that a cold chain delivery system is efficient and effective.

2.2.4.1 Trained Personnel

CDC (2021) stated that well-trained personnel is one of three essential aspects for the efficient cold chain management. Even with all the necessary logistical support and

management tools in place, a cold chain delivery system without adequately trained personnel for the management is bound to fail. As the last point of contact between the vaccines and the recipients, health personnel must preserve the cold chain (Ogboghodo et al., 2017). Because of this, regular training and supervision of healthcare workers are necessary to ensure that the cold chain management process is carried out efficiently. It is critical to give extensive training to all employees who deliver or handle vaccinations on safe vaccine handling and storage, the necessity of maintaining the cold vaccine chain, and the protocols to follow if the cold chain breaks (CDC, 2021). As part of their orientation, all new employees must complete training (Rogers et al., 2010b). As the principal vaccination coordinator in the workplace, the occupational and environmental health nurse is responsible for most training and must know the cold vaccine chain at the job site (Rogers et al., 2010b). The CDC (2008) produced a vaccine toolkit that may be used as a training guide for vaccination professionals at work to guarantee compliance with vaccine cold chain management. The ultimate goal of training is to avoid conditions that might result in a vaccine cold chain failure, focusing on preventing this from happening again (Rogers et al., 2010b).

As training tools for staff, the National Center for Immunization and Respiratory Disease (NCIRD) has established a variety of materials, including primary vaccine storage and handling standards, multimedia training resources, and practice resources, such as how to use and interpret thermometers (Rogers et al., 2010b). Vaccine storage and handling errors (Sidebar) may be costly to an organization; thus, vaccine workers should be aware of the most common vaccine storage and handling errors and how to avoid them. All vaccination workers should get ongoing training (CDC, 2021). The principal vaccine coordinator should conduct an annual training and refresher course to ensure that all vaccination staff are up to speed on best practices for vaccine storage and handling (Rogers et al., 2010a). Current

information on vaccine storage and handling protocols from the CDC and the World Health Organization should be included in the training (WHO, 2000). Vaccine professionals should be evaluated on their job performance concerning safe vaccine storage and handling standards using training logs (Rogers et al., 2009). With the training of cold chain personnel comes the opportunity for personnel to discuss why errors occur, what errors they have observed, and recommendations to reduce or eliminate errors (Rogers et al., 2010b).

Cold chain management training improved the practice of health workers who had undergone it, according to Ogboghodo et al. (2017). However, cold chain management training had a greater impact on those who had just completed the course. Respondents with less than a year after their most recent cold chain management training had superior cold chain management practice. This emphasizes the need for ongoing training and that training provides a fertile environment for responders to learn how to apply all of their cold chain management expertise (ibid).

2.2.4.2 Reliable Transport

The cold chain sector has a variety of urgent challenges, including timely delivery of freight and reduced transportation costs, which has drawn a large number of academics to the Vehicle Routing Problem (VRP) in the cold chain area (Wang and Wen, 2020). The employment of specialized cooling transport in the cold chain poses logistical issues not found in any other mode of transportation, necessitating the creation of a specialist fleet for cold chain management (Zwierzycki et al., 2011). Choosing a mode of transportation is a difficult undertaking (ibid). Because of the perishability of shipments, it is vital to increase cold chain logistics efficiency to keep supplies fresh and reduce waste (Wang and Wen, 2020). Meanwhile, the negative external effects of freight transportation, such as carbon emissions, deserve equal consideration (Bektas et al., 2019). Neglecting basic transportation

practices may cause damage to the cargo and put the customer, who is the final link in the supply chain, in danger (Zwierzycki et al., 2011).

Furthermore, time directly influences the shelf life of food goods like fruits and vegetables, hence the potential revenue a consignment might produce. At the same time, new transportation technologies have made it possible to send perishable goods across larger distances. Improved highways and intermodal links along the African coast, for example, cut food delivery time to European markets from 10 to 4 days (Rodrigue and Notteboom, 2014). Temperature stabilization is one of the most critical parameters for cold chain transit efficiency (Zwierzycki et al., 2011). The following variables must be considered to achieve this requirement: I selected a vehicle with enough thermal insulation and capacity, (ii) planning the loading/unloading operation (particularly the load preparation) in light of the distribution schedule as well as the weather (ibid).

Vaccines must be kept at the right temperature to guarantee efficacy (Rogers et al., 2010a). A dependable cold chain transport is necessary to ensure adequate adherence during the transit, shipment and receiving of vaccines. Written instructions should contain standard operating procedures (SOPs) for reference (Sidebar), vaccination personnel training and assessment of staff performance, and protocols for safe storage and handling to protect and maintain vaccine efficacy (CDC, 2021). According to manufacturers, all vaccines are delicate biological chemicals that can lose their efficacy when exposed to temperatures beyond the specified storage range (WHO, 2000). When a correctly packed cooler is used in cold chain transit to keep vaccine temperatures within the authorized permissible range, the influence of the external temperature on the cooler's interior temperature is reduced (CDC, 2021). According to Rogers et al. (2010a), the precise quantity and positioning of ice packs within the cooler is critical because too few ice packs can fail to maintain the inside cooler temperature. At the same time, too many ice packs can freeze the vaccine. A certified

thermometer should be provided in the shipping container to allow vaccine transport employees to check the interior cooler hourly. It should be positioned next to the vaccine rather than the cold pack (CDC, 2021). The US Food and Drug Administration prohibits the transport of partially used vaccines across state lines, transportation inside the trunk of a vehicle because the temperature inside the trunk cannot be controlled as well as the temperature inside the vehicle, and leaving the vaccine unattended in the vehicle because the temperature inside the vehicle may become warmer or cooler, affecting the internal temperature of the cooler (ibid). Because thin-walled Styrofoam® containers and soft-sided coolers are insufficient to sustain the vaccine cold chain throughout transit, the CDC proposes that vaccines be delivered in appropriately insulated containers such as Styrofoam® with 2-inch-thick walls and certified hard-sided coolers (CDC, 2021).

The transportation of cold chain products starts with delivery of products from the producer to the final destination. However, many cold chain transactions are made by individuals or corporations on behalf of the final consumers. For instance, in terms of healthcare products, healthcare facilities, institutions, agencies and or professionals procure temperature-sensitive products for their consumers (patients, corporations, institutions etc). The same case can be said for the agricultural sector. In both cases, the first transport of said goods is made to these intermediaries before reaching the consumer. The last and final delivery of the goods to their final destination is termed as the “last mile” in logistics (Rodrigue and Notteboom, 2014). Therefore, when planning a final delivery, it's crucial to think about the destination and the schedule because the trucks and vans utilized as the major means of transportation for this stage must fulfil the standards needed to transfer the cold chain cargo (ibid).

2.2.4.3 Reliable Storage Equipment

Vaccines are sensitive to heat and cold and must be stored at the correct temperature from the time they are manufactured until they are utilized. They must be stored at a specified

temperature range in cold chain equipment (refrigerators, freezers, and cold boxes) to work properly. The WHO recommends a temperature range for keeping and shipping vaccines based on manufacturer data. Each vaccination has its own storage needs, so it is critical to know how long and at what temperature each vaccine may be stored. All vaccines can be stored at +2 to +8°C. Only a few vaccinations may be stored at negative temperatures (-15 to -25°C). Equipment maintenance ensures that refrigeration equipment operates consistently and reliably in order to maintain the cold chain for vaccines (CDC, 2021). Refrigerators, freezers, portable coolers, ice packs, and thermometers should be examined and cleaned regularly to ensure safe use (Rogers et al., 2010b). Equipment inspections are performed periodically to ensure that it is in good operating order and to detect and minimize any problems (CDC, 2021).

Policies and processes for repairing and maintaining malfunctioning equipment should be established ahead of time as well (Rogers et al., 2010b). The CDC (2008) recommends softly tugging on a piece of paper held behind the door seal. The paper should be held in place by a good seal. Problems that cannot be reliably repaired should be directed to an authorized appliance technician for immediate service (CDC, 2008). According to Rogers et al. (2010b), a logbook should be utilized with cold chain storage equipment to record and track installation dates, repair dates, and routine maintenance. Refrigeration storage equipment should not be put in places with large temperature swings, such as near intermittent direct sunlight or changeable heating or cooling equipment, unless the ambient room temperature is less than 109°F or 42°C (WHO, 2002). According to Rogers et al. (2010b), preventative maintenance and inspections of portable coolers must address serviceability and cleanliness to maintain dependable cold chain storage equipment. It is critical to follow storage requirements while transporting and distributing pharmaceutical items (Kim et al., 2012). This covers the temperature and humidity of containers, storage facilities, and vehicles, since

delivered pharmaceutical items may be harmful even if they are genuine products if the temperature and humidity are not correctly managed (ibid).

2.2.4.4 Efficient Management

According to the World Health Organization (WHO), program planning and administration are important parts of a well-functioning vaccination program system. Effective management is critical in the vaccine cold chain to provide continuous supervision and control of vaccine supply and storage. The success of cold chain storage, handling, stock management, temperature control throughout the cold chain, and adequate logistics management information systems depend on effective cold chain management. Inventory management, equipment maintenance, access control concerns, power supply, and quality improvement activities are all part of efficient management (Rogers at al., 2010b). Guidelines for inventory management and recordkeeping systems are provided by the CDC (2021) and the WHO (2002). Vaccine access, expiry dates, stock rotation, inventory accounting, stock calculations, and vaccine orders are all part of efficient inventory management, according to the CDC (2021). Only authorized and trained persons should have access to vaccines, according to Rogers et al. (2010b). According to the CDC (2021), this would protect the vaccination supply against unskilled employees mishandling and removing vaccines.

WHO also warns vaccination management program staff that diluents received with vaccines may have varied expiration dates (WHO, 2002). Inventory accounting keeps track of stock levels to ensure that vaccinations are used and ordered efficiently. Stock levels should be calculated based on the number of vaccinations planned to be administered, the amount of vaccines that can be securely kept, and the period between ordering and receiving new shipments (Rogers, 2010b). According to the CDC (2021), Validating the running count may

be done by comparing the actual vaccination stock count to the recordkeeping form. The CDC also recommends using tally sheets to maintain track of vaccination delivery without changing the stock recordkeeping form for each dosage. Cold chain management is a complicated problem that includes vaccine predictions, ordering frequency, storage capacity, and planning (WHO, 2009). To ensure proper supply levels while limiting overstocking and waste, forecasting of anticipated consumption and ordering frequency is critical (Rogers et al., 2010b). Limiting stock levels to operational demands will save waste in the case of vaccine cold chain failures, which might threaten a year's worth of vaccine inventory unnecessarily. In contrast, an efficient stock level would only put three months' worth of vaccine inventory at risk (ibid). When evaluating stock level consumption, the WHO forecasting and planning tools are good resources to consult (WHO, 2009). Stock levels of vaccines and diluents should not exceed the capacity of refrigeration systems' on-hand storage space while planning vaccine and diluent stock levels (Rogers, 2010b).

2.2.5 Healthcare Service Delivery

The part of a health system where patients receive the care and supplies to which they are entitled is service delivery. WHO posited that "access to timely, acceptable, affordable, and high-quality health care is a fundamental right of every human being" (Mohamoud and Mash, 2020). Good service delivery contributes significantly to the health of the population, along with other factors such as social determinants of health (WHO, 2010). Service delivery is the immediate result of the health system's inputs, such as the health personnel, procurement of supplies, and financing. Therefore, it is expected that increased inputs would lead to better service delivery and better access to services (WHO, 2010). However, providing quality health care in areas with limited human and financial resources is difficult. For example, in low-resource settings, health professionals may have limited access to training and reference

materials, as well as poor communication mechanisms for expert or supervisor feedback, which can impede the quality of health services they can give to patients (Orton et al., 2018). Good service delivery is therefore essential in any health system. WHO (2010) outlined eight (8) key characteristics of good service delivery in a health system. These include comprehensiveness, accessibility, coverage, continuity, quality, person-centredness, coordination, accountability, and efficiency. This study presents three (3) aspects of service delivery in healthcare, consolidating each of the dimensions propounded by WHO (2010).

2.2.5.1 Waiting Time

The World Health Organization (WHO) has recognized patient waiting time as a critical indicator of an efficient healthcare system (Sun et al., 2017). It is one of the benchmarks used to measure the efficiency of healthcare service delivery in healthcare institutions (Wanyenze et al., 2010). According to Sun et al. (2017), every patient deserves access to timely and convenient health care in a well-designed health care system. Waiting time for patients seeking care at healthcare facilities is the length of time it takes before patients are seen for consultation and treatment (Valentine et al., 2003; Silva, 2010). During their interactions with healthcare systems, patients must wait at multiple points (McIntyre and Chow, 2020). According to McIntyre and Chow (2020), waiting time encompasses when patients wait at home for an initial healthcare provider appointment, diagnosis, or an elective procedure, and time spent in waiting rooms when patients access healthcare facilities. Access to and engagement in the healthcare delivery system is hampered by long waiting times (McIntyre and Chow, 2020). One possibility is that patients would endure longer waiting times for care as the strain on global healthcare systems grows (McIntyre and Chow, 2020). Nonetheless, patients should not have to wait long periods for appointments and consultations in a well-designed healthcare service delivery system. Patient dissatisfaction has long been linked

to the lengthy waiting time (Pitrou et al., 2009; Preyde et al., 2012; Michael et al., 2013; Katre, 2014), which is a major source of frustration for patients (Sun et al., 2017). According to Huang (1994), patients were satisfied if they had to wait no longer than 37 minutes when they arrived on time. Similarly, in the United Kingdom (UK), the Patient's Charter government set some regulations requiring all patients to be seen within 30 minutes of their scheduled appointment time (Harper, 2003; Sun et al., 2017). Patients would usually prefer to spend less time (i.e., between 30 and 45 minutes) and attain satisfaction; however, this is not always the case in most hospitals in Ghana (Appiah, 2019). Appiah (2019) asserted that waiting times at the Outpatient Departments (OPDs) are quite long, with most patients spending more than two hours there. The most common reasons for the delays were heavy workload, a high number of patients requiring care, and patients arriving late to the unit.

2.2.5.2 Quality

The quality of service delivery is a very important determinant in healthcare. Quality of service delivery refers to "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (WHO, 2018). WHO (2018) suggests that high-quality healthcare services involve the right care at the right time, responding to the service users' needs and preferences while minimizing harm and resource waste. Quality health care increases the likelihood of desired health outcomes. Most definitions of quality treatment include multiple dimensions: effectiveness, safety, patient-centeredness, and timeliness. The intricate processes of evaluating, diagnosing, and treating a patient and the treatment outcomes make assessing the quality of healthcare services difficult (WHO, 2010). Patients' feedback about the practice, consultations and practitioners can help assess healthcare or primary care quality (Mohamoud and Mash, 2020). The extent to which patients' expectations of their consultations are met has a significant impact on their level of satisfaction and the perceived

quality of service (Mohamoud and Mash, 2020). When healthcare providers deliver high-quality services (i.e., exceeding patients' expectations), patients become satisfied. However, research studies indicate that service delivery or care quality is subpar in most countries, particularly low- and middle-income countries (WHO, 2018). Patients' lives, resources, time, revenue, trust and respect, hospital reputation and community apathy could all be lost due to poor healthcare quality. Hence, specific measures need to be considered to enhance the service delivery quality: setting standards; changing clinical practice at the front line; engaging and empowering patients, families and communities; legislation and regulation; informing and educating healthcare workers, managers and policy-makers; use of continuous quality improvement programmes and methods; and establishing performance-based incentives (financial and non-financial) (WHO, 2018). In Ghana, a strategic plan on quality was developed to help guide health professionals and emphasize the health condition and services in Ghana and the quality of health. The project aimed to (1) improve client-centred services due to poor customer relations in public health institutions, (2) improve patient safety to prevent medical errors and thus ensure healthcare safety, (3) improve clinical practice through activities that result in a patient's ailment being correctly diagnosed and successfully treated, and (4) improve management systems through managerial processes employed to improve the quality of healthcare in Ghana.

2.2.5.3 Responsiveness

Responsiveness is how well the health system meets the population's legitimate expectations for the non-health enhancing aspects of the health system (Darby et al., 2003). According to WHO, responsiveness in the health system is important because it improves the health systems' performance and addresses reasonable patient expectations. Policymakers and health administrators must pay close attention to responsiveness as it is one of the most critical aspects of any health care system (Baharvand, 2019). Although responsiveness is

often discussed under patient satisfaction and quality of care concerned in most scholarly works, it is a separate concept that refers to how patients are handled and the environment in which they get care (Mohammed et al., 2013). Previous studies (WHO, 2000; Carrin and James, 2005; Mohammed et al., 2013) identified that a responsive health insurance plan assures people to access healthcare in a client-oriented and non-discriminatory manner. WHO (2000) proposed a set of domains relevant in determining responsiveness, including respect for dignity of persons, prompt attention, communication, autonomy, choice of healthcare provider, quality of facilities and care, confidentiality, and access to social support networks. The first feature of human behaviour is respect for the patient's dignity. This notion stresses gaining the patient's trust and portraying excellent manners with them (Ugurluoglu and Celik, 2006). Another part of responsiveness is respecting an individual's autonomy, independence, and competence to make decisions about their health (Ugurluoglu and Celik, 2006). Communication is another vital part of responsiveness. A patient's needs are considered, and the practitioner takes the time to explain things clearly. If a patient does not understand something, they have the opportunity to ask questions throughout their visit (WHO, 2000; Valentine et al., 2003; Mohammed et al., 2013). The confidentiality of who has access to the patient's personal information is another issue. Patients anticipate that, in addition to keeping them healthy, the health system would treat them with dignity, help them make decisions about their care and treatment, and keep their information secret (De Silva, 2002; Mohammadi and Kamali, 2015). Patients can also choose their health care provider (location or person) and seek a second opinion or visit with a specialist if necessary (Mohammed et al., 2013). Mohammed et al. (2013), in explaining the prompt attention domain of responsiveness, stated that patients should benefit from shorter travel or waiting times and easier access to healthcare facilities. Also, while patients obtain access to healthcare facilities, facilities must be decent and convenient for patients. Baharvand (2019) asserted that patients

in developed countries are most satisfied with the health system because they are informed about their care and treatment options. In contrast, most patients let their caregivers decide on their care and treatment in developing nations rather than taking part in it.

2.2.6 Impact of Cold Chain Delivery System on Healthcare Service Delivery

The supply chain in healthcare, particularly cold chain logistics, has taken the interest of the healthcare sector in the global fight against the Corona Virus. Vaccines are a special kind of drug, which is highly sensitive to temperature and directly related to public health. These drugs are known to be one of the most cost-effective methods to prevent infectious diseases (Lin et al., 2020). In 2018, it was reported by the World Health Organization (WHO) that 2 to 3 million deaths per year could be prevented through vaccinations (WHO, 2018). Similarly, Ventola (2016) points out that according to estimates, the mortality reductions in nine diseases due to vaccinations averaged 97.8%. These benefits accrued in healthcare delivery from vaccinations would not be achievable without an efficient and effective cold chain delivery system. Lee and Haidari (2017) indicate that the failure to understand and properly address issues in the vaccine supply chain (cold chain delivery system) will greatly reduce vaccines' effects. Thus, the impact of cold chain delivery system on healthcare service delivery cannot be overemphasised. Managing the cold chain efficiently and effectively enhances the utilization of healthcare resources, decreases waste, and improves the quality of healthcare services (Feyisa et al., 2021). It eventually ensures that customers get the cold chain products they require at the service delivery points and at the minimum time possible.

The risk of a long-term potential outbreak of some diseases within a population is heightened with unsound vaccines caused by non-cold chain storage and transportation (Lin et al., 2020). An efficient cold chain delivery system ensures that the healthcare service delivery is not

overburdened in storage capacity ensuring the procurement and stocking of only enough vaccines and other pharmaceutical products to meet patient needs (CDC, 2021). This leads to the cost-effective delivery of healthcare service delivery. Efficient management of the cold chain is critical to the effectiveness of health initiatives such as expanded immunization programs (EPI), reproductive health services, maternity and newborn care (RMNCAHS), diabetes care, and HIV/AIDS care (HIV/AIDS) (Feyisa et al., 2021).

2.2.7 Challenges Associated With the Cold Chain Delivery System in The Healthcare Sector.

In the healthcare sector, the necessity of a well-functioning cold chain cannot be overstated, particularly in the current global healthcare crisis where vaccination is essential in the current fight against COVID-19. It can be gleaned from existing literature the various benefits the healthcare sector can reap from an efficient cold chain delivery system in terms of reduced mortality rates from vaccination against VPDs, financial savings from reduced wastage of vaccines and medical products, etc. Notwithstanding these numerous benefits an efficient cold chain delivery system brings to the table in the healthcare sector, various research works have discovered some challenges faced in the healthcare cold chain delivery system.

Bhatnagar et al. (2018) pointed out that a lot of retailers and consumers believe that only insulins, vaccines and hormonal preparations require temperature control. Still, several other drug categories do require temperature control. According to the Drugs and Cosmetics act and rules 1940 of the Indian Government, this belief is due to the lack of a consolidated list of cold chain medicines. Similarly, in 2006 a workshop by the World Health Organisation (WHO) outlined the challenges associated with medicine supply in Africa; the main challenges being poor information, communication and consumption data, inadequate storage

facilities and temperature control systems and a lack of quality assurance procedures (WHO, 2006). Furthermore, cold chain systems, as per Ashok et al. (2017), are challenged by the lack of performance management systems limiting the understanding of cold chain performance due to infrequent, ad-hoc cold chain assessments (taking of inventories or monitoring of temperatures) and the non-existence of established routine systems to provide consistent insight into cold chain performance.

A study by Oli et al. (2016) indicated that vaccine wastage in Nigeria is attributable to some challenges being faced in managing the vaccine cold chain system, such as erratic electric power supply, fuelling and transport, which are necessary to ensure continuous running of cold chain equipment. According to Ashok et al. (2017), the present diverse population settlements (e.g., urban, semi-urban, rural) of many African nations of which Ghana is a part present unique contextual challenges that test cold chain capabilities and managerial responses, in Uganda for instance, road and mains power access is challenging for over 70% of health facilities.

Shafaat et al. (2013) assert that the cold chain system is often challenged by the non-uniformity in storage temperature instructions on labels of pharmaceutical products. They are at times not well-written, ambiguous, and missing. According to Bhatnagar et al. (2018), such severe variations in labelling pharmaceutical products can be misleading and make the last-mile delivery of such specific medicines more challenging.

The work of Clinton Health Access Initiative, Inc. (CHAI) with partner nations, as indicated by Ashok et al. (2017), identified three key issues that limit cold chain performance; (i) Insufficient cold chain capacity; (ii) Lack of latest technology or ‘optimal’ equipment and; (iii) Inadequate temperature monitoring and maintenance systems. According to Rogie et al,

(2013) and Lakew et al. (2015), some factors that contribute to weaknesses of the cold chain are transportation delays, poor quality of refrigerators, power interruption, equipment breakage, and lack of trained personnel capable of managing the cold chain.

Ashok et al. (2017) reveal that, even when sufficiency gaps are identified in cold chain systems, these gaps lack adequate implementation systems due to inadequate financing, limited delivery and installation capabilities, and the inadequacy of the implementation monitoring and management systems at hand. An assessment of the capability and performance of Ghana's National Supply Chain by the United States Agency International Development (USAID) in partnership with the Ghana Health Service (GHS) revealed that except for the four teaching hospitals in Ghana, not all the health facilities have a cold chain storage facility: Community-Based Health Planning and Services (CHPS)/ Clinics (29%), Health Centres/ Polyclinics (61%), district hospitals (84%), Regional hospitals (90%) (USAID, 2020). This implies that the cold chain infrastructure within the Ghanaian healthcare sector is very poor. Thus, impeding the cold chain management in the sector.

2.2.8 Overview of The Global Healthcare Sector

The healthcare sector consists of many industries, including pharmaceuticals, biotechnology, equipment manufacturing, distribution, residential care facilities and managed healthcare contributing significantly to the economic output of the United States of America and other developed economies (Yeganeh, 2019). Healthcare is a strong and fast-growing sector with an estimated value of $9 trillion globally (PricewaterhouseCoopers, 2016).

Yeganeh (2019) asserts a strong relationship between income levels and healthcare expenditure per capita. According to Yeganeh (2019), the percentage of Gross Domestic Product spent on healthcare in developed economies and emerging economies is about 12%

and 6%, respectively. Furthermore, the Economist Intelligence Unit Limited (2015) recognizes the healthcare sector as a superior sector because human health is the most valuable asset and the source of all other assets; it is the engine of economic growth and prosperity. For that reason, as per Yeganeh (2019) healthcare is a predominant occupation of policymakers, business leaders and citizens in many developed and emerging countries.

Current health crises are caused by COVID-19, which has compelled all organizations, public or private, to revise their mission statements and visions, meaning that the healthcare sector's ability to adapt to a rapidly changing environment would be crucial in determining its success (Burlea-Schiopoiu and Ferhati, 2021). Yeganeh (2019) indicated that the global expenditure on medicines is growing around 6% annually, which is expected to reach nearly $1.5 trillion by 2021.

2.2.8.1 The Ghanaian Healthcare Sector

According to the Ghana Statistical Service (GSS), the Ghanaian population per the 2021 Population and Housing Census Provisional Results is 30.8 million (GSS, 2021). Human Development Index (HDI) data from the United Nations Development Program (UNDP) in 2017 puts Ghana in the middle category of human development (0.592) (UNDP, 2018). However, in the last three decades, the HDI value of the country has improved by 30%, indicating advances in health, education, and living standards (USAID, 2020).

Procurement and Supply Directorate (PSD), Procurement Unit, Office of the Chief Pharmacist, Food and Drug Authority (FDA), and National Healthcare Insurance Authority are all part of Ghana's public healthcare sector. The supply chain management responsibilities of these departments, as well as other supply chain management agencies and units in

Ghana's public healthcare sector, are heavily overlapping and decentralized (USAID, 2020). The number of health facilities as of 2020 by Statista is 2857, comprising of 1625 government health facilities, 928 private health facilities, 220 Christian Health Association of Ghana (CHAG) health facilities, 79 Quasi-Government health facilities, 2 Non-Governmental Organizations health facilities, 2 Islamic health facilities and a Mission health facility (Statista, 2021).

In 2003, the Ghanaian government established a lofty goal: to make quality, affordable health care available to all citizens through the implementation of the National Health Insurance Scheme (NHIS) (Sightsavers, 2019). A national health insurance program, community-based primary health initiatives, and an increase in the number of health care workers have all contributed to Ghana's recent expansion of access to health care (USAID, 2020). Although Ghana's healthcare workforce has made significant progress, the density of health care employees virtually doubled between 2005 and 2015, from 1.07 to 2.14 per 1,000 people (Asamani et al., 2018). However, many types of health facilities in Ghana—regional and district hospitals, polyclinics, health centers, clinics, and Community-Based Health Planning and Services (CHPS) facilities—offer diminishing degrees of health services at the Service Delivery Points level (USAID, 2020).

The Ghanaian health system continues to bear the greatest financial and mortality burden from communicable diseases, which account for 51% of all deaths, with malaria, HIV/AIDS, ischemic heart disease, and lower respiratory infections ranking as the top four primary causes of death (USAID, 2020). According to the World Bank, the most recent health expenditure of the Ghanaian healthcare sector is 3.539% of Ghana’s Gross Domestic Product

(GDP) (World Bank, 2019). As of 2010, the percentage of government spending on health care in the United States was 12 per cent; by 2016, this figure had dropped to 7 per cent (WHO, 2017). Ghana has fallen short of the 15% target set by the Abuja Declaration of 2001 (WHO, 2011).

Access to health care varies greatly depending on location in the country (USAID, 2020). In 2016, for instance, the Ghana Health Service (GHS) indicated that in Greater Accra, the doctor to person ratio is one doctor to 3,582, but in the Upper East region, over 25,000 persons are to 1 doctor (GHS, 2017). In addition, Adua et al. (2017) found that Accra and Kumasi, two of Ghana's most populous cities, have a disproportionately high concentration of health professionals, while rural healthcare facilities have fewer, typically less-qualified and overworked health workers.

However, according to Johnson et al. (2011), the Government of Ghana, aimed at incentivizing work in rural areas, has instituted rural oriented healthcare programs. Nevertheless, rural labour retention is still plagued by pay disparities, lack of advancement opportunities, lack of infrastructure, and excessive effort. In addition, there is a continual increase in the population in urban areas, according to the Ghana Statistical Services (GSS), and it is projected to exceed 63 per cent by the year 2025 (GSS, 2014). According to the GSS's 2010 population and housing census report, population growth correlates with an increase in closeness and access to health facilities. Still, these benefits are countered by the unfavourable health outcomes associated with high-density living in poor hygienic conditions (GSS, 2014).

2.3 Theoretical Review

There is no specific formula for selecting a theory or combination of theories. What is important and helpful is the assimilation of the research objectives and a good understanding of some theories (Mkhomazi and Iyamu, 2013). This study, assessing an efficient cold chain delivery system and its impact on healthcare service delivery, considers the Systems Theory to expound on the subject under investigation and facilitate understanding. Systems theory largely originates from Von Bertalanffy's work, which dates back to the 1950s (Lindskog, 2012). The concept of system has been used in scientific description and explanation of natural phenomena for decades. A system is a combination of components that work together to achieve a goal. Kasianiuk (2021) referred to a system as a set of objects and relationships between the objects and their attributes. Theory is a coherent set of broad propositions that explain a class of phenomena. Thus, systems theory uses system structure to describe phenomena (McLeod and McLeod, 2016). According to Halldorsson et al. (2007), the systems theory focuses on managing the institution's supplies or resources. Therefore, the theory is based on the organization's systems.

Lavassani and Movahedi (2010) assert that one of the most popular theories in supply chain management research is based on the concept of systems (i.e., systems theory). Conceptually, the systems theory is an approach to understanding the components of a system in connection to each other and other systems, rather than in isolation (Wilkinson, 2011). Hence, the systems approach is crucial to supply chain management as supply chains are viewed as systems. Stock et al. (1998, p. 45) wrote that: "This systems approach within the firm has been the underlying premises of much of current logistics management, thought, and practice". As the cold chain is part of the broader supply chain concept, the systems theory can explain cold chains and their management. The definition of cold chain by Zhang et al.

(2018) supports this assertion where they refer to cold chain as a systematic logistics program in a supply chain where temperature-responsive goods are always supplied and kept in a cold environment throughout the overall process, such as storage, manufacturing, transit, dissemination, and marketing, to ensure product safety and quality, speedy delivery, and reduced logistics wear and tear. Despite all the attention, the fundamental ideas of systems theory are frequently overlooked. According to McLeod and McLeod (2016), the theory might provide a technique for systematically solving supply chain problems and organising the various functions as a theoretical framework. Chuang and Inder (2009) posited that to enhance health care outcomes based on systems theory, it is necessary to take a systematic approach to understand how the entire healthcare system contributes to the patient's safety and quality of care. Therefore, healthcare professionals should grasp the basic principles of the systems theory (Anderson, 2016). The current study employs the systems theory as an underpinning theory to investigate efficient cold chain management in the Ghanaian healthcare sector and its impact on healthcare service delivery.

2.4 Empirical Review

Ogboghodo et al. (2017) conducted a study to assess cold chain management practices among healthcare workers in primary healthcare in Southern Nigeria. The study, which found the practice of cold chain management to be fair, identified that efficient cold chain management depends on cold chain management training, the presence of functional refrigerators, NPI supervision and a higher education level. In their study, Najwa and Minhat (2016) found that beyond high coverage and timely vaccination, efficient vaccine cold chain maintenance is critical to maximizing the benefits of paediatric immunization. Therefore, to ensure the efficacy of vaccines provided and the effectiveness of the national immunisation program, healthcare staff must be adequately trained in vaccine cold chain maintenance. In addition,

healthcare professionals must have sufficient knowledge of the cold chain at the end of the chain (de Timóteo Mavimbe and Bjune, 2007). Health care practitioners' knowledge and cold chain practices can only be enhanced with adequate training and supportive supervision (Ojo et al., 2019). Aside from training and supportive supervision of health workers, health institutions should also have appropriate cold chain equipment available at their disposal (Ogboghodo et al., 2017).

Generally, previous studies (CDC, 2021; Ogboghodo et al., 2017; Rogers et al., 2010a, 2010b) revealed have that well-trained employees or personnel, reliable transportation, reliable storage equipment, and efficient management processes require attention for the efficient cold chain management. There are many advantages to having an effective healthcare cold chain management system, including maximizing the use of healthcare resources, reducing waste, and enhancing the standard of care provided (Feyisa et al., 2021). In the end, it ensures that clients receive the cold chain products they demand at the service delivery points and in the shortest period. Yet, many studies have found significant drawbacks to having an efficient cold chain delivery system. Some of the significant challenges collated from previous studies include erratic electric power supply, fuelling and transport, inadequate financing, transportation delays, poor quality of refrigerators, equipment breakage, and lack of trained personnel, insufficient cold chain capacity, lack of latest technology or 'optimal' equipment, inadequate temperature monitoring and maintenance systems (Rogie et al., 2013; Lakew et al., 2015; Oli et al., 2016; Ashok et al., 2017). This study sought to assess the efficient practice of cold chain management in the healthcare sector and its impact on healthcare service delivery in Ghana and attempt to advise on the current state of cold chain practice in the Ghanaian healthcare sector and the

challenges associated with it for steps to be taken to improve cold chain practice in the Ghanaian healthcare sector.

2.5 Conceptual Framework

The conceptual framework for the study is shown in figure one. It shows the the relationship between the independent variable and dependent variable. The independent variable is cold chain delivery and the dependent variable is healthcare delivery.

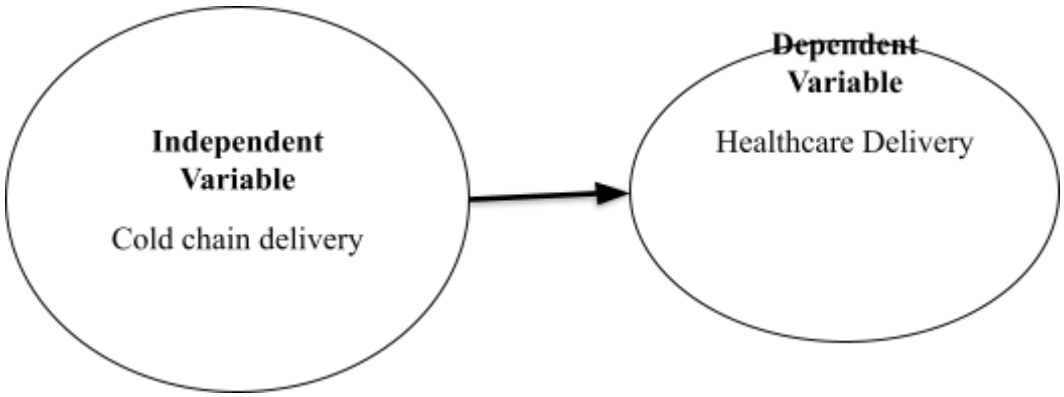

Figure one: Conceptual framework

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter delved into the methodology to embrace this research study. This chapter will concentrate on the research strategy, approach, and design, how the population, sample frame, and size will be decided, and the procedures to be utilized for data collecting, processing, and analysis. It is appropriate to define the difference between research methods and research methodology at this juncture. The term "research methods" refers to all of the procedures and strategies used to conduct a study (Kothari, 2004). On the other side, research methodology refers to the complete approach to the design process, from theoretical foundations to data collecting and analysis (Collis & Hussey, 2014). It is a method for systematically solving a research problem. It may easily be mistaken for science that studies how scientific research is conducted (Kothari, 2004).

3.2 Research Strategy

Quantitative, qualitative, and triangulation are the three main research methodologies (Baiden, 2006). Fellows and Liu (2015) noted that research methods and types are not completely unrelated, yet only one or a few strategies are frequently used because of the research's resource constraints. According to Fellows and Liu (2015), data collection strategies determine the types of analyses that may be performed and, as a result, the study outcomes, hypotheses, utility, relevance, and reliability.

However, the primary issue dealt with under the research strategy is how the objectives of a research are questioned. The rationale for adopting a specific research strategy depends on the study's objective, the type, and the availability of material for the study. Therefore, the quantitative research strategy was chosen as the overarching method for this investigation. The three main research strategies are outlined here to help you understand your study's decision.

3.2.1 Quantitative Research

Creswell (2012) stated that a quantitative strategy provides a clear way for data to be gathered from many people (a population) and summed up results. A quantitative technique will be used to collect factual data for this investigation. It is critical to ensure that the research question is both clearly understood by the researcher and effectively represented; otherwise, the variables will not be correctly calculated, and the study and results will be destroyed (Fellows and Liu, 2015). Quantitative research aims to develop and apply numerical models, ideas, and hypotheses about natural processes (Sarantakos, 2005). Quantitative research entails a rigorous and accurate analysis of issues using statistics and

mathematics and numerical data processing. Quantitative research data is regularly picked and broken down in a mathematical sequence (Goertz and Mahoney 2012).

3.2.2 Qualitative Research

This broad phrase encompasses research methodologies that investigate phenomena by studying experiences, behaviours, and relationships without statistics, mathematics, or numerical data processing (Hennick et al., 2010). The hidden supposition is that qualitative research methods are inductive, with the hidden supposition that the truth is a social construct, that variables are difficult to quantify, mind-boggling, and intertwined, that subject matter is paramount, and that the information gathered will be from an insider's perspective (Rovai et al., 2014).

One of the most important advantages of qualitative research is that it encourages in-depth investigation (Goertz and Mahoney, 2012). However, this approach is difficult to copy or repeat since it relies on unstructured data. Because there are no standard techniques to follow, the quality is dependent on the analyst's ingenuity and intellect. Once again, this research method raises the issue of supposition because qualitative research is typically limited in scope. Finally, this approach lacks openness due to the difficulty that arises from what the qualitative researcher actually performed and how the qualitative researcher reached his study conclusions.

3.2.3 Mixed Methods

This research strategy is categorized as quantitative or qualitative. Qualitative and quantitative approaches might be utilized to decrease or dispense demerits of each approach

while acquiring the benefits of each, and of the blend, a multi-dimensional perspective regarding the matter acquired through some form of binding energy. Creswell and Plano Clark (2011) expressed that this approach enables comprehension to be formulated than if a sole approach were adopted to specific studies. Moreover, they remark that a collection of core features inside a mixed-method research strategy. They further stressed that researchers gather and investigate qualitative and quantitative data in a sequential and or simultaneous and thorough way that coordinates the two types of data. The manner by which this data is collected will rely upon the nature of the inquiry and the philosophical viewpoint of the researcher.

3.3 Research Approach

According to Burney and Saleem (2008), there are two basic thinking styles in research activity. Deductive and inductive research approaches are the two approaches.

3.3.1 Deductive Research Approach

According to Burney and Saleem (2008), Deductive research moves from the broad to the specific. It is also referred to as the "top-down approach". This is most commonly seen in quantitative investigations. The deductive method entails the creation of hypotheses and their testing during the research process. Deductive research is refining an idea or conjecture based on an existing hypothesis that may be tested through data collecting.

3.3.2 Inductive Research Approach

The approach to research is the total opposite of deductive research, according to Burnley and Saleem (2008). It progresses from direct impressions to more in-depth hypotheses. Also

known as a bottom-up method. Ends are usually based on assumptions and involve a tremendous lot of risk. This methodology is commonly used in observatory studies. Having a basic understanding of the deductive and inductive research approaches, the research method used in this study is a deductive research approach.

3.4 Research Design

The study adopted explanatory research and descriptive design. Explanatory research aims to understand phenomena by discovering and measuring causal relations among them (Saunders, Lewis & Thornhill, 2007). Explanatory research frequently includes descriptive elements but goes beyond this to identify the nature of the relationships between the dependent and independent variables; this study is deemed to be explanatory since it seeks to establish and explain the relationship between cold supply chain and healthcare delivery system..

Descriptive research is conducted to describe phenomena as they exist; It gives an accurate description of the characteristics of the subject, population, market, situation or problem the researcher is investigating (Robson, 2002). A descriptive study provides a comprehensive and clear picture by describing the characteristic of variables in the phenomena of interest to the researcher from an individual, organization, industry or other perspective (Sekaran, 2003). The study is also descriptive because this study seeks to collect data to provide a clear picture and accurate profile on cold chain supply.

3.5 Unit of Analysis And Data Sources

The phrase “unit of analysis” can be described as “the entity that is being analysed in a scientific research,” and determining or being aware of the research's unit of analysis plays a

critical function in every research project (Dolma, 2010). When dealing with any real-life problem, it is frequently realized that the available information is insufficient, making it necessary to obtain appropriate information (Kothari, 2004). Data is information that researchers use to conclude the event they're studying (Walliman, 2017). Primary and secondary data sources are the two sorts of data sources that support any research plan.

3.5.1 Unit of Analysis

The study's unit of analysis of was health professionals abreast with cold chain delivery issues and who have lines of influence on the management of cold chain systems in the healthcare sector. Thus, pharmacists, pharmacy technicians, medical doctors, nurses and midwives.

3.5.2 Source of Data

Primary data refers to data collected recently to answer a research question or achieve research objectives (Saunders et al., 2019). Questionnaires were used to collect the primary data. The questionnaires were distributed to pharmacists, medical physicians, nurses, and midwives, the target populations. Their responses were gathered and analyzed using a variety of tools. Kothari (2004) defines secondary data as information that the statistical process has sifted. Secondary data for this study was gathered from auxiliary sources such as books, inspections of previously processed data from journals, online libraries, periodicals, reports, libraries, and journal articles.

3.6 Population

Following the determination of the unit of analysis, the population from which the sample will be taken must be identified (Ritchie et al., 2013). According to Pandey and Pandey

(2015), a population or universe denotes the features of a specific group, which is the parent bunch from which a sample is to be constructed. According to Walliman (2017), a population does not refer to a particular number of people, units, or elements but rather to a total quantity of a specific type of individual, unit, or case relevant to the researcher's subject. The population for this study will include the Komfo Anokye Teaching Hospital health professionals involved in the management of the cold chain.

3.6.1 Sample Size and Sampling Technique

Because this study sought many respondents, the sample size was established using purposive and convenience sampling procedures to achieve a sample size of the required number of respondents. This study used a non-probability sampling technique. The decision to include a certain element in the sample is not based on chance in non-probability sampling. The important respondents, primarily healthcare professionals, were identified via purposeful sampling, a non-probability sampling technique. Due to a large number of respondents/populations, non-response, time, and cost constraints, the study employed the purposive sampling technique, which entails the researcher using his or her discretion to select a sample that, in his or her opinion, possesses the necessary knowledge and expertise to provide the required information for the study (Greener, 2008). Convenient sampling aided the purposive sampling by picking samples that are both accessible and eager to participate in the study (Teddlie and Yu, 2007). Owing to a gigantic sampling frame, the researchers relying on their judgement and contacts, a hundred (100) respondents were selected for the study. This represents the sample size.

3.7 Data Collection Techniques

To gather data, researchers must employ a number of instruments or methodologies that differ in complexity, interpretation, design, and administration. Each tool is made to capture a specific type of data (Pandey and Pandey, 2015). The most appropriate instrument or technique for acquiring quantitative data is a questionnaire (Walliman, 2017). Questionnaires are a set of questions or inquiries that are used to collect information from study participants. Questionnaire questions can be open-ended, closed-ended, or a combination of both (Frazer and Lawley, 2000; Ismail et al., 2018). The four means of distributing questionnaires are telephone questionnaires, online questionnaires, mail surveys, and physically presented questions.

A detailed questionnaire was designed based on the study's stated objectives to meet the research's aim and objectives. The questionnaire consisted of two parts. Part 1 is comprised of questions designed to elicit information from responders. Part 2 consisted of questions that will seek to gather data on identified existing cold chain practice in the Ghanaian healthcare sector, the challenges associated with the cold chain delivery system in the Ghanaian healthcare sector, and finally, the impacts cold chain delivery system has on healthcare service delivery. Some of the questionnaires were self-administered by hand delivery to identified respondents. Others were delivered online because of the proximity of the researcher to the respondents and convenience.

3.8 Data Processing And Analysis Techniques

Following the usage of questionnaires to collect data, a massive amount of information has to be presented. Data is information that researchers use to conclude the event they are studying

(Walliman, 2017). The degree of measurement included in the data collecting instrument (nominal, ordinal, interval, and ratio) and the number of cases studied to determine the kind of analysis appropriate for research (Walliman, 2017). The analysis for this study was done using the Statistical Package for the Social Sciences (SPSS). SPSS was used for data input as well. Mean score ranking, the one-sample t-test and regression analysis was employed to analyze the data received. Cronbach's Alpha Coefficient test was also conducted to check the test scales' internal consistency. A scale is judged trustworthy by Tavakol and Dennick (2011) if the Cronbach's alpha test yields a co-efficient of 0.700 or above. The regression equation is presented below.

$$Healthcare\ delivery_i = \alpha + \beta_1 Cold\ supply\ delivery_i + \varepsilon_i \ldots\ldots (1)$$

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

The methodology for the research study was addressed in the preceding chapter, which detailed the methods for identifying, selecting, processing, and analyzing the research data. This chapter presents the analyzed data and the outcomes of the analysis and comments, which are based on the study's research goals. This chapter is divided into two sections. The first section examined the respondents' backgrounds or profiles, analysed using descriptive statistics (frequencies). The second portion examined the study's goals using descriptive and

inferential statistical analysis. Cronbach's Alpha Coefficient Test was used to determine the internal consistency and reliability of data from the chosen measuring scale before further analysis. The IBM Statistical Package for Social Sciences (SPSS) software version 25 was used to perform these analyses. A total of 100 questionnaires were sent to health professionals through an online survey using "Google Form," with 62 being collected and utilized for statistical analysis, suggesting a 62 per cent response rate. Because the proper proportion of survey replies spans between 50% and 70%, the research authorized the 62 per cent response rate for further examination (Mellahi and Harris, 2016).

4.2 Demography Of Respondents

This section aims to characterize the respondents' backgrounds based on the information received. The goal of displaying the respondents' background data findings is to improve knowledge of the participants' profiles while also increasing trust in the data's accuracy and dependability. The respondents' background information is essential, according to Ahadzie (2007), to certify the data's reliability. The respondents' background information for this research included: professional category, academic qualifications, years of experience, gender, and knowledge with cold chain methods. The findings, notably the frequencies, were presented using descriptive statistical analysis, as shown in Table 4.1. This section seeks to describe the respondents' background based on the data gathered. The purpose of presenting the respondents' background data results is to enhance understanding of the participants' profiles and increase confidence in the data reliability and precision. According to Ahadzie (2007), the respondents' background information is required to authenticate the credibility of the data. For this study, the background information of the respondents was related to the following: category of professionals, academic qualification, years of experience of

professionals, gender and familiarity with cold chain practices. The results, summarized in Table 4.1, were presented using descriptive statistical analysis, particularly frequencies.

Table 4.1: Tabular Summary of Respondents' Profile

Variable	Category	*Frequency*	*Percentage*
Gender	Male	38	61.3
	Female	24	38.7
Professional Background	Pharmacist	9	14.5
	Pharmacy Technician	11	17.7
	Medical Doctor	21	33.9
	Nurse	13	21.0
	Midwife	8	12.9
Years of Professional Experience	Less than 5 years	23	37.1
	5-10 years	18	29.0
	11-15 years	16	25.8
	16-20 years	4	6.5
	Over 20 years	1	1.6
Academic Qualification	Doctor of Pharmacy (PharmD)	9	14.5
	Bachelor's degree	14	22.6

	Master's degree	18	29.0
	Doctor of Medicine (MD)	21	33.9
Cold Chain Familiarity	Yes	52	83.9
	No	10	16.1

Source: Field Survey (2021)

4.2.1 Gender

There were 62 respondents involved in the study. Out of the 62 respondents, 38 representing 61.3%, were males, while 24 were females representing 38.7%. Below is figure 4.1, which means the visual impression of male and female respondents.

4.2.2 Professional Background

Questionnaires were sent to healthcare practitioners in the Ashanti of Ghana for this research. The responders are healthcare professionals who, in one way or another, have a say in how cold chain practices are managed. Consequently, incorporating them improves the credibility and trustworthiness of the data and findings of this research. Figure 4.2 shows the number of professionals who answered the survey in each category. There were 9 (14.5 per cent) pharmacists, 11 (17.7%) pharmacy technicians, 21 (33.9 per cent) medical doctors, 13 (21.0 per cent) nurses, and eight (8) midwives who replied. According to the table, Medical Doctors were the most common respondents to the surveys, followed by Nurses and Pharmacy Technicians. This research includes a wide range of healthcare experts, which boosts the study's generalizability and trustworthiness.

4.2.3 Experience of Professionals

The respondents' years of work experience were also asked about in the survey. Establishing the respondent's job experience is critical since it lends credibility to the data and makes it more relevant to the kind and quality of data supplied. DeRue (2009) backs up this argument by saying that on-the-job experience assures quality and quantity in task execution. According to Figure 4.3, 23 (37.1%) of the respondents have less than five years of job experience, 18 (29.0%) have 5-10 years of work experience, 16 (25.8%) have 11-15 years of work experience, and 4 (6.5%) have 16-20 years of work experience. Only one of the responders had more than 20 years of experience in the workforce. The results show that the survey respondents had a positive working experience.

4.2.2 Academic Qualification

Academic qualifications are essential for boosting the credibility of a study's conclusions. According to Hegarty et al. (2011), higher education may aid in professional development and critical thinking development. Therefore, the study looked at the respondents' academic degrees to better understand their cognitive abilities. Figure 4 depicts the results of the research participants' comments on academic qualifications. 9 (14.5%) of the 62 respondents had a Doctor of Pharmacy (PharmD) degree, followed by 14 (22.6%) with a Bachelor's degree, 18 (29.0%) with a Master's degree, and 21 (33.9%) with a Doctor of Medicine (MD) degree. This indicates that the respondents have a good educational background and the necessary competence to analyze the questionnaire questions. As a result, the survey outcomes would be more trustworthy since the respondents would be better prepared to answer the questions.

4.2.5 Cold Chain Familiarity

As shown in Figure 4.5, the majority (83.9%) of the respondents are familiar with the concepts of cold chain, whereas 16.1% indicated that they are not familiar with the concepts of cold chain.

4.3 Reliability Analysis

The research used a questionnaire with a 5-point Likert scale that allowed respondents to rate their answers. This then announces the use of Cronbach's Alpha Coefficient test to assess the scale's reliability and consistency before proceeding with further study. Scales' dependability has been confirmed using the Cronbach's Alpha coefficient test (George and Mallery, 2018, Owusu et al., 2018; Agyekum et al., 2021). According to Santos (1999), Cronbach's Alpha coefficient measures the consistency and reliability of quantitative inputs on a scale ranging from 0 to 1, with 1 being the greatest degree of validity and reliability. A Cronbach Alpha's Coefficient of 0.700 or above is regarded as very dependable, allowing for additional study. The Cronbach's Alpha for the scale used to measure each goal is shown in Table 4.2. Cronbach's Alpha for each goal in the table surpassed 0.70: objective 1 (0.968), objective 2 (0.956), objective 3a (0.957), objective 3b (0.880), and objective 3c (0.880). (0.913). The result shows that additional analysis (descriptive and inferential statistics analysis) may be performed utilising the established measurement scale for each goal.

Table 4.2: Reliability Analysis

Objective	Number of Items	Cronbach's Alpha
Cold Chain Practices	17	0.968

Challenges	16	0.956
Objective 3a	23	0.957
Objective 3b	11	0.880

Source: Field Survey (2021)

4.4 Cold Chain Practices in the Ghanaian Healthcare Sector

The questionnaire survey explored the respondents' agreement on the identified cold chain practices in managing the cold chain delivery system at their workplace. The study achieved this by requesting the respondents to rate their level of agreement using a 5-point Likert scale: "1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree". To identify the existing cold chain practice in the Ghanaian healthcare sector, a list of seventeen (17) cold cahain practices was provided, as shown in Table 4.3. The data gathered was analyzed using descriptive statistics, particularly mean scores and one-sample t-test. Before the descriptive analysis, the reliability of the test scale was assessed using the Cronbach's Alpha Co-efficient test, which yielded an alpha value of 0.968, indicating extreme reliability of the scale.

The One-Sample T-test was used to establish the statistical significance of the cold chain practices used in the Ghanaian healthcare sector, at a test value of 3.5 and 95% confidence level with a p-value of less than 0.05. Other criteria such as 't-value', 'degree of freedom (df)', 'p-value', 'mean difference' and 'upper and lower confidence limits were included in the One sample T-test as shown in Table 4.3 (Ahadzie, 2007; Owusu-Manu et al., 2021). The study adopted a test value of 3.5 (which approximates the scale point of 4) for the One sample t-test, meaning "significant". Before the non-parametric test (i.e., the one-sample

t-test), preliminary descriptive analyses such as mean scores and standard deviations were conducted to measure the central tendency and the degree of variation on the factors, respectively.

The mean scores and standard deviation were used to rank the factors as shown in Table 4.3. The cold chain practices were mainly ranked according to their mean scores from largest to smallest with the standard deviation values serving as a tiebreaker between factors having the same means score, in which case the one with the lower standard deviation was ranked higher. The ranking is as follows: Use of fridge tags or functional thermometers [mean=3.95, SD=0.895, 1st]; Presence of emergency power supply [mean=3.92; SD=0.874; 2nd]; Use of appropriate refrigeration (storage) equipment [mean=3.87; SD=0.778; 3rd]; Use of requisition forms for ordering and reporting [mean=3.85; SD=0.865; 4th]; Storage of products at required temperatures [mean=3.81; SD=0.972; 5th]; Supervision and monitoring [mean=3.79; SD=0.792; 6th]; Adequate storage capacity [mean=3.79; SD=0.908; 7th]; Possession of policies, procedures and guidelines on cold chain management [mean=3.77; SD=0.913; 8th]; Use of earliest expiry first out (EEFO) principle [mean=3.77; SD=0.931; 9th]; Storing medical products with non-medical products [mean=3.77; SD=0.895; 10th]; Use of temperature logging charts [mean=3.77; SD=0.838; 11th]; Use of cold chain inventory book [mean=3.76; SD=0.987; 12th]; Training of staff in cold chain management [mean=3.73; SD=0.908; 13th]; Presence of backup equipment for emergency [mean=3.71; SD=0.818; 14th]; Timely cold chain equipment maintenance [mean=3.71; SD=0.818; 15th]; Presence of cold chain management officers [mean=3.69; SD=0.879; 16th] and Regular cleaning and defrosting of refrigerator ice [mean=3.63; SD=0.854; 17th].

Table 4.3: Cold chain Practices

				Test Value = 3.5					
								95% Confidence Interval of the Difference	
Cold Chain Practices	**Mean**	**SD**	**Rank**	**t**	**df**	**p-value**	**Mean Difference**	**Lower**	**Upper**
Use of fridge tags or functional thermometers	3.95	.895	***1st***	3.974	61	.000	.452	.22	.68
Presence of emergency power supply	3.92	.874	***2nd***	3.778	61	.000	.419	.20	.64
Use of appropriate refrigeration (storage) equipment	3.87	.778	***3rd***	3.752	61	.000	.371	.17	.57
Use of requisition forms for ordering and reporting	3.85	.865	***4th***	3.228	61	.002	.355	.14	.57
Storage of products at required temperatures	3.81	.972	***5th***	2.482	61	.016	.306	.06	.55
Supervision and monitoring	3.79	.792	***6th***	2.886	61	.005	.290	.09	.49
Adequate storage capacity	3.79	.908	***7th***	2.518	61	.014	.290	.06	.52
Possession of policies, procedures and guidelines on cold chain management	3.77	.913	***8th***	2.365	61	.021	.274	.04	.51
Use of earliest expiry first out (EEFO) principle	3.77	.931	***9th***	2.320	61	.024	.274	.04	.51
Storing medical products with non-medical products	3.77	.895	***10th***	2.413	61	.019	.274	.05	.50
Use of temperature logging charts	3.77	.838	***11th***	2.576	61	.012	.274	.06	.49
Use of cold chain inventory book	3.76	.987	***12th***	2.060	61	.044	.258	.01	.51
Training of staff in cold chain management	3.73	.908	***13th***	1.957	61	.055	.226	.00	.46
Presence of backup equipment for emergency	3.71	.818	***14th***	2.019	61	.048	.210	.00	.42
Timely cold chain equipment maintenance	3.71	.818	***15th***	2.019	61	.048	.210	.00	.42
Presence of cold chain management officers	3.69	.879	***16th***	1.733	61	.088	.194	-.03	.42
Regular cleaning and defrosting of refrigerator ice	3.63	.854	***17th***	1.190	61	.239	.129	-.09	.35

Source: Field Survey (2021)

4.5 Challenges Associated with the Cold Chain Delivery System in the Ghanaian Healthcare Sector

The questionnaire survey explored the respondents' agreement on the identified challenges associated with the cold chain delivery system in the Ghanaian healthcare sector with regards to their place of work. The study achieved this by requesting the respondents to rate their level of agreement using a 5-point Likert scale: "1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree". To identify the challenges associated with the cold chain delivery system in the Ghanaian healthcare sector, a list of sixteen (16) cold chain challenges was provided, as shown in Table 4.4. The data was analyzed using descriptive statistics, particularly mean scores and one-sample t-test. Before the descriptive analysis, the reliability of the test scale was assessed using the Cronbach's Alpha Co-efficient test, which yielded an alpha value of 0.956, indicating extreme reliability of the scale.

As earlier mentioned, the One-Sample T-test was used to establish the statistical significance of the challenges associated with the cold chain delivery system in the Ghanaian healthcare sector, at a test value of 3.5 and 95% confidence level with a p-value of less than 0.05. In addition, other criteria such as 't-value', 'degree of freedom (df)', 'p-value', 'mean difference' and 'upper and lower confidence limits were included in the One sample T-test as shown in Table 4.4 Before the non-parametric test (i.e., the one-sample t-test), preliminary descriptive analysis such as mean scores and standard deviations were conducted to measure the central tendency and the degree of variation on the factors, respectively.

The mean scores and standard deviation were used to rank the factors as shown in Table 4.4. The cold chain practices were mainly ranked according to their mean scores from largest to

smallest. The ranking is as follows: Lack of modern technology or optimal equipment [mean=4.11, SD=0.851, 1st]; Inadequate financing [mean=4.10; SD=0.863; 2nd]; Lack of reliable transportation [mean=4.02; SD=0.779; 3rd]; Erratic electric power supply [mean=4.00; SD=0.868; 4th]; Transportation delays [mean=3.98; SD=0.735; 5th]; Poor supervision and monitoring of cold chain management [mean=3.97; SD=0.868; 6th]; Lack of information/consumption data [mean=3.97; SD=0.789; 7th]; Inadequate temperature control systems [mean=3.95; SD=0.876; 8th]; Inadequate storage facilities or cold chain capacity [mean=3.95; SD=0.858; 9th]; Shortage of service providers [mean=3.94; SD=0.827; 10th]; Absence of alternative power sources [mean=3.92; SD=0.816; 11th]; Lack of appropriate cold chain equipment [mean=3.90; SD=0.824; 12th]; Lack of a consolidated list of cold chain products [mean=3.90; SD=0.670; 13th]; Equipment failure [mean=3.89; SD=0.770; 14th]; Lack of trained personnel [mean=3.87; SD=0.713; 15th]; and Non-uniformity in storage temperature instructions on labels [mean=3.84; SD=0.751; 16th].

The study results confirm the findings of Oli et al. (2016), where vaccine wastage in Nigeria was attributed to inconsistent electric power supply, fuelling, and transportation, which are all necessary to maintain the continuous functioning of cold chain equipment keep vaccines safe. Ashok et al. (2017) also identified that cold chain management systems suffer from inadequate financing. Transportation delays, power interruption, Lack of modern technology or optimal equipment were also found by Rogie et al. (2013) and Lakew et al. (2015).

Table 4.4: Cold Chain Challenges

				Test Value = 3.5					
								95% Confidence Interval of the Difference	
Challenges	**Mean**	**SD**	**Rank**	**t**	**df**	**p-value**	**Mean Difference**	**Lower**	**Upper**
Lack of modern technology or optimal equipment	4.11	.851	***1st***	5.669	61	.000	.613	.40	.83
Inadequate financing	4.10	.863	***2nd***	5.446	61	.000	.597	.38	.82
Lack of reliable transportation	4.02	.779	***3rd***	5.219	61	.000	.516	.32	.71
Erratic electric power supply	4.00	.868	***4th***	4.534	61	.000	.500	.28	.72
Transportation delays	3.98	.735	***5th***	5.181	61	.000	.484	.30	.67
Poor supervision and monitoring of cold chain management	3.97	.868	***6th***	4.244	61	.000	.468	.25	.69
Lack of information/consumption data	3.97	.789	***7th***	4.670	61	.000	.468	.27	.67
Inadequate temperature control systems	3.95	.876	***8th***	4.057	61	.000	.452	.23	.67
Inadequate storage facilities or cold chain capacity	3.95	.858	***9th***	4.147	61	.000	.452	.23	.67
Shortage of service providers	3.94	.827	***10th***	4.145	61	.000	.435	.23	.65
Absence of alternative power sources	3.92	.816	***11th***	4.048	61	.000	.419	.21	.63
Lack of appropriate cold chain equipment	3.90	.824	***12th***	3.853	61	.000	.403	.19	.61
Lack of a consolidated list of cold chain products	3.90	.670	***13th***	4.736	61	.000	.403	.23	.57
Equipment failure	3.89	.770	***14th***	3.956	61	.000	.387	.19	.58
Lack of trained personnel	3.87	.713	***15th***	4.100	61	.000	.371	.19	.55
Non-uniformity in storage temperature instructions on labels	3.84	.751	***16th***	3.552	61	.001	.339	.15	.53

Source: Field Survey (2021)

4.6 Impacts of an Efficient Cold Chain Delivery System on Healthcare Service Delivery

The relationship between cold chain delivery and healthcare delivery is presented in this section.

4.6.1 Analysis of Variance

According to Table 4.5, the regression model strongly predicts the dependent variable. The "Sig." column reflects the statistical significance of the regression model, which is at 0.05 and implies that the regression model predicts the outcome variable statistically.

Table 4.5 Analysis of variance

	Sum of Squares	df	Mean Square	Freq	Sig.
Regression	0.898	1	0.898	3.856	.05**
Residual	13.975	60	0.233		
Total	14.874	61			

Source: Field Survey 2022, **: 5% significance level.

4.6.2 Regression Results

The regression results are presented by Table 4.6. The table shows that the r-square is 6 per cent. This information means that the independent variable is able to explain the dependent variables by 6 per cent of the study.

Table 4.6 Regression results

	Coefficients	Std. Error	T-stat	Sig.
Constant	3.434	0.333	10.306	0.00***
Cold chain delivery	0.17	0.087	1.964	0.05**
R-square	0.06			

Source: Field Survey 2022, **: 5% significance level, ***: 1% significance level.

The study found a positive relationship between cold chain delivery and healthcare service delivery. This is because the significance level of cold chain delivery is 5 percent, implying that the relationship is significant. The relationship implies that an increase in cold chain delivery leads to an increase healthcare service delivery. The findings may be explained by the fact that healthcare services depend on a consistent supply of drugs to care for patients, and moving these commodities may be a complicated logistical operation. Temperature is critical for the survival of many medications, including vaccinations and insulin, making cold vans a vital mode of distribution. Vaccines are critical in protecting Ghana's public health, preventing a wide variety of infectious illnesses and creating large annual healthcare savings. Each year, flu vaccinations are administered to a large number of immunocompromised persons and healthcare personnel in order to halt the spread of illness and its associated complications. In both circumstances, thousands of vaccinations must be delivered statewide quickly and under rigorous oversight. As a result, cold chain distribution becomes necessary to address the healthcare demands of those in need. Additionally, it improves the efficiency of healthcare systems by expediting the distribution of cold medications.

Many of the pharmaceutical products require temperature-controlled storage and distribution to maintain their effectiveness. Hence cold chain delivery enables healthcare centres to achieve that feat by delivery non-defective medicines to patients. Dongjiu, Hao, Qingnian, and Jiali, (2012) assert that cold chain delivery allows the temperature of medicines to be monitored. This feat means that hospitals distribute medicines that are safe to be administered. Also, it aids practitioners to be efficient by alerting them on the status of drugs before being administered to patients. Transporting the products through the cold chain ensures the maintenance of the quality of the products. Healthcare delivery is improved since cold chain supply ensures the potency of drugs are not reduced. This finding supports the study of Ogboghodo et al. (2017).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarized the research study and the outcomes of data collection and analysis. Firstly, it reviews the study findings concerning the research aim and objectives. This was followed by the study's contributions, recommendations, limitations, directions for future research. Finally, the chapter provides a conclusion to reflect the synthesize the key deliverables in this research.

5.2 Summary of Findings

The study aimed to assess efficient cold chain management practices in the health sector and their impact on service delivery in Ghana.

5.2.1 Objective One: To Identify the Existing Cold Chain Practice in the Ghanaian Healthcare Sector

A review of extant literature was conducted to identify cold chain practices in managing the cold chain delivery system at their workplace to achieve this objective. A total of seventeen (17) practices were identified. Respondents were then asked the extent to which the identified cold chain practices are considered or applied in the Ghanaian healthcare sector on a 5-point Likert scale: "1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree". Mean score ranking was performed to determine the relative importance of the cold chain practices. The results indicated that the top five (5) existing cold chain practices in the Ghanaian healthcare sector are the use of fridge tags or functional thermometers, presence of

emergency power supply, use of appropriate refrigeration (storage) equipment, use of requisition forms for ordering and reporting, and storage of products at required temperatures.

5.2.2 Objective Two: To Identify Challenges Associated with the Cold Chain Delivery System in the Ghanaian Healthcare Sector

A critical review of pertinent literature was carried out, resulting in identifying sixteen (16) obstacles that impede the cold chain delivery system in the Ghanaian healthcare sector. In the questionnaire survey, respondents were asked to rate the significance of the challenges, based on the 5-point Likert Scale: "1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree". The One sample T-test was used to analyze the data gathered to determine the statistical significance of the challenges. The results revealed that all the challenges were statistically significant. Nonetheless, in order of importance, the top five (5) ranked challenges were lack of modern technology or optimal equipment, inadequate financing, lack of reliable transportation, erratic electric power supply, and transportation delays.

5.2.3 Objective Three: To Determine an Efficient Cold Chain Delivery System and Its Impacts on the Healthcare Service Delivery

The study conducted a regression analysis to determine the relationship. The study found that cold chain delivery had a significant positive effect on healthcare service delivery. The relationship was significant at the 5% percent level implying that an increase in cold chain delivery leads to an increase in healthcare service delivery due to the fact that cold chain delivery insures the potency of drugs and vaccines are not diluted and also it ensure timely delivery of important drugs.

5.3 Conclusion

This study assessed efficient cold chain management practices in the health sector and their impact on service delivery in Ghana. The quantitative research approach was adopted for the study. Based on variables discovered from a comprehensive review of pertinent literature theoretically and empirically on the cold chain management, a structured questionnaire aided in collecting the data in a survey of health professionals. A total of 100 professionals purposively sampled were contacted to participate in the online survey by answering the questionnaire. Feedbacks were obtained from 62 professionals whose responses were received. The data gathered from the survey were coded and further analyzed to provide meaning to the result. The results (presented in Chapter four and summarized in Chapter five) enabled the achievement of the study's objectives outlined at the beginning of this research under the consideration of the stated scope. Its significant contributions to knowledge, theory and practice and the recommendations have been clearly stated in this chapter in the subsequent sections. This study would guide healthcare professionals and institutions, and the government to implement strategies necessary to improve cold chain practice in the Ghanaian healthcare sector. This study may also sensitize other researchers to delve into more issues better to understand the cold chain delivery system in the healthcare sector and the appropriate stakeholders to properly manage the cold chain system in developing countries.

5.4 Contribution of the Study

The study makes significant contributions to theory and practice. It adds to knowledge and serves as empirical evidence on cold chain management in the healthcare sector and its impact on service delivery in Ghana as a developing country. The significant positive impacts of an efficient cold chain on healthcare service delivery (including waiting time, quality and responsiveness) advises on the potential benefits to be gained by Ghanaian healthcare. The

study also identified the existing and predominant cold chain practices in the Ghanaian healthcare sector and the significant challenges that beset efficient cold chain management in the healthcare sector in Ghana. The healthcare sector is the major beneficiary of the findings of this study. Stakeholders of the healthcare sector, including healthcare professionals and the Government, should adopt the research findings and seek to avert the challenges that beset efficient cold chain practice in the Ghanaian healthcare sector.

5.5 Recommendations

From the findings of this study, below are the study's recommendations:

1. The Government should ensure that timely and sufficient funding is available to improve cold chain management efficiency.
2. Healthcare professionals need to be trained and motivated to apply the best cold chain practices to enhance healthcare service delivery.
3. Healthcare institutions should also invest in the management tools and necessary logistical support for the efficient cold chain management.

5.6 Limitations of the Study

Despite the wide contributions of this study to knowledge and practice, it has limitations which are usual of research studies. One of the study's limitations had to do with the small sample size. Future studies could adopt a larger sample size to improve the credibility and reliability of the findings and widen the scope to other developing countries. In addition, the data collected might potentially be affected by sampling and measurement errors.

5.7 Directions For Future Research

Directions for future research are suggested as follows:

1. Further studies could consider investigating effective strategies that could be employed to improve the efficiency of the cold chain delivery system in the Ghanaian healthcare sector.

2. Further studies could also develop appropriate frameworks that would guide efficient cold chain practice in the healthcare sector in Ghana.

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Appendix

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI.

DEPARTMENT OF SUPPLY CHAIN AND INFORMATION SYSTEMS

SURVEY QUESTIONNAIRE

Dear Sir/Madam,

My name Danielle Danso, a final year student of KNUST conducting a research on the topic Assessing Efficient Cold Chain Management Practice in the Health Sector and its Impact on Service Delivery in Ghana: A Study of the Komfo Anokye Teaching Hospital, Kumasi. You have been chosen as a key respondent by reason of your experience on the field of study. I wish to state that all data collected will be for academic purposes and will be treated with strict confidentiality. I would be very grateful if you could answer this questionnaire to aid our study.

Thank you for your time.

Sincerely,

……

Ms. Danielle Danso

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PART ONE: RESPONDENT'S PROFILE

Please provide the correct information by ticking [√] the appropriate box and fill in the blank spaces where necessary.

1. Please indicate your gender

   [ ] Male [ ] Female

2. Which category do you belong to?

   [ ] Pharmacist [ ] Pharmacy Technician [ ] Medical Doctor [ ] Nurse

   [ ] Midwife [ ] Other (specify) …….

3. Please indicate your years of experience in your field?

   [ ] Less than 5 years [ ] 5-10 years [ ] 11-15 years [ ] 16 – 20 years

   [ ] Over 20 years

4. Please indicate your highest educational qualification?

   [ ] Higher National Diploma (HND) [ ] Bachelor Degree [ ] MBA/MSc./MPhil [ ] PhD [ ] Others (specify)……..……

5. Are you familiar with the cold chain delivery system?

   [ ] Yes [ ] No

PART TWO

A. COLD CHAIN PRACTICES IN THE GHANAIAN HEALTHCARE SECTOR.

From your experience, indicate how often are the following cold chain practices in managing the cold chain delivery system at your workplace. Please answer using the scale: **1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree**

S/N	Cold Chain Practices	Agreement				
		1	2	3	4	5
1.	Use of temperature logging charts					
2.	Training of staff in cold chain management					
3.	Use of cold chain inventory book					
4.	Supervision and monitoring					
5.	Timely cold chain equipment maintenance					
6.	Storing medical products with non-medical products					
7.	Use of fridge tags or functional thermometers					
8.	Presence of cold chain management officers					
9.	Possession of policies, procedures and guidelines on cold chain management					
10.	Presence of emergency power supply					
11.	Use of appropriate refrigeration (storage) equipment					
12.	Adequate storage capacity					
13.	Storage of products at required temperatures					
14.	Presence of backup equipment for emergency					
15.	Use of earliest expiry first out (EEFO) principle					

16.	Use of requisition forms for ordering and reporting					
17.	Regular cleaning and defrosting of refrigerator ice					

B. CHALLENGES ASSOCIATED WITH THE COLD CHAIN DELIVERY SYSTEM IN THE GHANAIAN HEALTHCARE SECTOR

From your own opinion and knowledge, how do you agree with the following statements as challenges associated with the cold chain delivery system in the Ghanaian healthcare sector. *Please, answer by indicating your level of agreement with the following statements using the 5-point Likert scale*: **1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree**

S/N	Challenges	Agreement				
		1	2	3	4	5
1.	Lack of a consolidated list of cold chain products					
2.	Inadequate storage facilities or cold chain capacity					
3.	Inadequate temperature control systems					
4.	Erratic electric power supply					
5.	Non-uniformity in storage temperature instructions on labels					
6.	Lack of modern technology or 'optimal' equipment					
7.	Inadequate financing					
8.	Lack of trained personnel					
9.	Transportation delays					
10.	Equipment failure					
11.	Lack of information/consumption data					
12.	Poor supervision and monitoring of cold chain management					
13.	Absence of alternative power sources					

14.	Lack of appropriate cold chain equipment					
15.	Shortage of service providers					
16.	Lack of reliable transportation					

C. HEALTHCARE SERVICE DELIVERY

How significantly to the following dimensions of an efficient cold chain delivery system impact healthcare service delivery? *Please rank by using the key:* **1= Not Significant; 2=Less Significant; 3= Moderate; 4=Significant; 5=Very Significant.**

S/N	Dimension	Significance				
		1	**2**	**3**	**4**	**5**
	Trained personnel					
1.	Continuous in-service training of healthcare personnel					
2.	Staff knowledge and compliance with cold chain policies, procedures and guidelines					
3.	Appointment of trained officers for cold chain management					
4.	Motivation of healthcare workers					
5.	Regular supervision of healthcare workers					
	Reliable transportation					
1.	Use of specialized or temperature-controlled transport vehicles and equipment such as refrigerator vans or trucks.					
2.	Reduced number of hand-offs between products origin and destination					
3.	Monitoring to track and maintain precise product temperatures					

4.	Use of dry ice or frozen gel packs to maintain low temperatures during transportation					
5.	Avoiding temperature fluctuation					
	Reliable storage					
1.	Use of technically appropriate refrigerators					
2.	Use of tools for maintaining storage temperatures (thermometers, VVMs, temperature logging charts, etc.)					
3.	Storage of products within required temperatures					
4.	Adequate storage capacity					
5.	Clean and well-organized storage facilities					
6.	Separation of medical products from non-medical products					
7.	Availability of functioning power or electrical support (solar, generator, etc.)					
	Efficient management					
1.	Better record keeping and documentation					
2.	Proper feedback mechanism					
3.	Existence of cold chain policies and guidelines					
4.	Maintaining proper stock levels					
5.	Good monitoring and supervision					
6.	Adequacy of equipment for emergency					

Please rate the impact of efficient cold chain practice on healthcare service delivery using the Likert scale: **1= Very Low; 2= Low; 3= Moderate; 4= High; 5=Very High.**

S/N	**Dimension**	**Impact**				
		1	**2**	**3**	**4**	**5**
	Waiting time					
1.	Short patient waiting time					
2.	Timely and convenient healthcare					

	Responsiveness					
1.	Respectful treatment					
2.	Patients' autonomy in decision-making					
3.	Good communication by healthcare providers					
4.	Patient choice of healthcare providers					
5.	Clean facilities for patients' convenience					
	Quality					
1.	Effectiveness or quality of care					
2.	Safety of patients					
3.	Patient-centeredness					
4.	Healthcare equity					

In your opinion and knowledge, how do you agree with the following statements as impacts of efficient cold chain delivery practice on healthcare service delivery. *Please, answer by indicating your level of agreement with the following statements using the 5-point Likert scale*: **1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree**

S/N	**Impacts**	**Agreement**				
		1	**2**	**3**	**4**	**5**
1.	Reduced mortality rates					
2.	Reduced patient waiting time					
3.	Increased vaccination coverage					
4.	Increased responsiveness					
5.	Cost-effective delivery of healthcare service					
6.	Reduced cold chain products wastage					
7.	Reduced risk of a long-term potential outbreaks of diseases					
8.	Optimum utilization of healthcare resources					
9.	Patient satisfaction					

10.	Adequate stock of pharmaceutical products					
11.	Enhanced performance or efficiency					
12.	Improved quality of health services					

Thank You.