KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
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Evaluation of Healthcare Supply Chain (HCSC) Resilience in Public Hospitals

BY
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MASTER OF PHILOSOPHY IN LOGISTICS AND SUPPLY CHAIN

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DECLARATION

I hereby declare that this submitted thesis is my own work towards the attainment of a Master of Philosophy Business Administration (Logistics and Supply Chain Management option). To the best of my knowledge, it contains no material previously published by another person or material which has been accepted for the award of any other degree of the university except where references of other scholars' work have been cited and acknowledgment has been provided in the text.

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ABSTRACT

Healthcare Supply chain resilience has become a subject of interest owing to an increasing number of supply chain disruptions and its unintended consequences on healthcare delivery service operations. In particular, the emergence of COVID-19 pandemic has further highlighted the significant need for healthcare supply chain resilience which has undoubtedly attracted intense interest from both academics and policy makers. Thus, this study evaluates healthcare supply chain resilience in public hospitals in Ghana. A quantitative research design was adopted in conducting the study and also, a purposive sampling technique was employed to collect data from 300 respondents. Using structured questionnaire and regression analysis, specifically, Structural Equation Model (SEM) as tools for data collection and analysis respectively, the research found that healthcare supply chain risk identification positively and significantly impacts on healthcare supply chain performance. The research also revealed that, based on the proposed healthcare supply chain resilience framework, there are sufficient presence of supply chain resilience measures in healthcare delivery facilities across Ghana. Based on the findings, the study recommended that healthcare managers integrate all its internal processes to identify, assess, and mitigate potential risks in order to fully realize Supply Chain risk management in the healthcare sector as a means to achieving resilience. It also recommended that governments and healthcare managers invest in advanced Information Technology in managing supply chain risks to enhance supply resilience more especially in the healthcare sectors. As regard to future research, this study recommended that future could be conducted using private or mission-based health facilities as this study focused on public/government health facilities. In addition, in order that the findings of future research can be generalized, this study further proposed that future studies could consider representative sample enough for generalization to cover the entire country. Lastly, a comparative study between public and private healthcare facilities can be considered.

DEDICATION

I dedicate this study to my beautiful wife, Rashida Abdulai and my two sons, Adjei Aarif Boresa and Adjei Naeem Kanyiti.

Their understanding, patience and encouragement kept me going throughout the challenging journey.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AVE	Average Variance Extract
BD	Big data analytic
CAS	Complex Adoptive System
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CMV	Common Method Variance
CPS	Cyber Physical System
CR	Composite Reliability
EDI	Electronic Data Interchange
EFA	Exploratory Factor Analysis
GFI	Goodness of Fit Index
GHS	Ghana Health Services
GoG	Government of Ghana
HC	Healthcare
HCSC	Healthcare Supply Chain
HCSC 4.0	Healthcare Supply Chain fourth Generation ICT
HCSC RIM	Healthcare Supply Chain Risk Mitigation
HCSCI	Healthcare Supply Chain Integration
HCSCP	Healthcare Supply Chain Performance
HCSCRAS	Healthcare Supply Chain Risk Assessment
HCSCRes	Healthcare Supply Chain Resilience
HCSCRID	Healthcare Supply Chain Risk Identification
HCSCRM	Healthcare Supply Chain Risk Management
ICT	Information Communication Technology
IFI	Incremental Fit Index
IoS	Internet of Service
IoT	Internet of Things
IT	Information Technology
KATH	Komfo Anokye Teaching Hospital
KMO	Kaiser-Meyer-Olkin
MOH	Ministry of Health
NFI	Normed Fit Index

PLS	Partial Least Square
RAS	Risk Assessment
RBV	Resources Based View
RFID	Radio Frequency Identification
RID	Risk Identification
RIM	Risk Mitigation
RMSEA	Root Mean Square Error of Approximation
SC	Supply Chain
SCI	Supply Chain Integration
SCM	Supply Chain Management
SCRM	Supply Chain Risk Management
SEM	Structural Equation Model
TLI	Tucker-Lewis Index
TTH	Tamale Teaching Hospital
UK	United Kingdom
WHO	World Health Organization

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Supply chain resilience (SCRes) has lately become a subject of immerse interest for practitioners as well as supply chain (SC) scholars and this is as a result of increasing number of supply disruptions and risks confronting supply chains (Gligor et al. 2019b; Holcomb, M. and Ponomarov, Y. 2009; Quaddus, M. and Chowdhury, S. 2017; Ali, I. and Golgeci, I. 2019; Behzadi, G. Sullivan, M. and Olsen, T. 2020; Anbumozhi, V. Kimura, F. and Thangavelu, M. 2020; Dubey et al. 2021). Supply chain disruptions, in its broader context, can be described as the occurrence of unexpected events that interrupts the delivery of supply services to organizations (Kochan, C. and Nowicki, D. 2018). Although disruptions and risks are embedded in all sectors of supply chains, the hardest hit in most recent times is the health sector due to the Corona Virus Pandemic (WHO, 2021). The pandemic overwhelmed global health systems and supplies and almost grinding the healthcare sector to a halt.

The COVID-19 pandemic exposed frailty of healthcare supply chains across the globe when healthcare facilities experienced severe scarcity of critical medical supplies such as personal protective equipment (PPE), ventilators, drugs for COVID-19 treatment (Moss et al., 2021; Chamola et al. 2020). The pandemic certainly presented a disruptive crisis which was a novelty in terms of the scale, duration and the levels of uncertainties (Ivanov, D. and Dolgui, D. 2020). Though, Covid-19 pandemic is not the first to have disrupted supply chain systems but the magnitude of the impact was lethal and this has seriously drawn the attention of stakeholders and academics on the need for supply chain resilience especially in healthcare (Colicchia, C. and Strozzi, F. 2012; Craighead et al., 2020; van Hoek, R. 2020). Supply chain resilience is very critical for healthcare institutions largely because of the inherent high uncertainty levels and the direct implications of disruptive activities on human lives (Zepeda et al., 2016). Supply chain disruptions in the context of healthcare has been described by Mandal, S. (2017), as the unexpected event that can hinder the delivery of healthcare services to patients. Discussions around issues of supply chain resilience has certainly gained momentum to help mitigate the impact of these unavoidable supply chain disruptions especially in healthcare (Craighead et al., 2020; van Hoek, R. 2020).

Supply chain resilience (SCRes) has emerged in the literature as multidisciplinary and multidimensional concept which cut across industries. The concept looks at strategies for the rebound from the adverse effect of disruptions in systems (Azadegan, A. 2017; Bhamra et al. 2011; Spiegler et al. 2012; Ponis and Koronis. 2012; Pettit, Croxton, K and Fiksel, J. 2013). Supply chain resilience has been defined as the ability to adapt in preparation or in response to disruptions to ensure timely and cost-effective recovery to reach a post disruption state of operation; producing a better disruption state (Tukamuhabwa et al. 2015). The concept has, summarily, been elucidated to presuppose the adoptive capabilities of supply chains to prepare for and/or respond to disruptions to make a timely and cost effective recovery and even progresses far better after experiencing disruptive events (Mandal, 2012; Shuai et al. 2011).

Just as other sectors, supply chain resilience in healthcare sector has received several literature reviews describing and addressing what the concept entails (Gligor et al., 2019b; Hohenstein et al., 2015; Takamuhabwa et al., 2015). Colicchia, C. and Strozzi, F. (2012), defined healthcare supply chain resilience as the ability of healthcare systems to anticipate, adopt, respond and recover from disruptions without compromise to service delivery to patients. Mandal, S. (2017) and Meehan et al. (2017), also described healthcare supply chain resilience as the synchronization of healthcare supply chain entities in providing uninterrupted supplies for treatments and care to patients in the event of a disruption. The primary objective of supply chain resilience in healthcare, is to save lives by providing the best of care devoid of supply interruptions (Senna et al. 2020). The preoccupation of supply chain resilience in healthcare is the ability of care provider to consistently deliver patient treatment with the help of constant supplies (Hohenstein et al. 2015; Abdulsalam et al, 2015).

From literature, systematic efforts are being pursued by stakeholders in building resilient systems to guard against supply disruptions and risks which are inevitable in the supply chains of healthcare institutions (Colicchia, C. and Strozzi, F. 2012). To successfully build robust supply systems against supply disruptions, specifically, in the healthcare sector, appropriate strategies must be identified, adopted and applied (Senna et al. 2021). Identifying appropriate strategies for building HCSC resilience brings about the need for a framework that will envelope and give directions to the application of the strategies in their right tracks. In healthcare, strategic frameworks are critical tools for the evaluation of supply chain resilience (Finkenstadt, D. and Handfield, D. 2021).

Studies have variously outlined and discussed strategies and theoretical frameworks that are considered to appropriate for evaluating supply chain resilience in the healthcare. (Senna et al. 2021; Hohenstein et al., 2015; Takamuhabwa et al., 2015; Gopalakrishnan, V. 2009; Mavi, R. Goh, M. and Mav, C. 2016; Ivanoc, D. and Dolgul, A. 2020). However, divergent views exists as to the appropriate and comprehensive strategies and frameworks that best define and support the concept of supply chain resilience in healthcare.

For instance, Ochieng A. (2018), considered supply chain collaboration, risk management culture, agile supply chain and supply chain reengineering as the appropriate healthcare SC Resilience measures. They recommended that healthcare stakeholders invested in them to realize organizational performance.

Kamalahmadi and Mellat-Parast (2015), viewed healthcare SC Resilience from the perspective of risk management strategies as the means to mitigating the effect of environmental interruptions. They argued flexibility and reliability of suppliers play crucial role in building emergency strategies for supply disruptions and therefore recommended fewer and highly dependable suppliers to lower risk of disruptions.

Aigbogun et al., (2018), also considered the function of collaborative regulation as an appropriate healthcare SC Resilience strategy. They deemed collaborative regulation as being activities that are coordinated, consistent and strategic including knowledge and information dissemination. They argued that, positive collaborative regulation among actors in a supply chain contributes significantly to improving healthcare SC Resilience. Again, Aigbogun, O. Ghazali, Z. and Razali, R. (2014), considered the orthodox risk management strategies as appropriate tools for measuring healthcare supply chain resilience because the strategies allowed for the identification, categorization and interpretation of the existing and measurable risks in the supply chain. However, Kunreuther, (2006); Pickett, (2006); Starr et al, (2003), disagreed to these strategies as the appropriate tools with the argument that, they failed to factor risks that are unquantifiable, unforeseen and unexpected. Mandal, S. (2016), also looked at the application of technology on organizational culture dimensions as the appropriate strategies for supply chain resilience in healthcare. In their estimation, development culture, rational culture, group culture and hierarchical culture were identified to influence in guarding against disruptions.

As outlined in various studies, it is obvious that divergent views exists on the strategies that best builds and describes supply chain resilience in healthcare. In fact, clearly missing in the debates is the frameworks for measuring supply chain resilience in healthcare institutions. However, there has been several attempts towards closing this literature gap concerning the development of a comprehensive frameworks that best analyze and measure supply chain resilience in healthcare institutions. One of the recent academic efforts towards building a framework as a measuring tool for evaluating supply chain resilience in healthcare is the works of Senna et al (2021). Senna et al (2021), through extensive content reviews of the literature identified factors considered relevant for building healthcare supply chain resilience. Their study went further to propose a theoretical framework for analyzing the relationships that exists between antecedents, mediators and consequents of supply chain resilience in healthcare.

The strategic factors considered by Senna et al. (2021) to appropriately propel supply chain resilience in healthcare are somehow not so different from the risk management strategies proposed by Aigbogun, O. Ghazali, Z. and Razali, R. (2014). Senna et al. (2021), identified the traditional risk management steps i.e. risk identification, risk assessment, risk mitigation alongside supply chain integration and advanced technology as strategies that can help propel supply chain performance in healthcare. These identified strategies were further used to build a theoretical framework for evaluating supply chain resilience in healthcare. In developing the theoretical framework, Senna et al. (2021), viewed supply chain resilience in healthcare as a cross-functional process which demands appropriate mix of strategies to achieve the desired results.

The general objective of Senna et al. (2021), proposed theoretical framework is to serve as an encompassing tool for evaluating healthcare supply chain resilience in healthcare by analyzing the relationships that exist between the antecedents' factors, mediators and the consequents for supply chain resilience. In their framework, Senna et al. (2021), proposed healthcare supply chain risk identification, healthcare supply chain risk assessment, healthcare supply chain risk mitigation and healthcare supply chain integration as the supply chain resilience antecedents. Healthcare supply chain 4.0 (HCSC 4.0) as the mediator and healthcare supply chain performance as the consequents for healthcare supply chain resilience. Adopting Senna et al.'s framework although slightly modified, this study therefore seeks to empirically apply the framework to test its applicability and to also establish the relationships among the constructs.

1.2 Problem Statement

Increase in the global scale disasters and the resultant disruptive impact on organizational performance has made a case for building supply chain resilience (Carvalho et al, 2012). Academics and practitioners, noticing the challenges with risks of uncertain future, became interested in resilience i.e. the potential anticipate, adapt, respond and recover in times of unstable challenges (Senna et al., 2021; Vanvactor, 2016; Carvalho et al, 2012; Blackhurst et al, 2008*)*. Several research studies on supply chain resilience were conducted to proffer measures against risks and future disruptions for organizations. However, there has been a challenge with a standardized definition, accepted variables or measurement tools for the supply chain resilience concept (Pettit, 2008, Senna et al, 2021; Lu, Koufteros, and Lucianetti 2017; Ibey et al. 2015; Chaudhuri, Boer and Taran 2018; Cagliano, Grimaldi, Rafele 2016). For instance, one key observation with these studies are that, they are mainly concentrated on elements and strategies for increased supply chain resilience regardless of the organization or nature of operations (Nabelsi,2011). Although the literature is replete with several theoretical frameworks for measuring supply chain resilience (Gopalakrishnan, V. 2009; Mavi, R. Goh, M. and Mav, C. 2016; Ivanoc and Dolgul, 2020), conspicuously missing is the empirical applicability of these frameworks. Informed by past studies and recent supply risks events due to Covid-19 pandemic, Senna et al., (2021), undertook a study and designed a framework for evaluating healthcare supply chain resilience. However, to the best of my knowledge, the different facets of healthcare supply chain resilience model and framework and its implication for healthcare supply chain performance in healthcare organizations have not been tested empirically for clarification. This research study, therefore, seeks to fill this gap by empirically evaluating the healthcare supply chain resilience model and establishing the relationships among the variables and constructs, particularly, using the African context.

1.3 Objectives of the Study

1.3.1 The general objective of the study is to evaluate and present valuable insights into analyzing supply chain resilience in public healthcare facilities in Ghana.

1.3.2 The following are the three (3) specific objectives this study intends to achieve:

i. To assess the impact of healthcare supply chain risk Identification on healthcare supply chain performance.
ii. To assess the impact of healthcare supply chain risk assessment on healthcare supply chain performance.
iii. To assess the mediating role of healthcare Supply Chain 4.0 in the relationship between healthcare supply chain risk management and healthcare supply chain performance.

1.4 Research Questions

Three (3) main research questions are posed as follows:

i. What is the impact of healthcare supply chain risk Identification on healthcare supply chain performance?
ii. What is the impact of healthcare supply chain risk assessment on healthcare supply chain performance?
iii. What is the mediating role of healthcare Supply Chain 4.0 in the relationship between supply chain risk management and healthcare supply chain performance?

1.5 Significance of the study

The study is significant in many ways. The research study would contribute significantly to scholarly literature. Academically, the study would empirically examine the antecedents, the mediators and the consequents of healthcare supply chain resilience and also determine the suitability of the proposed theoretical framework in healthcare delivery set-ups, especially, in Africa. This would therefore push forward the frontiers of academic studies.

On policy front, the outcomes of this study would inform stakeholders in the healthcare delivery sector on measures and preparation to be put in place against supply chains disruptions which are inevitable in everyday life of the organizations. The study would be beneficial to the Government of Ghana (GoG) with specific benefits to the Ministry of Health (MOH), Ghana Health Service (GHS) and other healthcare facilities and providers.

1.6 Brief Overview of Research Methodology

1.6.1 Study Design

This part explains the methodology used for this research. The research methodology is the process by which research data on the topic will be collected, analyzed and presented in the light of the research objectives and research questions (Yin, 2003). The methodology comprises choice of particular research design and approach, data type and data sources, unit of analysis for the study, data gathering and analysis techniques and the relevant justification associated with each approach. This research adopted a quantitative research design. A quantitative research, as described by Creswell (1994), explains happenings by gathering statistical data and are analysed using statistically based methods. Cohen (1980), went further to describe quantitative research in the light of social research which applies empirical methods and statements in empirical evaluations.

Cohen et al., (2018), also alluded to a correlational research method to include a non-experimental research method which examines relationships among two or more variables with the aid of statistical analysis. For this research study, quantitative data collection tools as well as quantitative data analytical instruments such as Structural Equation Model (SEM) – AMOS 18.0 was used. Some advantages associated with this method of design is that, it allows for large sample size with few variables, measures level of occurrence, actions, trends and it produces highly reliable outcomes because of the use of close ended questions and the outcomes can be generalized and reused (Sukamolson, 2007). The major disadvantage of the quantitative research model is that, it is difficult to determine nonresponse bias.

1.6.2 Data Collection (Study Instruments)

Primary data and secondary data sources were accessed. The primary data collection was done using instruments such as self-administered questionnaires (closed-ended) and face-to-face interaction in order to explain the purpose of the study to participants. The secondary data was obtained through extensive review of existing literature with a content guide as a valuable instrument. To empirically assess healthcare supply chain resilience (i.e. antecedents, mediators and consequents) and the applicability of the theoretical framework developed by Senna et al, (2021), a data collection instrument was developed based on extant literature and works that share similar characteristics with this research. The research instrument was informed by relevant variables and theoretical considerations of the research. To validate the instrument, it was presented for review and pilot-testing.

1.6.3 Sample selection and Sample size

Several factors come to play in sample size selection process, thus, type of research and purpose of the study (Dawson, 2009). According to Babbie (2015), sampling is the process undertaken to select from a total targeted study population and a reasonable number to be contacted for critical information regarding the occurrence being researched into (Babbie, 2015). What is important for a sample size is that it should be representative in order that inferences and logical conclusions can be reached from the sample. Purposive sampling technique was employed for the selection of the healthcare facilities and the respondents' thereof. The targeted population for this research were public healthcare facilities in Ghana and the target respondents included health administrators, medical superintendents, procurement directors/officers, the pharmacist/pharmacy technicians, medical stores managers and supply chain managers/officers. The healthcare supply chain practitioners are responsible for the day to day handling of medical supplies in the healthcare facilities and were in the better position to respond to the research questions. A sample size of 342 was selected using Hair et al. (2010) sample size estimation formula.

1.6.4 Data Analysis

Data analysis has been described by Salajeghe, Nejad, and Soleimani, (2014), as the step by step review of elements of data which requires data interpretation to determine the meaning of the data. The steps involved in data analysis includes: data preparations, data analysis and data interpretation. Like many other studies, this study followed these steps outlined. Statements was identified, clustered, coded and analyzed based on themes (Sotiriadou, Brouwers, and Tuan-Anh, 2014). Multiple data sources was used to ensure reliability and validity of the research findings, (Yin, 2012; Wahyuni, 2012). The data was coded and entered into the statistical package after which the data analysis commenced (Leavy, 2017). Structural Equation Model (SEM) approach was used to evaluate multiple variables and their relationships. The SEM techniques are of two types: Partial Least Square (PLS) based and Covariance based SEM. For this research study, PLS-SEM analysis was the option we employed because it is considered appropriate for exploratory research (Lai and Peng, 2012).

1.7 Scope of the Study

It would have been very revealing if this study was conducted across the 16 regions of Ghana and probability in all public healthcare facilities. However, this was not possible considering the time frame and the cost involved. Therefore, this study geographically focused on three (3) regions in Ghana: Ashanti, Greater Accra and Bono. The research settled on these regions because of the concentration of healthcare facilities of various levels of services and also, the characteristics of healthcare facilities in these regions mirror that of other regions. The researcher is also familiar with healthcare facilities in these terrain which largely aided in data gathering.

Within these regions, tertiary, secondary and primary healthcare facilities were purposively sampled for the study. The healthcare facilities selected were teaching hospitals, district hospitals, regional hospitals, polyclinics and health centres. These category of healthcare facilities were selected because, they are known to have formalize units or supplies and supply chain departments with designated personnel or staff in charge of the day to day management of hospital supplies.

The study respondents were conveniently selected to include health administrators, medical superintendents, procurement directors/officers, the pharmacist/pharmacy technicians, medical stores managers and supply chain managers/officers. This category of staff were the target because of their levels of influence on decisions concerning the management of medical supplies the healthcare facilities.

1.8 Limitation of the study

The study is limited, first, in scope as it focused on selected public healthcare facilities in only three (3) regions in Ghana. Looking at the study topic, it would have been prudent, if the study was organized across all the regions of Ghana for a larger response base. However, time and the budget constraints was a major obstacle.

Secondly, the sample size was not representative enough to guarantee generalization and this is as a result of the limited scope of the study. This however, did not invalidate the findings of the study because of the scientific processes the research went through.

Lastly, a cross-sectional survey design was used. However, the study could have engendered a nuanced results and findings if longitudinal survey design were employed.

1.9 Organization of the Study

The entire research study is structured into five (5) main chapters: Chapter one comprises the background of the study, statement of the problem, objective of the study, research questions, significance of the study, overview of research methodology, scope of the study and limitations of the study. Chapter two (2) covers the literature review of works relating to the subject matter of the study from scholarly sources as well as policy and practitioners' perspectives. Chapter three (3) focuses on the methodology for the study research i.e. research design, sampling techniques, Data collection procedures, etc. Chapter four (4) presents data and the discussions in relation to the research objectives and chapter five (5) presents summary of findings, conclusions, recommendations, managerial and practical implications and finally future research.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

In this chapter relevant concepts, theories and studies central to the subject under consideration are reviewed. The literature review contextualizes and anchors the research, situating the present study within existing body of knowledge. The literature review further underscores findings of similar works that are related to the study and situate the research study into the appropriate dialogue to help plug a research gap. The research study borders on healthcare HSCM resilience; the empirical evaluation of the situation in public healthcare facilities in Ghana.

2.2 Conceptual Review

This section proffers and explicates the concepts relevant to the study. The concepts include:

2.2.1 Healthcare Supply Chain (HCSC)

Senna et al. (2021) define healthcare supply chain a supply chain in which all organization found within the process of supplies deliveries are propel by the overarching objective of delivering healthcare and saving lives. Healthcare supply chain is a multi-faceted framework of institutions and processes with numerous mediators.

2.2.2 Healthcare Supply Chain Resilience (HCSCRes)

Supply chain resilience has attracted immerse research interest over the past two decades and therefore has been defined in many ways. It has been defined as the supply chain ability to adapt in preparation or in responds to disruptions, to ensure timely and cost-effective recovery to reach a post disruption state of operation; producing a better disruption state (Tukamuhabwa et al., 2015). For Senna et al. (2021) supply chain resilience is the ability to reducing uncertainties with fast decision making and generating adaptability to systems configuration for improved availability of supplies. This study leans on the former definition presented because it provides the opportunity for clearly balkanized into phases including: preparation for an incident, response to an incident, recovery from the incident and growth /competitive edge after the incident

(Xiao et al. 2012). It also captures important components, which is, ensuring that indispensable processes enumerated above are done not only in an appropriate manner but also at a reduced cost (Xiao et al. 2012).

2.2.3 Healthcare Supply Chain Risk Management (HCSCRM)

Supply Chain Risk Management (SCRM) is described as managing supply chain risks through the coordination or collaboration actions among supply chain stakeholders in order to maintain profitability and continuity (Tang, 2006:452). In the analysis of healthcare SC Risk Management, SC can be seen as cross-functional process and risk management described as the appropriate measures for the identification, evaluating, mitigating and monitoring of risks (Elleuch et al, 2013). Healthcare SC risk management becomes holistic when risks are identified, assessed and mitigated.

2.2.4 Healthcare Supply Chain Risk Identification (HCSCRID)

Supply chain risk identification is significant within the realm of supply chain risk management. It is one of the processes in the risk assessment processes. Undoubtedly this stage (RID) is crucial to the efficient supply chain risks (Nabelsi, 2011). Thus, supply chain risk identification reveals health organizational exposure to uncertainty by ensuring that all the important activities within and outside the organization have been realized and all its attendant risks associated to the activities are clearly spelt out (Neiger, Rotaru and Churlov, 2009).

2.2.5 Healthcare Supply Chain Risk Assessment (HCSCRAS)

Healthcare supply chain risk assessment is among major steps in the risk management process in supply chain. It is about determining critical characteristics of the risks in the supply chain to inform risk management in healthcare delivery. In an elaborate fashion Noel et al. (2013) refer to healthcare supply chain risk assessment as process of determining the right mix of responses for each of the risk event upon which subsequent risk management activities should focus. In this case risk events are often assessed relative to the ability and effects on supply chain and the other features which proposes more appropriate responses to the risk event.

2.2.6 Healthcare Supply Chain Risk Mitigation (HCSCRIM)

Risk mitigation, according to Senna et al. (2020) is a plan to minimize or reduce the risks. As it were, to mitigate risk, strategies are developed. Thus, strategies to mitigate to risk in healthcare is by increasing stockpile for buffer inventory, multi-sourcing and agility (Barroso, Machado and Machado, 2010; Vlachos and Xanthopolous, 2007).

2.2.7 Healthcare Supply Chain Integration (HCSCI)

Supply Chain Integration (SCI), according Flynn et al. (2010) is about the alignment and interlinkages between a firm and its partners, involving internal and external integration. The basis and concept of Healthcare Supply Chain Integration is not that different from that of manufacturing firms. Healthcare supply chain is accomplished by expanding the limits of management both inside and outside of organizations by incorporating suppliers and customers (Geary et al., 2002). Internal integration in organizations allow the circulation of risk information among intra-firm departments whiles integration between firms smoothens the flow of information among supply chain partners and instigates them to be alert and swiftly respond to disruptions by way of data sharing and coordinated operations (Senna et al., 2020).

2.2.8 Healthcare Supply Chain 4.0 (HCSC 4.0)

The inception of digitalization and automation of processes has changed the entire supply chain architecture (Tjahjomo et al., 2017). The transformations have created many possibilities of interconnecting persons and equipment in a cyber-physical system context with information gained from different sources but also direct communication between equipment (Federal Ministry of Education and Research-Germany, 2013). Supply chains has been impacted by the rapid innovations with the transition from computers to smart devices utilizing the infrastructure services premised on cloud computing. Healthcare delivery services have gained much from implementing information technologies even though they have been slowest of all industries (Qin, Liu and Grosvenor, 2016). Healthcare Supply Chain 4.0 in the view of several analyst as a seismic transformation of organizations by the introduction of digitalization and internet to promote the use of fourth generation systems (ref). Supply Chain 4.0 core principles include; emerging technologies, for instance blockchain, big data (BD), Internet of Things (IoT), Internet of Service, Inetroperability, Cyber-physical systems and Artificial Intelligence (AI) as one (Monogara, Thota, Lopez, and Sundarasear, 2017).

2.2.9 Healthcare Supply Chain Performance (HCSCP)

In simple terms performance is considered as a measure of the extent by which goals are achieved. Performance can also refer to effectives and efficiency, responsiveness, reliability (Lai et al., 2002). For Seth et al. (2006) defined performance as quality of services in supply chain. In fact, performance is a relative concept and there seems to be no single definition that captures its several aspects. Performance is normally evaluated using profitability however, monetary yardstick is no indicator enough for public sector, especially the healthcare sector (Nabelsi, 2011). Thus, healthcare supply chain performance here is about delivering healthcare and saving lives at minimum cost (Senna et al., 2021).

2.3 Healthcare Resilience: A Literature Review

Several researchers have argued that resilience is not only multidisciplinary but multidimensional in nature (Rezaei, Shokouhyar and Zandieh, 2019; Singh and Singh, 2019). The literature on resilience cuts across several disciplines giving the concept and expansive nature and this has generated many conceptualizations. This highlights the lack of consensus on the concept. For instance, in some cases, a broad view was presented on the concept of resilience and its applicability without necessarily looking at it from supply chains perspective (Bhamra et al, 2011). Supply Chain Resilience (SCRes) as a concept is developed based on the diverse literature by drawing on the various perspective of resilience that had been developed within the various disciplines (Tukamuhabwa, 2015). The concept supply chain resilience gained research interest at the beginning of the new millennium. Rice and Caniato (2003), coined the earliest definitions for the concept which was further developed by Christopher and Peck (2004). This concept further received attention from further research when the imminent impact of interruptions on firms and its supply chain came to light. Added to this, there still remains arguments and lack of uniformity over the definition of supply chain resilience (Spiegler et al 2012; Mensah and Merkuryev, 2014). According to Tukamuhabwa (2015), the two most elaborate conceptualizations of supply chain resilience are put forth by Ponis and Koronis (2012) and Ponomarov (2012). They incorporated features such as capability and capacity, preparation, adaptive, connectedness response, and control as well as timely recovery to the status quo or, if possible a better state. Supply chain resilience (SCRes) can described as adaptive capabilities of supply chains to be able to anticipate, prepare and respond to the threats of supply disruptions in a timely and cost effective manner for progress to a post-disruption state of operations, or to a better position than prior to the disruption (Tukamuhabwa, 2015).

Supply chain resilience has become crucial and a matter of survival for managing supply chain risks (Barroso, Machado and Machado, 2011; Carvallo, Azevedo and cruz Machado, 2012). Contemporary factors such as natural disasters, market volatility, variations in demand and supply, single sourcing among others are impacting the global supply chain and the results is leading to the increase in supply chain complexities (Aigbogun et al., 2014). Like any other sectors, healthcare supply chains are highly prone to risks which makes them vulnerable and more susceptible to disruptions (Carvallo et al., 2012; Aigbogun et al, 2014). Therefore creating consciousness and know-how about supply chain risk management and supply chain resilience is no lesser issues to be relegated, because disruption even in small proportion can throw off organizations from achieving targets (Shen and Li, 2017). Supply chain resilience constitute an optimal way of managing unpreventable disruptions and even forecasting when risk may happen (Nartey, Aboagye-Otchere and Simpson, 2018). In this sense, healthcare supply chain risk management is an essential building block for healthcare resilience (Senna et al, 2021). Given the complexities within the healthcare supply chain and its unending vulnerabilities, supply chain risk management is now very important and a critical factor in supply chain fitness (Aigbogun et al, 2014). In this sense, reducing uncertainties with fast decision making and generating adaptability to systems configuration for improved availability of supplies is a form of resilience generation (Senna et al, 2021). An organizations wherewithal to manage supply risks by being able to anticipate, adapt, respond, and recover, is crucial to generating supply chain resilient (Ali, Mahfouz and Arisha, 2017).

According to Mandal (2016), organizations in the service sector needs resilience to aid them withstand complexities, shield them from disruptive risks and ensure efficient performance. Supply chain disruptions are usually caused by factors like distortions in information flow, material flow, knowledge flow, and controls and coordination flows

(Ancarani and DiMauro, 2011). The notion of resilience has been extended to medical supply chain and calling for clinical chain organizations to plan resource usage in order to shield against disruption (Mandal, 2016). A healthcare supply chain is a supply chain where all companies must be driven by the objective of offering healthcare and saving lives (Abdulsalam et al, 2015; Rakovska and Stratieva, 2018; Senna et al, 2021). Healthcare supply chain resilience is the capacity of healthcare supply chain entities to work in a concerted way with an objective to ensure smooth provision of medical service during periods of disruptions (Mandal, 2016).

Resilience is germane to the services sector and there are numerous studies on SCRe and theories underpinning it (Tukamuhabwa et al., 2015; Kamalahmadi and Prast, 2016; Aigbogun et al., 2014). Resilience can be best described as a multidimensional and multidisciplinary concept which emanated from materials science and basically referred to the capacity to rise back after distortions (Sheffi, 2005). As a theory in social psychology, resilience concept has now emerged a theory in itself (Alfarsi et al, 2019). Various literature has highlighted and acknowledged the significance of resilience. Alfarsi et al, (2019) in a study, explored how supply chain resilience influences firm reputation because, prior studies conceptualized supply chain resilience to be avenue for opportunity exploration for competitive advantage and good firm reputation. In their estimation, the theory linking resilience to firm reputation did not have any empirical backing and therefore their study went on to empirically investigate that theoretical assertion. Kamalahmadi and Mellat-Parast (2015), argue that, the strategy of regionalizing a supply chain suggested by Chopra and Sodhi (2014) by dealing with suppliers of several regions provided the opportunity cost of minimal cost in the world supply chains.

Aigbogun, Ghazali and Razali (2018), also came up from a different perspective to look at joint regulation and supply chain resilience in their study. According to them, that, although many studies have highlighted the importance of supply chain resilience, scanty explanation exist on the role of collaborative regulations in supply chain resilience performance. This is therefore an attempt to bridge the knowledge gap for healthcare managers and academics alike on this subject matter.

Despite the numerous arguments put forward backing the need for supply chain resilience, this research stands to further argue for the role and influence of external environment factors and how they help during disruptive times. Holcomb and Ponomarov (2009), in a study entitled "understanding the concept of supply chain resilience" came to a realization that the concept is multidisciplinary and multi-dimensional. Going by their study, it was concluded that resilience had some semblance in development psychology and ecosystem before it become a subject of interest in risks and supply chain management. This considerations and scenarios are actually breeding confusion and contradiction especially in the conceptual definition of resilience. To cure the confusion breeding around the concept of supply chain resilience, a conceptual framework encompassing the antecedents, mediators and the consequents was developed through a multidisciplinary approach. This conceptual framework is to mainly serve as a basis for a unified theory around the supply chain resilience concept. Evaluating the conceptual framework for generalization is the justification for this research.

Critically going through the views of various researchers and studies and what they stand for in terms of analyzing the concept of supply chain resilience, this researcher is of the realization that most studies explicating the concept, proposed strategies and arguments that appeared to make a case for universal applicability of strategies regardless of the organization type, nature and objectives. For instance, increasing flexibility, use of information technology, contingency planning, inventory management, supply chain agility, creating collaboration, supply chain integration were all strategies proposed as resilience measures (Tukamuhabwa et al., 2015; Senna et al., 2021; Aigbogun et al., 2018; Zepeda et al, 2016; Elleuch et al, 2014; Ochieng, 2018; Kamal-Ahmadi and Mellat-Parast, 2015). This research completely holds a contrary wiew from the early studies and argues for building resilience based on the type, nature and objectives of an organization. This research therefore stands for building SC resilience especially for healthcare, by evaluating and analyzing risk management and collaboration strategies alongside the adoption and application of advanced technology techniques. This is because, the role and influence of external environmental factors in supply disruptions cannot be overlooked. It is a fact that in healthcare, risks mostly emanates from their external environment because, they entirely depend on the external suppliers for their operational resources. To conclude, this research will set its discussions around risk management, collaboration and technology strategies highlighted by Kamalahmadi and Mellat-Parast (2015) and Senna et al. (2021), as the means to mitigating the effect of environmental interruptions.

2.4 Theoretical Review

Essentially, this section reviews the dominant theories that are often employed to explain supply chain resilience. Normatively, the rationale of employing theories are that they serve as lenses through which a phenomenon can be looked. Besides, it also aids in not only explaining an issue but also in pointing the linkages among variables (Foy et al, 2011). Thus, the theories in this study are intended to help in explication of the issues under consideration. The theories reviewed include; resources-based view (RBV) theory, dynamic capabilities theory, strategic choice theory, systems theory, Complex systems theory, complex adaptive systems theory, Contingency theory, Resources dependence, strategic choice, Relational view, Social capital and rational choice theory. The resources based view (RBV), theory and the others such as systems dynamic capabilities theory and the systems theory are the most applied theories.

2.4.1 Resources Based View (RBV) Theory

The resource based theory (RBV) suggests that quantum of resources organizations possess should explicate the difference in organizational performance (Barney, 1991). In other words, the internal organizational resources that are valuable, imitable, rare and non-substitutable are given competitive urge. The theory is built on the assumption that an organization is made up of resources (tangible and intangible). If these resources are combined create competitive advantage that can depict how internal and external threats are approached or reacted to (Wemerfelt 1984; Barney 1991). The Resource Based View (RBV) has been employed in various supply chain researches in order to comprehend resources and capabilities deemed resilience antecedents including redundant resources and flexible capabilities (Park, 2011), logistics capabilities (Ponomarov and Holcomb, 2009), human. Organizational and inter-organizational capital resources (Blackhurst et al, 2011). Risk identification, assessment, mitigation and monitoring demand that firms possess certain resources such as best practices, technology and concept so as to prevent and limit risks in the firm (Ochieng, 2018). Few counter arguments have been presented against the views of Resource-Base View theory on supply chain resilience. For instance, the counter argument here is that, the

RBV theory concentrates on organisations internal resource and fails to go beyond the firm but supply chain resilience is a system wide process occurring the state of supply chain instead of firm's level.

Kraaijenbrink et al, (2010), foresees that, the BRV assumes predictable environment where resources are determinable at all times. However, this view is contrary to the characteristics of the supply chain resilience as being dynamic, and unpredictable phenomenon in response to changing environments in which it is a response. Also, the RBV's emphasis on component level operations whiles ignoring synergies goes against the collectivism and un-linear interaction between organizations along the supply chain essence of resilience. This alongside other considerations therefore goes against objective measurement of RBV in supply chain resilience.

2.4.2 Dynamic Capabilities Theory

Dynamic capabilities Model has also been used in supply chain resilience studies. Teece (2007), in a study argued that capabilities of enhancing supply chain resilience be manipulative to suit transformations in the environment and authors like Lamba and Singh (2018), Blackhurst et al (2011) and Erol et al, (2010) have all incorporated this their study. One major challenge with this model viz-a-viz SCRes is that, the dynamic capability model has a firm level focus and therefore considers market transformations and changes in organizations over a period and cannot therefore adequately espouse the systemic behaviour of SCRes (Wang and Ahmed, 2007).

2.4.3 Strategic Choice Theory

Strategic Choice theory uses consolidative approach which indicates how business entities are adaptable i.e. shows how administrators and workers operate in volatile situations. The theory shows the linkages among risk management, choices and organization performance and organizational interactions. It assumes firms are influenced to some extent by the environment which in turn impact the choices made in order to stay above upheavals. According to Child (1972), Strategic choice theory reiterates the significance of managerial risk management choices. The theory focuses on the interplay of the actions of institutions and their activities (De Rond and Thietart, 2007).

2.4.4 Contingency Theory

Contingency theory has also been employed in SCRe litertature. For example, Parker (2011) used contingency theory in supply chain resilience situations and contends that appropriate actions rely on internal and external factors. The argument supporting the theory is that SCRe capacity to change and implement flexible supply chain resilience measures is premised on insights and responses to recent and sudden risk (Parker, 2011). Wagner and Bode (2008), went further to argue that, the contingency theory considers measures as optimal reactions to the environment. The short-comings of contingency theory in relation to SCRe is that, it looks at the fit between an organizational framework and emergencies.

2.4.5 Systems Theory

Systems theory views supply chain as a relative system that is susceptible to disruption from outside events and the effect of the supply chain disruptions will largely depend on the supplies level of resilience (Senna et al., 2020). SCRes according to the systems theory, has been argued as the inward characteristics made of agility, flexibility, robustness and adaptive ability (Erol et al., 2010; Blackhurst et al., 2011). For Blackhurst et al, (2011), SCRes disruptions cause by custom regulation, strict security, product complexity and lack of supplier capacity could weaken supply chain resilience thus viewing it from the lens of systems theory. According to Takumhabwa et al. (2015), the theory is appropriate for SCRes because it recognizes it as a systemic characteristic; but SCRes can be accomplished via adaptive and co-evolving process because of complex systems with which elements constantly interplay with one another and the outside world in an adaptive fashion and therefore go beyond the traditional systems (Lamba and Singh, 2018; Takumhabwa, 2015).

Generally, the application of theories in supply chain resilience literature has been scanty (Fang et al, 2012) and this situation allows not the generalization of research findings from one place to another cumbersome. In other words, the lack of theory application limits the ability of understanding resilience and its related elements and the associations between the elements as well.

2.4.6 Complex Adaptive Systems (CAS): The Theory chosen for this study

The theory of CAS evolved from complexity theory (Weick, 1976; March, 1991), which in turn is derived from the natural sciences (Beautement and Broenner, 2010). However, it widely employed in several disciplines including supply chain management. The crux of the theory is that it focuses on ambiguity and non-linearity. The theory postulates the interactions between the associated feedback connections invariably change systems. Although, it argues the unpredictability of systems, it reiterates that systems are limited by order-generating rules (Brownlee, 2007; Wycisk et al., 2008). It is assumed that Complex Adoptive System is a complex system that possesses adaptation capability and thus can transform and self-organize itself (Nilsson, 2003). The key principles of Complex Adoptive System include: self-organization, complexity, emergence, interdependence, space of possibilities, co-evolution, chaos and self-similarity (Stuart, 1992; Julian, 2013; Takumhabwa et al., 2015). Like in other fields such as organizational studies and strategic management, Complex Adoptive System is now part of the repertoire of theories used to espouse supply chain resilience.

Holland (1995) cited in Takumhabwa et al. (2015) refers to CAS as: "a kind of system that, over a period of time, emerges into a coherent form through the [p21] [features (responsive, flexible, and reactive)] of adaptation and self-organization. It is composed of interrelated network of many firms that adapt to innovations within and outside the firm.

Complex Adoptive System best explicates how institutions respond to the outside world and how they adapt to situations of uncertainties and disruptions. It dispels the notion of organizations as static within a supply chain. Instead, it reckons institutions as complex systems that are adaptive. As noted earlier, Complex Adoptive System possesses what is referred to as co-evolution which occurs in the adaptation process. This allows for learning, which in turn aids in appropriate modification to the institutions and the systems. The co-evolution is also driven and influenced by non-linearity. Non linearity refers to uneven interaction between cost and effect of Complex Adoptive System (Takumhabwa et al., 2015). The non-linearity in Complex Adoptive System also engenders self-organization which can be defined as the combine effect of the decisions and actions of individuals' agents in a Complex Adoptive System that leads to transformation (Takumhabwa et al., 2015

2.5 How theories underpin the study

The complex adaptive theory fits well and better anchors this study because, healthcare supply chain disruptions could emanate from either internal or external. Like other theories which focus on the internal strengths of organizations to build resilience, Complex Adoptive System looks beyond the internal and captures and harnesses from an institution's external environment to build resilience. Supply chain in the healthcare delivery often rely more on the external environment for majority of its supplies. This is well showcased in the proposed framework as supply chain integration. This makes Complex Adoptive System an appropriate theory to be deployed. Also, in view of the fact that the world is in constant flux, health organizations would also have to be self-organized and adaptive in order to build resilient supply chain systems. Among the key assumptions of Complex Adoptive System is that organizations should be adaptive flexible and self-organization. In view of this, it allows Complex Adoptive System to also explain how healthcare resilience must be addressed. In addition, features of Complex Adoptive System such as co-evolution and non-linearity (where non-linearity refers to the eruptive relationship cause and effect) again leverage Complex Adoptive System as the theory for this study.

2.6 Empirical Review

According to literature there are many studies on supply chain resilience and how it impacts organizational performance (Aigbogun et al., 2018; Haohua, 2007; Sheffi, 2005; Pettit, 2008; Haimes, 2006; Senna et al, 2021; Ochieng, 2018). However, barriers may exist in the application of SCRes knowledge (Noorfa and Andrew, 2009). This is rightly so because, divergent views are held as to the measures that can appropriately support supply chain resilience. Among other streams that were looked at were, increasing flexibility, use of information technology, contingency planning, inventory management, supply chain agility, creating collaboration, supply chain integration etc. (Tukamuhabwa et al., 2015; Senna et al., 2021; Aigbogun et al., 2018; Zepeda et al, 2016; Elleuch et al, 2014; Ochieng, 2018; Kamal-Ahmadi and Mellat-Parast, 2015). This section outlines some studies conducted on supply chains and measures that they deemed capable of making them resilience against disruptions. The studies on supply chain resilience appeared to have mostly depended on literature methodologies i.e. conceptual, theoretical and normative approaches are used in arriving at their findings on supply chain resilience especially in healtcare. Some of the resilience studies and what they presented are discussed below.

Aigbogun et al., (2018) in their study, introduced the function, collaborative regulation as a stream in SC Resilience. In their study, they refer to collaborative regulation for better SCRes as being activities that are coordinated, consistent and strategic including knowledge and information dissemination (Aigbogun et al, 2018). The study concluded that positive collaborative regulation among actors in a supply chain contributes significantly to improving healthcare performance.

Kamalahmadi and Mellat-Parast (2015), examined SC Resilience from the perspective of supplier flexibility and reliability determination. The study suggested that organizations develop emergency strategy focusing on flexibility of the suppliers, production capacity and the appropriate way to mitigate the impact of disruptions. The study revealed that flexibility and reliability of suppliers play crucial role in building emergency strategies for supply disruptions. They observed that highly flexible suppliers get inadequate orders and that is because, organizations mostly fail to cater for risk in the choosing and allocating suppliers thereby increasing their risks of disruptions. The study recommended that, fewer and highly dependable suppliers means lower risk of disruptions. Finally, Kamalahmadi and Mellat-Parast (2015) highlighted supply risk management strategies as the means to mitigating the effect of environmental interruptions.

Researchers (Aigbogun, Ghazali and Razali, 2014) in a study of pharmaceutical supply chain resilience, posited that orthodox risk management tools are only able to identify, categorize and interpret existing and measurable risks in the supply chain. Their study failed to envisage risks that are unquantifiable, unforeseen and unexpected. Thus, the risks tools they employed cannot be effective techniques against supply disruptions (Kunreuther, 2006; Pickett, 2006; Starr et al, 2003). The survey revealed that adapting supply chain vulnerabilities dimensions and supply chain capabilities had a mitigating and enhancing effect on a supply chain performance.

Mandal (2016) in another study explored how dimensions of organizational culture influence SC Resilience in healthcare. Development culture, group culture, and hierarchical culture were examined, and the results revealed that these dimensions of cultures had positive and significant influence on healthcare SC Resilience. It also emerged that technology has profound positive effect on development, group and rational culture on healthcare supply chain performance. The study recommended that healthcare stakeholders focus on developing the various organizational cultures in order to prevent risk and build healthcare SC Resilience.

Ochieng A. (2018), attempted to prove the level of influence of SC Resilience on organizational performance within the pharmaceutical sector. The findings of the study showed that, supply chain collaboration, risk management culture, agile supply chain and supply chain reengineering were the most used strategies for achieving supply chain resilience in healthcare. The study went further to establish that, risk management culture, supply chain reengineering, supply chain collaboration and agile supply chain all affected pharmaceutical supply chain performance positively and significantly. Therefore, they recommended that healthcare managers invest in healthcare supply chain resilience for a sustained organizational performance.

Supply chain resilience literature exposes a glaring gap as far as framework for measuring healthcare SC Resilience is concerned (Senna et al, 2021). To succeed in building a framework for measuring resilient in healthcare, appropriate measures and strategies must be identified. Senna et al. (2021), systemically developed a theoretical framework through extensive literature reviews which highlighted antecedents of healthcare SC resilience and factors seen as the strategic drivers of resilience in the framework. The framework further highlighted that the antecedent strategies may influence the mediator factors of resilience and the consequent factors of the resilience which is represented by healthcare SC performance. In terms of the consequents, the study tailored the constructs and unified the healthcare supply chain risk disperse literature to show why it is crucial to build effective HCSC Resilience. The mediators for SC Resilience in the framework are developed around risk management and application of advanced technology. Lastly, the consequent factors of the resilience were represented by healthcare SC performance in the framework. The glaring gap so far as this framework is concerned is the empirical validation of the variables and the applicability of the model as a measurement tool for supply chain resilience in healthcare.

2.7 Conceptual Framework

A conceptual framework has been defined by Kombo and Tromp (2009) as diagram that shows the relationship between various variables in a study. The conceptual framework in this study shows various variables of Healthcare SC Resilience. Healthcare supply chain risk management (HCSCRM) which is made up of healthcare supply chain risk identification (HCSCRID), healthcare supply chain risk assessment (HCSCRAS), healthcare supply chain risk mitigation (HCSCRIM) and healthcare supply chain integration (HCSCI) are the healthcare supply chain resilience antecedents. Healthcare supply chain 4.0 (HCSC 4.0) is the mediator and healthcare supply chain performance (HCSCP) is the consequents. The conceptual framework is illustrated below.

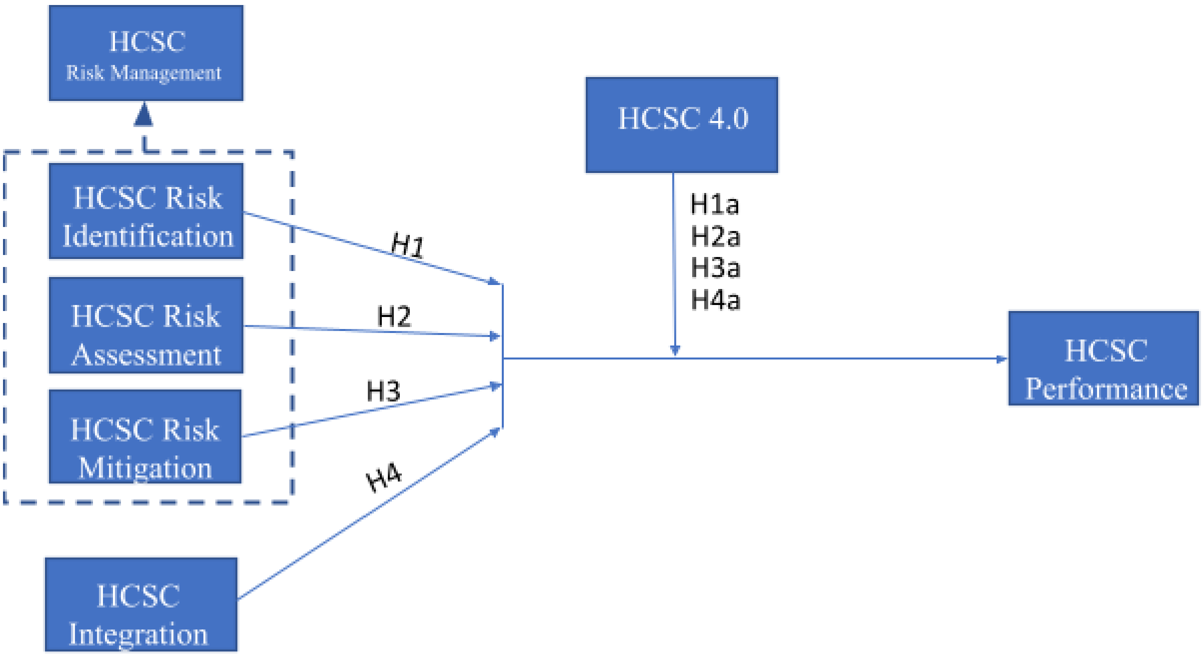


Figure 2.1: Conceptual Framework

Source: Adapted from Senna et al., (2021)

2.8 Conceptual Framework and Hypothesis Development

This section elaborates on the variables in the conceptual framework and how they presume to interact and impacting healthcare performance.

2.8.1 Healthcare Supply Chain Risk Management (HCSCRM)

Risk management is about all activities linked with identification of hazards, assessment, choosing the right responses and monitoring of risks (Pascarella et al, 2021). Risk in the health sector is quite high and multi-dimensional necessitating effective and efficient management. There are seemingly inadequate in-depth studies on HCSCRM and this leads to reviewing the literature around supply chain risk management in order that the outcome can be address challenges in HCSC context (Wang, 2018). The complex environment coupled with fast changing and complicated operational strategies of firms is increasingly contributing to the vulnerabilities and risks in the supply chains thereby resulting in unexpected disruptions in their wake. The resultant effect of the supply risks has compelled firms and researchers in bringing risk management to the forefront (Munir et al, 2020).

SCRM has been viewed and described from different perspectives in the literature (Wang, 2018). SCRM is an intense information laden process geared towards identification and management of SC risks through concerted efforts among the institutions (Fan et al, 2017; Juttner et al, 2003; Kauppi et al, 2016). Juttner et al. (2003) contended that SCRM involves various facets like risk identification, risk assessment and risk mitigation. This means the successful implementation of risk management is premised on collaboration and coordination between the Organizations in question and its SC partners (Juttner at al., 2003). Unlike the traditional industrial supply chains, healthcare supply chains are unique and different and this is because, the healthcare supply chains handles a diversity of supplies in response to larger number of healthcare needs (Abukhousa et al, 2014).

The internal systems and surrounding environment of the healthcare sector causes a lot of risks threat which in some cases causes serious threats to patient's care (Wang, 2018). There has been an upsurge in risk management in SC regarding the health sector and Wang (2018), in a study emphasized the urgent demand for support for healthcare supply chains. Undoubtedly SCRM has become an integral part of the supply chain (Shenoi et al., 2018) and literature points that numerous studies are conducted on healthcare SC risk management (Elleuch et al, 2014; Kim et al, 2016; Zepeda et al, 2016; Breen, 2008; Aguas et al, 2013; Illie and Virgil, 2013; Kanyoma et al, 2014).

There has been no consensus around the concept of SC risk management (Baryannis et al, 2019; Sodhi et al, 2012; Norrman and Jasson, 2004). However, in the analysis of

SCRM, SC can be seen as cross-functional process. SCRM has been described as the appropriate measures for the identification, evaluating, mitigating and monitoring of risks. According to Elleuch et al, (2013) risk management becomes holistic when risks are identified, assessed and mitigated. Supply chain risk management should be viewed as a strategic event which affects financial performance of organizations (Senna et al., 2021). The three (3) major stages of healthcare supply chain risk management and supply chain integration (SCI) as SC resilience strategies and how they are theoretically presumed to impact healthcare supply chain performance are further discussed below.

2.8.2 Healthcare supply chain Risk Identification

Risk identification has gained attention and interest from industry practitioners as well as supply chain scholars (Battles and Lilford, 2003). Risk identification is the first stage and critical part of managing risk (Garcia, 2020). The processes begin with understanding the organization's objective which includes all potential risks and threats. Identifying the extent and nature of risks the organization is exposed to is key and the process should not be viewed as an event but a continual process in the life cycle of the organization because risks changes over time (Garcia, 2020). For effective risk identification process, information availability and experience are crucial elements (Simsekler and Jayaraman, 2018).

It is significant in healthcare to have a contextual undertaking of risk identification (Boult et al, 2010; Simsekler et al, 2018 and Hollnagel, 2004). Risks in the healthcare sector occasioned by internal and external systems could cause grave repercussions that could affect patients (Simsekler and Jayaraman, 2018). Risk Identification approaches can be either reactive or proactive (Simsekler, 2018). According to Simsekler (2018), learning from past experience is the common idea behind the reactive approach whiles the proactive approach aims to analyze potential risks instead of focusing on previous events or relying on past incidents. Healthcare organizations can learn and adapt risk identification process from other industries because, the catastrophic effects of risks remains the same across industries (Simekler and Jayaraman, 2018). There is no perfect method in risk identification however, there are several approaches used by other industries which presents potentials for healthcare organizations to learn from (Simsekler et al, 2018; Hudson et al, 2012).

Considering the complexity of the healthcare organizations and in adopting any approach to risk identification, healthcare managers must be concerned with the actual and practical benefits. Though theoretically literature has posited that, healthcare Supply Chain Risk Identification can impact healthcare performance with or without a mediator, no empirical study has been sighted confirming this assertion. Therefore we examine how healthcare Supply Chain Risk Identification as a dimension influences healthcare supply chain performance. Therefore we hypothesizes that;

- **H1:** Healthcare supply chain risk identification positively and significantly influences Healthcare supply chain performance.
- **H1a:** Healthcare supply chain 4.0 mediates the relationship between healthcare supply chain risk identification and healthcare supply chain performance.

2.8.3 Healthcare supply chain Risk Assessment

Risk assessment is another crucial stage in the risk management processes (Pascarella et al, 2021). Risk assessment involves appraising the probability of occurrence of risk incident and the associated risk. In conducting risk assessment duty bearers' estimates risks based on the identified risk. They also have the opportunity to rank risks and with what possible options for risk management (Liu et al., 2016). Risk assessment process basically aims to achieve comprehensive understanding of the risks identified (Wagner and Bode, 2008). Healthcare SC risk assessment involves considering the causes of risks, the resultant effect of risks and the probability that the consequences could affect patients, the personnel and the organization itself (Ekwall and Lantz, 2017). Literature on risk assessment and the proposed methods for risk assessment is enormous (Kern et al, 2012; Ho et al., 2015; Nakandala et al., 2017).

Existing literature has no conclusive evidence of the impact of healthcare SC risk assessment on healthcare SC performance. Neither literature is sighted espousing the mediating role of healthcare supply chain 4.0 in the relationship between healthcare SC risk assessment and healthcare SC performance. Theoretically, Senna et al, (2021), established that healthcare SC risk assessment directly and significantly impact on healthcare SC performance. Nevertheless, no empirical study has been conducted confirming this assertion. It is therefore necessary to determine cause-effect relations between healthcare supply chain risk assessment, healthcare risk management and supply chain 4.0 and how they directly influence on healthcare supply chain performance. Therefore we hypothesize that;

- **H2:** Healthcare supply chain risk assessment positively and significantly impacts healthcare supply chain performance.

- **H2a:** Healthcare supply chain 4.0 mediates the relationship between healthcare supply chain risk assessment and healthcare supply chain performance.

2.8.4 Healthcare supply chain Risk Mitigation

Risk mitigation involves developing risk response action plans to contain and control the risks presented (Tummala and Schoenherr, 2011). Appropriate risk mitigation measures are determined by evaluating the risk probability and severity. Due to the multifaceted nature of supply chain risks, it is essential that risks are identified and properly assessed and that the mitigation strategy must be geared towards revolving the risk context (Chang et al, 2015). Risk management strategies are effective to the extent with clarity with which risks are identified (Kern et al, 2012). Risk mitigation plans are categorized as either preventive or reactive strategies and are devised prior to the occurrence of risks. While preventive risk is to decrease the likelihood of risk occurrence, reactive risk mitigation strategy is aimed at reducing the adverse impact of risks (Gouda and Saranga, 2018).

Existing literature has no conclusive evidence on the impact of healthcare SC risk mitigation on healthcare SC performance. Also, literature has not been sighted affirming the role of healthcare SC 4.0 in the relationship between healthcare SC risk mitigation and healthcare SC performance. Although theoretically, Senna et al (2021) has posited that healthcare SC risk mitigation strategies has a direct and significant impact on healthcare supply chain performance, there is dearth of empirical quantitative studies to buttress this theoretical claim. To assess the role of healthcare supply chain risk mitigation as a dimension and how it affects healthcare supply chain performance. We hypothesize that;

- **H3:** Healthcare supply chain risk mitigation positively and significantly influences healthcare supply chain performance.
- **H3a:** Healthcare supply chain 4.0 mediates the relationship between healthcare supply chain risk mitigation and healthcare supply chain performance.

2.8.5 Healthcare supply chain Integration

Supply Chain Integration (SCI), according Flynn et al., (2010) is the level of strategic balancing and interlinkages of an organization and its SC partners. The import of SC integration in minimizing supply disruptions and raising operational performance is underscored (Chaudhuri et al, 2018; Zhu et al, 2017). Supply Chain Integration enable

SC partner to coordinate and work in concert to respond swiftly to internal and external disruptions via information sharing (Liu and Lee, 2018). Literature reiterates collaboration to address risk management through SC integration which enhances the cross flow of information among supply chain partners and helps them stay alert for effective rapid response to disruptive events through effective and efficient information sharing and coordinated operations (Li et al, 2015).

The role of SC integration in the organizations is gathering information from the external environment and developing effective information processing along an entire supply chain for effective risk management (Munir et al, 2020). In other words, SC integration supports SC risk management in beefing partner institution's ability to process information with the aid of timely access to accurate information. Supply Chain Integration has been conceptualized differently in different literature but the key themes that run through them are customer integration, internal integration and supplier integration (Kleindorfer and Saad, 2005; Shou et al., 2018; Fan et al., 2017; Kauppi et al., 2016). In fact organizations following an inter-organizational outlook to risk management stands to encounter minimal level of disruption throughout the SC (Revilla & Saenz, 2017), and that the Amalgamation of many organizations to address risks ensure economic and competitive advantage (Munir, 2020).Yet, many other studies indicate that enhancing SC integration is no panacea to minimize risks in the supply chain due to some environmental factors (Lavastre et al, 2014; Wong et al, 201; Wiengarten et al, 2016; Munir et al, 2020).

Even though, theoretically, it has been established that heakthcare SC integration has significant impact on healthcare supply chain performance, there is scant empirical studies in the literature linking healthcare Supply Chain Integration (HSCI) to healthcare supply chain performance. Also there is no conclusive evidence on the mediating role of healthcare SC 4.0 (HSC 4.0) in the relationship between healthcare SC integration and healthcare supply chain performance. This study therefore intends to examine how healthcare SC integration as a dimension impacts healthcare SC performance. Therefore we hypothesize as follows;

- **H4:** Supply chain Integration positively and significantly influences healthcare supply chain performance.
- **H4a:** Healthcare supply chain 4.0 mediates the relationship between healthcare supply chain integration and healthcare supply chain performance.

2.8.6 Healthcare Supply Chain 4.0

Information Technology (IT) has witnessed swift transformation and revolution over the last three decades impacting every aspect of daily lives including that of supply chains (Tjahjono et al, 2017). Among the grand institutional changes according to Tjahjono et al, (2017) is the transition from computers to smart devices. From supply chain point of view, healthcare SC 4.0 is the planned administration and digitization of both the internal and external SC network comprising materials, patients, clinical supplies for the purpose of building value for stakeholders (Beaulieu and Bentahar, 2021). Healthcare supply chain 4.0 is bringing together and the application of the tenets of industry by incorporating technologies such as internets of things (IoF) and Artificial intelligence (AI). Where the IoT is for data collection, the AI is for analysis and patient care processes (Tjahjono et al, 2017; Ehie and Ferreira, 2019; Dau et al, 2019). Healthcare supply chain 4.0 focuses on global networking of machines working automatically in sharing information and auto checking each other by use of cloud computing, big data analytic. IoT, AI, CPS, Internet of Service (IoS), and blockchain (Beaulieu & Bentahar, 2021; Ehie and Ferreira, 2019).

The application of technology in healthcare supply chains has enabled possibilities of networking suppliers, manufacturers and equipment using information from different sources. The collaboration among suppliers, manufacturers, clients and direct communication between machines is vital to upheld transparency in every step of the SC (Federal Ministry of Education and Research, Germany, 2013). Healthcare supply chains have generally been relegated relative to other industries in terms of performance (Beaulieu and Bentahar, 2021). This and other factors have pushed healthcare managers to bridge the gap by adopting and implementing digitalization initiatives to improve the performance in the healthcare supply chains. Notably, the concept of supply chain 4.0 does not entirely exclude the old technologies (including EDI, RFID) previous used (Beaulieu and Bentahar, 2021). The benefits of adopting healthcare supply chain 4.0 technology is allowing information to be appropriately used for informed decision making (Chawla and Davis, 2013). The emergence and intentions of healthcare 4.0 today is by integrating industry 4.0 principles and technology for a more predictive and personalized healthcare delivery. Literature in areas of healthcare supply chain 4.0 are enormous (Quint et al., 2017; Sligo et al., 2017; Tjahjono et al., 2017; Beaulieu and Bentahar, 2021). However, there is no conclusive evidence outlining the effects of healthcare SC 4.0 on healthcare SC performance. Though theoretically, it has been argued by Senna et al, (2021) that healthcare Supply Chain 4.0 directly and significantly impacts healthcare supply chain performance, no empirical evidence exits buttressing the claim and this is what this study seeks to examine. We therefore hypothesized that:

- **H5:** Healthcare supply chain 4.0 positively and significantly impacts healthcare supply chain performance

2.8.7 Healthcare supply chain performance

Performance enables the organization to gauge how well it has accomplished targeted goals for specific time frame, based on efficiency and effectiveness through the use of specific measure yardsticks spell out by a firm (Henri, 2011). According to Kirkendall, (2010), Performance is a tool for ranking organizational objectives and achieve them as well. Due to uncertainties and complexities in healthcare systems, service providers' demand improved performance (Karadeniz et al, 2020). According to Neely et al. (2000), supply chain performance measures the effectiveness and efficiency of actions to which customers requirement are met and how economically a firm's resources are utilized when providing a pre-specified level of customer satisfaction. Healthcare systems encounter challenges such as operational efficiency and reduced running costs, HCSCP has attracted the attention of healthcare stakeholders. It enhances organizations by strengthening their practices which ensures their efficiency and effectiveness that leads to the achievement of firms' objectives and goals. For an organization to realize success in their performance, they need for the organization to identify its strength and the strategies that will act as the drivers (Mburu et al. 2015).

This study is focusing on healthcare supply chain performance which entails how well a healthcare facility is able to deliver patient satisfaction through quality services and continuous availability of medicine supplies (Scholten, Sharkey and Fynes, 2004). According to Senna et al. (2021), healthcare supply chain performance here is about delivering healthcare and saving lives at minimum cost.

2.9 Research/Literature Gap

The causes and cost of high profile supply disruptions faced by organizations due to external and internal factors has made a case for of building SCRe (Carvalho et al,

2012). Academics and industry players noticing the challenges with risks of uncertain future became interested in resilience, that is, the capacity to anticipate, adapt, respond and recover in terms of challenges (Vanvactor, 2016; Blackhurst et al., 2008*)*. However, the traditional risk management techniques of resilience is not well-positioned to survive unpredictable occurrence, extreme complexities and adaptive (Pettit, 2008; Senna et al., 2021; Zepeda et al., 2016). In the light of these, further conceptualization of the concept was recommended by Ponomarov and Holcomb (2009). A number of researches (Cheng & Zhu, 2010; Anderson, 2007; Mahmood and Shahab, 2011) further recommended holistic strategy in supply chain resilience since isolated measures are no longer adequate.
A considerable number of studies on supply chain resilience were conducted to proffer measures against risks and future disruptions for organizations. However, there has been a challenge with a standardized definition, accepted variables or measurements tools for the supply chain resilience concept (Pettit, 2008, Senna et al., 2021; Lu, Koufteros, and Lucianetti 2017; Ibey et al., 2015; Chaudhuri, Boer and Taran 2018; Cagliano, Grimaldi, Rafele 2016). For instance, various studies have considered varied streams and measurement criteria for improving supply chain resilience and some examples are increasing flexibility (Kamalahmadi and Mellat-Parast, 2015), use of information technology (Senna et al, 2021), contingency planning (Elleuch et al, 2014), inventory management (Ochieng, 2018), supply chain agility (Ochieng, 2018), creating collaboration (Senna et al, 2021), risk management culture (Aigbogun et al, 2018), supply chain integration (Senna et al, 2021). One key observation with these studies are that, they mainly concentrated on elements for increased supply chain resilience regardless of the organization or nature of operations (Nabelsi, 2011).

The literature is replete with several theoretical methodologies for measuring supply chain resilience (Gopalakrishnan, 2009; Mavi, Goh and Mav, 2016; Ivanoc and Dolgul, 2020). Yet, although these frameworks have been extended to embrace the healthcare sector, conspicuously missing is the empirical applicability of these frameworks. It is therefore crucially important to address this critical gap in the literature. And also, there are still no enough quantitative studies about healthcare supply chain resilience Senna and Reis (2020) argued. Furthermore, hitherto conceptual frameworks for supply chain resilience are based on literature content analysis (Pettit, 2008; Senna et al, 2021). Informed by past studies and recent supply risks events due to Covid-19 pandemic, Senna et al., (2021), undertook a study and designed a framework for evaluating HCSCRe. The designed framework comprised antecedents, the mediators and the consequents, unified the disperse literature on risk and integrated information technology, collaboration and risk management (Senna et al, 2021). Nonetheless, the different facets of healthcare supply chain resilience models and frameworks and its implication for healthcare supply chain performance in healthcare organizations have not been tested empirically for clarification. This research fills this gap by empirically evaluating the supply chain resilience in public healthcare facilities using Senna et al. (2021), theoretical framework as the measuring tool. Again, this research would seek to also establish the relationship among the variables and constructs through a Structural Equation Model (SEM). According to Cagliano, Grimaldi, and Rafele (2016), risk management approaches are either too general or require pieces of information not regularly recorded by organizations. Based on literature, the entire healthcare supply chain resilience framework is divide into three dimensions: the antecedents, the mediators and the consequents. The antecedents are healthcare supply chain risk identification, risk assessment, risk mitigation and supply chain integration. Healthcare supply chain risk management and healthcare supply chain 4.0 are the mediators and finally, healthcare supply chain performance is the consequents. The comprehensive theoretical models proposed by various studies including that of Senna et al. (2021) has not been sighted to have been tested empirically which is a gap. This study therefore seeks to empirically validate the reliability and validity of Senna et al. (2021) framework to serve as a basis for generalization as the healthcare supply chain resilience framework.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter present the methodology indispensable to carry out the study. The chapter relies on extant studies, employing appropriate methods, techniques and processes. It offers a comprehensive research design, strategy and philosophy. It also embodies discussions of the chosen methods and processes.

3.2 The Research Design for This Study

Basically, research designs serve as blueprints for research. However, several analysts have offered several explications of a study design. Cohen, Manion and Morrison (2018) referred to designs as plans or strategies determined for organizing and coordinating research in order that research questions posed are addressed based on evidence and warrants This is undertaken in order that the research questions and hypotheses posed may be addressed through evidence and plans. In a more elaborate fashion, Singh, (2006:77) mentioned that a design of research does not consist of ordered sequential step-by-step procedures but rather, the planning stage of the research is where logical visualization is practicalized. It is importance to state that there is no single way for conducting research, instead researches are normally tailor-made aim to serve a purpose. The objectives of a study determine the design required. Further, the research philosophy must be anchored on a research philosophy.

For Creswell and Creswell (2018) research designs are kinds of research studies stemming from either qualitative, quantitative or mixed methods perspectives that give directions for investigating problems. A qualitative approach to research refers to inquiry that explores and comprehends meanings groups attribute to culture, social or human problem or phenomenon. This normally involves the use inductive style of researching. With regard to quantitative inquiry, the focus is on testing theories objectively through the examination of associations among variables using statistical processes and procedures. Typically, studies under quantitative involves deductive style of researching. Lastly, the mixed method approaches involve investigations combining both quantitative and qualitative perspectives, blending the two (quantitative and qualitative) methods to carried research. The basic rationale of this approach is that the merging qualitative and quantitative methods offers detailed and utter comprehension of the issue being studied than either approach alone (Teddlie and Yu, 2007; Creswell, 2014). Thus, this study, clearly, is under the quantitative approach of inquiry as it studies relationship among variable under this study.

Quantitative research designs involve three (3) main designs: experiments, quasi-experiments and non-experiment (Leavy, 2017; Crewell and Creswell, 2018). Experiments (also called true experiments) designs aims to establish whether specific treatments influence certain outcomes. Under this design, the researcher divides the sampled population into treatment group and non-treatment group; and then determines how both groups scored on an outcome (Creswell, 2014). This relies on random assignment which ensures internal validity of a research. However, Marczyk, Dematteo and Festinger (2005:137) opine that true experiments are "often not feasible in real-world environments." In this regard, quasi-experimental designs are typically used. Generally, the quasi-experimental design is similar to true experimental design but it employs non-randomized assignments (Creswell and Creswell, 2018).

The last key quantitative design is the non-experimental design. These include designs in which the researcher has no control over the variables and environment that the study. Although there are several non-experiment designs, one of the major designs under this is the survey design. The survey design is most widely used quantitative design in social research (Cohen et al., 2018). According to Leavy (2017) survey involves asking people standardized questions that can be analyzed statistically. On one hand, surveys are employed in obtaining individuals' attitudes, beliefs, opinions, their experiences or behaviour (Creswell, 2014). On the other hand, surveys are undertaken to find relations between variables under consideration. When surveys determine the relationships, they are described as "*correctional studies*" Marczyk et al. (2005:151) reiterate. In addition, surveys can either be cross-sectional or longitudinal. Cross-section survey design seeks collect information from a sample at one point in time, whereas longitudinal survey designs collections seek information at multiple times in over to track transformation that may occur over time.

This study, therefore, is specifically anchored on survey design but cross-sectional. This can also be referred to as cross-sectional correctional study. Cross-sectional survey design is employed when a study proffers opportunity for investigating relationships among variables with the aid of quantifiable data. Moreover, they (survey designs) are deductive research designs that use mostly large quantitative data and with the aid of descriptive and inferential statistic (Labaree, 2013). The chosen design is one of designs employed in supply chain studies.

The researcher relied on survey design because the research intended to use large data from different health facilities. Secondly, because of the fact that the research study has several variables which the research must capture and measure at the same time period and also make analysis about the impact of explanatory variables on the outcome variables, called for adoption of the survey design (Crewell, 2014). Finally, the fact that responses of participants were to be analyzed from the standardized questionnaire, using descriptive and inferential statistics dictates the appropriate choice was the cross-sectional survey design (Leavy, 2017).

3.2.1 Research Purpose

The literature points that there are essentially three purposes for conducting a research study and these include: exploratory, descriptive and explanatory (Leavy, 2017Creswell and Creswell, 2018; Cohen et. al., 2018). Exploratory aids in learning about a new topic or phenomenon. When an issue is under-researched, an exploratory purpose is in indispensable as it helps in filling the gap in our knowledge about the new topic. Whiles descriptive research aims to generate thick descriptions involving detailed, meaningful and context-specific findings chiefly from the perspective or lived experiences of the people being studied, explanatory research aims to explicate causes and effects, correlations or why events or issues are the way they appear (Leavy, 2017: 5-6). In this light, this study can be placed under the rubric of explanatory research because it examines the conceptual framework under consideration and also investigates relationship between the various constructs.

3.2.2 Research Philosophy for this Study

Research philosophy also called research paradigm and is defined as the worldview or framework through which knowledge is pursued (Lincoln, Lynham and Guba, 2011); "it is a foundation perspective carrying a set of assumptions that guide the research process" (Creswell & Creswell, 2018:11) or as Mertens (2010) contended it is primary set of principles or beliefs that undergird a research study. Thus, research philosophies become the lenses through which research is conceived and executed (Babbie, 2015). In this regard, it is imperative to state the philosophy upon which this research is anchored. Generally, there are several paradigms depending on the focus and aims of research. In this research the positivism philosophy was adopted.

Positivism/Postposivism

The positivism/postpositivism research philosophy evolved from natural science with basic assumptions assumption that reality is objective, patterned and knowable (Lincoln, Lynham and Guba, 2011; Leavy, 2017). This paradigm espouses that research is basically about making and testing claims, including identifying and testing casual relationships (Leavy, 2017; Creswell, 2014). Within this rubric, the major objective is to support or disprove assertion through the application of the scientific method (Babbie, 2015). Thus, the positivism philosophy believes in objectivity, researcher neutrality and replication (Lincoln, Lynham & Guba, 2011; Leavy, 2017). The philosophy clings to a deterministic worldview where causes determine effects or outcomes. To this end, positivists also seek to identify and evaluate the factors that impact outcomes. Also, positivism hold on to reductionistic, that is, research working with this paradigm always reduce ideas into a small, discrete set to test, such as the variables that comprise hypotheses and research questions. Moreover, positivism advocates believe the world is anchored on laws and theories, and these laws or theories must be tested or verified if indeed the world is to be comprehended. Thus, positivists research proceeds are follows: looking for a theory to start; collect data that support or rejects the theory; revise when required, or conduct further test (Creswell & Creswell, 2018).

3.3 Population of the Study

Population has been defined in several ways. Basically, a population refers to the entire mass of observation, which is the main group from which a sample is formed. It means the characteristics of a specific group or phenomenon (Cohen et al., 2018). In the views of Leavy, (2017) population is a group of elements research intends to elicit information. Upon the determination of the people or elements the research is interested in, then a study population (sometimes called the sampling frame) is determined. In terms of the sample frame, this study draws it study population from government healthcare facilities starting from the levels of health centers, primary, secondary and tertiary healthcare facilities. The total number of public healthcare facilities under these levels of care is estimated at 973 (NHIA accreditation list, 2021). The study population is the group of elements from which an actual sample is drawn. Given the exploratory nature of the study, the population for this study included all stakeholders associated directly or indirectly to supply chain activities and decisions in public healthcare facilities in the selected regions in Ghana. Currently, the target study population is estimated to be around 1,735 (GHS annual reports, 2018). The target population or respondents included health administrators, medical superintendents, procurement directors/officers, the pharmacist/pharmacy technicians, medical stores managers and supply chain managers/officers.

3.4 Sampling Techniques and Sample Size

Sampling involves the selection of population unit that can be credibly generalized to the target population (Trochim and Donnelly, 2008). With regard to sampling techniques, the literature indicates there are basically two strategies: probability sampling and non-probability sampling (Babbie, 2015; Zikmund, Babin, Carr and Griffin, 2010). Probability sampling (also known as random sampling) is sampling procedures in which all members of the wider population have chance of being selected. Non-probability sampling also referred to as purposive or convenience sampling the chance of members of the wider population being chosen is unknown (Cohen et al., 2018). The differences between the two techniques include a chance for any to be selected whilst in the non-probability sampling, known members of a population determined; are selected for data collection. (Creswell and Creswell, 2018; Leavy, 2017).

This study adopts the non-probability technique as its sampling technique to obtain its sample. Specifically, the study employs purposive sampling because of specific purpose (Teddlie and Yu, 2007) as it recruits staff whose decisions directly or indirectly influences supply decisions in the public healthcare facilities. Purposive sampling, lead to the capturing of the targeted category of staff listed earlier.

With respect to sample size, it is basically the number of participants to sample and interact with in a given study. Sample size is no fix number, instead, the number of participants to elicit information from depend on factors including the type of research and the purpose of the research (Yin, 2014). For the purposes of this study, the sample size was determined based on Hair et al. (2010), proposal for minimum sample size determination for SEM. According to Hair et al. (2010), the number of indicators plus the latent variables multiplied by estimated parameters will give a minimum sample size. i.e. (Number of indicators + number of latent variables) x (estimated parameters). Adopting Hair et al (2010), formula, the sample size arrived for this research was 342. Therefore, three hundred and forty two (342) questionnaires were administered to respondents (health administrators, medical superintendents, procurement directors/officers, the pharmacist/pharmacy technicians, medical stores managers and supply chain managers/officers) in selected public healthcare facilities across the selected three (3) regions. However, two hundred and fifty (250) questionnaires were returned complete and usable, representing response rate of 73.1%. Twenty-Seven (27) respondent questionnaires were not fit for use due to incompleteness with the remaining twenty-three (23) unattended to for unknown reasons.

3.5 Data Collection

This section outlines the data collection sources, the instruments and procedures employed to gather the data.

3.5.1 Sources of Data

Following the research objective this study employs primary and secondary data to carry out work.

3.5.1.1 Primary Data

This study is based primarily on primary data; which is referred to as an afresh information or data collected directly from participants for the first time (Leavy, 2017). Without doubt, there are several instruments for collecting primary quantitative data. However, in this study the survey method (questionnaire) is used as the main instrument to gather the data. The instrument is succinctly explicated below.

3.5.1.2 Data Collection Instrument (Questionnaire*)*

For this survey, the questionnaire instrument was the main means to gathering the primary data. In the development of a new items instrument for this study, useful information and frameworks were drawn relevant studies. As noted by Hatch (2002), "existing studies can provide the foundation needed to design an instrument (Questionnaire) as it allows the researcher to recognize the gaps in the literature". For the study constructs, the instrument were elaborately developed by the researcher with recourse to existing literature and processes. Experts in the study area were also at hand to guide and direct the reseacher to ensure that the adaptions made within the areas to be applied. The principal in this was my project supervisor. The questionnaire was structured using a six-point Likert scale which is a common psychometric scale employed in empirical study that requires the study participant to respond to series of statements about a topic in terms of the extent to which they agree or disagree with them according to Bhattacherjee (2012). The questionnaires were designed such that it allowed for ease of understanding that could lead to valid results. The six-pointed Likert scale gave respondents the opportunity to select answer choices spanning from strongly disagree (1) to don't know (6). The questionnaire was self-administered; however, the researcher had the opportunity to interact face-to-face in order that objectives of the study were explained to the participants. Appendix (I) is the questionnaire employed to collect the primary data. The justifications for the use of the questionnaire method included first, the fact it is allows for uniform and large information to be collected with a short space of time (Bairagi and Munot, 2019; Saunders et al., 2016). Second, the purpose of the study necessitated the used of survey method. Again, the questionnaire ensures fast and ease quantification of huge volumes of information that can be carried out with the aid of an appropriate software (Creswell and Creswell, 2018; Cohen et al., 2018). Last but not the least, the use of the questionnaire is economical, dependable for collecting relevant information for research.

The questionnaire was closed ended, which gave participants series of closed-ended questions with options to tick their preferred choices. The questionnaire is made up of thirty (30) thematic items categorized into two major sections (A and B). Section A covered the demographical characteristics. Section B embodied the various supply chain resilience constructs under review. The section B is further Balkanized into sub-sections. Sub-section I focused healthcare supply chain risk identification; sub-section II looked at healthcare supply chain risk assessment and sub-section III dealt with healthcare supply chain risk mitigation. While sub-section IV and V is about healthcare supply chain integration and healthcare supply chain risk management, sub-section VI and VII relates to healthcare supply chain 4.0 and healthcare supply chain performance.

3.5.1.3 Secondary data

The study also heavily relied on secondary data too. Secondary data are information that are collected by others (Saunders et al., 2016). Undoubtedly, it is data collected by others for some purposes in the past. Secondary data can exist in several forms: written, typed or in electronic forms (Bairagi and Munot, 2016). For the secondary data, journal articles including international Journal of Operations & Production Management, Journal of Business Logistics, Journal of Operations Management et cetera; and books germane to the study were consulted and used.

3.6 Variables: Dependent, Independent and Mediating

This section presents the various variables used in this study. The study embodies three main variables including dependent, independent and mediating.

3.6.1 Dependent Variable

Dependent variable, according Creswell and Creswell (2018) is the variable the researcher is studying. It is the variable that is affected or influence by another variable (Leavy, 2017). Thus, it is the variable researchers observe to determine the effect of an intervention. In this study, healthcare supply chain performance (HCSCP) is the dependent variable.

3.6.2 Independent Variables

For Leavy (2017), independent variables are the ones that likely affect or influence another variable. They are variables or elements that a researcher can manipulate to observe a reaction of the dependent variable (Gravetter and Wallnau, 2013). The independent variables in this study include: healthcare risk identification, healthcare risk assessment, healthcare risk mitigation and healthcare supply chain integration.

3.6.3 Mediating Variables

Mediating variable is also referred to as intervening variables. It is the variable that can mediate the effect of the independent variable on the dependent variable (Leavy, 2017). For this study, healthcare supply chain 4.0 (HCSC 4.0) is the mediating variable.

3.7 Pilot Study or Pre-Testing

Pre-testing boosts the internal validity of the questionnaire employed as it measures the constructions of the items to determine whether they are in tandem with hypothesized constructs and at the same time allowing for the measurement of content validity (Clark and Watson, 1995). Following the completion of the survey instrument, a pilot study was undertaken to determine the reliability and validity of the synthesized research instrument ahead of the main study. The pre-test exercise was especially significant given the instrument was newly created (albeit fashioned out from extant literature and guided by previous scales administered in other studies) making a compelling case for reliability and validity analysis, as a basic climacteric component of the much-desired research quality. O'Leary (2010) further reiterates that pilot study aids in measuring the validity of questions and probable reliability of data gathered. Besides, the pilot study according to Saunders et al (2018) helps to weed out badly worded or ambiguous questions. The appropriate sample size for a pilot study may range between 25 and 35 respondents (Johanson & Brooks, 2009). For this pilot study, non-sampled 35 supply chain officers in different healthcare facilities were selected chiefly because it fulfilled the minimum criteria for pilot studies. Again, it conforms to assertions that the participants of a pilot study necessarily need not to be statistically selected (Cooper and Schindler, 2011; Babbie, 2018). Thirty (30) thematic item questionnaires were administered to the non-sampled respondents. These questionnaires were retrieved and painstakingly examined by the researcher. The analysis revealed that respondents lucidly comprehended all the questions and encountered no problems answering them.

3.8 Reliability Test and Validity

In general terms reliability relates to the consistency and dependability of a measurement technique. In specific terms, it refers to the consistency and stability of the values gotten from a measure or assessment technique over time and across environments (Cohen et al., 2018). Reliability provides important information about the random factors that could affect results. For instance, if the measurement is reliable, then there is less chance that the obtained score is due to random factors and measurement error. Reliability is normally expressed as a correlation co-efficient, which is a statistical analysis that tells us something about the relationship between two sets of scores or variables. Adequate reliability is present when the correlation co-efficient is 0.80 or higher. Usually, test-retest reliability and internal consistency are the two (2) frequently used indicators of a scales' reliability (Babbie, 2015). Following the reluctancy of participants to double do participation the test-retest was relegated and proceeded with internal consistency. Although, there are several ways to measure internal consistency, the researcher employed the Cronbach's alpha co-efficient method of gauging reliability (Leavy, 2017; DeVellis, 2012). It is indicated that when Cronbach's alpha score is above 0.70 then the questionnaires are reliable. On the other hand, when the Cronbach's alpha is below 0.70, then the questionnaires are unreliable and must be redesigned (Numally, 1978).

Undoubtedly, validity is an important element in research particularly quantitative designs like this study. Basically, validity can be explained as the conceptual and scientific soundness of a research study (Saunders, 2016). The significance of validity is to remove and lessen the impact of extraneous influences, variables and explanations that could sway the study's ultimate findings. According to Marczyk et al. (2005: 158), it is also intended to increase the accuracy and usefulness of findings by eliminating or controlling as many confounding variables as possible which allows for greater confidence in the findings of a given study.

3.9 Data Analysis Process

In most research studies, data analysis involves steps including: preparing the data for analysis; analyzing the data and interpreting the data. Like many other studies, this study followed these steps outlined. Upon the collection of the data, the analysis proceeded as follows. First, the collected data was tracked until it was ready to be analyzed (Creswell and Creswell, 2018). That is, the information was log and tracked with a well-established procedure. This was done to prevent the data of becoming disorganized, uninterpretable, and ultimately unusable. A recruitment log (which involves a comprehensive record of all individuals approached about participation in the study) was set up. The advantages of this is that, it allows the researcher to have adequate records of the research participants. Secondly, prior to data entry, I carefully screened all the data for accuracy. This was necessary because it offered the opportunity to re-contact study participants to address any omissions, errors, or inaccuracies (Creswell and Creswell, 2018), with the overall aim to ensure that data are clean accurate and complete.

Third, after the data was screened for completeness and accuracy, the researcher proceeded to code and enters the data into the statistical package (Leavy, 2017). Furthermore, the data was transformed. This involved identifying and coding missing values, computing totals and new variables and recording and categorizing (Marczyk et al., 2005). After this, the actual data analysis commenced. Descriptive statistic was undertaken. That is descriptive statistics were used to describe the data collected by accurately characterizing the variables under consideration. Frequencies and averages were done. In addition, with the help of Smart PLS Software, a Structural Equation Model (SEM) was used to assess and investigate the association and relationships (hypothesized paths) among the variables. According to Hair et al., (2014), Structural Equation Model (SEM) as a statistical procedure, models multiple relationships among independent and dependent variables simultaneously with a great speed. This statistical procedure is preferred especially where the research design includes complex models (Hair et al., 2014). Even though, the Structural Equation Model has two distinctive approaches i. e. Covariance-based technique and the Variance-based technique, in terms of the application, this study used the "variance-based SEM" (AMOS 18). This decision for selection was informed by the research purpose, research framework and the data characteristics. The variance-based SEM" technique "focuses on maximizing the variance of the dependent variables explained by the independent variables instead of reproducing the empirical covariance matric" (Hair et al., 2014).

3.10 Ethical Issues

Basically, ethics is about what is good and bad, right and wrong that helps to guide/shape behavior when doing something or carrying out an activity. In this respect, observing ethics in research is concern with what researchers ought and ought not to do in the process of conducting research (Cohen, 2018; Saunders et al., 2016). In the conduct of this study, the researcher has endeavor to abide by the tenets for conducting ethical research. First, the purpose of the research was in an unambiguously fashion communicated to the research participant in order to apprise that for them to make informed decisions as to whether to partake in the study or not. Second, the researcher sought the informed consent of participants from whom information were gathered. This was done by the researcher clearly outlining that the study is an academic study intended to fulfil academic requirements. Typically, obtaining consent is often done by allowing potential participants to sign consent form. However, in this study verbal consent sufficed. The researcher opted for verbal consent because demanding participants' sign a form of consent appeared too formal which some participants were uncomfortable with.

Third, the respondents were guaranteed of confidentiality and anonymity. This was done by not allowing the participants to disclose their identities in order that no response can be trace or attributed to participants. In addition, all necessary access protocols were obtained. In view of the fact that the research participants worked in public hospitals, management of participants hospitals were contacted for clearance. Lastly, participants were informed the data collected would not be shared with them because it was purely an academic work.

3.11 Characteristics of the Study Area

The study was focused on the Ashanti, Greater Accra and the Bono regions in Ghana.

The Ashanti region is centrally located in the middle belt of Ghana and it lies between longitude 0.15W and 2.25West, and latitude 5.50N and 7.46N. The region shares boundaries with four of the sixteen (16) political regions thus Bono Region in the north, Eastern Region in the east, Central Region in the south and Western Region in the south-West. The Ashanti region occupies a total land area of 24,389 square kilometres representing 10.2 percent of the total land area of Ghana. The region has a population density of 5,440,463 (GSS, 2021). In terms of healthcare facilities, the region has about a total of 530 healthcare facilities out of which 170 are operated by Ghana Health Service (Sasu, 2021).

The Greater Accra region has the smallest area of Ghana's sixteen (16) administrative regions occupying a total land surface of about 3,245 square kilometres or 1.4 percent of the total land area of Ghana. In terms of population, it is the second most populated region in Ghana with a total population of 5,455, 692 (GSS, 2021). The Greater Accra Region is bordered on the north by the Eastern Region, on the east by the Volta Region, and on the South by the Gulf of Guinea, and on the west by the Central Region. In terms of healthcare facilities, the region has about 438 healthcare facilities most of which are operated by the Ghana Health Service (GHS).

The Bono region is one of the 16 administrative region recently created. The region shares a border at the north with Savannah Region, bordered on the west by Cote d'iviore, and on the east by Bono East and on the south by Ahafo Region. The region has a population of 1, 208,649 according to Ghana Statistical Service in 2021 census.

The Bono region has about 200 healthcare facilities out of which 120 are operated by the Ghana Health Service (GHS).

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the data analysis, data interpretation and discussions in accordance with the objective of the research. Just as the questionnaire, this chapter is presented in two parts: respondents' demographics and the research constructs. This chapter begins with an analysis of both the profile and the research constructs to ascertain responses to the research questions. To determine the authenticity of the research instruments used, reliability analysis was performed. The responses were further evaluated and present to determine the correlation and regression between the constructs. After the results, followed by interpretation and discussion of the findings.

4.2 Response Rate

Out of the three hundred forty two (342) questionnaires distributed between August and November 2021, two hundred and fifty (250) were realized and qualified to be usable after scrutinizing the individual questionnaire for acceptability for data analysis. Having said that, the study achieved 73.1% as response rate. The achievement of greater response rate was as a result of the commitment the researcher got from the staff. In furtherance to this, some top management in the facilities were very instrumental in identifying the right respondents for the study. The response rate of 73.1% was deemed fit for data analysis because the data sample is appropriate for the present study.

4.3 Pretest and Pilot Study Results

Pre-testing and pilot-testing are techniques that aid in the successful conduct of research. The study's development and the research's quality output can be reached by improving the method and the final result's reliability. The pre-testing of research instruments is critical in assessing the effectiveness of a survey study. It improves the questionnaire's wording and retention of dimensions while deleting those that aren't needed. The use of a pre-test to improve the research instruments before distributing them to the respondents is highly recommended. Pre-testing allowed the researcher to get comments from experts in the field as well as identify potential flaws in the instrument design so that they could be addressed (Saunders et al., 2016).

Viechtbauer et al., (2015), highlighted the importance of research instruments pre-testing or pilot study and asserted that it helps the researchers in evaluating the responses against the research objective. It also helps in detecting ambiguities in the research questions. In choosing a pilot sample size, Mugenda (2013), suggested that 1% to 10% of the sample size should be chosen. Lackey and Wingate (1998) also proposed 10% of the population for the study. Hertzog, (2008), recommended absolute value of 35-40 sample size to be used for pilot study. Therefore, the study conducted a pilot study using Hertzog (2008), recommendation of the sample size i.e., conducted a pilot study on 35 respondents from selected public hospitals within Ashanti and Bono regions. Through the pilot study, the researcher obtained data and generated the Cronbach's which was within the acceptable ranking level of 0.70 (Hair et al., 2018). The lowest acceptance level of the Cronbach's alpha should be 0.70 this is according to Hair et al., (1998). The few items that recorded values below the 0.70 mark were all removed from the questionnaire. Before the actual data collection exercise, the research questionnaire was adjusted accordingly based on the pilot test results. The results of the 35 sampled responses showed the construct reliability to be above 0.9 as presented in the table 4.1 below.

Table 4.1: Reliability Test of the Pilot Study

Variable	No. of Items	Cronbach's Alpha
RID	9	0.959
RAS	15	0.931
RIM	14	0.945
SCI	14	0.941
HCSC 4.0	14	0.915
HCSCP	10	0.939

4.4 Survey Bias

Survey bias can be described as the divergence of outcomes or deduction from the truth. In other words the steps that lead to a divergence. Survey bias can be influenced severally, the accuracy and coherence of research interviews and as well the responses provided by respondents. Several forms of biases exist in survey.

4.4.1 Non-Response Bias

To assess non-response bias in the survey sample, the approach described by Oppenheim (2001, p.106) was applied in (Table 4.2). It is expected that the early 125 responses should not statistically differ from last 125 responses. The initial 125 responses and the last 125 responses were categorized as the first and the last responses respectively. Afterwards, an analysis using T-test was carried out to ascertain if non-response bias was present. The T-test analysis disclosed that all the other variables did not show statistically significant differences which demonstrate the absence of non-response bias as indicated by earlier studies (Oppenheim, 1992; Bias and Berg, 2010). The results showed that RID, RAS, RIM, SCI, HCSC 4.0 and HCSCP were non-bias (see Table 4.2).

Table 4.2: None-Response Bias (Independent Sample T-Test)

		Levene's Test for Equality of Variances		
Variables	Group	F	Sig.	t
RID	1.00	0.765	0.382	1.096
	2.00			
RAS	1.00	0.176	0.675	-0.755
	2.00			
RIM	1.00	0.765	0.382	1.096
	2.00			
SCI	1.00	0.230	0.632	1.096
	2.00			
HCSC 4.0	1.00	0.029	0.865	0.139
	2.00			
HCSCP	1.00	1.233	0.627	1.490
	2.00			

4.4.2 Common Method Bias/Variance

Common Method Variance (CMV) is erroneous difference caused by measurement approaches instead of the constructs that the measurements are meant to represent (Podsakoff, et al, 2003). The concern with the issues of CMV in the instance where data for both dependent and independent variables are being collected from peoples with different characteristics using questionnaires (Hair, et al., 2017; Podsakoff et al., 2003). However, because this study involved participants with similar features, it's critical to examine the CMV. When the principal construct inter-correlations have a very big value (>0.90), the Common Method Variance appears in the dataset (Bagozzi, 1990; Bagozzi and Yi, 1993; Fornell and Larcker, 1981).

The current study used factor analysis with SPSS to investigate the inner-correlations with the main constructs, and the results show that there are no substantial difficulties with Common Method Variance in the data, since the inner correlations were less than 0.9. Herman's single factor test was employed to validate the results of the Common Method Variation from unrelated factor solutions to determine the number of explanatory factors of variance within the variables (Hair et al., 2018).

Harman's single factor test assumes that common bias may be identified in two ways. Firstly, when the study data reveals a single factor and also when that factor accounts for more than half of the entire variance. Podsakoff et al., (2009), stated that the number of variances reported for Common Method Variance (CMV) varies by research department. As a result, the most common difference determined by the one factor in the Harman's one factor test used in this study is 19.838 percent, which is less than 50% threshold of the variance as recommended by Centobelli et al. (2019)., shown in Table 4.3. From the scenario demonstrated below, the findings shows that Common Method Variance is not an issue.

Table 4.3: Common Method Bias/Variance

Total Variance Explained						
Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	19.838	22.803	22.803	19.838	22.803	22.803
2	7.779	8.941	31.744	7.779	8.941	31.744
3	4.071	4.679	36.423	4.071	4.679	36.423
4	3.565	4.098	40.521	3.565	4.098	40.521
5	3.195	3.672	44.193	3.195	3.672	44.193
6	2.590	2.977	47.170	2.590	2.977	47.170
7	2.271	2.610	49.781	2.271	2.610	49.781
8	2.146	2.467	52.247	2.146	2.467	52.247
9	1.851	2.128	54.375	1.851	2.128	54.375
10	1.726	1.984	56.359	1.726	1.984	56.359
11	1.633	1.877	58.236	1.633	1.877	58.236
12	1.521	1.748	59.985	1.521	1.748	59.985
13	1.419	1.631	61.616	1.419	1.631	61.616
14	1.353	1.556	63.171	1.353	1.556	63.171
15	1.319	1.516	64.687	1.319	1.516	64.687
16	1.174	1.349	66.036	1.174	1.349	66.036
17	1.131	1.300	67.336	1.131	1.300	67.336
18	1.116	1.282	68.619	1.116	1.282	68.619
19	1.086	1.248	69.867	1.086	1.248	69.867
20	1.042	1.197	71.064	1.042	1.197	71.064
21	.962	1.105	72.169			
22	.931	1.070	73.239			
23	.922	1.059	74.299			
24	.908	1.044	75.342			
25	.891	1.025	76.367			
26	.824	.948	77.315			
27	.806	.926	78.241			
28	.783	.900	79.141			
29	.738	.848	79.989			
30	.734	.844	80.832			
31	.718	.825	81.657			
32	.685	.788	82.445			
33	.644	.740	83.185			
34	.639	.735	83.919			
35	.601	.691	84.610			
36	.577	.663	85.273			
37	.551	.633	85.906			
38	.529	.608	86.515			
39	.520	.598	87.112			
40	.487	.560	87.672			
41	.479	.551	88.223			
42	.465	.534	88.757			
43	.455	.523	89.280			

44	.428	.492	89.772
45	.421	.483	90.255
46	.403	.463	90.718
47	.397	.457	91.175
48	.379	.436	91.611
49	.366	.421	92.031
50	.362	.416	92.448
51	.331	.380	92.828
52	.328	.376	93.204
53	.312	.359	93.563
54	.307	.353	93.916
55	.302	.348	94.264
56	.288	.331	94.595
57	.272	.312	94.907
58	.270	.310	95.217
59	.249	.286	95.503
60	.242	.278	95.781
61	.234	.270	96.050
62	.222	.255	96.306
63	.219	.252	96.557
64	.207	.238	96.795
65	.201	.232	97.027
66	.187	.215	97.242
67	.183	.211	97.452
68	.177	.203	97.655
69	.169	.194	97.849
70	.166	.191	98.040
71	.156	.180	98.220
72	.142	.163	98.383
73	.137	.158	98.541
74	.130	.150	98.691
75	.121	.139	98.830
76	.119	.137	98.967
77	.111	.127	99.094
78	.107	.123	99.217
79	.106	.122	99.338
80	.098	.112	99.451
81	.090	.103	99.554
82	.080	.092	99.645
83	.076	.087	99.732
84	.068	.079	99.811
85	.062	.072	99.883
86	.058	.066	99.949
87	.044	.051	100.000

Extraction Method: Principal Component Analysis.

4.5 Demographic Characteristics

This section outlines and presents key information and the demographic attributes of the research respondents. Table 4.4 below outlines that.

Table 4.4: Demographic Characteristics

Variables				Frequency	%
Gender of Respondent	Male			163	65.2
	Female			87	34.8
	Total			**250**	**100**
Respondent Age	Less than 30 Years			54	21.6
	31 – 40 Years			131	52.4
	41 – 50 Years			57	22.8
	51 – 60 Years			8	3.2
	61 Years and Above			0	0.0
	Total			**250**	**100**
Respondent education	Basic			0	0.0
	Junior High School			0	0.0
	Senior High School			1	0.4
	Tertiary			249	99.6
	Total			**250**	**100**
Respondent position	Procurement/SC Manager			99	39.2
	Supply Chain Officer			83	33.2
	Stores Manager/Officer			34	13.6
	Medical Superintendents			24	9.6
	Others			11	4.4
	Total			**250**	**100**
		Min	Max	Mean	SD
Respondent managerial experience (years)		1	4	1.53	0.729

Source: Field Data, (2021)

From table 4.4, two hundred and fifty (250) responses were received and useable. Out of this, 163 (65.2%) were males, whiles the remaining 87 (34.8%) were females indicating that, males appeared to be at the forefront of healthcare supply chain issues in Ghana's healthcare facilities.

In terms of the age categorization of the respondents, majority of the study respondents i.e. 131 (52.4%) were in the age bracket of 31 – 40 years. This was followed by 57 respondents i.e. (22.8%) falling within the age bracket of 41 – 50 years. Eight (8) i.e. (3.2%) of the respondents were in the age bracket of 51 - 60 which was the least. No respondent appeared to have been between the ages of 61 and above.

On respondents educational qualifications, almost all the respondents i.e. 249 (99.6%) had obtained tertiary level education, with only one respondent being a Senior High School (SHS) certificate holders representing 0.4%. This meant that almost all the respondents had higher form of education which made them appreciate issues surrounding hospital supplies and supply chain matters.

In terms of the respondents' functional role and their ability to provide reliable information about hospital supplies and supply chain activities in the healthcare facilities, 99 (39.2%) of the respondents were procurement/Supply chain Managers. Respondents holding the position as Supply chain Officers were 83 (33.2%). Respondents who were stores managers/officers were 34 (13.6%) and 24 (9.6%) were medical superintendents and medical assistants. Health administrators and administrative officers, medical superintendents and other designated persons fell in the category of others and they were 11 responses representing (4.4%).

The respondents' average number of years working with the healthcare facilities was three (3) years. Most of the respondents had work with the healthcare facilities for four (4) years and the least number of respondents working years in the facility was one (1) year. A mean/average experience of 2 years was recorded. The results showed that all the respondents met the minimum working experience criteria set for this research as respondents.

4.6 Descriptive Analysis of Constructs

Descriptive analysis was conducted for each observable and latent variables of the framework. Healthcare Supply Chain Risk Identification (HCSCRID), Healthcare Supply Chain Risk Assessment (HCSCRAS), Healthcare Supply Chain Risk Mitigation (HCSCRIM), and Healthcare Supply Chain Integration (HCSCSCI) are SC resilience antecedents. Healthcare Supply Chain 4.0 (HCSC 4.0) and Healthcare supply chain performance are respectively the mediating and consequent variables of SC resilience (Senna et al. 2021).

4.6.1 Descriptive Statistics on Healthcare Supply Chain Risk Identification

Healthcare Supply Chain Risk Identification (HCSCRID) was measured using nine (9) constructs items. Standardized mechanism for identifying risks in the healthcare facility, past supply chain incidents, advanced notifications from suppliers, demand uncertainties and financial challenges were some of the constructs. The table below outlines the mean, standard deviation, and other measures of the nine (9) item.

Table 4.5: Descriptive Statistics for Healthcare Supply Chain Risk Identification

Construct	N	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
1. The hospital has standard mechanism for identifying risks (supply disruptions) E.g. supplier monitoring, risk mapping etc.	250	1	6	3.66	1.076	-.546	.086
2. Complaints from patients, supplier or internal staff are a risk identifying factor in the hospital.	250	1	6	3.92	1.147	-.784	.303
3. Demand uncertainties or forecasting challenges is a risk identification factor in the hospital.	250	1	6	3.86	1.214	-.726	.098
4. Stock-holding capacity challenges are a risk identification factor in the hospital.	250	1	6	3.59	1.275	-.433	-.645
5. Financial challenges are a risk identification factor in the hospital.	250	1	6	3.71	1.346	-.468	-.806
6. Past supply incidents and result are used as risk identification factors.	250	1	6	3.92	1.129	-.881	-.391
7. The hospital and suppliers have formal agreements in place which holds them accountable against supply breaches.	250	1	6	4.14	1.018	-1.09	1.450
8. Information from external sources such as health alerts, media news, etc. is a risk identification factor for the hospital	250	1	6	3.93	1.113	-.966	.886
9. Advanced notifications from suppliers on supply disruptions is a risk identification factor for the hospital.	250	1	6	3.91	1.098	-.816	.573

Source: Field Data, (2021)

From table 4.5, the standard mechanism for identifying risks such as supplier monitoring and risk mapping recorded a mean of 3.66 and a standard deviation of 1.076. Meaning that the standard mechanisms for risk identification in healthcare facilities are somewhat high and therefore critical to evaluating risk identification. Complaints from patients, supplier or internal staff is a risk identifying factor in the hospital had a mean 3.92 and a standard deviation 1.147 which is somewhat high and therefor critical to the risk identification variable. Demand uncertainties or forecasting challenges as a risk identification factor in the hospital had a mean 3.86 and a standard deviation 1.214 also meaning somewhat high. Stock-holding capacity challenges is a risk identification factor in the hospital had a mean 3.59 and a standard deviation 1.275

indicating that supply chain risks can be identified by looking at the stock-holding capacity of the healthcare facilities. Financial challenges as a risk identification factor in the hospital had a mean 3.71 and a standard deviation 1.346. This implies respondents somewhat see financial challenges as a risk identification factor. Past supply incidents and result used as risk identification factors had a mean 3.92 and a standard deviation 1.129 indicating that healthcare supply chain risk identification can be measured by using past supply incidents and results because the mean is somewhat high.

The hospital and suppliers have formal agreements in place which holds them accountable against supply breaches as a construct to evaluating supply chain risk identification had a mean 4.14 and a standard deviation of 1.018 which is high and therefore critical in the whole subject matter. Information from external sources such as health alerts, media news, etc. as a risk identification factor for the hospital had a mean 3.93 and a standard deviation of 1.113 which is somewhat high. This implies that, external sources of information is critical for healthcare supply chain risk identification. Advanced notifications from suppliers on supply disruptions as a risk identification factor for a hospital had a 3.91 and a standard deviation 1.098 which is high. This means suppliers advanced notifications is critical in healthcare supply chain risk identification. Finally, all the constructs sort to assist in evaluating healthcare supply chain risk identification in healthcare facilities. The results revealed that, the nine (9) items had mean score ranging from 3.59 to 4.14, indicating that the evidence of healthcare supply chain Risk Identification in healthcare facilities is somewhat high. The standard deviation for the same constructs ranges from 1.018 to 1.346 meaning there is somewhat high degree of risk identification.

4.6.2 Descriptive Statistics on Healthcare Supply Chain Risk Assessment

The Healthcare Supply Chain Risk Assessment (HCSCRAS) was evaluated using 15 constructs items. The availability of risk register, risk factors visibility, risk indicators monitoring, availability of risk assessment teams, continuous staff training, stakeholder engagement and allocation of financial resources were some of the constructs. The table below details out the mean, standard deviation and the other measures.

Table 4.6: Descriptive Statistics for Healthcare Supply Chain Risk Assessment

Items	N	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
1. The hospital has a risk register.(operational, technical, legal, financial & environment risks)	250	1	6	3.34	1.274	-.190	-.873
2. All the supply risk factors are made visible to all the hospital stakeholders.	250	1	6	3.47	1.145	-.342	-.426
3. The hospital prioritizes supply risks based on severity and frequency of supply disruptions	250	1	6	3.51	1.159	-.316	-.566
4. Past events is used as basis for assessing supply risks (supply disruptions).	250	1	6	3.95	1.021	-.931	.895
5. The hospital performs analysis on causes for supply risks.	250	1	6	3.66	1.147	-.633	-.459
6. The hospital has notification systems for risks assessments.	250	1	6	3.26	1.249	-.013	-.994
7. Identified supply risks are analyzed using a procedure (qualitative or quantitative).	250	1	6	3.36	1.222	-.358	-.874
8. The hospital monitors indicators of national supply risk for planning.	250	1	6	3.61	1.228	-.379	-.706
9. Stakeholder engagements on supply risk assessment are always held and documented.	250	1	6	3.65	1.163	-.651	-.052
10. Departments within the hospital provides adequate inputs for risk assessment actions.	250	1	6	3.82	1.020	-.893	.154
11. The hospital has a standing risk assessment team in place.	250	1	6	3.36	1.229	-.160	.154
12. The hospital has identified and mapped the key indicators of supply risks.	250	1	6	3.34	1.120	-.417	.154
13. The hospital has a risk assessment register.	250	1	6	3.36	1.273	-.092	.154
14. The hospital allocates financial resources for risk assessment activities.	250	1	6	3.57	1.571	12.786	.154
15. The hospital promotes continuous training for the risk assessment team members.	250	1	6	3.43	1.224	-.331	.154

Source: Field Data, (2021)

From Table 4.6, the availability of hospital risk register as a measure to evaluating healthcare supply chain risk assessment had a mean 3.34 and a standard deviation of 1.274. The visibility of supply risk factors to all the hospital stakeholders was also used and it came out with a mean 3.47 and a standard deviation of 1.145 which is somehow high. A mean 3.51 and a standard deviation of 1.159 was recorded when respondents were asked if the hospital prioritizes supply risks based on severity and frequency of supply disruptions. This implies that, the construct was strong in measuring the variable. Past events is used as basis for assessing supply risks had a mean 3.95 and a standard deviation of 1.021. This implied that past supply events is critical to healthcare supply chain risk assessment as the mean is closer to the maximum mark. The hospital performs analysis on causes for supply risks as a construct had recorded a mean score of 3.43 and a standard deviation of 1.224 which is somehow high and therefore relevant to the assessment. The hospital has notification systems for risks assessments as a construct had a mean 3.26 and a standard deviation 1.249 which indicted relevance to the evaluation. Identified supply risks are analyzed using a procedure i.e. qualitative or quantitative had a mean 3.36 and a standard deviation of 1.222. This meant the construct was somehow useful in risk assessment.

From table, monitoring of indicators of national supply risk for planning had a mean 3.61 and a standard deviation of 1.228. This means the national risk monitoring was critical for risk assessment. Stakeholder engagements on supply risk assessment are always held and documented had a mean 3.65 and a standard deviation of 1.163. This mean is closer to the maximum mark making it an important factor. A mean and a standard deviation of 3.82 and 1.020 respectively was realized for the construct bordering on whether departments within the hospital provides adequate inputs for risk assessment actions. The mean was closer to the maximum mark meaning the department feedback was critical to risk assessment. The hospital having a standing risk assessment team in place had a mean 3.36 and a standard deviation of 1.229. This is somehow high and critical to risk assessment. The identification and mapping of key indicators of supply risks in the hospital had a mean 3.34 and a standard deviation of 1.120. This means identification and mapping is important in healthcare supply chain risk assessment. A mean of 3.36 and a standard deviation of 1.273 was realized out of the construct “the hospital has a risk assessment register”. This means respondents tilted towards the maximum mark making it an important factor.

The hospital allocates financial resources for risk assessment activities had a mean 3.57 and a standard deviation of 1.571 which is somewhat high. This means allocation of financial resources is a critical factor in risk assessment as a whole. The hospital promotes continuous training for the risk assessment team members as a construct had a mean 3.43 and a standard deviation of 1.224. This meant that training for risk assessment team members was critical since the mean was somehow closer to the maximum mark. In conclusion, all the constructs sort to assist in evaluating healthcare supply chain risk assessment in healthcare facilities. The results revealed that, the fifteen (15) items have mean score ranging from 3.26 to 3.95, indicating that the evidence of Healthcare supply chain Risk Assessment in healthcare facilities is somewhat high. The standard deviation for the same constructs ranges from 1.02 to

1.57 meaning there is moderately high degree of healthcare supply chain risk assessment.

4.6.3 Descriptive Statistics on Healthcare Supply Chain Risk Mitigation

Healthcare supply chain Risk Mitigation (HCSCRIM) was measured using fourteen (14) constructs items. The availability of risk mitigation team, effective communication across supply chain, departmental collaboration on risk mitigation, availability of alternative source of supplies and action plan for risk mitigation.

Table 4.7: Descriptive Statistics for Healthcare Supply Chain Risk Mitigation

Items	N	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
1. The hospital has a unit responsible for coordinating supplies (buffer inventory).	250	1	6	4.03	1.029	-1.134	1.149
2. As a mitigating measure, the hospital has made financial provision for restocking outside their supply chain.	250	1	6	3.96	1.187	-.628	-.052
3. The hospital has an action plan (schedule, responsible, resources and indicators) for risk mitigation.	250	1	6	3.91	1.087	-.695	.753
4. There is cross employee training across the hospital supply chain risk mitigation.	250	1	6	3.66	1.199	-.573	-.396
5. The hospital has reliable alternative sources of supply in times of supply disruptions.	250	1	6	4.06	1.049	-.878	.688
6. The hospital has a standing mitigation response team for supply disruptions.	250	1	6	3.42	1.269	-.173	-.738
7. There is effective communication across the supply chain as risk mitigation measure.	250	1	6	3.95	.970	-.667	.401
8. Departments within the hospital collaborate on risk mitigation issues at all times.	250	1	6	3.86	1.110	-.742	.175
9. The action plan for supply risk assessment is strictly followed by the hospital.	250	1	6	3.90	1.139	-.517	.093
10. The hospital has reliable supplies at all times.	250	1	6	4.00	1.022	-.911	.933
11. The hospital has clear safety procedures on supplies.	250	1	6	3.96	.991	-.701	1.117
12. The hospital can back-up supplies when the need arises.	250	1	6	4.11	1.057	-.773	1.037
13. There is lack of visibility concerning placement and availability of stock.	250	1	6	3.20	1.364	-.082	-1.029
14. The hospital has sufficient storage space for holding enough volumes of stock as a mitigation measure.	250	1	6	3.90	1.096	-.751	.281

Source: Field Data, (2021)

From Table 4.7, Unit responsible for coordinating supplies in the hospital had a mean 4.03 and a standard deviation of 1.029. This means supplies coordination in the hospital is critical to healthcare supply chain risk mitigation as the mean is closer to maximum mark. As a mitigating measure, the hospital has made financial provision for restocking outside their supply chain had a mean 3.96 and a standard deviation of 1.187 which is somewhat closer to the maximum mark and therefore critical to healthcare risk mitigation. An action plan i.e schedule, responsible, resources and indicators for risk mitigation had a mean of 3.91 and a standard deviation 1.087. This mark is closer to the maximum and therefore signifies that an action plan is critical in healthcare risk mitigation. The cross employee training across the hospital supply chain risk mitigation as a construct had a mean 3.66 and a standard deviation of 1.199 which is somehow closer to the maximum mark. This signifies that cross employee training is critical for risk mitigation.

The hospital having reliable alternative sources of supply in times of supply disruptions recorded a mean of 4.06 and a standard deviation of 1.049 which is closer to the maximum. This means that having reliable alternative source of supplies is critical to healthcare supply chain risk mitigation.

An enquiry into hospital having a standing mitigation response team for supply disruptions had a mean 3.42 and a standard deviation of 1.269. This implied response teams were critical in times of risk mitigation. Effective communication across the supply chain as risk mitigation measure had a mean 3.95 and a standard deviation 0.970 which is closer to the maximum mark. This meant effective communication across healthcare supply chain was critical in healthcare supply chain risk mitigation. Departments within the hospital collaborates on risk mitigation issues at all times as a construct had a mean 3.86 and standard deviation 1.110. The mean of 3.86 is closer to the maximum mark and therefore collaboration at all levels within the hospital is very critical. The action plan for supply risk assessment is strictly followed by the hospital. This construct had a mean 3.90 and standard deviation 1.139 which is high because of its closeness r to the maximum mark of 6. This implies that the strict adherence to action plans is critical. A 4.00 mean and a standard deviation 1.022 which is a high score because of its closeness to the maximum mark of 6 was realized for the construct "The hospital has reliable supplies at all times". Reliable healthcare supplies is critical in healthcare supply chain risk mitigation. The hospital has clear safety procedures on supplies as a construct had a mean 3.96 and standard deviation of 0.991 which is somehow high and critical as an assessment tool for risk mitigation. The statement "the hospital can back-up supplies when the need arises" had a mean 4.11 and a standard deviation of 1.057 which is closer to the maximum mark of 6. Supplies back-up in the hospital is critical for healthcare supply chain risk mitigation. The lack of visibility concerning placement and availability of stock had a mean 3.20 and a standard deviation of 1.364. This means stock visibility in healthcare facilities is essential in risk mitigation. The hospital has sufficient storage space for holding enough volumes of stock as a mitigation measure had a mean 3.90 and a standard deviation of 1.096. This is somehow high as the mean is closer to the maximum mark of 6.

The purpose for these statements were to assess Healthcare Supply Chain Risk Mitigation in healthcare facilities. The mean and standard deviation were between the range 3.20 to 4.11 and 0.99 to 1.36 respectively. This results revealed that there is somewhat high level of healthcare Supply Chain Risk Mitigation in healthcare facilities.

4.6.4 Descriptive Statistics on Healthcare Supply Chain Integration

For the measurement of Healthcare Supply Chain Integration (HCSCSCI), the researcher used 14 constructs items to evaluate it. Continuous collaboration among hospital internal departments, stakeholder collaboration, continuous information sharing, general systems integration and supplies tracking systems.

Items	N	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
1. There is continuous collaboration among the hospital's internal departments on supply disruptions.	250	1	6	3.93	.905	-1.013	1.340
2. The hospital continuously collaborates with Patients' for feedback on service delivery and effective risk management.	250	1	6	3.88	1.020	-.710	-.018
3. Supply chain Integration helps the hospital in the implementation of Supply chain risk management practices.	250	1	6	4.03	.950	-.368	.621
4. Due to stakeholder collaboration, there is risk sharing among the hospital and the suppliers.	250	1	6	3.92	1.015	-1.047	1.222
5. There is continuous information sharing between the hospital and its outside suppliers.	250	1	6	4.08	.983	-.827	1.019
6. There is continuous information sharing between the hospital's departments on supplies.	250	1	6	4.03	.909	-1.098	1.681
7. General systems Integration has facilitated efficient and effective flow of information between the hospital and its suppliers.	250	1	6	4.02	1.068	-.527	.795
8. The integration is fostering continuous supply replenishment.	250	1	6	4.10	.906	-.558	1.256
9. There is collaboration on stock-levels in the hospital.	250	1	6	3.94	1.022	-.675	.797
10. The hospital and its external suppliers have a joint supply evaluation team for decision making on supplies.	250	1	6	3.44	1.326	-.224	-.730
11. The hospital has inter department supply evaluation team for decision making.	250	1	6	3.62	1.279	-.528	-.532
12. Integration has facilitated efficient and effective decision making on supplies for the hospital.	250	1	6	3.74	1.063	-.786	.074
13. The hospital has electronic system for tracking supply orders.	250	1	6	3.20	1.309	-.091	-1.053
14. The hospital and their suppliers have a common electronic platform for supply decision making.	250	1	6	3.20	1.304	-.073	-1.030

Table 4.8*: Descriptive Statistics for Healthcare Supply Chain Integration*

Source: Field Data, (2021)

From Table 4.8, the continuous collaboration among the hospital's internal departments on supply disruptions had a mean 3.93 and standard deviation 0.905. This means the response was tilted towards the maximum mark. The hospital continuously collaborate with Patients' for feedback on service delivery and effective risk management as a construct had a mean 3.88 and a standard deviation 1.020 which means patients feedback is critical in healthcare supply chain integration. Supply chain Integration helps the hospital in the implementation of Supply chain risk management practices had a mean 4.03 and standard 0.950 which is somewhat closer to the maximum mark. This means that supply chain integration is a critical factor for healthcare facilities. The construct "Due to stakeholder collaboration, there is risk sharing among the hospital and the suppliers" had a mean 3.92 and a standard deviation of 1.015 which is moderate considering the maximum mark. Continuous information sharing between the hospital and its outside suppliers recorded a mean of 4.08 and a standard deviation of 0.983. This is high considering how close it is to the maximum mark. Therefore continuous information sharing between the hospital and its suppliers, is critical for healthcare supply chain integration. The continuous information sharing between the hospital's departments on supplies as a construct wasn't so different. The construct had a mean 4.03 and standard deviation 0.909 which was high considering the maximum mark. Therefore, it also plays an important factor in the process.

General systems Integration have facilitated efficient and effective flow of information between the hospital and its suppliers had a mean 4.02 and a standard deviation of 1.068 which is somehow high. This means the factor is also very important. The integration is fostering continuous supply replenishment was another statement assessed by the respondents and it had a mean 4.10 and a standard deviation of 0.906 which is high because it is closer to the maximum mark and this makes it a critical in healthcare supply chain integration. There is collaboration on stock-levels in the hospital had a mean 3.94 and standard deviation of 1.022 which is moderately high and therefore useful in the discussion. The hospital and its external suppliers have a joint supply evaluation team for decision making on supplies recorded a mean 3.44 and standard deviation of 1.326. In a similar vein, a mean 3.62 and a standard deviation of 1.279 was realized for the construct "The hospital has inter department supply evaluation team for decision making". This means inter departmental supply evaluation team for decision making is important for healthcare supply chain integration.

Integration has facilitated efficient and effective decision making on supplies for the hospital as a construct had a mean 3.74 and standard deviation of 1.063 which signifies some level of acceptance for healthcare supply chain integration. The hospital has electronic system for tracking supply orders had a mean 3.20 and a standard deviation of 1.309 signifying some level of agreement. The hospital and their suppliers have a common electronic platform for supply decision making also had a mean 3.20 and a standard deviation of 1.304 making it an important factor. For the healthcare supply chain integration variable, the researcher used 14 constructs to solicit information on it. The results of the mean score analysis of the 14 items ranged from 3.20 to 4.10 indicating that healthcare supply chain integration is somewhat high.

4.6.6 Descriptive Statistics on Healthcare Supply Chain 4.0

Healthcare supply chain 4.0 (HCSC 4.0) was measured using 14 construct items. The hospital has deployed ICT infrastructure in their daily operations. The internal supplies order processes of the hospital is automated. Evaluation committee meetings for the hospital are sometimes done virtually. The hospital has staff with dedicated roles on ICT management and data on medicines supplies are standardized between the hospital and their suppliers.

Table 4.10: Descriptive Statistics for Healthcare Supply Chain 4.0

Construct	N	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
1. The hospital has deployed ICT infrastructure in their daily operations.	250	1	6	3.64	1.261	-.401	-.516
2. Stock management in the hospital is done using ICT.	250	1	6	3.58	1.294	-.514	-.721
3. The internal supplies order processes of the hospital is automated.	250	1	6	3.44	1.456	-.183	-1.094
4. The external supply order processes of the hospital is fully automated	250	1	6	3.16	1.435	.101	-1.092
5. The hospital and its suppliers have a common ICT platform for stock management information exchange	250	1	6	3.17	1.442	-.069	-1.254
6. Evaluation committee meetings for the hospital are sometimes done virtually.	250	1	6	3.02	1.434	.106	-1.122
7. The hospital uses the drone technology to order some supplies.	250	1	6	3.09	1.477	-.001	-1.332
8. The information and network infrastructure of the hospital has a back-up.	250	1	6	3.79	1.118	-.764	.307
9. The hospital has staff with dedicated roles on ICT management.	250	1	6	3.91	1.057	-.749	.085
10. The supplies department has tracking system for stock-management in the hospital.	250	1	6	3.61	1.267	-.424	-.708
11. The hospital has real-time data on medicine supplies and usage.	250	1	6	4.08	1.015	-.975	1.265
12. There are binding agreements on information and data sharing between the hospital and their suppliers.	250	1	6	3.94	1.142	-.754	.458
13. There are standard regulations on information and data sharing between departments in the hospital.	250	1	6	4.08	.977	-.935	1.774
14. Data on medicines supplies are standardized between the hospital and their suppliers.	250	1	6	3.15	.909	-.751	1.759

Source: Field Data, (2021)

From Table 4.10, the hospital has deployed ICT infrastructure in their daily operations had a mean 3.64 and a standard deviation of 1.261. This implies ICT deployment is critical to healthcare supply chain 4.0. Stock management in the hospital is done using ICT had a mean 3.58 and a standard deviation of 1.294 which is somehow on the maximum score side. The internal supplies order processes of the hospital is automated, had a mean 3.44 and a standard deviation of 1.456 which is closer to the maximum mark. Therefore process automation is very critical for healthcare supply chain 4.0. In a similar vein, the external supply order processes of the hospital is fully automated had a mean 3.16 and a standard deviation of 1.435 which implies significance according to the respondents. The hospital and its suppliers have a common ICT platform for stock management information exchange had a mean 3.17 and a standard deviation 1.442. This means information exchange through common ICT platform is critical for healthcare supply chain 4.0. Evaluation committee meetings for the hospital are sometimes done virtually had a mean 3.02 and a standard deviation 1.434. This indicates a slight significance to healthcare supply chain 4.0. The hospital uses the drone technology to order some supplies had a mean 3.09 and a standard deviation of 1.477 which is also slightly towards the maximum mark. The information and network infrastructure of the hospital has a back-up had a mean 3.79 and a standard deviation of 1.118 which implies significance in the healthcare supply chain 4.0. This is because, the means is somehow closer to the maximum score.

The hospital has staff with dedicated roles on ICT management recorded a mean of 3.91 and a standard deviation of 1.057 which is somehow closer to the maximum mark. This means that staff with dedicated roles is critical to healthcare supply chain 4.0. The supplies department has tracking system for stock-management in the hospital had a mean 3.61 and a standard deviation of 1.267. This implies that tracking of stock management is critical for healthcare supply chain 4.0 because the mean is somehow closer to the maximum mark. Mean of 4.08 and a standard deviation of 1.015 was scored for the construct “the hospital has real-time data on medicine supplies and usage”. The mean score was high as it appeared closer to the maximum mark. This implied that real time data on hospital supplies was very critical to healthcare supply chain 4.0. There are binding agreements on information and data sharing between the hospital and their suppliers has a mean score of 3.94 and a standard deviation of 1.142 which is significantly higher towards the maximum mark. This implies that agreements on information sharing is critical to healthcare supply chain 4.0. There are standard regulations on information and data sharing between departments in the hospital had a mean 4.08 and a standard deviation 0.977 which is significant considering its clones to the maximum score. This means that standard regulations is important for issues of healthcare supply chain 4.0. Data on medicines supplies are standardized between the hospital and their suppliers had a mean 3.15 and a standard deviation 0.909 implying that data standardization is critical to healthcare supply chain 4.0 because the mean score is closer to the maximum mark. The results from the analysis revealed that, the 14 items have their mean/standard deviation score ranging from 3.02 to 4.08 and 0.977 to 1.477, indicating that the supply chain 4.0 of the healthcare institution is somewhat low.

4.6.7 Descriptive Statistics on Healthcare Supply Chain Performance

The Healthcare Supply Chain Performance (HCSCP) was measured in the study using 10 construct items. There is continuous supply of medicines to the hospital. There is minimal occurrence of drugs and products perishability in the hospital due to management measures. Due to Risk and ICT measures in place, there is minimal chances of the hospital receiving sub-standard medicines from suppliers. Due to Risk and ICT measures in place, the hospital maintains quality data on current and past supplies and there is high sense of patient satisfaction in the hospital.

Table 4.11: Descriptive Statistics for Healthcare Supply Chain Performance

Items	N	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis
1. There is continuous supply of medicines to the hospital.	250	1	6	4.25	.872	-.991	1.722
2. Disruptions in medicines supply are detected in advance due to risk management measure in place in the hospital.	250	1	6	4.04	.875	-.831	1.210
3. There is minimal occurrence of drugs and products perishability in the hospital due to management measures.	250	1	6	4.05	.936	-1.110	1.706
4. There is minimal occurrence of pilfering and wastage of supplies due to technology and risk management measures in place in the hospital.	250	1	6	4.02	1.006	-1.130	1.520
5. Due to Risk and ICT measures in place, there are minimal chances of the hospital receiving sub-standard medicines from suppliers.	250	1	6	4.06	1.130	-.960	.922
6. Due to Risk and ICT measures in place, there is minimal chance of receiving counterfeit medical supplies.	250	1	6	3.97	1.115	-.724	.410
7. Due to Risk and ICT measures in place, the hospital maintains quality data on current and past supplies.	250	1	6	4.00	1.085	-.772	.639
8. Patients' treatments in the hospital are devoid of medicines shortages.	250	1	6	3.92	1.056	-.838	.312
9. There is high sense of patient satisfaction in the hospital.	250	1	6	4.04	.870	-1.229	2.260
10. The quality of service delivery in the hospital is high.	250	1	6	4.10	.872	-1.010	2.320

Source: Field Data, (2021)

From Table 4.11, there is continuous supply of medicines to the hospital had a mean 4.25 and a standard deviation 0.872 which is closer to the maximum score. This implies that continuous supply of medicines is critical for healthcare supply chain performance. Disruptions in medicines supply are detected in advance due to risk management measure in place in the hospital had a mean score of 4.04 and a standard deviation of 0.875. This means that detection of disruptions in medical supplies is critical because, the mean score is closer to the maximum mark. There is minimal occurrence of drugs and products perishability in the hospital due to management measures has mean 4.05 and a standard deviation of 0.936 which is closer to the maximum score. This means that drug perishability is critical to healthcare supply chain performance. There is minimal occurrence of pilfering and wastage of supplies due to technology and risk management measures in place in the hospital had a mean 4.02 and a standard deviation of 1.006 which is closer to the maximum score. This means that reducing pilfering and wastage through technology is critical for healthcare supply chain performance.

Due to Risk and ICT measures in place, there is minimal chances of the hospital receiving sub-standard medicines from suppliers had a mean 4.06 and a standard deviation of 1.1130 which is also critical to healthcare supply chain performance because, the mean score is closer the maximum mark. Due to Risk and ICT measures in place, there is minimal chance of receiving counterfeit medical supplies had a mean of 3.97 and a standard deviation of 1.115. The construct is slightly significant because the mean score is slightly close to the highest mark. Due to Risk and ICT measures in place, the hospital maintains quality data on current and past supplies had a mean 4.00 and standard deviation of 1.085. This mean scores is closer to the maximum score therefore making quality data maintenance critical for healthcare supply chain performance. Mean of 3.92 and a standard deviation of 1.056 was realized for the construct "Patients' treatments in the hospital is devoid of medicines shortages". This construct is critical for healthcare supply chain performance due to the closeness of the mean score to the maximum score. There is high sense of patient satisfaction in the hospital had a mean of 4.04 and a standard deviation of 0.870. Patient satisfaction is critical to healthcare supply chain performance because the mean score is slightly closer to the maximum mark and the quality of service delivery in the hospital is high had a mean of 4.10 and a standard mean of 0.872 which is somehow critical because the mean score is closer to the maximum score making quality of service delivery significant for healthcare supply chain performance. The purpose of this analysis was to assess the extent of Healthcare Supply Chain Performance in Healthcare institution.

The findings revealed a high level of performance in Healthcare Supply Chain Performance. This finding was evidenced by the mean results of the 10 items which range from 3.92 to 4.25 and standard deviation of 0.870 to 1.130.

4.7 Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA), can be described as a variable reduction technique which identifies a set of latent constructs and the possible underlying factor structure of a set of measured variables without imposing any preconceived structure on the outcome (Child, 1990). In a research context, the goal of conducting Exploratory Factor Analysis (EFA) is to aid a researcher to determine or investigate the number of latent constructs underlying a set of variables by defining the content and meaning of each factor (O'Leary-Kelly and Vokurka, 1998; Duhr, 1999). Accordingly, Chang and Chen (2013), viewed EFA as a tool for measurement reduction for research variables with constructs of between twenty (20) to fifty (50) items. Considering the indicators in this research, Exploratory Factor Analysis was carried out to identify the various items that could represent or actually measure the latent variables as suggested by Edkins and Pollock (1996). In other words, EFA was performed to enable the reduction in variability so as for easy understanding and analysis for easier evaluation of each conceptual behavior. The Principal Components Analysis (CPA) and varimax rotation were the procedures employed for the measurements. Using both the CPA and the varimax procedures was to guarantee adequate psychometric process and a good component interpretation more especially in a study where the parameters are inconsistent. Any factor loading matrix for an object higher than or equal to 0.30 is considered important as suggested by Pallant (2005). Contrary to the views of Pallant (2005), is the view by Norusis (1993), who presented that the significant factor loading for an object in a study should be greater than or equal to 0.50. For the purposes of this study, a threshold of 0.50 was used and surprisingly, all the research items met the threshold and therefore were all included in the analysis.

4.7.1 Bartlett's Test of Sphericity and Kmo Test

The results as presented in Table 4.12 shows that the KMO sampling adequacy for this study is 0. 843. The result indicates that there exists high significance of variables under this dimension regarding the correlation among the variables differently from 0 or an identity matrix. The implication is that the study used adequate sample hence employing exploratory factor analysis would produce real-value estimates. This was significant with p value lower than 0.05 as showed in Table 4.12 below. The result indicates that the within correlations with variables could be attributed to other variables. The analysis provided evidence that majority of the items used in measuring the latent construct had appreciable lodgings.

Table 4.12*: Bartlett's Test of Sphericity and KMO Test*

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.843
Bartlett's Test of Sphericity	Approx. Chi-Square	15260.316
	df	3741
	Sig.	.000

Source: Field Data (2021)

4.8 Correlation Analyses

To preview for a reasonable relationships among the research variables, a Correlation Analysis (CA) is required. Correlation analysis basically evaluates for a linear relationship that might exist between the independent and dependent variables. To measure the degree of strength between the independent and dependent variables, a Person correlation coefficient is used and is usually denoted by "r". A coefficient value greater than zero (0) indicates the existence of positive relationship among variables signifying that an increase in the independent variable will result in an increase in the dependent variable and the vice versa. It is important to note that Pearson correlation coefficient does not evaluate the causal effects of the independent variables. The correlation coefficient (r) can range from a value of +1 to a value of -1. Before going for the regression model/Amos, a correlation analysis was conducted to preview for the presence of multi-collinearity and association among the study variables. As shown in (Table 4.13), the values of the matrix were obtained using Pearson's correlation coefficient (r) for each pair of the study variables. From the correlation analysis conducted, the variables RID, RAS, RIM, and HCSCP were all within the acceptable range and in the expected direction satisfying Hair et al, (2004), assumption of nomological validity. Supply Chain Integration (SCI) was the only variable with highest correlation coefficient observed; r = 0.674. On the basis of the correlation results, it was concluded that there is no multi-collinearity among the variables because no extreme correlation or highly related variables for any of the pairs was observed confirming the view of Pallant, (2007). It further assumed that, theoretically, a positive relationship existed among the study variables.

In order to assess and investigate on the stated hypothesis, the researcher needs to analyze the regression coefficient/Amos. The summary of the regression analysis output is given in the Table.

Table 4.13*: Inter-Variable Correlation Matrix*

Variable	RID	RAS	RIM	SCI	HCSC	HCSCP
1. (RID)	1					
2. (RAS)	.252**	1				
3. (RIM)	.341**	.484**	1			
4. (SCI)	.360**	.548**	.674**	1		
5. (HCSC4.0)	.207**	.531**	.514**	.648**	1	
6. (HCSCP)	.320**	.316**	.579**	.496**	.528**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Results from Table 4.13, revealed that healthcare supply chain risk identification has a strong and positive relationship with healthcare supply chain risk assessment (r = 0.252, p<0.001). Healthcare supply chain risk identification was also found to a positive and strong relationship with healthcare supply chain risk mitigation (r = 0.341, p<0.001). The relationship between healthcare supply chain risk identification and healthcare supply chain integration was positive and strong (r = 0.630, p<0.001). A strong and positive relationship exited between healthcare supply chain risk identification and healthcare supply chain 4.0 (r = 0.207, p=0.001). There existed a strong and positive relationship between healthcare supply chain risk identification and healthcare supply chain performance (r = 0.320, p<0.001).

Healthcare supply chain risk assessment have a positive and strong relationship with healthcare supply chain risk mitigation (r = 0.484, p<0.001). Healthcare supply chain risk assessment presented a positive and strong relationship with healthcare supply chain integration (r = 0.548, p<0.001). Healthcare supply chain risk assessment presents a strong and positive relationship with healthcare supply chain 4.0 (r = 0.531, p<0.001). Healthcare supply chain risk assessment have a positive and strong relationship with healthcare supply chain performance (r = 0.316, p<0.001).

Healthcare supply chain risk mitigation possess a strong and positive correlation with supply chain integration (r = 0.674, p<0.001). Healthcare supply chain risk mitigation has a strong and positive relationship with healthcare supply chain 4.0 (r = 0.514, p<0.001). Healthcare supply chain risk mitigation has a strong and positive relationship with healthcare supply chain performance (r = 0.579, p<0.001).

Healthcare supply chain integration possess a strong and positive relationship with healthcare supply chain 4.0 (r = 0.648, p<0.001). Healthcare supply chain integration has a strong and positive relationship with healthcare supply chain performance (r = 0.496, p<0.001). Finally, healthcare supply chain 4.0 presented a strong and positive relationship with healthcare supply chain performance (r = 0.511, p<0.001).

The correlation results show high relationship among the research variables. This is because, almost all of the correlation values were greater than the cut-off point value of 0.50 signifying that multicollinearity was not a problem (Pallant, 2016).

4.9 Confirmatory Factor Analysis (CFA) Results

Confirmatory Factor Analysis (CFA) is the use of statistical technique in the verification of the structure of a set of measured variables (Suhr. D. D, 1999). A Confirmatory Factor Analysis was conducted to assess the validity and reliability of the research constructs and to also allow for the testing of the hypothesis for confirmation for the existence of relationship between the observed variables. In this study, three (3) indicators were employed in conducting the Confirmatory Factor Analysis (CFA) for the research construct and variables; the Composite Reliability (CR), Average Variance Extract (AVE),) and the Cronbach Alpha.

4.9.1 Convergent Validity and Divergent Validity of Scales

Convergent validity and divergent validity are means by which a construct validity measurement procedure are evaluated (Campbell and Fiske, 1959). Convergent validity can be described as the means of establishing the construct validity when two different measurement procedures are applied for data collection regarding the study constructs. Convergent validity is established when the strength of the relationship between the scores obtained from the two different measurement methods used in the data collection are ascertained. According to Campbell and Fiske (1959), convergent validity is achieved when the scores after data collection of items used to measures the constructs correlates to other scores designed to measure the same construct. Going by Komiak and Benbasat (2006), convergent validity can be examined by measuring the reliability of survey items using Composite Reliability (CR), Average Variance Extracted (AVE) and the factor analysis. According to Garver and Mentzer (1999), in practice, the standardized regression loading of an item on each construct is achieved and statistically significant when the item loadings are greater than or equal to 0.70. In some instances convergent validity is considered achieved and acceptable even when the item loading is as low as 0.40. In this study, some of the items were removed for further analysis whiles others were altered because of the low loadings they presented. This action was in line with Bollen and Lennox (1991), who are of the view that items with inadequate loadings or significant loading across constructs can be altered or removed without changing the meaning of the construct.

4.9.2 Discriminant Validity

Discriminant Validity is a subcategory of construct validity and it is a key building block for model evaluation (Hair et al, 2010; Bagozzi and Phillips. 1982). According to Barclay et al. (1995), discriminant validity is used to examine the level at which a measure correlates with measure of constructs that are different from the construct the measure intended to evaluate. Comparing the average variance extract (AVE) for each factor against the squared correlation of each construct is a means by which discriminant validity can be assessed. Technically, discriminant validity should not correlate too much with the measure from the measure from which it is supposed to differ (Campbell 1960, p.548). Discriminant validity is demonstrated by evidence that a construct measure is unique and represents a phenomenon of interest that other measures in a structural equation model do not capture (Hair et al. 2010; Hubley. A. M., 2014). Practically, discriminant validity is proved when the latent variables accounts for more variance in its associated indicator variables than it shares with other constructs in the same model. The discriminant validity loadings should be noticeably smaller in size than the convergent validity loadings (Fornell and Larcker 1981; Hubley. A. M., 2014). To satisfy such a requirement, each constructs average variance extracted must be compared with its squared correlation with other constructs in the model. According to Fornell and Larcker (1981), discriminant validity is said to be attained or realized when the AVE for each construct is higher than 0.50. Table 4.14 below shows the loadings of each measurement item on it latent variable which is larger than its loading on any other construct. All the constructs and their factor loadings indicates good discriminant validity.

Table 4.14: Validity and Reliability Results

Variable	No. of Items	AVE	CR	Cronbach Alpha
RID	9	0.603	0.983	0.758
RAS	15	0.541	0.942	0.867
RIM	14	0.581	0.925	0.824
SCI	14	0.549	0.960	0.844
HCSC4.0	14	0.586	0.954	0.871
HCSCP	10	0.562	0.927	0.900

Source: Field data, 2021

Average Variance Extract (AVE) is the computation of the value that is captured by an indicator as opposed to the value due to measurement errors. In this scenario a value above 0.50 is recommended (Fornell and Larcker, 1981). From Table 4.14 above, the AVE for all the variables in this research are above the 0.50 value and therefore meets the requirements.

Composite Reliability (CR) is used to assess the research scale items and their internal consistencies. Thus the ability to explain the variance of the latent variables using the indicators. According to Netemeyer (2003), composite reliability considers the actual loading of items and therefore it is in a better position to test unidimensionality much better than the Cronbach alpha. For composite reliability (CR), the unidimensionality of the latent variables acceptability is realized if a bench mark of 0.70 is attained. From the Table 4.14 above, composite reliability (CR) of all the variables has exceeded the minimum threshold values of 0.70.

Cronbach alpha is the measure of correlation among indicators of latent variables for internal consistencies. According to Hair et al., (2010), the unidimensionality of the latent variables and the acceptance bench mark criteria should be 0.70 or more. Chin (1998b), assumes that all indicators should be equally weighted. For this research, the Cronback alpha for the factor loadings are significant and exceeded the minimum threshold value of 0.70. The three variables show results above the minimum acceptance threshold of 0.70 recommended. All factor loadings are significant and are closer to or exceed recommended threshold values as shown in Table 4.14. Also, the average variance extract (AVE) and composite reliability (CR) of the constructs were within the required threshold values of 0.50 and 0.70 respectively. This is thereby establishing significant and sufficient convergent validity and reliability. From the assessments done, the standardized estimators of each variable on their respective indicators appeared significant statistically.

4.9.3 Model Fit Indices

A model fit test was conducted to examine the fitness of the model so as to ascertain how the proposed model fit well with the data. According to Hair et al., (2014), Chi-square ($\chi2/df$), Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), Incremental Fit Index (IFI) and Normed Fit Index (NFI) are sufficient enough to test the fitness of a measurement model. The indices and the recommended value range for each is briefly presented below. The results of initial runs of the SEM showed that the model resulted in a very satisfactory statistical fit ($\chi2/df=2.927$, GFI = 0.956, Df=106, CFI=0.958, TLI=0.935, IFI = 0.961, RMSEA=0.08) (Hu & Bentler, 1999). Details are presented in Table 4.15 below;

Table 4.15: Model-Fit Indices

Fit indices	Required	Values obtained
χ^2		2719.514
Df		106
χ^2/df	$5.0\leq \chi^2/d\leq 1.0$	2.927
Goodness of Fit (GFI)	$0.90\leq GFI\leq 1.0$	.956
NFI	$0.90\leq NFI\leq 1.0$	.963
RFI	$0.90\leq RFI\leq 1.0$	.934
IFI	$0.90\leq IFI\leq 1.0$	.961
TLI	$0.90\leq TLI\leq 1.0$	.935

CFI	$0.9 \leq CFI \leq 1.0$	.958
RMSEA	$0.08 \geq$ RMSEA	.08

Source: Field data, 2021

4.9.3.1 Chi-Square ($\chi 2$) Goodness of Fit

The chi-square ($\chi 2$) goodness of fit test is a statistical hypothesis test used to evaluate whether sample data is representative of the full population. The chi-square ($\chi 2$) goodness of fit test has a univariate applicability of any distribution and it helps to determine whether a variable is likely to come from a specific distribution or not. To measure the incremental fit for comparing measurement variance across groups, the chi-square goodness fit test is recommended. According to Gulliksen and Tukey, (1958); Garver and Mentzer, (1999), the chi-square goodness of fit test is sensitive to sample size so therefore, the larger the sample size, the likelihood of unimportant departure and negligible departure will be detected. A significant finding usually indicates the lack of fit and therefore the measure is usually applied alongside other indices fit like RMSEA and CFI. From table 4.15 the value of 2719.514 for the chi-square goodness of fit was obtained.

4.9.3.2 The Chi-Square Ratio (CMIN/df)

The chi-square ratio examines the levels of freedom and hence not as independent on sample size as the chi-square fit index by itself. To calculate the chi-square ratio, the chi-square fit index divided by degree of freedom. Hair et al., (1998), suggests the acceptable measure ratio range of fit to be 2 to 5. Garver and Mentzer (1999), in a conservative approach has recommended the range of the ratio to be or not exceed 2 to 3 threshold. From table 4.15 the value of 2.927 was obtained which falls within the acceptable measures of 2 to 5 range.

4.9.3.3 The Comparative Fit Index (CFI)

The Comparative Fit Index differentiates the existing model fit with a fit of model that assumes uncorrelated variables and is a commonly incremental statistical measure of fit. According to Medsker et al. (1994), the generally accepted measure of fit ranges from 0 to 1 with the value of index greater than 0.90 which could be interpreted as 90% of the covariation in the data and can be reproduced by the model. From table 4.15 the values obtained for the CFI is 0.958 which falls within the acceptable range, affirming the fitness of the model.

4.9.3.4 The Tucker-Lewis Index (TLI)

The Tucker-Lewis Index (TLI) is an incremental fit indices used particularly in exploratory factor analysis especially in the aspects of linear mean and covariance structure modelling (Tucker and Lewis, 1973). By way of evaluation to set a baseline, the TLI index compares the degree of freedom of proposed and null models in order to determine the proposed model's parsimony. Just like the other indexes, TLI is also measured against a set of range before it is considered acceptable. According to Medsker et al. (1994), the TLI could range from 0 to a value greater than 0.90. From table 4.15 the value obtained for the TLI is 0.935 which falls within the acceptable range making the model fit.

4.9.3.5 The Root Mean Square Error of Approximation (RMSEA)

The root mean square error of approximation (RMSEA) is another measure by which a fit in applications of proposed model is determined. This is done by comparing the average difference per degree of freedom occurrence in a population. The traditional standard or accepted value for RMSEA should be less than or equal to 0.05. However, Medsker et al. (1994) and Tatham et al. (1998), stated that RMSEA values between 0.08 and 0.05 or less are still considered within a reasonable error of approximation and deemed acceptable. The RMSEA measure of fit is considered the most reliable, this is because it is not affected by the sample size. For this study, a combined criteria was used for the model formulation. As shown in Table 4.15 the value of 0.08 was obtained for RMSEA which was within the acceptance range making the model fit.

4.10 Structural Model Analysis

As shown in Figure 2 of the structural equation model (SEM), the coefficient paths appeared mixed. For instance, the effects of healthcare supply chain risk identification on healthcare supply performance (HCSCP) ($p>0.05$; $p = 0.08$) appeared not positive and significant, therefore bearing no support for H1. On the other hand, the paths between healthcare supply chain risk identification and healthcare supply chain 4.0 (HCSC4.0) ($p>0.05$; $p = 0.05$) appeared positive and significant, therefore bearing support for H1a.

The paths between healthcare supply chain risk assessment (RAS) and healthcare supply chain performance (HCSCP) ($p<0.05$; $p=0.01$) appeared positive and significant, therefore bearing support for H2. In a similar vein, the paths between healthcare supply chain risk assessment (RAS) and healthcare supply chain 4.0 (HCSC4.0) ($p<0.05$; 0.002) was positive and significant bearing support for hypothesis H2a.

Again, the path between healthcare supply chain risk mitigation (RIM) and healthcare supply chain performance and the path between healthcare supply chain risk mitigation healthcare supply chain 4.0 appeared mixed. The effects of healthcare supply chain risk mitigation (RIM) on healthcare supply chain performance (HCSCP) ($p<0.05$; $p = 0.024$) was significant and positive bearing support for H3. However, the relationship between healthcare supply chain risk mitigation and healthcare supply chain 4.0 (HCSC4.0) ($p>0.05$; $p = 0.423$) was not positive and significant and therefore did not bear support for H3a.

The paths from healthcare supply chain Integration (SCI) to healthcare supply chain performance (HCSCP) and healthcare supply chain 4.0 (HCSC4.0) also appeared mixed. From the analysis, the effects of healthcare supply chain integration (SCI) on healthcare supply chain performance (HCSCP) ($p>0.05$; $p = 0.664$) was not significant and positive and therefore did not bear support for H4. However, the relationship between healthcare supply chain Integration (SCI) and healthcare supply chain 4.0 (HCSC4.0) ($p>0.05$; $p = 0.048$) appeared positive and significant and therefore bear support for H4a. Also, the effects of healthcare supply chain (HCSC 4.0) on healthcare supply performance (HCSCP) ($p<0.05$; $p = 0.022$) appeared positive and significant indicating support H5.

In conclusion, the relationship between control and dependent variable was significant even though mixed. The empirical analysis showing the hypothesized relationships are shown in Table 4.16 below. From the table, only three hypothesized relationships were not supported. The relationship between healthcare supply chain identification and supply chain healthcare performance, healthcare supply chain risk management and healthcare supply chain 4.0. Finally, the relationship between healthcare supply chain integration and healthcare supply chain performance. Interestingly, the empirical analysis suggested a full mediating effect of healthcare supply chain 4.0 on healthcare supply chain risk identification and healthcare supply chain performance.

Table 4. 16 Hypotheses Results

Hypothesis Paths	Unstandardized Coefficients	Standardized Coefficients	P-Value	State of Hypothesis
RID→HCSC4.0	-0.24	-0.07	0.05	Supported
RID→HCSCP	0.80	0.20	0.08	Not Supported
RAS→ HCSC4.0	0.57	0.40	0.002	Supported
RAS→HCSCP	-0.63	-0.39	0.01	Supported
RIM→ HCSC4.0	-0.39	0.72	0.423	Not Supported
RIM→HCSCP	1.31	-0.19	0.024	Supported
SCI→ HCSC4.0	1.11	0.70	0.048	Supported
SCI→HCSCP	-0.29	-0.16	0.664	Not Supported
HCSC4.0→HCSCP	0.21	0.19	0.022	Supported

Source: Field data, 2021

4.11 Discussion of Findings

This research set out to evaluate and presents valuable insights into supply chain risk management, supply chain integration and advanced technology framework, an essential building block for analyzing healthcare supply chain resilience. Various studies highlighted and defined supply chain resilience strategies and how they impact organizational performance.

For instance, Ochieng A. (2018), defined supply chain resilience as the reactive capability post disruptive actions. Ochieng, identified supply chain collaboration, risk management culture, agile supply chain and supply chain reengineering as the most appropriate strategies for achieving supply chain resilience. In terms of impacts, their study concluded that risk management culture, supply chain reengineering, supply chain collaboration and agile supply chain collectively influences supply chain performance especially in healthcare.

Mandal (2016), defined supply chain resilience as the capacity of supply chain entities to work in concert to ensure smooth provision of medical service during periods of disruptions. The study explored the influence of development culture, group culture, rational culture and hierarchical culture as strategies for achieving healthcare supply chain resilience. They also declared positive effect of technological orientation on development, group and rational culture on healthcare supply chain resilience. The study recommended developing dimensions of organizational culture for effective risk mitigation.

Aigbogun et al. (2014), developed a framework for evaluating healthcare supply chain resilience in healthcare. The conventional risk management techniques such as risk identification, risk assessment and risk mitigation were recognized to possess the ability to identify, categorize and interpret known and quantifiable risks events in the supply chain. However, the deficiency identified with this resilience strategy was that, risks were unquantifiable, unforeseen, and unexpected and therefore recommended supply chain vulnerabilities dimensions and supply chain capabilities as the enhanced measure for healthcare supply chain resilience.

Silva et al. (2014), identified collaboration, flexibility and visibility as the necessary strategies for supply chain resilience. They explored that each of the introduced elements has a positive effects on supply chain performance which highly influence supply chain resilience of organizations.

Kamalahmadi and Mellat-Parast (2015), examined supply chain resilience through strategies such as supplier flexibility and reliability assessment. The research study emphasized the failure of organizations to incorporate risk management in their supplier selection and allocations, thereby, increasing their risks of disruptions. The study highlighted the adoption of supply risk management strategies as the most critical means to achieving seamless supply performance.

Tukamuhabwa et al. (2015), reviewed the theoretical aspect of supply chain resilience and concluded that strategies such as forming collaborative supply chain relationships, increasing flexibility, creating redundancy, and improving agility were the most effective in terms of improving firm performance.

Despite the numerous propositions of strategies and theories for supply chain resilience, especially for the healthcare, Senna et al. (2021), outlined healthcare supply chain resilience as lacking an encompassing framework. This is because, the literature on supply chain resilience measures presents varying perspectives and strategies on how to gauge resilience in organizations. So therefore, through a multi-disciplinary and integrative approach, Senna et al. (2021) developed an encompassing theoretical framework for measuring supply chain resilience in healthcare. The proposed theoretical framework has supply chain risk identification, supply chain risk assessment, supply chain risk mitigation and supply chain integration as its antecedents.

Supply chain 4.0 and supply chain performance as the mediator and the consequents respectively.

This study sought to empirically provide significant intuition into the direct and interactive effect of the antecedents, the mediator and the consequents of the proposed framework. Also, the possible effects of healthcare risk management strategies (risk identification, risk assessment, and risk mitigation) and healthcare supply chain Integration on healthcare performance was evaluated. The possible mediating role of healthcare supply chain 4.0 in the relationship between the resilience antecedents (risk identification, risk assessment, risk mitigation and supply chain integration) and healthcare supply chain performance as a consequents was also evaluated.

The proposed hypothesis of the study were as follows; healthcare supply chain risk identification positively and significantly impacts healthcare supply chain performance (H1); healthcare supply chain risk assessment positively and significantly impacts healthcare supply chain performance (H2); healthcare supply chain risk mitigation positively and significantly impacts healthcare supply chain performance (H3); healthcare supply chain Integration positively and significantly impacts healthcare supply chain performance (H4); healthcare supply chain 4.0 mediates the relationship between the antecedents (risk identification, risk assessment, risk mitigation and supply chain integration) and healthcare supply chain performance (H5). The empirical data analysis and evaluation brought to bear the following results.

The first objective of the research was to assess the extent to which risk identification as a supply chain resilience strategy impacted healthcare supply chain performance in public healthcare facilities in Ghana. The empirical results showed that, healthcare supply chain risk identification as a strategy did not have any positive and significant impact on healthcare supply chain performance and therefore the hypothesis (H1) was not supported. This results confirmed the argument of Juttner (2005), who contended that, whereas the central focus of supply chain risk management was to reduce vulnerabilities through the identification and management of risks, supply chain resilience especially in healthcare aimed at building adaptive capabilities towards unexpected supply disruptions. Simsekler and Jayaraman, (2018) and Nabelsi, (2011), recognized supply chain risk identification as significant and critical step within the realm of supply chain risk management, however, risk identification strategies are most times insufficient in influencing organizational performance because they thrive based on information and experience which are often lacking among the suppliers and their partner organizations.

Another evaluation was undertaken to assess the extent to which healthcare supply chain risk identification was impacted by healthcare supply chain 4.0 for healthcare supply chain performance in public healthcare facilities in Ghana. The empirical results showed that healthcare supply chain 4.0 impacted positively and significantly, healthcare supply chain risk identification strategy for healthcare supply chain performance and therefore, the hypothesis (H1a) was supported. This finding supports Yusof et al. (2017) and Chanchaichujit et al., (2019), who argued for and outlined some known befits for organizations who embrace emerging technologies especially in their supply management processes. For instance, interactive communication, real-time data, accurate predictions and the maximization of healthcare resources are some of the benefits that can be derived from the implementation of advanced IT.

Again, the study sought to assess the extent to which healthcare supply chain risk assessment as a strategy impacted healthcare supply chain performance in public healthcare facilities in Ghana. The empirical results showed that healthcare supply chain risk assessment had an impact on healthcare supply chain performance supporting the hypothesis (H2). This finding supports Liu et al. (2016), who affirmed the performance capabilities of risk evaluation for organizations. They argued for supply chain risk evaluation as an extremely important strategy which permits decision-makers to determine which risks to be treated with which priority and with what possible options. Vanvactor (2016), concluded that risk assessment was understanding information about risks and therefore performance impact exists in the relationship. Kern et al, (2012), observed and concluded risk assessment as major part of supply chain risk management that helps in identifying the appropriate mitigation measures.

The impact of healthcare supply chain 4.0 on healthcare supply chain risk assessment strategy in healthcare supply chain performance was also assessed. The empirical results of the evaluation showed positive and significant impact. Therefore, hypothesis (H2a) was supported. This finding confirms similar finding by Bayo – Moriones, (2013) who found information technology to impacts positively on supply chain risk management and by extension supply chain performance. Zhang (2011), also came up with a finding that suggested that information technology had influence on supply chain and supply chain performance. Technology appear to have been helping is risks assessment efforts in healthcare confirming the assertions of by Liu et al., (2016), who stated that risk assessment facilitated the decision making process by helping to determine priorities and options appropriate for risk management.

The study sought to identify the extent to which risk mitigation as a supply chain resilience strategy impacted the performance of healthcare supply chains in public hospitals. The empirical results showed that healthcare supply chain risk mitigation impacted positively and significantly on healthcare supply chain performance, confirming hypothesis (H3). This results is in line with a similar findings by Tummala and Schoenherr (2011), who found risks mitigation as a crucial component in the risk management processes. Chang et al. (2015), identified risk mitigation as essential given that supply chain risks comes from multiple sources and therefore risk mitigation strategy should be tailored to dealt with the characteristics in context. Ellis et al. (2011) and Wiengarten et al. (2016), concluded that effective risk mitigation practices are the best tools for efficient risk management in organizations.

Again, the study sought to identify the extent to which healthcare supply chain 4.0 as a mediator impacted healthcare supply chain risk mitigation as a strategy in healthcare supply chain performance. The empirical finding showed no positive and significant impact in the relation. Therefore the study did not support hypothesis (H3a). The empirical results shows healthcare facilities application of advanced ICT in risk mitigation is highly minimal. According to Senna et al. (2021), the possible reason for this is that, HCSC 4.0 requires huge capital investments and qualified workforce for implementation. However, government budgets are highly constrained for the full realization of these strategies especially that the strategies are interconnected. Even though Micheli et al, (2014), mentioned that risk mitigation with the aid of information technology lessen the likelihood and severity of supply disruptions thereby improving firm performance, this study reveals that, the impact of ICT in risk mitigation in healthcare is not visible and significant. Though a fully automated SC can generate efficiency and minimize several risks, it may as well create others (Senna et al. 2021).

The study sought to assess the impact of healthcare supply chain integration on healthcare supply chain performance. The empirical results revealed no positive and significant impact of supply chain integration on healthcare supply chain performance. Therefore, hypothesis (H4) was not supported. Supporting this study outcome is Kauppi et al. (2016), who in a study showed that enhancing SCI does not always minimize risks in the supply chain due to some environmental factors. Tang (2006), gave a possible explanation that, supply chain integration is outside the premises for SCRM thereby making the risk impact on it as a tier different. Also, the results confirms a similar findings by Zhao et al., (2013), who argued supply chain integration hindered effective supply risk management and hence organizational performance. According to their studies, supply chain integration will lead to higher risk exposure and failure rates as a result of increased interdependency between the chains. The survey responses showed substantial indications of the lack of integration among the hospital internal processes and among the external suppliers.

The study assessed the impact of healthcare supply chain 4.0 on healthcare supply chain integration as a strategy in healthcare supply chain performance. The empirical results showed a positive and significant impact of healthcare supply chain 4.0 on healthcare supply chain integration supporting hypothesis (H4a). According to Munir et al, (2020), effective information gathering and processing along an entire supply chain is the role of supply chain integration. In a similar study, Li and Sohal (2009), concluded that IT implementation enhances SC performance through its positive effect on supply chain integration. Yu et al. (2021), also asserted that advanced IT significantly promotes supply chain integration which enhances operational performance.

Finally, the study sought to assess the impact of healthcare supply chain 4.0 on healthcare supply chain performance. The empirical results showed a significant and positive impact of healthcare supply chain 4.0 on healthcare supply chain performance supporting (H5). This finding confirms Tseng et al. (2018), who argued that fourth generation (4.0) technology application in healthcare supply chain improves SC performance. Chawla et al. (2013), also mentioned that fourth generation technologies allows for valuable data to be used consistently and effectively for improvement and informed decision making in organizations. Wittenberg (2016), also found in a study that the introduction of advanced technology in industry optimizes operations and enable real-time decision making.

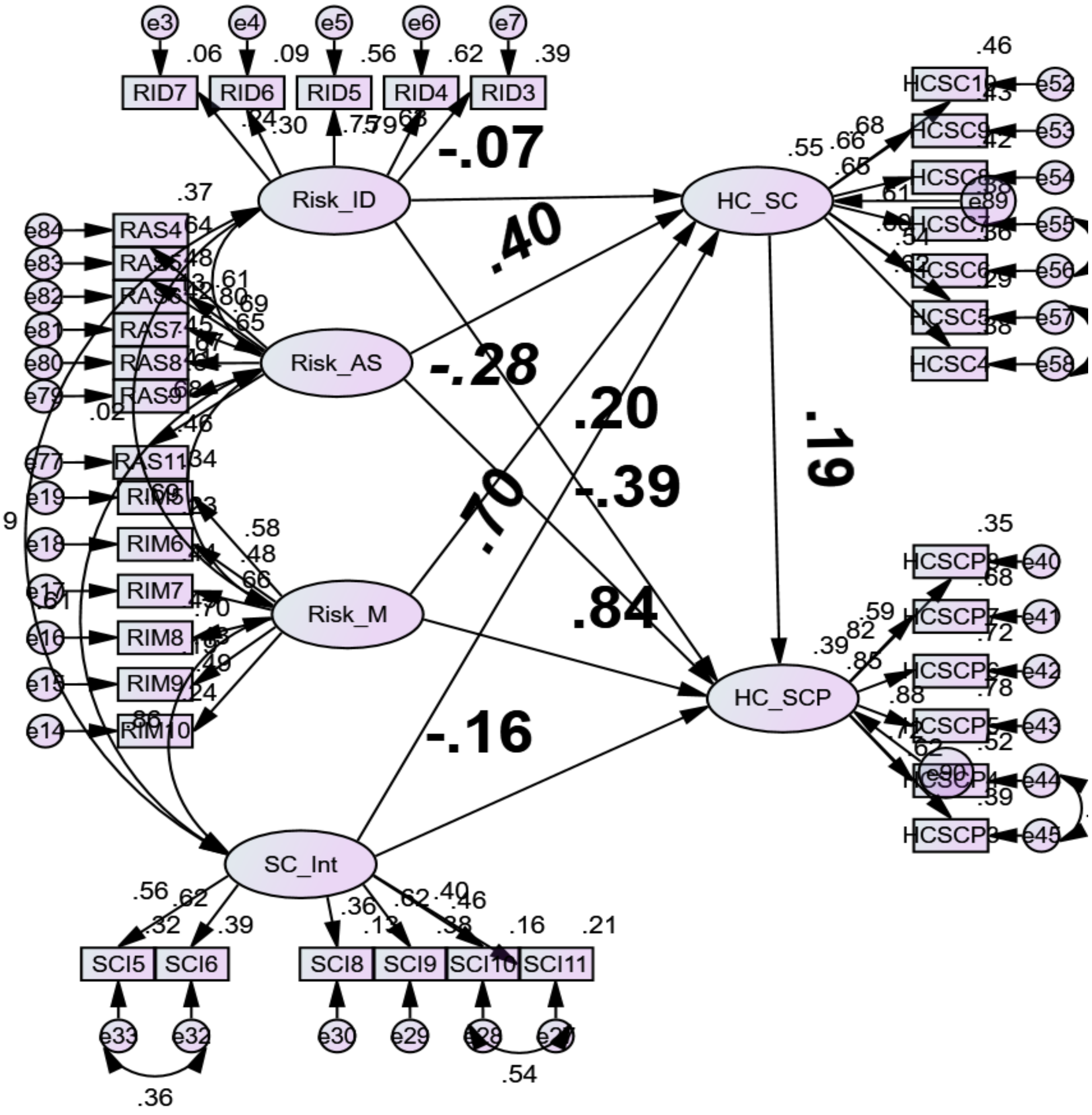
From the discussions above, the empirical evaluation of the proposed healthcare supply chain resilience antecedents, mediators and consequents showed mixed impacts. Whiles HCSCRAS and HCSCRIM strategies positively and significantly impacted HCSCP, HCSCRID and HCSCI did not show any significant impact in HCSCP. Also, through the empirical analysis, the results revealed significant impact of HCSC 4.0 on healthcare supply chain performance. It is important to mention that, the mediating effect of HCSC 4.0 on each supply chain antecedent variable (i.e. HCSCRID, HCSCRAS, HCSCRIM, and HCSCI) was not significant in terms of performance impact. The mediating effect of HCSC 4.0 in the relationship between healthcare supply chain antecedents as a whole and healthcare supply chain performance was positive and significant. Meaning that fourth generation technology had influence on the identified strategies for healthcare supply chain performance.

Generally, discussions around the role of supply chain integration and risk management and advanced information technology in maximizing supply chain performance and enhancing supply chain resilience has been minimal (Tukamuhabwa et al, 2015; Aigbogun et al, 2018; Zepeda et al, 2016; Elleuch et al, 2014; Ochieng, 2018; Kamal-Ahmadi and Mellat-Parast, 2015). However, through this study, the impact of risk identification, risk assessment, risk mitigation and supply chain integration as key enablers for supply chain resilience in healthcare showed some significance.

Again, whiles advanced technology has been acknowledged to play critical role in organizational performance (Mashreghi et al. 2018), its role in risks identification for healthcare supply chain resilience has not been fully harnessed by healthcare facilities in Ghana as shown in the data analysis. The performance benefits of advanced technology application for firms other than the healthcare sector has been highlighted by various theoretical studies (Tukamuhabwa et al, 2015; Kamalahmadi and Mellat-Parast 2015; Aigbogun et al., 2018; Jasti and Kodali 2015; Agarwal et al. 2019; Raval and Kant 2017). This study therefore advances the literature on advance technology application on healthcare supply chains. Even though, the study findings pointed out that HCSCRID did not directly and positively impact HCSCP, the performance benefits of risk management strategies has been highlighted in some studies (Jasti and Kodali 2015; Tukamuhabwa et al, 2015; Aigbogun et al., 2018).

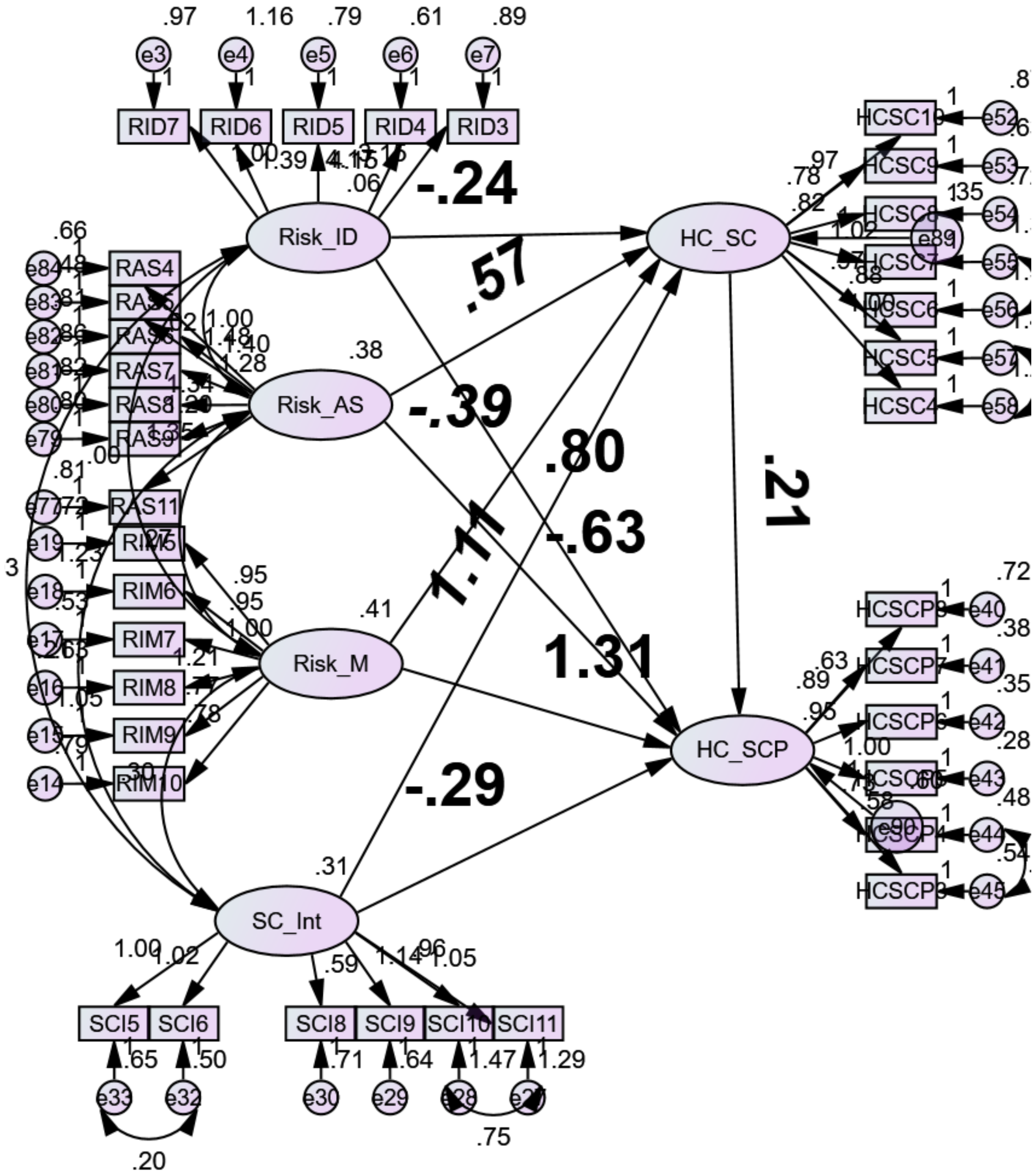
In conclusion, the impact of all the proposed factors that precede healthcare supply chain resilience framework were somehow significant on ground. However, for healthcare institutions to sustain their resilient levels, more resources and investments are required in the directions of advanced information technology and staff development. The exercise of empirically evaluating healthcare supply chain resilience, by adapting Senna et al. (2021), proposed framework as a measuring tool, suggested sufficient supply chain resilience measures in healthcare facilities in Ghana.

Figure 4.1*:* Structural Equation Model Results for the Standardized Coefficients



Source: Field Data, (2021)

Figure 4.2: Structural Equation Model Results for the Unstandardized Coefficients



Source: Field Data, (2021)

CHAPTER FIVE
SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the study findings, hypothesized results, the theoretical implication, the managerial implication, as well as the recommendations stemming from the findings and directions for future research.

5.2 Summary of key Research findings

This study sought to evaluate healthcare supply chain resilience in public healthcare facilities in Ghana using a proposed framework developed by Senna et al. (2021). In summary, the study confirmed existence of healthcare supply chain resilience measures in public healthcare facilities in Ghana. Again, the research results revealed that, the risk management and supply chain integration strategies used as measurement criteria in the proposed framework were all sufficiently present in the healthcare facilities sampled. This means, public healthcare facilities in Ghana had measures in place to be able to anticipate, adapt, respond and recover from unexpected supply disruptions with a minimal effect on healthcare service delivery. In terms of the specific objectives, the study sought to assess the impact of healthcare supply chain risk identification on healthcare supply chain performance, to assess the impact of healthcare supply chain risk assessment on healthcare supply chain performance, and to assess the mediating role of healthcare supply chain 4.0 between healthcare supply chain antecedents (risk identification, risk assessment, risk mitigation and supply chain integration) and healthcare supply chain performance. The results on the specific objectives are presented below;

5.2.1 Specific Objective 1

On the first specific objective, the empirical results showed that healthcare supply chain risk identification did not have any positive and significant impact on healthcare supply chain performance. Juttner, (2005) with a similar research finding argued that, whereas the central focus of supply chain risk management is to reduce vulnerabilities through the identification and management of risks, supply chain resilience aims at building adaptive capabilities towards unexpected events. Making a case for against this finding is Garcia (2020), who stated that, identifying the extent and nature of risks to organization as a continuous process impacts its performance and therefore risk identification as a supply chain resilience dimension can lead to a superior performance for healthcare service facilities.

5.2.2 Specific Objective 2

On the second objective, the research results confirmed that healthcare supply chain risk assessment as a strategy had a positive and significant impact on healthcare supply chain performance. This finding confirmed the works of Kern et al, (2012), who affirmed risk assessment to be an important component in the risk management processes because of its capabilities in aiding to devise the right strategies for risk mitigation which in the long run helps in achieving performance. This implied that risk assessment was key in the entire risk management processes and therefore recommended healthcare managers to uphold risk assessment measures at all times in the healthcare facilities.

5.2.3 Specific Objective 3

On the last specific objective, the empirical results showed that healthcare supply chain 4.0 played a mediating role in the relationship between healthcare supply chain antecedents' strategies (risk identification, risk assessment, risk mitigation and supply chain integration) and healthcare supply chain performance. This finding supports Kochan et al. (2017), who argued that innovation in information technology has been leveraged to improve supply chain performance due to the inadequacies of the traditional information sharing processes in supply chain. This means that the introduction of advanced technology in information sharing in the healthcare facilities improved visibility in healthcare supply chains. With that, healthcare facilities were better positioned to adjust in times of supply fluctuations and supply lead times. Which implied that healthcare supply chains was reducing inventory costs and supply shortages. Contrary to this finding Yusof, et al. (2008), argued that, the success of advanced technology in healthcare is hinged on the fit between the technology and the clinical processes.

5.3 Hypotheses

As earlier indicated, the hypothesized relationships results came out varied. The findings of the empirical analysis only supported the hypothesized relationships between healthcare supply chain risk assessment and healthcare supply chain risk mitigation. Surprisingly, the empirical analysis of the hypothesized relation of healthcare supply chain risk identification and healthcare supply chain integration on healthcare supply chain performance was not supported. Finally, the empirical analysis also suggested a full mediating effect of healthcare supply chain 4.0 in the relationship between healthcare supply chain antecedent strategies (risk identification, risk assessment, risk mitigation and supply chain integration) and healthcare supply chain performance.

5.4 Conclusion

This research is motivated largely by discussions around frameworks for evaluating healthcare supply chain resilience. Healthcare Supply chain resilience discussions have gained momentum because of the impact of unavoidable supply chain disruptions on healthcare performance (Craighead et al., 2020; van Hoek, 2020). This study is focused on empirically presenting valuable insights into strategies identified as essential building blocks for evaluating supply chain resilience in healthcare. Senna et al (2021), through a content analysis proposed a theoretical framework for evaluating healthcare supply chain resilience. However, the theoretical framework has not been empirically tested as a measuring tool for resilience especially in healthcare. This research therefore, empirically assessed the impact of the antecedent strategies (RID, RAS, RIM and SCI) on healthcare supply chain performance (HCSCP). Again, the mediating role of healthcare Supply Chain 4.0 in the relationship between the supply chain resilience antecedents (risk identification, risk assessment, risk mitigation and supply chain integration) and healthcare supply chain performance was also evaluated.

The empirical results revealed that, most of the healthcare supply chain resilience strategies in the proposed theoretical framework impacted significantly and positively on healthcare supply chain performance. This means, healthcare facilities were in some position to anticipating, adapt, respond and recover from unexpected supply disruptions with a minimal effect on service delivery. The empirical results further revealed that healthcare supply chain 4.0 played a mediating role in the relationship between supply chain antecedents as a whole and healthcare supply chain performance.

Finally, the impact of the proposed factors that precede supply chain resilience in healthcare are to a greater extent significant. This implies that healthcare supply chain resilience measures are sufficiently present in public healthcare facilities in Ghana. However, for the healthcare facilities to be able to sustain their supply performance for effective service delivery, healthcare managers must commit more resources to build supply systems and also invest in advanced information technology that are designed for supply chains.

5.5 Theoretical implication

The first main contribution of this study by way of theory is the empirical evaluation of Senna et al. (2021), which proposed theoretical framework for healthcare supply chain resilience. The research has examined the interrelationship between the variables, constructs and the measurement dimensions in the entire proposed framework and how they impact healthcare performance. For instance, the observable variables such as risk identification, risk assessment, risk mitigation and supply chain integration can be considered as the most relevant indicators and used as a standard measurement for healthcare supply chain resilience in healthcare.

Based on the empirical outcomes of this study, the proposed healthcare supply chain resilience framework can be used to identify and intensify the relationship between the factors and their relevance in maximizing the use of organizational resources and capacities. For instance, through the framework, the strength and weaknesses in risk management in the healthcare facilities can be identified and enhanced.

Per the literature sighted on the subject area, there is currently no empirical study focusing on evaluating supply chain resilience in healthcare services facilities more especially in the African context. This study addressed this call in the literature by lending empirical support for Senna et al., (2021), proposed framework as the appropriate measuring tool for healthcare supply chain resilience in the healthcare facilities. This framework can therefore be adopted as an encompassing tool for application in healthcare resilience management in facilities.

5.6 Managerial Implication

In this wake of frequent supply chain disruptions, healthcare institutions must reinvent themselves to be able to identify, adapt, respond and mitigate unforeseen threats to their performance. To be able to mitigate the effects of supply disruptions to achieve maximum performance, advanced technology and technological solutions should be adopted to complement traditional risk management processes and supply chain integration in healthcare facilities.

Though, the implementation of efficient and effective healthcare supply chain risk management practices especially with the aid of fourth generation technology comes with a huge costs as mirrored by Gu et al. (2020), the importance cannot be wished away, more especially, when external contingencies are threatening supplier outlets. Therefore, healthcare managers are encouraged to adopt advanced information technology systems across their supply chains which will aid in building the foundation for cross-inventory visibility and the capacity to shift resources quickly in times of supply disruptions. Delays or failure by healthcare managers to adopt these measures will have devastating repercussions on healthcare delivery going into the future, especially, considering how COVID -19 pandemic has generated disruptions in world healthcare supply chains.

Again, healthcare managers should also intensify efforts towards bridging the gap with their existing suppliers by intensifying coordination and information exchange by outlining their delivery and supply plans to timely increase action on medical supplies availability. Healthcare facilities should also consider expanding its activity scope by expanding the supplier networks.

Finally, Ministry of Health (MOH), Ghana Health Service (GHS) and all other regulatory agencies in the health sector develop a proactive and joint contingency plan that will clarify supply responsibilities and ensure transparent communication flow between healthcare providers and the suppliers.

5.7 Recommendations

Based on the research outcomes, the following key recommendations are suggested for adoption and implementations:

1. Healthcare facilities should think around implementing risk management strategies proactively more especially at the planning stages of the supply chain.
2. Healthcare managers should ensure a joint collaboration through supply chain integration of all supply chain partners for effective implementation of the strategies.
3. Governments and healthcare managers should invest in advanced Information Technology in managing supply chains risks to enhance supply chain resilience more especially in the healthcare sectors. In doing this, healthcare staff should also be given training and the necessary expertise on how to use fourth generation ICT to mitigate the effects of risks.
4. The researcher further recommends that the proposed framework for healthcare supply chain resilience can be used in a whole or in part as a measuring tool for healthcare supply chain performance.
5. To fully realize supply chain risks management in the healthcare sector as a means to achieving resilience, it is recommended that healthcare managers integrate all its internal processes to identify, assess and mitigate potential risks.

5.8 Suggestion for Future Studies

For future studies, this study suggests that further research should be embarked on to look at evaluating healthcare supply chain resilience in private healthcare facilities and in mission hospitals at the status of primary hospitals. This is to suggest that a larger study should be undertaken with a large sample size to cover the whole country in order that nuanced findings could be obtained that would allow for generalization of the findings. Furthermore, a comparative study of the private and public hospitals in terms of supply chain resilience can be carried out.

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APPENDIX

RESEARCH ON EVALUATING HEALTHCARE SUPPLY CHAIN RESILIENCE

QUESTIONNAIRE

Please you are invited to assist this researcher by participating in a questionnaire designed to "Evaluate healthcare supply chain resilience" in public hospitals in Ghana. This is in partial fulfilment for the award of an M.Phil. Business Administration from Department of Supply Chain and Information Systems, School of Business-KNUST. Thus, the study is strictly academic exercise and any information received from respondents would be treated with all the confidentiality it deserves. Each question involves a set of scaled choices which would require you thick in the bracket based on your opinion.
Thank you for your cooperation.

SECTION A:

1. Sex: ( ) Female ( ) Male

2. Age: ( ) < 30 years old
   ( ) 31 to 40 years old
   ( ) 41 to 50 years old
   ( ) 51 to 60 years old
   ( ) 61 years and above

3. What is the highest level of education you have acquired?
   ( ) Basic
   ( ) Junior High School
   ( ) Senior High School
   ( ) Tertiary

4. Respondent's functional role within the Supply chain
   ( ) Supply chain Manager
   ( ) Supply chain officer
   ( ) Stores Manager
   ( ) Stores Officer
   ( ) Other Specify ---

5. Number of years with healthcare facility
   ( ) 0 -1 Year
   ( ) 1-3 Years
   ( ) 3-5Years
   ( ) 5-Above year

6. Number of years in current position
   ( ) <5 Years
   ( ) 6 to 10 Years
   ( ) 11 to 15 Years
   ( ) >15 Years

SECTION B

This section solicits response from participants and this research instrument is informed by relevant variables and theoretical considerations of this research. The constructs and variables considered here are healthcare supply chain risk identification, risk assessment, risk mitigations and healthcare supply chain Integration (SCI). The others are the healthcare supply chain risk management, healthcare supply chain 4.0 and healthcare supply chain performance.
All the responses to the questions in this instrument are close ended and a Likert-scale mode of response is demanded here.
1-Strongly Disagree, 2-Disagree, 3-Neither agree nor disagree, 4-Agree, 5-Strongly Agree,
6-Don't Know.

I. Healthcare Supply Chain Risk Identification (RID)

1-Strongly Disagree, 2-Disagree, 3-Neither agree nor disagree, 4-Agree, 5-Strongly Agree, 6-Don't Know.

Healthcare Risk Identification (RID): ***Factors and actions that can disrupt the hospital's medical supplies and affect healthcare delivery services.***		**SCALE**					
		1	**2**	**3**	**4**	**5**	**6**
Promotion of risk Identification practices (Hospital, Suppliers, Patients)	1). The hospital has standard mechanism for identifying risks (supply disruptions) E.g. supplier monitoring, risk mapping etc.						
	2). Complaints from patients, supplier or internal staff is a risk identifying factor in the hospital.						
	3). Demand uncertainties or forecasting challenges is a risk identification factor in the hospital.						
	4). Stock-holding capacity challenges is a risk identification factor in the hospital.						
	5). Financial challenges is a risk identification factor in the hospital.						
	6). Past supply incidents and result are used as risk identification factors.						
Supplier Accountability	7). The hospital and suppliers have formal agreements in place which holds them accountable against supply breaches.						
Information Management	8). Information from external sources such as health alerts, media news, etc. is a risk identification factor for the hospital						
	9). Advanced notifications from suppliers on supply disruptions is a risk identification factor for the hospital.						

Source: Developed by Researcher (2021)

II. Healthcare Supply Chain Risk Assessment (RAS)

1-Strongly Disagree, 2-Disagree, 3-Neither agree nor disagree, 4-Agree, 5-Strongly Agree, 6-Don't Know.

Healthcare Risk Assessment (RAS): *Involves the identification of risk-taking events in the supply chain system and helping to know which of the events to pay more attention in order to avoid supply disruptions for the hospital*		**SCALE**					
		1	**2**	**3**	**4**	**5**	**6**
Key Process Indicators and visibility	1). The hospital has a risk register.(operational, technical, legal, financial & environment risks)						
	2). All the supply risk factors are made visible to all the hospital stakeholders.						
	3). The hospital prioritizes supply risks based on severity and frequency of supply disruptions.						
	4). Past events is used as basis for assessing supply risks (supply disruptions).						
Risk events monitoring	5). The hospital performs analysis on causes for supply risks.						
	6). The hospital has notification systems for risks assessments.						
	7). Identified supply risks are analyzed using a procedure (qualitative or quantitative).						
	8). The hospital monitors indicators of national supply risk for planning.						
	9). Stakeholder engagements on supply risk assessment are always held and documented.						
	10). Departments within the hospital provides adequate inputs for risk assessment actions.						
Risk register and Mapping	11). The hospital has a standing risk assessment team in place.						
	12). The hospital has identified and mapped the key indicators of supply risks.						
	13). The hospital has a risk assessment register.						
	14). The hospital allocates financial resources for risk assessment activities.						
	15). The hospital promotes continuous training for the risk assessment team members.						

Source: Developed by Researcher (2021)

III. **Healthcare Supply Chain Risk Mitigation (RIM)**

1-Strongly Disagree, 2-Disagree, 3-Neither agree nor disagree, 4-Agree, 5-Strongly Agree, 6-Don't Know.

Healthcare Risk Mitigation (RIM): *Methods of dealing with unexpected supply disruptions in the hospitals in order to reduce the adverse impact on service delivery.*		**SCALE**					
		1	**2**	**3**	**4**	**5**	**6**
Capacity	1). The hospital has a unit responsible for coordinating supplies (buffer inventory).						
	2). As a mitigating measure, the hospital has made financial provision for restocking outside their supply chain.						
	3). The hospital has an action plan (schedule, responsible, resources and indicators) for risk mitigation.						
	4). There is cross employee training across the hospital supply chain risk mitigation.						
	5). The hospital has reliable alternative sources of supply in times of supply disruptions.						
	6). The hospital has a standing mitigation response team for supply disruptions.						
Information	7). There is effective communication across the supply chain as risk mitigation measure.						
	8). Departments within the hospital collaborates on risk mitigation issues at all times.						
	9). The action plan for supply risk assessment is strictly followed by the hospital.						
Logistics	10). The hospital has reliable supplies at all times.						
	11). The hospital has clear safety procedures on supplies.						
	12). The hospital can back-up supplies when the need arises.						
	13). There is lack of visibility concerning placement and availability of stock.						
	14). The hospital has sufficient storage space for holding enough volumes of stock as a mitigation measure.						

Source: Developed by Researcher (2021)

IV. **Healthcare Supply Chain Integration (SCI)**

1-Strongly Disagree, 2-Disagree, 3-Neither agree nor disagree, 4-Agree, 5-Strongly Agree, 6-Don't Know.

Healthcare Supply chain Integration (SCI): *Developing along the whole supply chain, an effective information gathering, and processing system having the adequate capability to timely process and apply the information gathered from the external environment*		**SCALE**					
		1	**2**	**3**	**4**	**5**	**6**
Collaborative SC Risk Management	1). There is continuous collaboration among the hospital's internal departments on supply disruptions.						
	2). The hospital continuously collaborate with Patients' for feedback on service delivery and effective risk management.						
	3). Supply chain Integration helps the hospital in the implementation of Supply chain risk management practices.						
	4). Due to stakeholder collaboration, there is risk sharing among the hospital and the suppliers.						
Information Sharing	5). There is continuous information sharing between the hospital and its outside suppliers.						
	6). There is continuous information sharing between the hospital's departments on supplies.						
	7). General systems Integration has facilitated efficient and effective flow of information between the hospital and its suppliers.						
	8). The integration is fostering continuous supply replenishment.						
Joint Decision Making	9). There is collaboration on stock-levels in the hospital.						
	10). The hospital and its external suppliers have a joint supply evaluation team for decision making on supplies.						
	11). The hospital has inter department supply evaluation team for decision making.						
	12). Integration has facilitated efficient and effective decision making on supplies for the hospital.						
Supply Chain Visibility	13). The hospital has electronic system for tracking supply orders.						
	14). The hospital and their suppliers have a common electronic platform for supply decision making.						

Source: Developed by Researcher (2021)

V. **Healthcare Supply Chain Risk Management (SCRM)**

1-Strongly Disagree, 2-Disagree, 3-Neither agree nor disagree, 4-Agree, 5-Strongly Agree, 6-Don't Know.

Healthcare Supply Chain Risk Management (HSCRM): *Coordinated efforts in identifying and managing supply chain risk in order to reduce supply chain vulnerabilities*		**SCALE**					
		1	**2**	**3**	**4**	**5**	**6**
Continuous Education Programs	1). The hospital continuously promotes training of its personnel on supply chain risks management.						
	2). There is collaborative trainings on supply chain risk management between the hospital and their suppliers.						
Multi skilled Workforce	3). There are personnel with formal roles dedicated to supplies risk management activities in the hospital.						
Strong Collaboration with Government agencies	4). The hospital deals with suppliers who are licensed under the laws of Ghana government.						
	5). Government agencies play collaborative roles between the hospital and their suppliers.						
	6). Financial provisions are made by Government towards the hospital's supplies.						
Quality Management Systems	7). The hospital has measures in place for checking against counterfeiting in medicines supplies.						
	8). The hospital has measures in place for checking quality of medicines supplies.						
	9). The hospital has adequate facilities in place against medicines perishability.						
	10). The hospital operates a collaborative risk management strategy supplies quality.						
	11). The hospital management plays key roles in quality managing in supplies.						

Source: Developed by Researcher (2021)

VI. Healthcare Supply Chain 4.0 (HCSC 4.0)

1-Strongly Disagree, 2-Disagree, 3-Neither agree nor disagree, 4-Agree, 5-Strongly Agree, 6-Don't Know.

Healthcare Supply Chain 4.0: *The transformation of the healthcare systems by automating parts of the hospital's supply operations through ICT such as big data, internet of things and artificial Intelligence (AI)*		**SCALE**					
		1	**2**	**3**	**4**	**5**	**6**
Process Automation	1). The hospital has deployed ICT infrastructure in their daily operations.						
	2). Stock management in the hospital is done using ICT.						
	3). The internal supplies order processes of the hospital is automated.						
	4). The external supply order processes of the hospital is fully automated						
Internet of Things (IoT)	5). The hospital and its suppliers have a common ICT platform for stock management information exchange.						
	6). Evaluation committee meetings for the hospital are sometimes done virtually.						
	7). The hospital uses the drone technology to order some supplies.						
	8). The information and network infrastructure of the hospital has a back-up.						
Security	9). The hospital has staff with dedicated roles on ICT management.						
	10).The supplies department has tracking system for stock-management in the hospital.						
	11). The hospital has real-time data on medicine supplies and usage.						
Compliance	12). There are binding agreements on information and data sharing between the hospital and their suppliers.						
	13). There are standard regulations on information and data sharing between departments in the hospital.						
	14). Data on medicines supplies are standardized between the hospital and their suppliers.						

Source: Self Developed (2021)

VII. **Healthcare Supply Chain Performance (HSCP)**

1-Strongly Disagree, 2-Disagree, 3-Neither agree nor disagree, 4-Agree, 5-Strongly Agree, 6-Don't Know.

Healthcare Supply chain Performance (HSCP)*: The delivery of services in a responsive manner that meets the end-customer needs*		**SCALE**					
		1	**2**	**3**	**4**	**5**	**6**
Low levels of SC Vulnerabilities	1). There is continuous supply of medicines to the hospital.						
	2). Disruptions in medicines supply are detected in advance due to risk management measure in place in the hospital.						
	3). There is minimal occurrence of drugs and products perishability in the hospital due to management measures.						
	4).There is minimal occurrence of pilfering and wastage of supplies due to technology and risk management measures in place in the hospital.						
Quality Management	5). Due to Risk and ICT measures in place, there is minimal chances of the hospital receiving sub-standard medicines from suppliers.						
	6). Due to Risk and ICT measures in place, there is minimal chance of receiving counterfeit medical supplies.						
	7). Due to Risk and ICT measures in place, the hospital maintains quality data on current and past supplies.						
Improved Patient satisfaction	8). Patients' treatments in the hospital is devoid of medicines shortages.						
	9). There is high sense of patient satisfaction in the hospital.						
	10). The quality of service delivery in the hospital is high.						

Source: Developed by Researcher (2021)