EFFECT OF HEALTH COMMODITY SUPPLY CHAIN RISK MANAGEMENT PRACTICES ON HEALTH COMMODITY SUPPLY CHAIN PERFORMANCE: THE CASE OF ETHIOPIAN PHARMACEUTICAL SUPPLY SERVICE IN ETHIOPIA.

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A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY SCHOOL OF COMMERCE LOGISTICS AND SUPPLY CHAIN MANAGEMENT UNIT IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ART DEGREE IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT.

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Logistics and Supply Chain Management program

This is to certify that Daniel Teferi's thesis, "**Effect of health commodity supply chain risk management practices on health commodity supply chain performance: the case of Ethiopian pharmaceutical supply service in Ethiopia.**" has been submitted in partial fulfillment of the requirements for the Master of Art degree in Logistics and supply chain management. It complies with university regulations and meets accepted standards in terms of originality and quality.

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DECLARATION

I, the undersigned, hereby declare that this thesis, titled "**Effect of health commodity supply chain risk management practices on health commodity supply chain performance: the case of Ethiopian pharmaceutical supply service in Ethiopia.**", is my original work and has not been presented in any other university or collage for the award of a degree, and that all sources of materials used for the thesis have been properly acknowledged.

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CERTIFICATION

This is to certify that Daniel Teferi worked under my supervision on the thesis "**Effect of health commodity supply chain risk management practices on health commodity supply chain performance: the case of Ethiopian pharmaceutical supply service in Ethiopia.**", This work is original and can be submitted in partial fulfillment of the requirements for the award of the Masters of Arts in Logistics and Supply Chain Management.

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ABSTRACT

Health Commodities Supply Chain Risk management is a risk assessment and treatment process that is critical to improving the various aspects of health commodities supply chain management performance. Ethiopian pharmaceutical supply service (EPSS), as the sole supplier of program health commodities and the primary supplier of Revolving Drug Fund health commodities to all public health facilities in Ethiopia, should prioritize health commodities supply chain risk management because any risk will have an immediate impact on availability of vital medicines and human life. The aim of this study is to assess effect of HCSCRM practices on EPSS's HCSC performance. The study used explanatory research design. A combination of stratified and simple random sampling were used, and 126(91.3%) responses were obtained. The collected data were analyzed using both descriptive and inferential statistics such as percent, mean, standard deviation, correlation and linear regression. The results revealed that supplier risks poses a much higher risk in EPSS supply chain, followed by demand risks, process risks and finally environmental risks. The risk analysis across national EPSS, central, and hubs shows supply risk is a greater concern at the hubs, whereas demand risk is the priority risk in the central EPSS. Based on the correlation result supply risks, demand risks, and process risks, strongly negatively correlated with HCSCM performance of EPSS and all risk categories are statistically significant. Whilst HCSCR assessment practices and treatment practices were strongly positively correlated with the HCSCM performance of EPSS. Finally, the study discovered that organizational barriers have a significant effect at the central EPSS than the hubs whereas technological barriers pose more effect on the hubs than the center. Regression analysis detected that supply risks, demand risks, and process risks all have a significant negative impact on performance. EPSS only used the HCSCRM to a limited extent, but it has a positive effect on performance when implemented properly. As a result, it is recommended that the organization may intensify systematizing and implementing the risk assessment and management strategies developed by the organization in 2021.

Keywords: Supply Chain risks, risk management, Performance, barriers of risk management

LIST OF ABBREVIATIONS AND ACRONYMS

ARVs	Anti-retroviral
AHP	Analytical Hierarchy Process
CSCMP	The Council of Supply Chain Management Professionals defines
EPSA	Ethiopian Pharmaceutical Supply Agency
EPSS	Ethiopian Pharmaceutical Supply Service
FMEA	Failure Mode and Effects Analysis
FP	Family Planning
HCSCM	Health Commodities Supply Chain Management
HCSCRM	Health Commodities Supply Chain Risk Management
HIV	Human Immunodeficiency Virus
LMIS	Logistics Management Information System
LSCM	Logistics and Supply Chain Management
IPLS	Integrated Pharmaceutical Logistics System
MNCH	Maternal, Newborn, and Child Health
MOH	Ministry of Health
NCD	Non-communicable Diseases
NTD	Neglected Tropical Diseases
PFSA	Pharmaceutical Fund and Supply Agency
PSCM	Pharmaceutical Supply Chain Management
RDF	Revolving Drug Fund
RPN	Risk Priority Number
RSV	Risk Score Value
SCM	Supply Chain Management
SCRM	Supply Chain Risk Management
SPSS	Statistical Package for Social Sciences
TB	Tuberculosis
USAID	The United States Agency for International Development
WHO	World Health Organization
WTO	World Trade Organization

CONTENTS

CHAPTER ONE

1. INTRODUCTION

This chapter presents background of the study, problem statement, research objectives, research questions, scope of the study, delamination of the study, limitation of the study, significance of the study, definition of terms and study organization.

1.1. Background of the study

Supply chain management has evolved over time to meet the changing needs of the global supply chain (GlobalTranz, 2015). To operate at peak efficiency, the supply chain networks must work seamlessly. Failure to recognize potential vulnerabilities can jeopardize the supply chain's ability to deal with unexpected and sudden shocks (Lund *et al*, 2020). Understanding risk both within and outside the supply chain allows an organization to more clearly identify its options for optimizing the supply chain to ensure viability and strength (Shahbaz, 2017).

Supply chain risk management is a formal approach used to identify and mitigate the sources of disruption and dysfunction within the supply chain(Watson & Mccord, 2015). To manage risks, organizations must identify the types and sources of the risks, analyze the impact and likelihood of these risks occurring, and implement interventions (Watson *et al.,* 2021). There is substantial evidence that failing to effectively manage supply chain risks can have a significant negative impact on organizations (Mitchell, 1995), and the health commodities supply chain is no exception, in fact, it has additional negative consequences on human life (Kafumukache, 2019).

The health commodities supply chain is a complex multi-tiered system comprised of public and private organizations such as private distributors, governmental warehouses, and non-governmental organizations (Kafumukache, 2019). Health commodities supply chain efficiency contributes to commodity security as well as to the success or failure of any public health program in a variety of ways, including increased program impact, improved quality of care, and improved cost effectiveness and efficiency (Deliver, 2011).

EPSS, formerly known as PFSA then EPSA, is a governmental pharmaceutical procurement and supply agency established by Proclamation No. 553/2007 (PFSA, 2017). Its mission is to provide high-quality pharmaceuticals to public health facilities at an affordable cost in a sustainable

manner (EPSA, 2020). It is in charge of the healthcare supply chain in the public sector and all of its key functions, such as forecasting, procurement, warehousing, and distribution of medicines, medical supplies, diagnostic chemicals and reagents, and medical equipment. In addition, the Organization is working to reduce national pharmaceutical waste and improve pharmaceutical distribution to service delivery points. Today, its activities constitute an annual turnover of almost USD 1 billion (EPSA, 2020). The Organization operates through eleven central warehouses and 19 branch warehouses, which serve over 3,800 health facilities, which in turn serve more 105 million people. In 2010, the Organization implemented The Integrated Pharmaceuticals Logistics System to integrate program pharmaceutical supply management and the Revolving Drug Fund, as well as to improve end-to-end stock visibility (FMOH, 2015; PFSA, 2017).

Understanding the levels and gaps of SCRM in EPSS is essential for the Organization and the Ministry of Health to improve access to essential health commodities for the people of Ethiopia (USAID GSHC-PSM, 2020).

1.2. Problem statement

Risks in the health commodities supply chain are mainly associated with shortages and wastage. Medicine stock outs/shortage has negative economic, clinical, and humanistic consequences for patients (Phuong et al., 2019). Whereas medicine wastage due to expiry, damage, lost, obsolete, or unsafe for use not only reduces therapeutic benefit but also has a negative impact on financial capability (Gebremariam et al., 2019). Health commodities are too expensive to buy in bulk to avoid stock outs but doing so also increases the risk of wastage (Jaberidoost et al., 2013a)

According to various studies, the top risks contributing to health commodities stock shortages and wastage are supply and supplier risks, organizational risks, product discontinuity, loss of cold chain integrity, product perishability, poor performance, counterfeit, and technological incapability. (Kafumukache, 2019; Faisal, 2013; Carlos, et al., 2021; Moktadir et al., 2017; Mokrini et al., 2016).

Recently, it was unearthed that one of the environmental risks, the Covid19 pandemic, contributed to the HCSCM crisis by causing a drop in trade of between 13% and 32%, resulting in a critical shortage of medicines in the US and Europe because more than 40% of active ingredients were

imported from abroad, and in Africa, trade volumes are expected to fall by 8% for exports and 16% for imports in 2020. (Mirchandani. 2020; Tirivangani et al., 2021).

Ethiopia's HCSCM system has several flaws, including non-availability, unaffordability, ineffective storage and inventory management, and irrational use (PFSA, 2015). According to Sisay et al., 2021, Mohammed et al., 2021, and Kefale & Shebo, 2019, stock outs of essential medicines at public health facilities continue to be a problem, ranging from 10 to 74 percent. On the other hand, 2 to 8 percent of medicines are still thrown away as a result of poor SCM practices.

In EPSS, two studies were conducted in 2016 and 2021. The studies revealed that poor risk identification, increased supplier risk, poor supply chain risk management implementation, and numerous barriers to implementing supply chain risk management all contributed to frequent shortages and stock outs of health commodities. Inability to meet customer demand, lead time variability, poor logistics performance of suppliers, and forecasting errors are also high-risk score categories. EPSS risk management practices were in their infancy, according to some of respondents (Mengistu, 2016; Tamire et al., 2021).

EPSS, as the sole supplier of program health commodities, and as the primary supplier of RDF pharmaceuticals to all public health facilities in Ethiopia, should prioritize SCRM in the health commodities supply because any risk will have an immediate impact on availability and human life. Nonetheless, according to some directorate interviews, EPSS lacks a dedicated department, team, or responsible directorate in charge of implementing SCRM, as well as a clear risk management strategy or system (EPSA, 2021).

As of the best of my knowledge there have been only two studies conducted at EPSS attempted to analyze SCRM practices. The first article has limited its scope to the central EPSS and operational directorates and believing reforms has occurred after which cannot show current and entire picture. The other research appears to be more comprehensive than the first but also focuses on EPSS's clusters rather than individual hubs. It considers the working environments of the previous PFSA and the reformed EPSS to be the same. Furthermore, only 25% of total participants were from the center, where major supply chain activities such as sourcing, contract management, and CC are performed, and it focuses on higher-level officials rather than lower-level workers where day-to-day risks are managed. Given the gaps identified and the fact that neither study covered all aspects, the aim of this study was to gain a more realistic understanding of how risk management is carried

out in EPSS's health commodities Supply Chain in order to provide some insight by balancing workload proportion and work force stratification. It will also serve as the basis for a larger research project.

1.3. Research question

With the aim of achieving the objective of the research, the study attempted to answer the following basic questions

1) What are the potential supply chain risks in EPSS's HCSCM?
2) What HCSCRM practices are in place to be resilient to HCSCM risks at EPSS?
3) What is the effect of health commodity supply chain risks on EPSS's health commodity supply chain management performance?
4) What are the major barriers affecting HCSCRM practices in EPSS?

1.4. Research Objective

1.4.1. General Objective

The general objective of this research is to assess the effect of health commodity supply chain risk management practice on EPSS's health commodity supply chain management performance

1.4.2. Specific Objectives

This research was conducted with specific objectives in mind:

1. To analyze potential health commodities supply chain risks that affect EPSS.
2. To assess the current health commodities supply chain risk management practices of EPSS.
3. To examine the effect of Health commodities supply chain risks on EPSS's Health commodities supply chain management performance.
4. To identify the major barriers that EPSS faces in implementing health commodities supply chain risk management.

1.5. Scope of the study

Given the various entities involved in the health commodities supply chain network, as well as a variety of perspectives on the SC process and numerous stakeholders, it is critical to establish research boundaries early on in order to develop valuable insights.

The geographic scope of this study was limited to the case of EPSS. It included all risks associated with core supply chain aspects such as quantification, procurement, warehousing and inventory management, distribution and fleet management, LMIS, financial, and human resource activities over the last three years, since its transition to EPSS. Major activities such as tendering and contract management are only practiced at the center, and due to the current security situation, time, and budget constraints, the study only focused on value-added and accessible hubs; sixteen hubs were studied (Annex 3). It started with the procurement plan and end with dispatch to the health facility via catchment hubs. However, no risk assessments was conducted at the supplier or health facility levels. The study attempted to conceptualize, explore, and describe EPSS's SCRM practices. The study identified major risks and challenges in EPSS SCRM implementation, as well as assessed risk identification, estimation, evaluation, mitigation, and monitoring and evaluation of mitigation practices.

1.6. Delamination of the study

This study has the potential to go as far as designing a strategy for identified risks by prioritizing them, as well as involving all pharmaceutical supply chain networks with EPSS, but due to time, budget, and the scope of the study, this study only implemented a descriptive case study at a point in time and recommendations were drawn. Which may not show chained and coiled risks occurring in EPSS for a longer period of time. And, for the same reasons stated above, objectives such as assessing the impact of risks on the Organization were not included.

1.7. Limitation of the study

This study might be vulnerable to respondent bias, in which individuals who participated in the study may not answer the respective questions based on the actual practice on the ground because they assumed that the failure was due to their poor performance, and some respondents might answered to purposefully advocate the program.

Today's supply chains are too complex and interconnected to study from the perspective of a single firm; therefore, a larger network must be studied to better understand the firm's position. However, suppliers, regulatory bodies, customer level and other stakeholders were not included in this study. This could have an adverse effect on the generalizability of results across the entire HCSCRM practice. Because of time and resource constraints, this study did not consider risk identification based on expert opinion, and there was little room to accommodate issues raised by respondents because much of the information was gathered from literatures and pretests and presented as closed-ended questions.

1.8. Significance of the study

Apart from its contribution to academic subject development, this study will have the following major implications. It attempted to identify EPSS's major risks and explored various supply chain risk mitigation practices in order to gain an understanding of the implications of those practices in EPSS's overall operations. As a result, the Organization will be able to re-examine which supply chain risks are most prominently affecting their supply chain, and the company will be able to design practical strategies for making appropriate improvements and taking action to mitigate those risks. Its contribution may extend to stakeholders and other non-pharmaceutical supply chain organizations in the country in visualizing risk assessment and risk control practices in order to reduce supply chain risks and improve product accessibility. Furthermore, it exposed the researcher to new avenues of investigation and future problem-solving activities. Finally, it will be useful for other researchers who are inspired to conduct additional research on the areas of supply chain risk mitigation practices in pharmaceutical supply chain management.

1.9. Definition of terms/Operational terms

Commodity security: is when clients have the products whenever and wherever they need them (Deliver, 2011).

EPSS National: The Ethiopian pharmaceutical supply service both the central and the Hubs

EPSS Central: The Ethiopian pharmaceutical supply service excluding the hubs

EPSS hubs: The 15 Ethiopian pharmaceutical supply service branches found in different regions

Program health commodities: Essential pharmaceutical products used in the diagnosis and treatment of specific diseases identified by the MOH as a major public health issue and used in exempted services. Examples include TB/Leprosy, ARVs, anti-malarials, FP products, drugs used to treat Ois, NTDS, and NCDs, and so on (FMOH, 2015).

RDF: are pharmaceutical products that are purchased, stored, and distributed entirely through a revolving drug fund (EPSA, 2017).

Supply chain risk evaluation and management: It is a formal approach used to identify and mitigate the sources of disruption and dysfunction within the public health supply chain (Watson & Mccord, 2015).

Supply chain risk: It is all about the variance that occurs during the distribution of the outcomes, likelihoods, and subjective values of a given supply chain (Project, 2013).

The Organization: Ethiopian pharmaceutical supply service

1.10. Organization of the study

The research is divided into five chapters. Introduction, background of the study, background of the study area, statement of the problem, objective of the study, basic research questions, delimitation of the study, limitation of the study, significance of the study, scope of the study, definition of terms, and organization of the study are included in Chapter One. Under the second chapter the relevant literature to the study and conceptual framework are discussed. The third chapter contain the research design, study participants, data sources, data collection instruments, data collection procedures, and data analysis methods. The fourth chapter present results, discussion, and interpretation. Finally, in the fifth chapter, a summary of findings, conclusions, recommendations, and future study suggestions are included.

CHAPTER TWO

2. REVIEW OF RELATED LITRATURE

This review will go over theoretical and empirical SCRM issues. The theoretical review will examine existing theories (concepts or whole) on supply chain risk management and their relationships to each activity within it. While previous studies attempting to answer SCRM practices will be reviewed in the empirical literature review. In addition, a conceptual framework for the study will be developed to define the study's relevant variables and map out how they may relate to one another. Most of the information in the literature review is obtained from published articles, books, governmental and nongovernmental websites, newspapers, proclamations, and conference papers.

2.1. Theoretical literature review

2.1.1. Supply chain risks

Risk is a critical concept in many scientific fields, but there is no agreement on how it should be defined and interpreted. ISO 9001:2015 defines risk as to the effect of uncertainty on an expected result. Risk, as defined by Wikipedia, is the possibility of something bad happening. Which entails uncertainty about the effects/implications of a particular activity in relation to something that human's value. According to Aleksandar and Radenko's 2015 review of risk definitions, some definitions are based on probabilities, others on expected values, some on uncertainty, and others on objectives. As a result, some define it as a measure of probability and the weight of undesirable consequences, while others define it as the product of probability and severity, among many other things. As a result, they stated that there is still an ongoing debate about how risk should be defined and the validity of various definitions. The term "risk" refers to future events and their consequences. The concept of 'risk' was invented by humans, so there is no such thing as 'real risk' or 'objective risk'.

The supply of medicine as a strategic product is a top priority in any health system. Every day, a lot of people work in the health commodities supply chain to ensure that clients and patients in public health facilities receive the products they require. In all of the HCSC activities and operations, including quantification, procurement, storage, distribution, inventory management, and reporting the supply chain is almost always vulnerable to risks such as limited procurement ability due to funding issues, longer lead time due to supplier issues or operations delays, natural

and man-made/artificial disasters impeding distribution channels, staff incompetence to handle operations, expiration and stock outs as a result of over and under forecasting, and many more (Watson & Mccord, 2015;Jaberidoost *et al.*, 2013b;Kafumukache, 2019).

The aforementioned risks disrupt the supply of health commodities in a variety of ways, including their quantity and quality, as well as their delivery to the right place and customers at the right time, resulting in increased morbidity and mortality due to a lack of access to essential medicines. Therefore, risk management is highly recommended in the supply process of pharmaceutical supply chain management ((Jaberidoost *et al.*, 2013a; Gómez & España, 2020).

2.1.2. Supply chain risk management Processes

Supply chain risk management is a formal approach used to identify and treat the sources of disruption and dysfunction within the public health supply chain. Risk management can assist organizations in ensuring the quality and availability of health commodities for their customers(Watson & Mccord, 2015). It foresees hazards and manages risk through a continuous process of risk awareness, reduction, or acceptance. It increases the likelihood of achieving supply chain objectives, reduces costs and improves overall efficiency of supply chain operations, improves supply chain governance and leadership, increases customer and stakeholder confidence and trust in the supply chain, and focuses the supply chain manager on proactively managing risk rather than only reacting to unforeseen events (Project, 2013). The risk management process involves the systematic application of policies, procedures and practices to the activities of establishing scope, context and identification, risk assessment, risk treatment, and monitoring and Evaluation (Gómez & España, 2020).

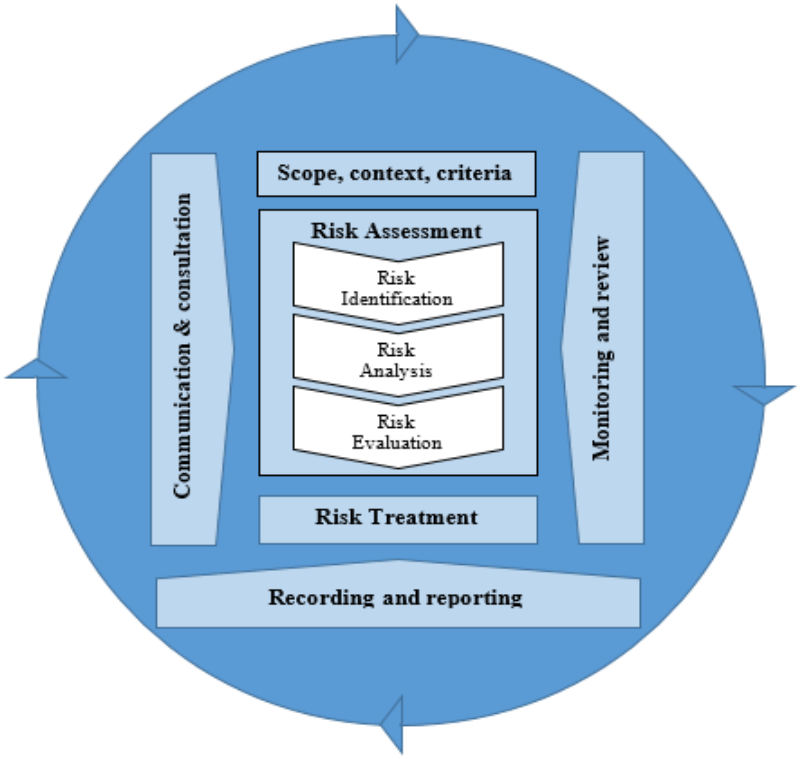


Figure 2.1.5.1.: Supply chain risk management processes
Source: ISO 31000, 2018

2.1.1.1. Establishing the scope, context and criteria

The purpose of establishing the scope, the context and criteria is to customize the risk management process, enabling effective risk assessment and appropriate risk treatment. It addresses the circumstances in which a supply chain operates (Deliver 2011). By establishing the context, the objectives, scope and criteria for the remaining risk management process are defined. This addresses both company external and as well as internal factors, the role of the risk management process with the company as well as the basic criteria used to evaluate risks. The main input provided to the risk identification process is the scoping of risk causes and impacts (Project, 2013)

2.1.1.2. Risk assessment

A. Risk Identification

Risk assessment is a systematic process of organizing information to support a risky decision to be made within a risk management process. It consists of the identification of hazards and the analysis and evaluation of risks associated with exposure to those hazards. According to ISO 3100 Analysis of the risk would include clarifying the nature of the risks, identifying the causes,

knowing the likelihood of occurrence and the possible impact of these incidents. It is composed of the measurements of probability and impact. Likelihood measures the probability that the event will occur based on historical data and expert opinion at a specified time horizon while impact measures the consequences on the organization by financial measures or scales (Breen, 2008). Risk assessment is the degree of risk analysis associated with increasing danger to determine which areas and activities are most vulnerable within the supply chain. Risk assessment includes there steps, including risk identification, analysis and evaluation (Oehmen *et al*., 2010).

Risk Identification is the process of determining what, how, why and where things may happen (Deliver 2011). This step consists of identifying sources of risks, area of impact and, events with their cause and consequences. The step create a comprehensive list of risks based on events that have a significant influence on the achievement of the objectives (EPSA, 2021).

A.1 Sources of supply chain risks

According to Shahbaz *et al*., 2019 there are various perspectives for developing risk sources, i.e. supply chain risk sources can be divided into two main categories: internal risks/operational risks and external risks/disruption risks. Internal risks are further subdivided into operational activities, such as information risks and capacity issues, customer demand, and quality issues. External risks can also be further classified as competition, economic issues, political insecurity, natural disasters, and terrorist attacks. According to Shahbaz *et al*., 2019, sources of supply chain risks can be classified in three different clusters: (i) Environmental risks: - those external to the supply chain, (ii) Network-related risks, and (iii) Organizational risks: - which cannot be predicted with certainty and affect the supply-chain- outcome variables. Other literature categorize risks sources as Pipeline-related Incidents, Environment-related Incidents, and Stakeholder-related Incidents (Watson & Mccord, 2015).

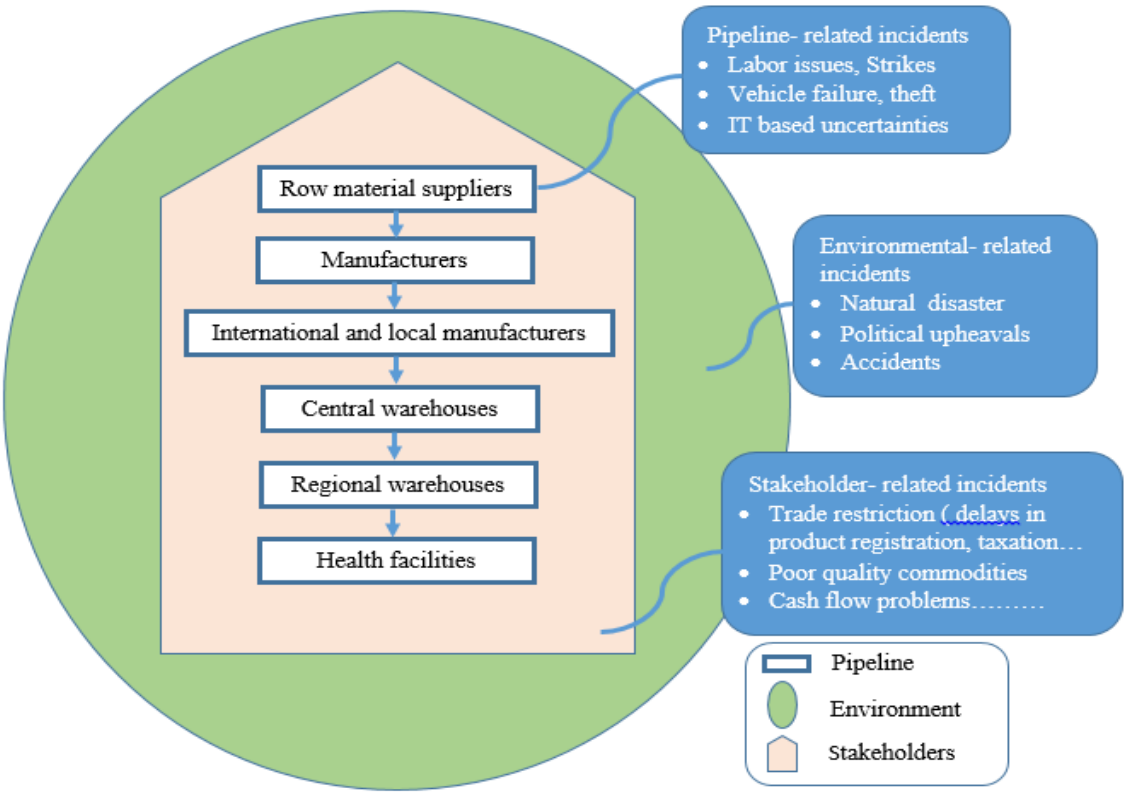


Fig: 2.1.4.1. Areas to examine for sources of supply chain risk
Source: Watson & Mccord, 2015

B. Risk analysis

The analysis of the risks identified previously develops a deeper understanding of these risks. It generates the necessary information for a correct evaluation of the risk and for the development of effective treatments (Watson & Mccord, 2015). At the following step as risk analysis, level of risk in terms of severity of hazard, the likelihood of occurrence and detection should be estimated that provides a quantitative idea of each risk (Kaur & Singh, 2018). Risk analysis should consider factors such as: the likelihood of events and consequences; the nature and magnitude of consequences; complexity and connectivity; time-related factors and volatility; the effectiveness of existing controls; sensitivity and confidence levels.

Risk Assessment matrix		Probability				
		Almost certain	Likely		Unlikely	Rare
Severity	Catastrophic	**Extremely high**	**Extremely high**	**Extremely high**	High	Medium
	Critical	**Extremely high**	**Extremely high**	High	Medium	Medium
	Moderate	High	High	Medium	Low	Low
	Negligible	Medium	Medium	Low	Low	Low
		Risk Assessment Code				
		Extremely high =1 High = 2 **Medium = 3** Low = 4				

Stop, Mitigation required

Mitigation needed consider stopping

Mitigation recommend

Possible acceptance, Mitigation optional

Figure: *2.1.5.3.2.1. : Risk Assessment Matrix*
Source: *The Global Risks Report 2021*

C. Risk Evaluation

Risk evaluation determines whether the risk is tolerable or not and identifies the risk that should be accorded the highest priority in developing responses for treatment (Jaberidoost *et al.*, 2015). Based on the information gather in the risk analysis, decisions are made regarding which risk need treatment and the priority of the risk treatments. It uses the criteria that were defined during the establishment of the context (EPSA, 2021). This can lead to a decision to: do nothing further; consider risk treatment options; undertake further analysis to better understand the risk; maintain existing controls; and reconsider objectives (ISO 31000, 2018).

D. Risk treatment

Determining risk treatment strategy: reducing or avoiding risk, developing contingency plans (Project, 2013). Justification for risk treatment is broader than solely economic considerations and should take into account all of the organization's obligations, voluntary commitments and stakeholder views. The selection of risk treatment options should be made in accordance with the organization's objectives, risk criteria and available resources (ISO 31000, 2018). When selecting risk treatment options, the organization should consider the values, perceptions and potential involvement of stakeholders and the most appropriate ways to communicate and consult with them. Though equally effective, some risk treatments can be more acceptable to some stakeholders than to others. It involves assessing different treatments, assessing the resulting residual risk and

deciding whether additional risk treatment necessary to achieve the intended risk reduction. The supply chain network consists of trade-offs interrelated by monetary, information, and material flows(Gurtu & Johny, 2021).

According to Kaur & Singh, 2018 Risk treatment handling options include

- Avoid: Adjust program requirements or constraints to eliminate or reduce the risk. This adjustment could be accommodated by a change in funding, schedule, or technical requirements.
- Control: Implement actions to minimize the impact or likelihood of the risk.
- Transfer: Reassign organizational accountability, responsibility, and authority to another stakeholder willing to accept the risk.
- Watch/Monitor: Monitor the environment for changes that affect the nature and/or the impact of the risk.

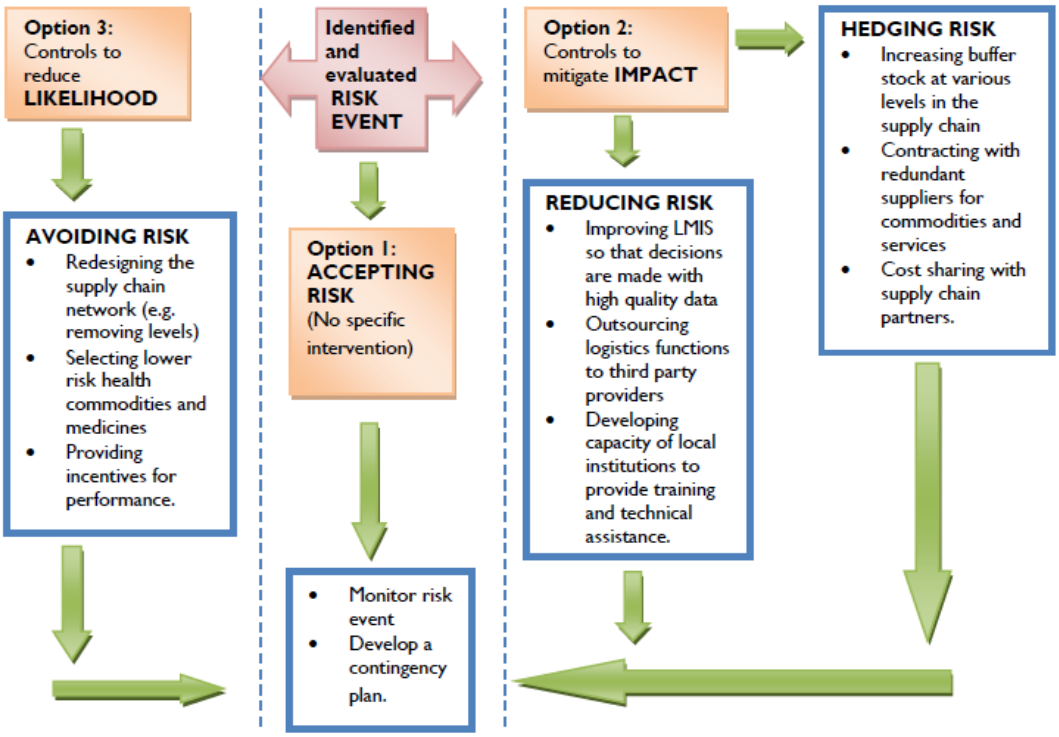


Figure 2.1.3.4.1.: Selecting Risk Treatment Strategies for Health commodities supply chain
Source: *Project 2013*

Health commodities supply chain managers must learn skillset in order to improve the efficiency and effectiveness of HCSC programs. To improve the risk treatment capabilities of their supply chains, they must first understand the current SCRs. Risk-mitigation practices include prioritizing the supply and quality of medicines, minimizing losses, adequate storage and handling, working in collaborations between the MOH and pharmaceutical companies, and waste minimization approaches (Jaberidoost *et al*., 2015; Moktadir *et al*., 2017).

E. Monitoring and review

The purpose of monitoring and review is to assure and improve the quality and effectiveness of process design, implementation and outcomes (Oehmen *et al*., 2010). Interacts with the identified risks, including the identification of emerging risks, are monitored and reviewed, so changes to their evaluation and treatment can be made if necessary. It interacts with all other risk management process to enable process control and improvements (Jaberidoost *et al*., 2015).

F. Communication and consultation

Communication and consultation with external and internal stakeholders should occur at all stages of the risk management process. It should facilitate the exchange of necessary information as well as the coordination of stakeholders and their perceptions throughout the risk management process. For the various process steps it mainly focus on: objectives, scope, and criteria (establishing the context); risk sources, consequences, and related events (identification); analysis method and data generation (analysis); judgment of evaluation criteria (evaluation); and appropriate treatment measures (treatment) (Oehmen *et al*., 2010). The risk management process begins with understanding the context of the health program.

2.2. Empirical literature review

2.2.1. Health commodities supply chain risks

Globally abundant amount of article could be found which focuses on supply chain risks management with a focus on health commodities; among them some review studies in supply chain risk management with a focus supply chain logistics, Jaberidoost *et al*., 2013b; Carlos 2021; Wang, 2018; Kafumukache, 2019; Etemadi, *et al*., 2021). Manufacturing firms risk management practices Zameer, 2017, quality assurance; Kumar, & Jha, 2018, and enterprise risk management (Rogachev, 2008). In Ethiopian context there are articles focus on supply chain risk management

to mention some, Mestawet, 2020; Yoseph, 2017; Yeshewas, 2020, Mekonnen 2019 and but only three articles specifically work on PSC risk management Tamire *et al.*, 2021, Neguse S., & Jebena, T 2019 and Mengistu 2016 as to my knowledge.

According to Etemadi *et al*., 2021, a large number of supply chain risk management articles were published in 2019 but drastically decreased in 2020.

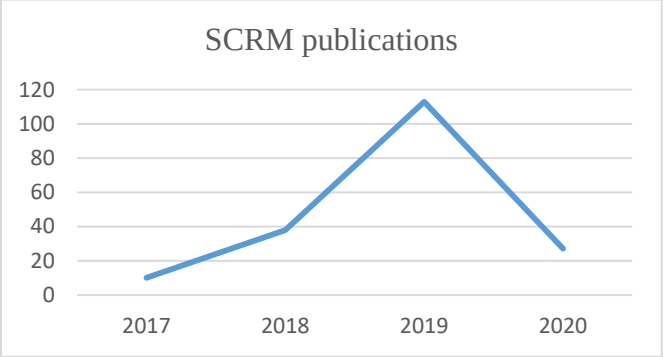


Figure 2.2.: Distribution of articles over time by year of publication
Source: *Etemadi, et al., 2021*

Supply chain risks have always existed in the process of balancing supply and demand. A literature review titled "A Novel Classification of Supply Chain Risks" classified supply chain risks into two categories: internal risks/operational risks and external risks/disruption risks. Internal risks are classified as operational activities, and these include information risks and capacity issues, customer demand, and quality issues. Competition, economic issues, political instability, natural disasters, and terrorist attacks are examples of external risks. In addition, he categorizes supply chain risks as supply risk, process risk, demand risk, and environment risk by combining an environmental, network-related, and organizational risk classification perspective with internal to the firm, external to the supply chain, and external to the firm classification perspectives (Shahbaz *et al*., 2019).

Two studies found that the majority of risks in the pharmaceutical supply chain were internal risks caused by poor process, people, and function management, which could be managed with appropriate mitigation strategies (Jaberidoost *et al*., 2013b; Mokrini *et al*., 2016).

According to Gomez and Espana 2020, identified risk factors in the health commodities supply chain include, but are not limited to, complex global supply chain networks, increased demand for

just-in-time deliveries, the outsourcing trend, constantly changing customer demand, and a reduction in supplier base, to name a few. (Gómez & España, 2020).

PwC, 2013 Survey participants ranked the most significant risks to their supply chain as 53% Raw material price fluctuation, 47% Currency fluctuations, 41% Market changes, 38% Energy/fuel prices volatility, 34%Environmental catastrophes, 28% Raw material scarcity, 26% Rising labor costs, and 22% Geopolitical instability(PwC, 2013).

Moktadir *et al*., 2017 conducted a study in Bangladesh that identified 16 risks using an extensive review of the literature and the Delphi method. Supply-side risks such as fluctuating import arrivals, a lack of information sharing, supplier failure, and material shortages were prioritized over operational, financial, and demand-side risks. The AHP was used to prioritize risks as they related to the supply, organizational, financial, and demand sides, in that order.

According to Yoseph, 2017, Ethio-telecom supply chain operations were primarily impacted by demand-side risks such as unexpected volatile demand and distorted information, supply-side risks such as poor logistics delivery system of suppliers and poor logistic service of third-party service providers, and quality-related, administrative barriers, capacity risks, and currency problems.

Tamire *et al.,* identified nine risks and classified them into six groups in his assessment of Pharmaceutical Supply Chain Risk Management at EPSS in 2021. Among these, supply and demand side risks have the greatest impact on supply chain operations. High risk score categories include suppliers' inability to meet customer demand, lead time variability, and poor logistics performance (Tamire *et al*., 2021). Another study also showed a higher supplier risks existed in the same organization (Mengistu, 2016).

2.2.2. Health commodities supply chain risk management practices

2.2.2.1. HCSC risk assessment practices

a) HCSCM risk identification practices

Several research papers report on risks in the health commodities supply chain, with some attempting to quantify or measure them. Supply and supplier issues, fragmentation, delivery reliability, information flow, quality management system, inventory management, customer service disruption, research and development, worker skill, planning, organization and processes,

company strategies, production cost and waste management, fiscal management, currency rate, logistic, demand, regulations are some of the topics that have been identified as sources of risk for HCSC in previous studies. (Tamire *et al.*, 2021, Jaberidoost *et al*., 2015; Carlos *et al*., 2021; Charpentier, & Flachaire, 2021).

In a Critical Risk Assessment and Management conducted in Pharmaceutical Industry respondents' ranked good communication on the top followed by Clear communication/ feedback and Organizational adaptation/ culture/ structure as a good strategy of risk identification. Risks have also prioritized as regulatory risk is more frequently encountered risk in the pharmaceutical industry followed by Relationship risk, Resource risk and operational risk. The study also revealed that 58.33% of respondents don't think that they have realistic expectations about their project job, for 50% there are critical skills in the project for which no one is identified and 41.67% people think that don't have tools in place. (Zameer, 2017).

In a study conducted at the Ethiopian Shipping and Logistics Service Enterprise, the organization has a formal supply chain risk identification Process but rarely performs risk identification (Mestawet, 2020).

According to Mengistu 2016, EPSS used risk identification methods to a limited extent, with risk estimation being the better employed, followed by previous risk, brain storming sessions, developing a risk register, and surveys. In another study conducted in EPSS, Ethiopia, revealed that the majority of respondents, 44.6 % agreed that the Organization's risk management practice is in its infancy. Risk estimation, previous risk assessment, and brainstorming sessions have been discovered to be effective risk identification methods (Tamire *et al*., 2021).

b) HCSCM risk analysis practices

HCSC risks, their identification, and their impact are determined by the position of the companies in the chain, as well as the level of analysis they can perform (Faizal, 2014). Carlos *et al*., 2021 by applying the queries in the ontology, the main Risks in transport and storage in pharmaceutical companies were identified and prioritized by FQFD methodology. Improper fleet followed by primary packaging material failures, Poor pest control in storage warehouses and transport vehicles, and Poor packaging are the most critical risks and therefore, those that must be addressed as a priority by the company.

In a critical risk assessment and management in Pharmaceutical Industry conducted revealed that Good leadership and clear communication and organization culture were determined to be the most important critical success factors for implementation of risk analysis practices (Zameer, 2017).

As stated at the outset of the empirical review, studies were conducted in Ethiopia on the SCRM process and practice for both health and non-health commodities. According to the findings of the Heineken brewery study, the factory has experienced risks associated with demand side, supply side, bureaucratic, infrastructure, and catastrophic risks. The key supply chain risks affecting the organization are known and documented by the organization but they are not well categorized/profiled as high, medium & low (Yeshewas, 2020).

In a risk assessment study conducted in Ethiopian Shipping and Logistic Service Enterprises revealed that majority of the respondent have moderate stand about the organization ability to prioritize its main supply chain risks (Mestawet, 2020).

c) HCSCM risk evaluation practices

The risk evaluation was based on three factors: the probability of risks, the hazards of risks on each supply chain function, and the priority of managing supply chain functions. The AHP group decision making method was chosen for prioritizing supply chain functions, and a rating scale was chosen for scoring the hazard of risks on supply chain functions and the probability of risks in the Iranian pharmaceutical industry. (Jaberidoost, *et al*., 2015).

A study conducted at the Ethiopian Shipping & Logistics Service Enterprise found that there was insufficient risk assessment practice and process, that very often followed the procedure to conduct the assessment, and that there was less emphasis on continuous review of the evaluation process during the supply chain risk evaluation stage (Mestawet, 2020).

2.2.2.2. HCSCM risk treatment practices

Enablers of risk treatment in the health commodities supply chain, according to Faisal, include information sharing that improves demand visibility across the supply chain, trust among supply chain partners, responsive supply chain, collaborative relationships among supply chain partners, strategic risk planning, and supply chain IT enablement (Faisal, 2013). When risks have been identified as requiring action, a decision will be made as to whether the health program and stakeholders require each risk to be controlled. It is technically, safely, and economically feasible

for the health program to reduce each of the risks, but there is a possibility that new risks will be introduced as a result of efforts to control the current risks. Accepting risk, avoiding risk, reducing risk, and hedging risk are the four general responses to supply chain risk (Kaur *et al*., 2018).

Two risk treatment actions were proposed in a study on Operational Risk Management in the Pharmaceutical Supply Chain Using Ontologies and Fuzzy QFD to mitigate and eliminate the main risks identified (improper fleet and primary packaging material failures). One, establish quality assurance programs that include procedures for certifying that all operations have been carried out in accordance with the applicable requirements, standards, and procedures. Two, create checklists that allow for the most thorough inspection of the vehicle's condition both before and after cargo entry (Carlos *et al*., 2021).

A peer review of Quality risk management during pharmaceutical 'good distribution practices' was conducted. It demonstrated that a quality risk treatment principle is well exercised during pharmaceutical good manufacturing practices, whereas the same principles are not diligently followed during good distribution practices (Kumar, & Jha, 2018).

In A study carried out at the Ethiopian Shipping and Logistics Service Enterprise discovered that the organization is capable of conducting and implementing risk treatment measures to ensure effective supply chain risk management (Mestawet, 2020).

According to a study conducted at the Heineken brewery Kilinto site, the most common risk treatment practices that are used are developing supply chain contingency plans, conducting supplier capacity assessment and qualification screening, and building long-term relationships with key suppliers (Yeshiwas, 2020).

Most Ethiopian pharmaceutical manufacturing firms used SCRM practices such as supply chain flexibility, supply chain collaboration, supply base rationalization, supply chain control, and supply chain avoidance to varying degrees. SC Collaboration was the most commonly used of the five SCRM practices, followed by SC Avoidance and SC Control, in that order, while SC Flexibility and Supply Base Rationalization were the least used. The study's main finding was that among SCRM practices, SC Flexibility, SC Collaboration, and SC Control had a significant impact on the supply chain performance of manufacturing firms (Neguse S., & Jebena, T 2019).

A PFSA SCRM study found a lack of supply chain risk management implementation, with supplier geographical distance, insufficient technology, poor communication across a supply chain, and a lack of supply chain management knowledge cited as frequently occurring barriers to adopting supply chain risk management (Mengistu, 2016).

Another study conducted in EPSS, Ethiopia, revealed that the majority of respondents, 44.6 % agreed that the Organization's risk management practice is in its infancy. Risk estimation, previous risk assessment, and brainstorming sessions have been discovered to be effective risk identification methods. Inventory optimization (29.9 %), sales (22.4 %), and operation planning tools are the most commonly used risk management tools (27.6 %). Overall, risk management strategies are being implemented at a lower rate than the national average. Supply side, process, and control risks all have a negative impact on supply chain performance, whereas risk management practices have a positive impact (Tamire *et al.*, 2021).

2.2.3. Effects of HCSC risks on the HCSCM performance

The aforementioned risks (supply risk, process risk, demand risk, and environment risk) disrupt health commodity supply chain in a variety of ways, including quantity and quality, as well as delivery to the right place and customers at the right time, resulting in increased morbidity and mortality due to a lack of access to essential medicines. As a result, risk management is highly recommended in the pharmaceutical supply chain management supply process (Jaberidoost *et al*., 2013b; Shahbaz *et al*., 2019).

Risk management involves at least risk assessment (risk identification, risk anlysis and risk evaluation) and risk treatment (Gómez & España, 2020). Risk management is not only leads to process optimization, productivity increase and minimizing business risk, but also will help health systems to meet goals of supply chain management; Accessibility, Quality and Affordability which has much influence on economic, social and political effect of the country (Gómez & España, 2020; Jaberidoost *et al*., 2013b) Risk management also plays an important role in other aspects of Pharmaceutical's handling, such as prescription drug management (highly regulated) and rational use of medicines. (WHO, 2021).

Based on the literature review, the following hypothesis are developed:

H1: The higher the supply risk, the lower the HCSC performance

H2: The higher the process risk, the lower the HCSC performance

H3: The higher the demand risk, the lower the HCSC performance

H4: The higher the environment risk, the lower the HCSC performance

H5: The higher the risk assessment practice, the higher the HCSC performance

H6: The higher the appropriateness of risk treatment practice, the higher the HCSC performance

2.2.4. Barriers in HCSCRM implementation

There are numerous internal and external factors that impede SCRM implementation (Christopher & Lee, 2001). According to a study conducted by Amato in 2014, the top five barriers to Enterprise risk management progress were: competing priorities, chosen by 51% of respondents, insufficient resources, 43%. Lack of perceived value (41%), perception of Enterprise risk management adding bureaucracy (33%), and lack of board or senior executive Enterprise risk management leadership (30%). In reality, any company that imports pharmaceuticals that have a direct impact on human life and have a high financial cost is expected to assess potential risks, but many companies still do not perform risk assessments due to a lack of time, resources, focus, follow-through, and a true risk assessment methodology (Fulford, 2017).

A study conducted by Mengistu, 2016 identifies increased costs, poor communication across the supply chain, insufficient technology, a lack of management support, supplier geographical distance, and a lack of supply chain management knowledge as potential barriers to the implementation of SCRM mitigation strategies.

H7: The higher the barriers to implement HCSCRM practices, the lower the HCSC performance

2.3. Conceptual framework of the study

The conceptual framework section on health commodities supply chain risks affecting a firm was adapted from Shahbaz *et al*., 2019 supply chain risk assessment categorization, in which the most common supply chain risks were identified and categorized based on their sources. Concerning supply chain risk management practices, it was adapted from ISO 31000, 2018, which

recommended possible supply chain risk management practices developed by various experts, scholars/empirical researchers in the field of supply chain risk management.

Given the existence of various risks with varying sources, probability of occurrence, and magnitude of consequences, an SCRM should be part of the management strategy of the given organization, and it is also an element of the conceptual framework of this research. The conceptual framework SCRM begins with identifying existing risks from various sources and rating their relative importance to the Organization's operations, followed by identifying used SCRM tools used for identifying these risks, and identifying potential barriers that impede SCRM implementation and progression. As a result, the conceptual framework of this research considers factors such as communication and consultation, establishing the scope, context, and criteria, risk sources, risk assessment method, risk treatment methods, Monitor and Review SCRM practices and potential barriers in implementing SCRM as deciding factors in controlling the SCR mitigation capability of EPSS.

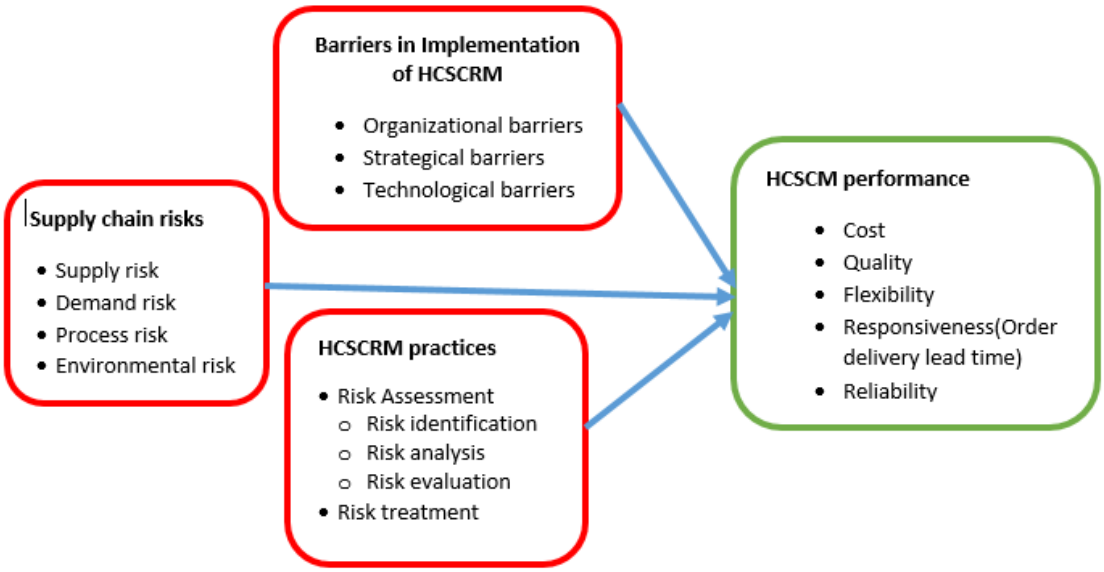


Figure: 2.3.1.: Conceptual frame work of the study

Source: Owen survey, 2022

2.4. Identified literature gaps

Several works have been completed in recent years by various scholars in the PSC area, specifically on understanding of concept, production and distribution system, availability/flow of medicines, and policy development (Jaberidoost *et al*. 2013; Carlos, 2021; Etemadi *et al*., 2021).

Nonetheless, there is a scarcity of research that has explicitly developed a thorough and sound risk management framework for evaluating integrated SCRM (e.g., risk factor identification, risk assessment, and risk mitigation) performance in the public healthcare sector, particularly with regard to physical flows (Wang, 2018).

In Ethiopia, there have also been completed scholar articles in the area of supply chain risk management practices of organizations (Mestawet, 2020; Yoseph, 2017; Yeshewas, 2020, Mekonnen 2019), but only three articles specifically work in relation to health commodity supply chain risk management practices of organization. As of my knowledge, Tamire *et al.*, 2021 completed SCRM on PSC at EPSS and its cluster, Mengistu 2016 at the central EPSS, and Neguse S., & Jebena, T 2019 on SCRM piracies on selected pharmaceutical industries of Ethiopia. This chapter attempted to review previous SCRM research and identify research gaps, particularly with regard to healthcare supply chain risk management (HCSCRM). Due to a lack of comprehensive studies on HCSCRM, this research focuses on how SCRM practices have been implemented in EPSS in order for the findings to be applied to healthcare supply chain contexts.

CHAPTER THREE

3. METHODS OF THE STUDY

This chapter presents the methodological aspects of the research. It discusses the study area, research design, research approach, population and sample design, data source and type, data collection procedure, method of data analysis and presentation, and Ethical considerations.

3.1. Description of the study area

The study was conducted at EPSS, with a particular emphasis on the operation directorates at the center and hubs that meet the inclusion criteria. The central EPSS operation directorates include the quantification and market shaping directorate, the tender directorate, the contract management directorate, the warehouse and inventory management directorate, and the distribution and fleet management directorate, Quality control and assurance and policy, plan, monitoring and evaluation directorate. The hubs are home to the Quantification and market shaping directorate, the Warehouse and inventory management directorate, and the Distribution and fleet management directorate. EPSS is an ideal location to study health commodities supply chain risk management, which is the focus of this paper, because it serves both program and RDF pharmaceuticals for over 3800 public health facilities across the country through its eleven central warehouses and 19 hubs (EPSA, 2017).

3.2. Research design

The study is primarily explanatory nature and it describes, contrasts, and analyze the current situation and practice in relation to the identified problem. Descriptive design enables the researcher to study the elements to be studied in their current state without modifying them, and it answers the question of "how" supply chain risk management is implemented in EPSS. The explanatory type was help explain why risks occur and predict future occurrences. It also helps to characterize the nature and direction of the relationship between supply chain risks and supply chain risk management practices of EPSS.

3.3. Research approach

The study adopted quantitative as well as a qualitative research approach. The quantitative research approach is expressed numerically and used to test or confirm theories and assumptions. This

method can aid in the establishment of generalizable facts about potential supply chain risk, SCRM practices, and barriers to implement HCSCRM activities. Though not much used in this research, a qualitative approach is expressed in words and used to comprehend concepts, ideas, or experiences. It enables the gathering of in-depth insights on topics that are not well understood and cannot be numerically explained (Streefkerk 2019). As a result, combining these approaches allowed the researcher to gain a comprehensive understanding of EPSS's health commodity supply chain risk management practices.

3.4. Population and Sample Design

The total target population is estimated to be around 2800 people. The central EPSS has 148 employees who work in the directorates that directly manage the EPSS's supply chain management operations. Of the 19 EPSS hubs Dessie, Kebridahar, Shire, and Mekele hubs were excluded from the study due to inaccessibility by the time of data collection. The remaining 15 hubs were included in the study, with an average operation worker of 14 people. Since the hubs only have three operational directorates, namely Quantification and Market shaping, and Warehouse and Inventory management, and distribution and fleet management two participants from each hub was included in the study. In total, 30 participants was invited to be a part from EPSS hubs. The Central EPSS's sampling size is calculated using a formula adapted from Israel (Israel, 1992). As a result, the following formula is used to calculate sample size: -

$n = N/ (1+N I^2)$ Where:

N = is the total population = 148

n = is the sample from the population

e = is the error term, which is 5% (i.e., at 95% confidence interval)

$n= 148/ (1+148(0.05)^2) = 108$ target respondent

Hence, the total sample from both hubs and central EPSS were be 138. The total sample is stratified according to the number of professionals employed in each Operational directorate (see the table below).

Table 3.4.1: Sample representation (Stratification by operation directorate)

Directorate	Number of Employee	Sample size from the directorates
Quantification and market shaping	20	20* 108/ 148 = 14
Tender Directorate	15	15* 108/ 148 = 11
Contract management Directorate	32	32* 108/ 148 = 23
Warehouse and inventory management	49	49* 108/ 148 = 35
Distribution and fleet management	12	12* 108/ 148 = 9
Quality management directorate	9	9* 108/ 148 = 6
Policy, plan, monitoring and evaluation directorate	6	6* 108/ 148 = 6
Delivery unit	5	5* 108/ 148 = 4
Central EPSS Total	148	108
EPSS hubs total		2*15 = **30**
Total participants		138

Source: Own study, 2022

3.5. Data source and type

The study used primary data which data was gathered using a pre-designed questionnaire. It was gathered through the distribution of questionnaires, which was filled out by professionals working in each of EPSS's responsible directorates. In this study secondary data was used in substantiating and triangulating the data obtained from primary sources and it was gathered from available company reports, published records such as textbooks, journals, magazines, company manuals, and procedures pertaining to EPSS's supply chain risk management practice. Overall, the data was regarded as useful for making comparisons and evaluating data. In this thesis, secondary sources of information were annual reports, books, journal articles, online data sources, and the Organization's webpages. E-newspapers, e-journals, and e-books were also considered as secondary data sources for this study.

3.6. Data collection Procedure

A structured questionnaire was used as the primary research tool in this study to collect primary data. The questionnaire was composed of at five sections. The first section contain general information, the second seek to identify the main supply chain risks, the third determine EPSS's supply chain risk assessment and risk treatment practices, the forth tried to capture the effects of supply chain risks on performance and the final section seek to identify the challenges to implementing appropriate supply chain risk management practices. There were both open-ended

and closed-ended questions on the questionnaire. When users don't have to type as much, closed-ended questions yield higher response rates. In addition, answers to closed-ended questions can be easily statistically analyzed. The closed-ended questions were the rating scale variety, with the goal of identifying supply chain risks, establishing evaluation, analyzing risks and treatment practices, and identifying the challenges in implementing supply chain risk management practices at EPSS. Long-form, open-ended questions allow the respondent to elaborate on their thoughts.

The questionnaire was pilot tested and revised in response to the gaps discovered, mostly type errors. It was then distributed to selected directorates and professionals who are directly involved in EPSS's pharmaceutical supply chain management and supply chain risk management practices before being collected and analyzed.

3.7. Method of data analysis and presentation

SPSS version 26 was used to process the quantitative data collected. The responses of the participants were interpreted using descriptive statistics such as percentage, frequency, interquartile range, median, and mean, as well as inferential statistics such as independent samples test and regression, and the results were presented in tables and graphs.

The Failure Modes and Effects Analysis (FMEA) method was used to evaluate and prioritize the supply chain risks identified in this study. The risk priority number (RPN) was calculated for each identified risk by multiplying its occurrence, severity, and detection score in EXCEL 2013 with SPSS output as input. And also the risk score value was calculated by multiplying occurrence and severity. Then Pareto's principle was followed to categorize the top priority risks (Charpentier & Flachaire, 2021).

Responses from qualitative sources was analyzed thematically using a triangulation strategy. The summarized data was interpreted in light of the research questions raised and the research objective in order to reach a meaningful conclusion and draw recommendations.

3.8. Validity and Reliability test

It is critical to consider reliability and validity when developing a research design, methods, and writing up results, especially in quantitative research (Middleton, 2021). Reliability and validity are concepts used to assess the quality of research. They indicate how well a method, technique,

or test measure something. The investigator tried to develop the questionnaire in such a way that the validity and reliability of the instruments are maintained in this study.

3.8.1. Validity

The accuracy of a measure is referred to as its validity. The majority of the study questionnaires was developed based on previous research and was pretested to ensure accuracy. In addition, most of the questionnaires were based on a review of literatures (Sharma, S. K., & Bhat, A., 2012; Ambe, I. M. 2014; Tamire *et al.,* T. 2021; Mengistu, W. 2016; Mestawet A. 2020). Furthermore, data triangulation, methodological triangulation, and theory triangulation was done in order to check and establish the validity of this study and increase its accuracy (UNAIDS, 2010). Data triangulation was performed to confirm the consistency of results obtained from various data sources. Methodological triangulation was carried out using various analytical methods such as qualitative and quantitative research approach to ensure that the results are consistent. It helps to reduce the flaws and biases that any single method introduces. Finally, theory triangulation was employed by using multiple hypotheses when investigating supply chain risks and management practices at EPSS.

3.8.2. Reliability

The consistency of a measure is referred to as its reliability. The researcher pilot tested the questionnaire to obtain valuable feedback from respondents and made adjustments based on the feedback. In addition to the pilot test to determine the consistency of the tool's output, the internal consistency of the questionnaire was tested using Cronbach's alpha reliability measurement scales (See the table below). Cronbach's alpha is a measure of reliability associated with the variation accounted for in the true score of the underlying construct, and it can only be calculated for variables with more than one measurement question. A value 0.5 is considered adequate, while.70 and above is good, .80 and above is better, and .90 and above is considered best (Chelsea, 2015).

Cronbach's alpha scores for the questionnaire items range from 0.749 to 0.957, which is within the acceptable range. As a result, the instrument's reliability accounted for an overall Cronbach's alpha coefficient of 0.966, indicating that the instrument was found to be reliable.

Table 3.8.2.1. : Cronbach alpha coefficient of the data collection tool used for HCSCRM analysis of EPSS, Ethiopia, 2022.

Section	Cronbach alpha	Number of Items
Supply risk	0.908	57
Demand risk	0.910	39
Process risk	0.957	99
Environmental risk	0.810	15
HCSCRM practices	0.870	37
HCSCM Performances	0.819	20
Potential barriers to implement HCSCRM	0.749	13
Over all (Total)	0.966	280

Source: Own study, 2022

3.9. Ethical Considerations

Permission was obtained from EPSS prior to data collection using a written support letter from the School of Commerce (Annex 5). Respondents was well informed about the purpose and benefits of the study, as well as their full right to refuse or accept participation, during the distribution of the questionnaire. Furthermore, on the first page of the questionnaire, the participant was informed that their response will be kept confidential and will only be used for academic purposes.

CHAPTER FOUR

4. RESULTS, DISCUSSION, AND INTERPRETATION

The data analysis and research findings are presented in this chapter. It begins with the response rate, then moves on to HCSC risks that are rated and analyzed using the FMEA method, EPSS's HCSCRM practices, the effects of the identified risks on performance, and finally barriers to implementing HCSCRM practices. The study used correlation analysis to determine the degree of association between different variables, and regression analysis to test the effect of independent variables on dependent variables. The main findings are then compared to the available literature, and the hypothesis is tested.

4.1. Response rate

A total of 138 questionnaires were distributed to EPSS employees. Of which 128(92.75%) were returned to the researcher. But from the returned 128 questionnaires 126 (91.3%) was completed and the rest two were incomplete and unfit for analysis hence discarded. From the 108 questionnaire distributed at the central EPSS 99 (91.67%) was returned and from 30 questionnaires expected from hubs 27 (90%) questionnaires were collected (see table below).

Table 4.1.1.: Response rate of participants from EPSS center and hubs by department stratification

Directorate	**Expected**	**Response**	**Percentage**
Quantification and market shaping	14	14	100%
Tender management	11	11	100%
Contract management	23	20	86.96%
Warehouse and inventory management	35	32	91.43%
Distribution and fleet management	9	9	100%
Quality control and assurance	6	5	83.33%
Policy, plan, monitoring and evaluation	6	5	83.33%
Delivery unit	4	0	0%
Others [a]	0	3	-
Central EPSS Total	108	99	91.67%
EPSS hubs total	30	27	90%
Total participants response rate	138	126	91.3%

[a] Include cross directorate workers mainly work in the delivery unit and are technical advisors

Source: Own survey, 2022

4.2. Socio-Demographic characteristics of respondents

Respondents' sociodemographic characteristics include gender, work area, level of academic achievement, area of specialization, work experience, and respondents' current working directorate, as detailed in the table below. The questionnaire was completed by 126 people, 100 of whom were male (79.4 %) and the rest were female. From the total number of respondents, 99 (78.6 %) were from the central EPSS, which handles the majority of procurement and contract management activities. More than 97 percent of respondents have a bachelor's degree or higher. The majority of respondents (65.1 %) are pharmacists, followed by LSCM professionals (23.0 percent), Biomedical engineers (7.1 %), and Laboratory professionals (1.6 %). More than 58.7 percent of respondents have more than 6 years of experience signifying that the respondents have a long history of working in supply chain management activities and that their information is reliable and relevant to the study. Eighty-two (65.1%) of the participants were officers, 29 (23%) were team leaders, and 2 (1.6%) were directors, demonstrating that the sample is representative of all employees.

Table 4.2.1. The sociodemographic characteristics of respondents

	Frequency	Percent
Gender		
Male	100	79.4
Female	26	20.6
Total	126	100.0
Work area		
EPSA Central	99	78.6
EPSA hubs	27	21.4
Total	126	100.0
Highest level of academic achievement		
College certificate	1	0.8
College diploma	1	0.8
Bachelor degree	66	52.4
Master's degree and above	58	46.0
Total	126	100.0
Area of specialization		
Pharmacy	82	65.1
Biomedical engineer	9	7.1
Laboratory	2	1.6
Logistics and supply chain management	29	23.0
Other [a]	4	3.2
Total	126	100.0
Work experience at EPSA		
Less than 1 year	9	7.1

1-5 years	43	34.1
6-10 years	50	39.7
Above 10 years	24	19.0
Total	126	100.0
Current position		
Officer	82	65.1
Team leader	29	23.0
Director	2	1.6
Other [b]	13	10.3
Total	126	100.0
Respondent current directorate		
Quantification and market shaping	20	15.9
Tender management	11	8.7
Contract management	20	15.9
Warehouse and inventory management	43	34.1
Distribution and Fleet management	19	15.1
Plan, Monitoring and Evaluation	5	4.0
Quality	5	4.0
Other [c]	3	2.4
Total	126	100.0

[a] include public health and business administration; [b] mostly technical advisors ; [c] professionals working across directorates.

Source: Own Survey, 2022

4.3. Health commodities supply chain risk analysis

Participants were asked to rate the occurrence, severity, and likelihood of EPSS's detection of identified risks in the second section of the questionnaire, and then the risk score value(RSV) and risk priority number(RPN) were calculated. Based on each risk RPN, HCSC risks were ranked, and the cutoff point was determined using the Pareto principle (80-20 rule), which holds that 20% of risks that affects 80% of EPSS supply chain performance (Alecu F. 2010). Top 10, 10, and 9 of the 70 identified HCSC risks cover 20 % of EPSS National, Central, and Hubs risks, respectively (Annex 6).

4.3.1. National EPSS HCSC risks analysis

The table and graph below show the top ten priority risks (20%) ranked from the identified 70 HCSC risks. The study findings revealed that a supplier risk poses a much higher risk in the EPSS supply chain. Potential risk factors such as exchange rate fluctuations, poor logistics performance by suppliers, key supplier failure, market failure, and sole supplier pose a greater threat than the other potential risk factors listed in the supply risk category. Unpredictable demand, forecasting risk, and product waste are among the top ten demand risks in the EPSS supply chain. IT infrastructure issues and a lack of technical and managerial skills among staff are two potential

risks ranked among the 20% risks according to the Pareto principle and thought to be the cause of more than 80% of EPSS supply chain disruptions. This finding is consistent with a study conducted by Mengistu, 2016, which found that supply risks such as sole supplier, lead time, currency fluctuation and item unavailability are the top risks for EPSS that could affect its performance. A similar study conducted in the same area by Tamire *et al.*, 2021 revealed that supply risks such as inability to meet customer demand, lead time variability, and supplier poor logistics performance are causes of EPSS's poor supply chain performance. In line with this study PwC, 2013 Survey participants ranked the most significant risks to their supply chain as 47% Currency fluctuations, 41% Market changes, 34%Environmental catastrophes, and 22% Geopolitical instability(PwC, 2013). Two other studies found, as this study did, that the majority of risks in the HCSC were internal risks caused by poor process, people, and function management, which could be managed with appropriate mitigation strategies. (Jaberidoost *et al*., 2013b; Mokrini *et al*., 2016).

Table 4.3.1.1.: Top ten prioritized National EPSS HCSC risks (20 %)

Code	Risk category	Risk type	O	S	D	RSV	RPN	Rank	Cumulative
A16	Supply risk	Exchange rate fluctuation	7.06	6.87	5.59	48.55	271.25	1st	2.2%
A7	Supply risk	Suppliers' poor logistics performance	6.86	7.01	5.61	48.05	269.64	2nd	4.5%
B1	Demand risk	Volatile/unpredicted demand	6.57	7.14	5.73	46.94	268.97	3rd	6.7%
B2	Demand risk	Risks in forecasting	6.63	7.00	5.48	46.44	254.71	4th	8.8%
B3	Demand risk	Wastage of product	6.93	7.21	5.09	49.93	254.01	5th	10.9%
A5	Supply risk	Key supplier failure	6.44	7.13	5.36	45.87	245.75	6th	13.0%
C33	Process risk	IT infrastructure problems	6.65	6.79	5.30	45.13	239.26	7th	14.9%
A17	Supply risk	Market failures	6.63	7.00	5.15	46.44	239.23	8th	16.9%
A1	Supply risk	Sole supplier	6.56	7.18	5.06	47.14	238.71	9th	18.9%
C32	Process risk	Lack of technical and managerial skill of staff	6.13	6.56	5.71	40.17	229.52	10th	20.8%

Key:
***O** : Occurrence, **S:** severity, **D**: Detection, **RSV:** Risk Score Value and **RPN:** Risk Priority Number*

Source: Owen survey

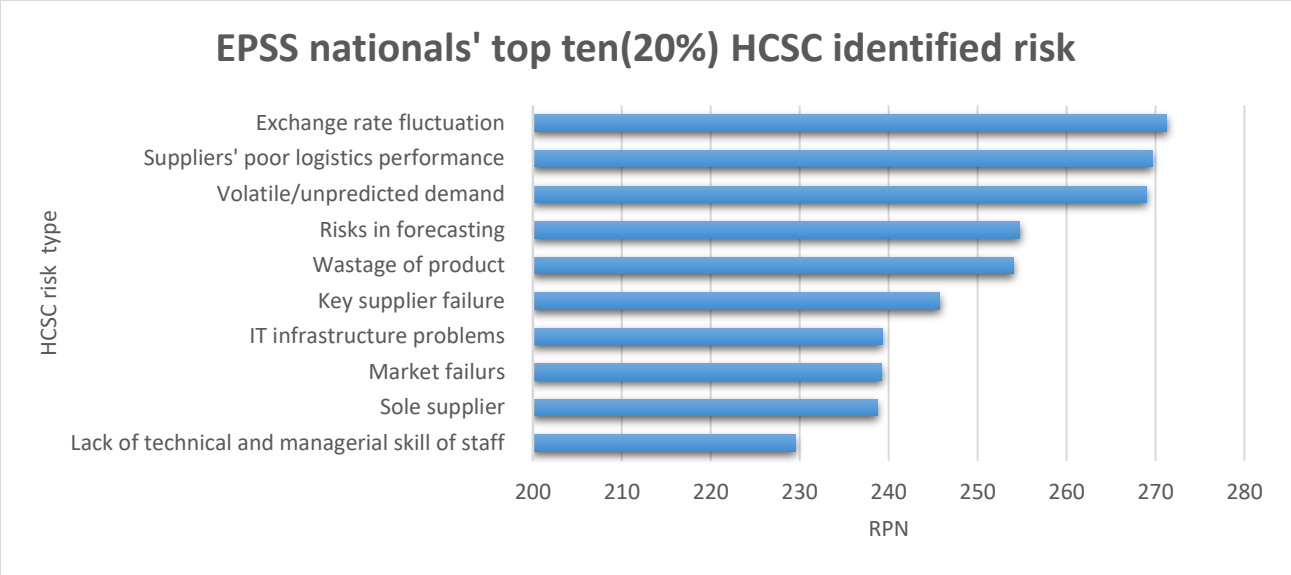


Figure 4.3.1.1: Prioritized most occuring HCSC risks in EPSS National
Source: Owen survey, 2022

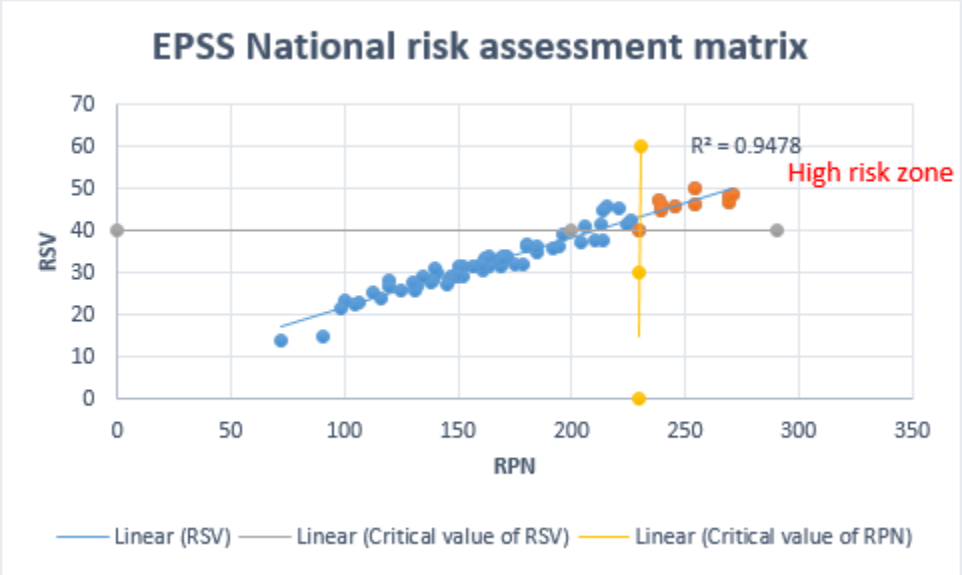
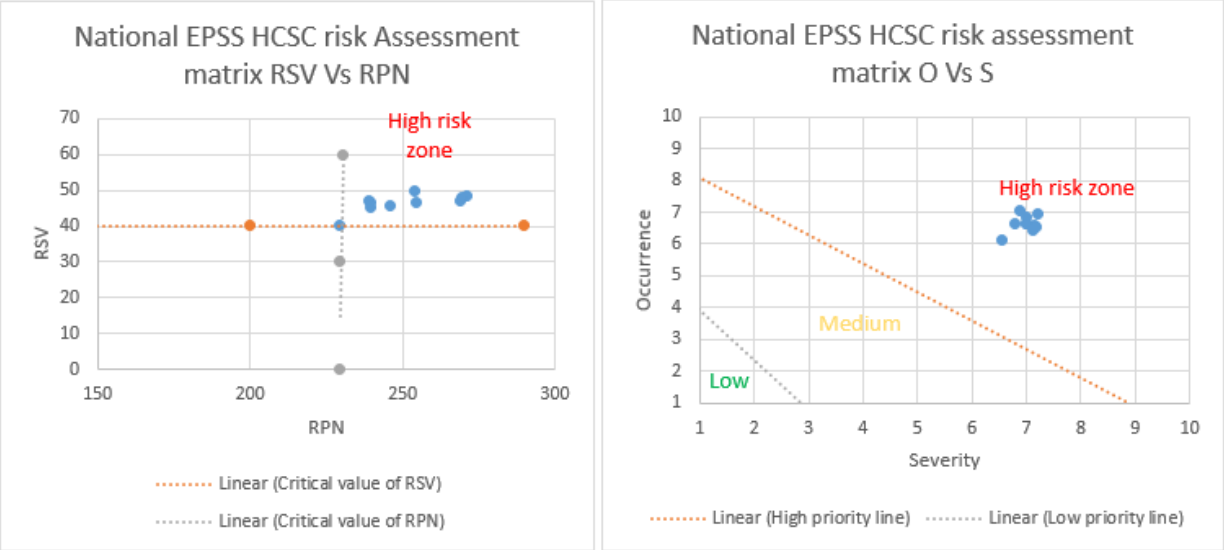


Figure 4.3.1.2.: The scatter plot of RSV versus RPN risk values in the national EPSS
Source: Owen survey, 2022

The graphs below depict the HCSC risk assessment matrix using RSV and RPN, as well as the occurrence vs severity comparison. As one can see, all of the top ranked HCSC risks are in the high potential risk zone in both graphs and require immediate risk treatment to keep the EPSS Supply chain performance improving. Based on the Pareto principle, the cut-off point for RSV is 40.17 and for RPN is 229.52.



Key: ***RSV:*** *Risk Score Value and* ***RPN:*** *Risk Priority Number*

Figure 4.3.1.3.: The scatter plot of RSV versus RPN risk values and Occurrence Vs Severity in National EPSS
Source: Owen survey, 2022

4.3.2. Central EPSS HCSC risks

There is no discernible difference between the central and the national EPSS HCSC risks. Except that the supply risk of exchange rate volatility comes after the demand risk of unanticipated demand here. Furthermore, here, the range between the first ranked HCSC risk is narrower than the national range. The table and graph below shows the top ten (20%) ranked EPSS central HCSC risks. In the risk assessment matrix below, all prioritized risks are classified as high risk.. In agreement with the study findings, Moktadir *et al*., 2017 conducted a study in Bangladesh using an extensive review of the literature, the Delphi method, and AHP to prioritize supply-side risks such as fluctuating import arrivals, supplier failure, and material shortages over operational, financial, and demand-side risks.

Table 4.3.2.1.: Top ten EPSS's central prioritized HCSC risks (20%)

Code	Category	Risk type	O	S	D	RSV	RPN	Rank	Cumulative
A7	Supply risk	Suppliers' poor logistics performance	6.88	6.95	5.74	47.80	274.27	1st	2.2%
B1	Demand risk	Volatile/unpredicted demand	6.57	7.11	5.73	46.69	267.40	2nd	4.4%
A16	Supply risk	Exchange rate fluctuation	7.00	6.80	5.46	47.59	260.04	3rd	6.5%
A1	Supply risk	Sole supplier	6.77	7.23	5.28	48.95	258.57	4th	8.7%
C33	Process risk	IT infrastructure problems	6.80	6.76	5.62	45.94	257.99	5th	10.8%
B3	Demand risk	Wastage of product	7.01	7.06	5.20	49.50	257.48	6th	12.9%
B2	Demand risk	Risks in forecasting	6.49	7.04	5.59	45.73	255.42	7th	14.9%
A5	Supply risk	Key supplier failure	6.49	6.99	5.54	45.40	251.30	8th	17.0%
C25	Process risk	Increased operational cost	6.81	6.54	5.65	44.49	251.23	9th	19.0%
C32	Process risk	Lack of technical and managerial skill of staff	6.06	6.49	5.75	39.36	226.24	10th	20.9%

Key:
***O** : Occurrence, **S:** severity, **D**: Detection, **RSV:** Risk Score Value and **RPN:** Risk Priority Number*

Source: Owen survey, 2022

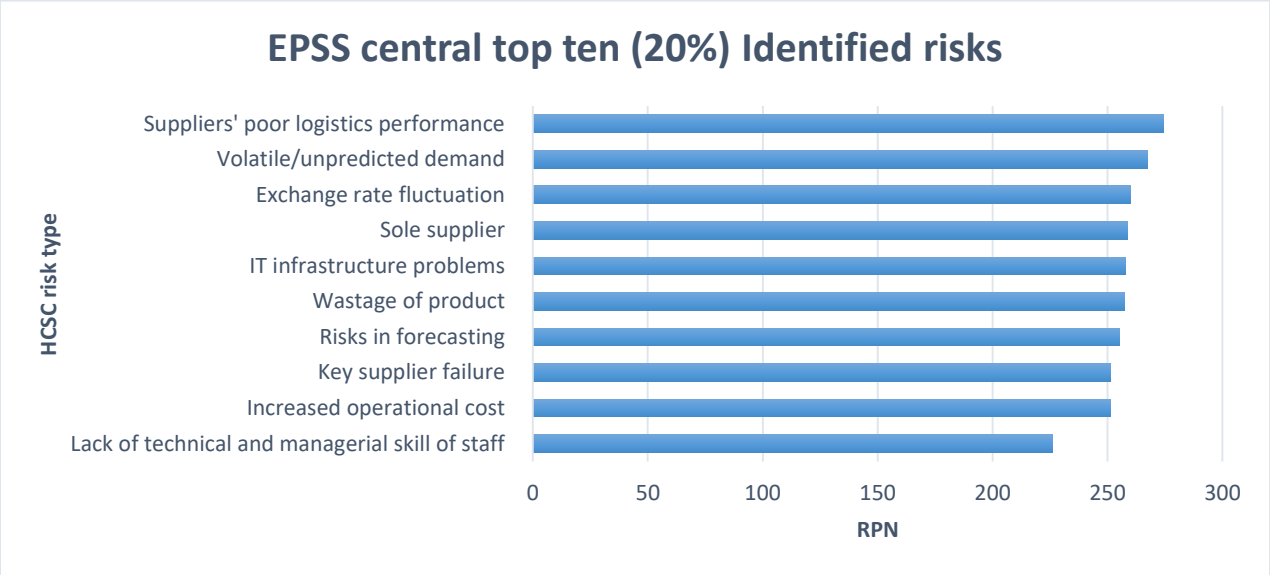
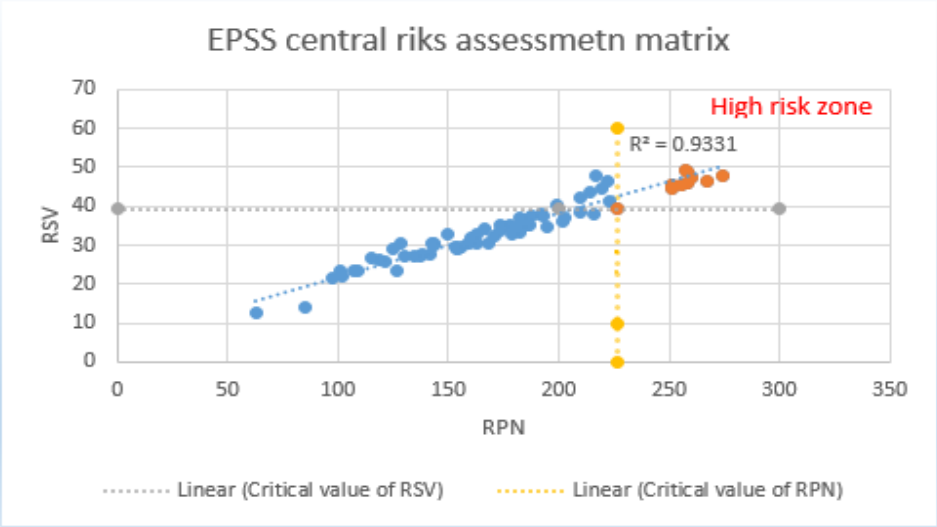


Figure 4.3.2.1.: Prioritized most occuring HCSC risks in EPSS central
Source: Owen survey, 2022



Key: ***RSV:*** *Risk Score Value and* ***RPN:*** *Risk Priority Number*

Figure 4.3.2.2.: The scatter plot of RSV versus RPN risk values in EPSS central
Source: Owen survey, 2022

The central EPSS risks, like the EPSS national prioritized HCSC risks, are included in the scatter plot of RSV versus RPN and compared with the Occurrence versus Severity scattered plot, and the results show that the identified risks in the center are also landed on the high risk zone. This demonstrates that the top ten ranked risks are the most significant treat for the organization's supply chain performance. According to the Pareto principle, the critical value for RSV is 39.36 and the critical value for RPN is 226.24.

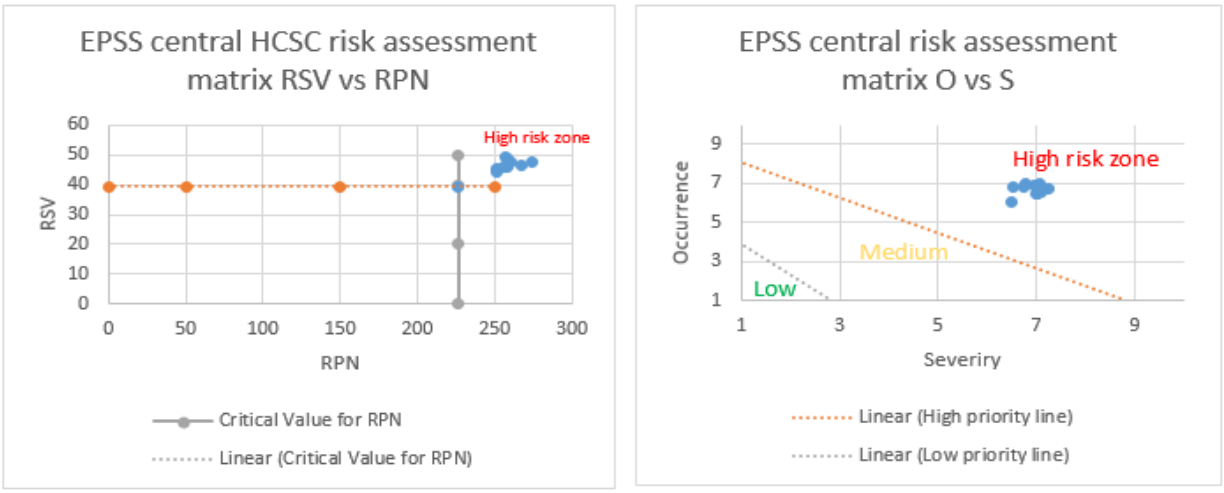


Figure 4.3.2.3.: The scatter plot of RSV versus RPN and Occurrence Vs Severity in EPSS central
Source: Owen survey, 2022

4.3.3. EPSS hubs HCSC risks analysis

Only nine of the 70 HCSC risks identified by EPSS hubs accounted for 20% of the risks, four of which are in the supply risk category, indicating that the central EPSS is the hubs' concern for the performance of their health commodities supply chain. This can be justified by the fact that the supply risk at the central EPSS has a direct impact on the ability of the central EPSS to supply the hubs. According to this study, supply risk is the most important factor influencing hub performance, followed by demand risk. Unexpected increases in demand and longer lead times are the next most serious threat to the supply chain, after the other potential risk factors. Tamire *et al*., 2021, in agreement with this study, revealed that hubs face supply and demand risks to supply facilities. This was also supported by a study conducted at, Ethio-telecom by Yoseph, 2017 which revealed that supply chain operations were primarily impacted by demand-side risks such as unexpected volatile demand and distorted information, supply-side risks such as poor logistics delivery system of suppliers and poor logistic service of third-party service providers, and quality-related, administrative barriers, capacity risks, and currency problems.

Table 4.3.3.1.: Top nine EPSS hubs prioritized HCSC risks (20%)

Code	Category	Risk type	O	S	D	RSV	RPN	Rank	Cumulative
A17	Supply risk	Market failures	7.15	7.44	6.04	53.21	321.25	1st	2.8%
A16	Supply risk	Exchange rate fluctuation	7.30	7.15	6.04	52.16	314.86	2nd	5.5%
B1	Demand risk	Volatile/unpredicted demand	6.59	7.26	5.74	47.86	274.74	3rd	7.9%
A7	Supply risk	Suppliers' poor logistics performance	6.78	7.22	5.15	48.95	252.01	4th	10.0%
B2	Demand risk	Risks in forecasting	7.15	6.85	5.11	48.98	250.33	5th	12.2%
A12	Supply risk	Prolonged lead time	7.30	7.04	4.81	51.34	247.21	6th	14.3%
C32	Process risk	Lack of technical and managerial skill of staff	6.37	6.78	5.59	43.18	241.47	7th	16.4%
C23	Process risk	The financial statements of the Organization are not well consolidated.	6.37	6.41	5.89	40.82	240.37	8th	18.5%
B3	Demand risk	Wastage of product	6.63	7.74	4.67	51.32	239.49	9th	20.6%

Key:
***O** : Occurrence, **S:** severity, **D**: Detection, **RSV:** Risk Score Value and **RPN:** Risk Priority Number*

Source: Owen survey, 2022

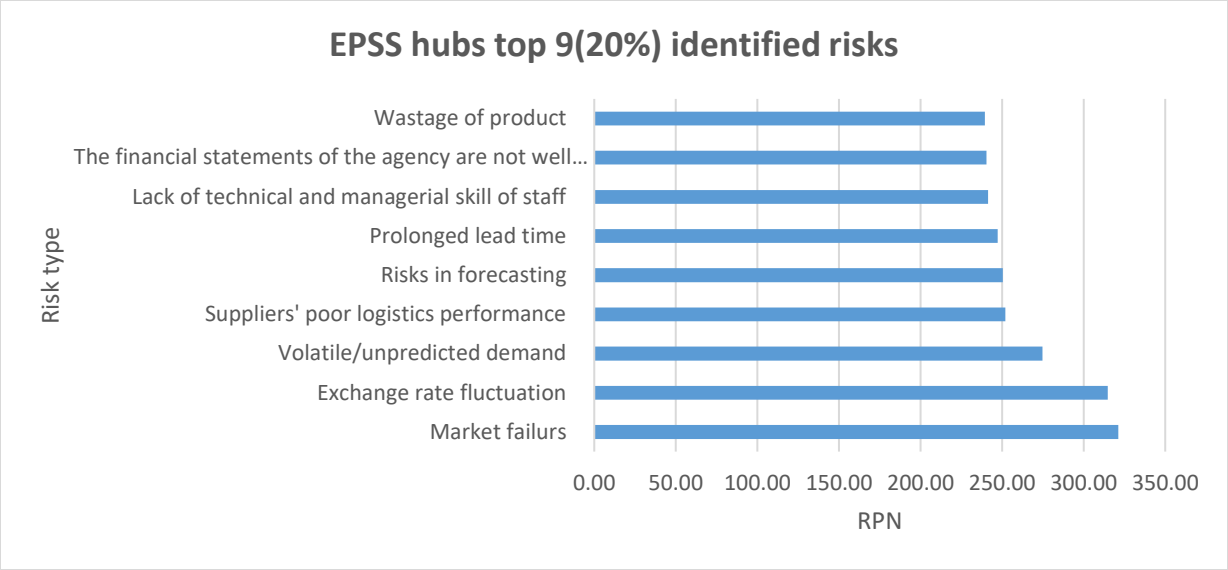
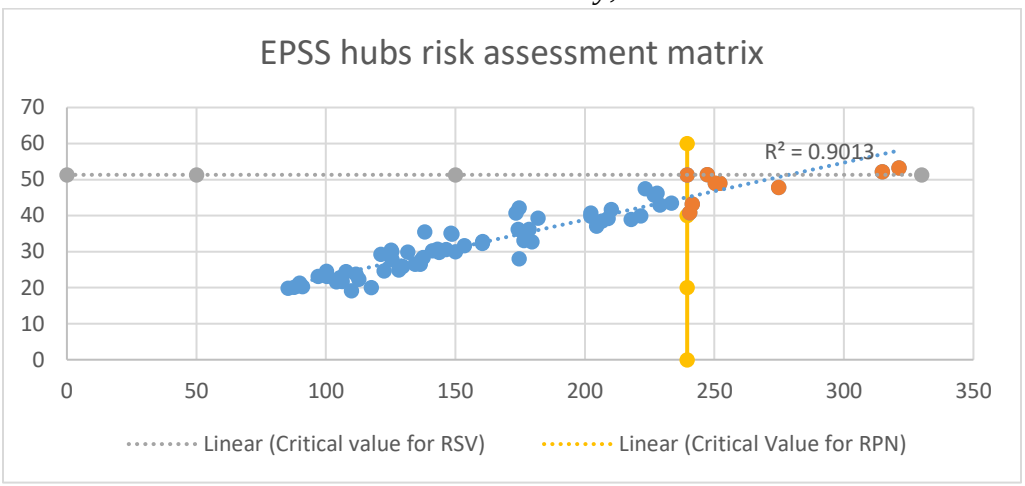


Figure 4.3.3.1.: Prioritized most occurring HCSC risks in EPSS hubs
Source: Owen survey, 2022

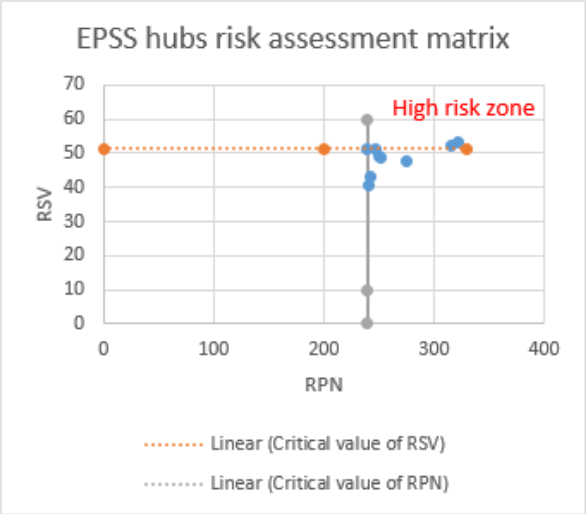


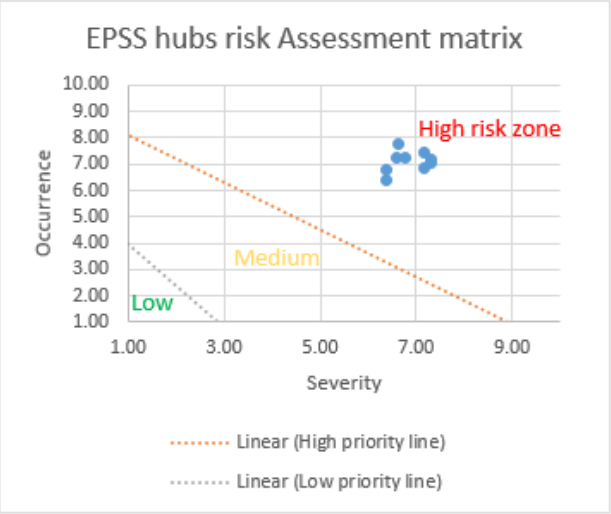
Key: *RSV:* *Risk Score Value and* ***RPN:*** *Risk Priority Number*

Figure 4.3.3.2.: The scatter plot of RSV versus RPN risk values in EPSS hubs
Source: Owen survey, 2022

In contrast to the above scattered plot, which shows that some risks are slightly below the high risk zone, the below scattered plot (O vs S) show that the prioritized top 9 (or 20%) of the identified HCSC risks at the hubs are still in the high risk zone. This means that EPSS is better at detecting some of the prioritized risks, as RSV remains high risk while RPN is moderate risk for some of the identified risks. The findings also revealed that the hubs face the most risks as a result of the risks created by EPSS central, as supply risk remains at the top of the ranked EPSS hubs HCSC

risks. Tamire *et al*., 2021 demonstrated that, with the exception of environmental risks, all risk categories at the hubs have a similar risk profile, implying that the above justification can be applied to all hubs.





Key: *RSV:* *Risk Score Value and* ***RPN:*** *Risk Priority Number*

Figure 4.3.3.3.: The scatter plot of RSV versus RPN risk values and Occurrence Vs Severity in EPSS Hubs

Source: Owen survey, 2022

4.3.4. Summary of risk profile across EPSS national, center and hubs

The table below summarizes risk analysis across national, central, and EPSS hubs. As previously stated, supply risk is a greater concern at the hubs ($\chi 2$= 126.000, P = 0.000) at 95% confidence interval, whereas demand risk is the priority risk in the central EPSS ($\chi 2$= 125.000, P = 0.000). The risk profile difference between the central EPSS and the hubs is statistically significant (Table 4.3.4.1.). However, as a single organization, supply risk is the priority risk to be assigned in order to improve the organization's supply chain performance. The findings of this study are similar to those of Mengistu (2016), who found that supplier risks pose a much greater threat in EPSS's supply chain. Another study conducted in Bangladesh found that supply-side risks such as fluctuating import arrivals, a lack of information sharing, supplier failure, and material shortages were prioritized over operational, financial, and demand-side risks (Moktadir *et al*., 2017).

Table 4.3.4.1.: Summary of risk profile across EPSS national, center and hubs

	Work area							
	EPSS Central		EPSS hubs		EPSS National		Pearson Chi-Square test	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Chi-Square	Sig.
Supply risk	224.27	105.72	235.48	113.53	226.68	107.07	126.000	0.000
Demand risk	224.82	100.65	215.13	118.16	222.73	104.24	125.000	0.000
Process risk	205.35	111.93	189.27	122.01	201.9	113.85	126.000	0.000
Environmental risk	126.48	105.48	136.6	84.07	128.65	101.04	126.000	0.000

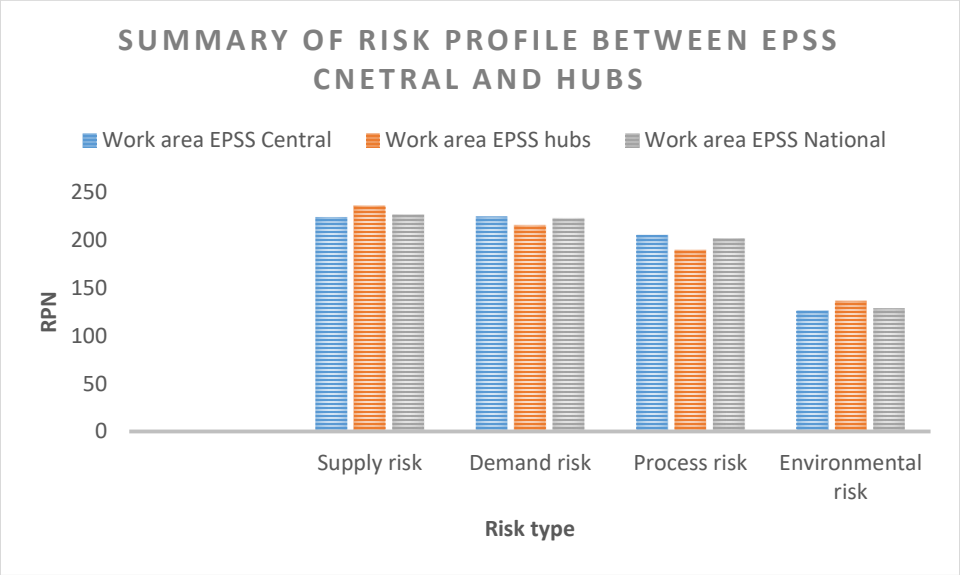


Figure 4.3.4.1.: Summary of risk profile across EPSS national, center and hubs

4.4. Health Commodities Supply Chain Risk management practices

As discussed in the literature review, risk assessment (identification, estimation, analysis) and risk treatment are regarded as critical components of SCRM because they enable an organization to be proactive in risk management, making it more efficient and cost effective. To determine the extent to which EPSS is implementing HCSCRM practices and what components are currently practiced at EPSS, participants were asked using a 5 point Likert scale and a Yes or No response. (See tables below). According to the findings of this study, the overall implementation of SCRM practice in EPSS to manage the impact of risks ranges from a low (41.4%) to a moderate extent (52.5 %). A study conducted at EPSS yielded a similar result (Tamire *et al.*, 2021). Similar study at EPSS also showed that EPSS used risk identification methods small to moderate extent (Mengistu, 2016).

Table 4.4.1. : Table of frequency for the extent of SCRM implantation

		EPSS (your hub) s' extent of SCRM use											
		No extent		Small extent		Moderate extent		Great extent		Very great extent		Mean	Standard deviation
		N	Row N %	N	Row N %	N	Row N %	N	Row N %	N	Row N %		
Work area	EPSS Central	3	3.0%	41	41.4%	52	52.5%	3	3.0%	0	0.0%	2.555556	0.609821
	EPSS hubs	1	3.7%	15	**55.6 %**	11	40.7%	0	0.0%	0	0.0%	2.370370	0.564879
	Total	4	3.2%	56	**44.4 %**	63	50%	3	2.4%	0	0.0%		

Source: Owen survey, 2022

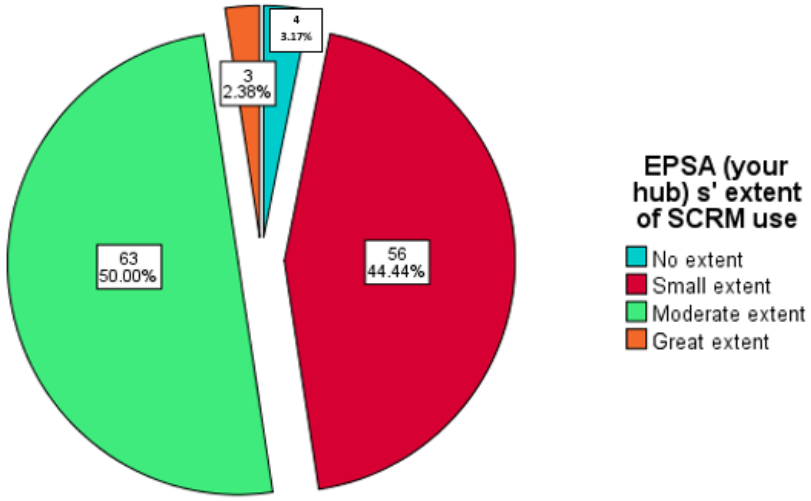


Figure 4.4.1. : Frequency distribution for the extent of SCRM implantation

Source: Owen survey, 2022

As stated at the outset of this session, implementing all HCSCRM components is required to improve EPSS's overall supply chain performance and become risk resistant. According to the findings of this study, the majority of respondents (72.7 %) at the central EPSS and 70.4 % at the hubs agreed that risk identification is practiced. Less than 37% of respondents at both the central and EPSS hubs believed that the remaining HCSCRM components, such as risk evaluation, analysis, and risk treatment, were in place in their organizations. Similarly, a study conducted at the Ethiopian Shipping and Logistics Service Enterprise revealed that while the organization has a formal supply chain risk identification Process, risk identification and other SCRM components are rarely performed. (Mestawet, 2020). According to Mengistu 2016, EPSS used risk identification methods to a limited extent, with risk estimation being the better employed.

Table 4.4.2. : HCSCRM processes employed at EPSS central and Hubs

HCSCRM processes		Work area: EPSA Central N	EPSA Central Column N %	EPSA hubs N	EPSA hubs Column N %	Total N	Total Column N %
Risk Identification	Yes	72	72.7%	19	70.4%	91	72.2%
	No	27	27.3%	8	29.6%	35	27.8%
Risk Evaluation	Yes	27	27.3%	5	18.5%	32	25.4%
	No	72	72.7%	22	81.5%	94	74.6%
Risk Analysis	Yes	37	37.4%	13	48.1%	50	39.7%
	No	62	62.6%	14	51.9%	76	60.3%
Risk treatment	Yes	21	21.2%	6	22.2%	27	21.4%
	No	78	78.8%	21	77.8%	99	78.6%

Source: Owen survey, 2022

4.4.1. Health Commodities Supply Chain Risk Identification practices

The study attempted to determine the current state of risk identification in EPSS. The main points raised were the extent of risk identification, the occurrence of supply chain risks, transparency among parties, and risk matrix tools. In the second part the methods used by EPSS to identify risks were raised. As a result, the data presentation, analysis, and interpretation are as follows.

The means recorded were interpreted as follows: mean (M) score of 0-1.49 indicates that the respondents strongly disagree meaning very weak performance, between 1.5 to 2.49 indicates they disagree meaning weak performance, 2.50 to 3.49 indicates the respondents were neutral meaning moderate performance, 3.50 to 4.49 indicates they agree meaning strong performance and a mean above 4.50 indicates the respondents strongly agreed meaning very strong performance (Wondafrash, 2019).

A Pearson chi-square test was used to determine whether the central EPSS and the hubs' risk identification practices and methods for identifying HCSC risks are similar. The findings revealed that there is a significant difference between the center and the hubs in terms of HCSC risk identification practice and methods used to identify risks, with the exception of a similarity in their risk identification practice based on previous experience, brainstorming, and surveys, which both practiced it rarely to moderate degree. Faizal 2014 revealed that the position of the companies in the chain, as well as the level of analysis they can perform, determine the significant difference in risk identification practices between EPSS center and hubs (Faizal, 2014). The average mean risk identification practice of EPSS central and hubs is 2.85 (standard deviation 0.61) and 2.90 (standard deviation 0.75), respectively (see table 4.4.1.1.). A study conducted at the Ethiopian Shipping and Logistics Service Enterprise yielded a similar result, revealing that the enterprise

rarely performs risk identification. (Mestawet, 2020). Similarly, Mengistu 2016 demonstrated that EPSS used risk identification methods to a limited extent.

Table 4.4.1.1. : HCSC risk identification practices of EPSS National, Central and hubs level

	Work area							
	National EPSS N = 126		EPSS Central N = 99		EPSS hubs N = 27		Chi Square test (Pearson)	
Risk identification practices of EPSS	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**	**Chi Square**	**Sig.**
EPSA uses a standard process for identifying supply chain risks	3.19	1.093	3.26	1.07	2.93	1.14	9.793	.044*,[b]
Supply chain risks are identified by their frequency of occurrence	3.33	0.947	3.41	0.87	3.04	1.16	13.536	.009*,[b,c]
All potential supply chain risks are communicated to all parties.	2.71	0.997	2.74	0.93	2.59	1.22	11.753	.019*,
The Organization record identified risks using risk matrix as a tool	2.9	1.007	3.04	0.97	2.41	1.01	14.636	.006*,
The Organization uses past lesson for identifying risks	3.11	1.045	3.07	1.02	3.26	1.13	5.881	.208[b]
EPSS's risk identification method use								
Previous risk assessment	2.79	1.03	2.63	0.86	3.41	1.34	32.543	.000*,b
Developing risk register	2.61	0.963	2.48	0.87	3.07	1.14	15.482	.004*,
Brainstorming session	2.79	0.966	2.76	0.93	2.93	1.11	6.115	0.191
Surveys	2.32	0.935	2.28	0.9	2.44	0.97	1.799	.773[b,c]

Results are based on nonempty rows and columns in each innermost sub table.

* The Chi-square statistic is significant at the .05 level.

[b] More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid. (20%-40%)

[c] The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.

Source: Owen survey, 2022

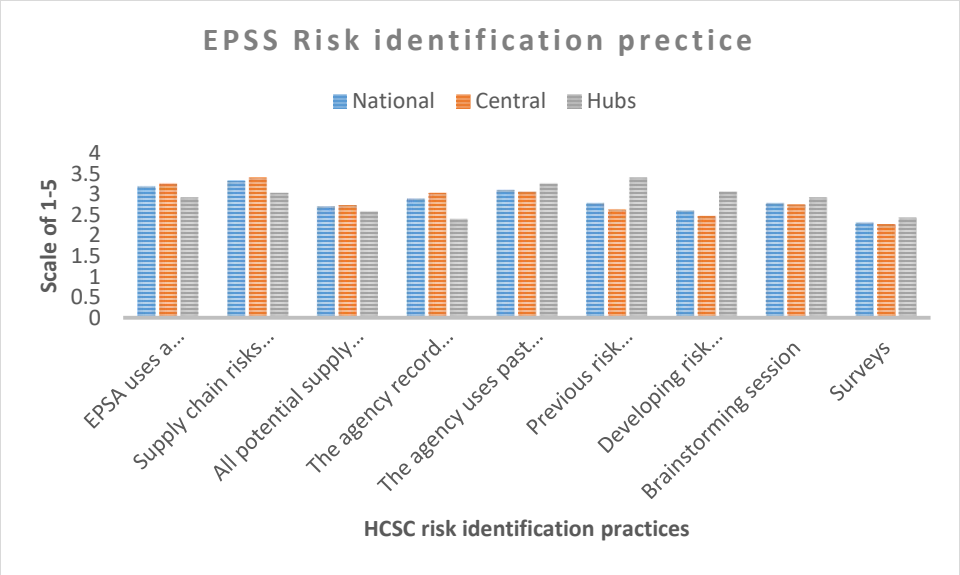


Figure 4.4.1.1.: Comparison of EPSS HCSC risk identification practices of EPSS nationl,central and hubs

Source: Owen survey, 2022

4.4.2. Health Commodities Supply Chain Risk Analysis practice

The results show that HCSC risk analysis practices are similar between the center and hubs, with the exception of reporting and communication practices, which show a significant difference (2= 12.339, P = 0.015) at the 95 percent confidence interval (see Table below). Despite similarities between the center and hubs, the bottom line is that as a National EPSS, all HCSC risk analysis practices are implemented from lower to moderate extent(see graph below). The average mean risk analysis practice of EPSS central and hubs is 3.10 (standard deviation 0.99) and 2.79 (standard deviation 0.71), respectively. A study conducted at Heineken brewery also showed that the key supply chain risks affecting the organization are not well categorized/profiled as high, medium & low (Yeshewas, 2020). Another study conducted in Ethiopian Shipping and Logistic Service Enterprises revealed that majority of the respondent have moderate stand about the organization ability to prioritize its main supply chain risks (Mestawet, 2020).

Table 4.4.2.1. : HCSC risk analysis practices of EPSS by National, Central and hubs level

HCSC risk analysis practices of EPSS	Work area						Chi-Square test (Pearson)	
	National EPSS N = 126		EPSS Central N = 99		EPSS hubs N = 27			
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Chi-Square	Sig.
The Organization prioritize its main supply chain risks	3.33	1.03	3.31	0.99	3.37	1.2	3.017	0.555
EPSA follows standard procedures for supply chain risk analysis	3.06	0.98	3.1	0.96	2.89	1.1	6.658	.155[a]
The level of supply chain risk analysis practice is appropriate for identified risks	3.09	0.98	3.09	1.02	3.07	0.8	3.961	0.411
Identified risks are quantified and, analyzed based on the severity of the hazard, the likelihood of occurrence, and detection by the Organization	2.97	1.00	3.04	0.96	2.7	1.1	8.565	0.073
The Organization's reporting and communication processes enable effective SCR analysis.	2.9	1.00	3.04	0.98	2.41	0.9	12.34	.015[a,*,c]
EPSA integrate all aspects of SCR factor during the assessment	2.81	0.96	2.84	0.96	2.7	1	8.415	.078[a,c]
The Organization's supply chain risk analysis processes are well documented.	2.76	1.02	2.87	1.03	2.37	0.9	6.688	.153[a]

Results are based on nonempty rows and columns in each innermost sub table.

*The Chi-square statistic is significant at the .05 level.

[a] More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid.

[C] The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.

Source: Owen survey, 2022

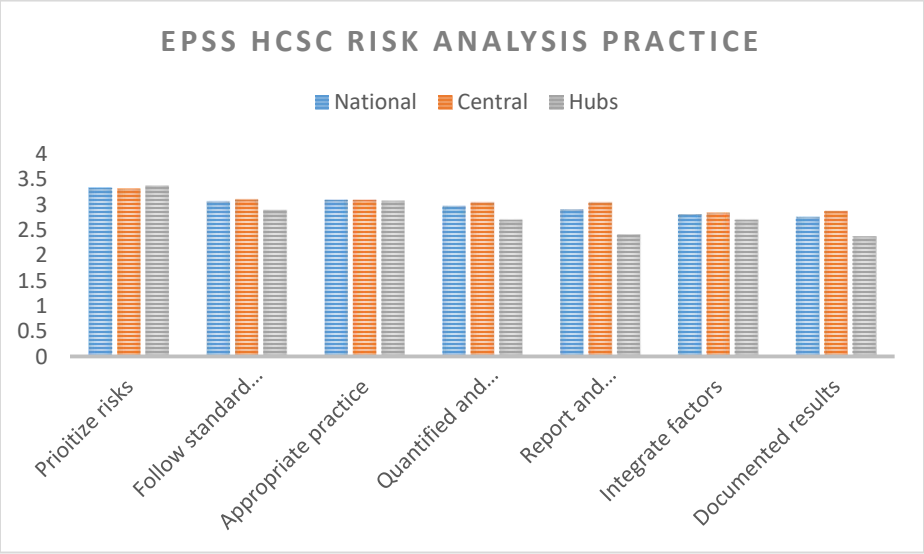


Figure 4.4.2.1. : Comparison of EPSS HCSC risk analysis practices of EPSS nationl,central and hubs

Source: Owen survey, 2022

4.4.3. Health Commodities Supply Chain Risk evaluation practice

According to the respondents HCSC risk evaluation practiced at EPSS to a moderate extent since the average mean risk analysis practice of EPSS central and hubs is 2.97 (standard deviation 0.96) and 2.86 (standard deviation 0.66), respectively. Mestawet, 2020 found that there was insufficient risk assessment practice and process in Ethiopian Shipping & Logistics Service Enterprise, that very often followed the procedure to conduct the assessment, and that there was less emphasis on continuous review of the evaluation process during the supply chain risk evaluation stage.

Table 4.4.3.1. : HCSC risk Evaluation practices of EPSS by National, Central and hubs level

HCSC risk evaluation practices of EPSS	Work area						Pearson Chi-Square Tests	
	EPSS National		EPSA Central		EPSA hubs			
	N = 126		N = 99		N=27			
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Chi-Square	Sig.
The Organization emphasizes the significance of reviewing the continuous evaluation process.	3.03	0.96	3.05	0.97	2.96	0.94	2.41	.661a,b
The Organization is well aware of the supply chain risk evaluation systems' strengths and weaknesses.	3.17	0.9	3.2	0.93	3.04	0.81	2.908	0.573
The Organization currently has procedures in place to evaluate supply chain risk and adjust policies accordingly	2.93	0.87	2.95	0.88	2.85	0.82	2.183	.702a,b
The Organization is capable of accurately evaluating the costs and benefits to taking risks	2.69	0.81	2.69	0.79	2.7	0.91	3.429	0.33
The Organization follows supply chain risk evaluation procedures correctly	2.73	0.86	2.69	0.89	2.89	0.75	7.17	.127a,b
The Organization integrate all aspects of supply chain risk factor during the evaluation	2.84	0.85	2.88	0.87	2.7	0.78	1.985	0.739

Results are based on nonempty rows and columns in each innermost sub table.
a More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid.
b The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.
Results are based on two-sided tests. For each significant pair, the key of the category with the smaller column proportion appears in the category with the larger column proportion.

Source: Owen survey, 2022

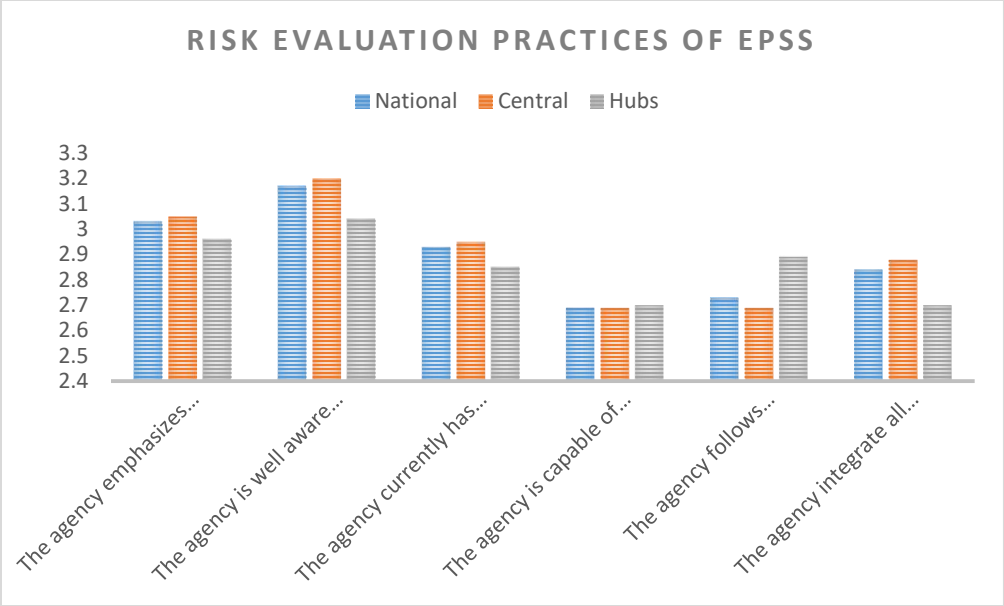


Figure 4.4.3.1.: Comparison of EPSS HCSC risk Evaluation practices of EPSS nationl,central and hubs

Source: Owen survey, 2022

4.4.4. Health Commodities Supply Chain Risk Treatment practice

With a 1-5 scale Likert questions, respondents were asked about HCSC risk treatment practice in general, with a particular emphasis on risk avoidance measures, risk control measures, and flexibility measures. In general, risk treatment practices are better practiced at the central warehouse than at the hubs, with a mean of risk avoidance of 2.82 with standard deviation of 0.71, risk control of 3.13 with standard deviation of 0.69, and flexibility measures of 3.12 with standard deviation of 0.74, compared to 2.8, 3.01, and 3.07 at the hubs. With statistical significance (X2= 38.363 and Sig. = 0.000), the risk treatment practice of risk control measure implementation is much better at the center than at the hubs. As a nation EPSS risk treatment practice is practiced to a moderate extent. The same result was revealed by Tamire *et al.,* 2021. Another study found that while the quality risk treatment principle is well applied during pharmaceutical good manufacturing practices, the same principles are not rigorously applied during good distribution practices (Kumar, & Jha, 2018). Because risk management is not well practiced in EPSS, it may have a significant impact on its HCSC performance, as Neguse S., & Jebena, T 2019 discovered that among SCRM practices, SC Flexibility, SC Collaboration, and SC Control had a significant impact on supply chain performance (Neguse & Jebena, 2019).

Table 4.4.4.1.: Summary of risk treatment practices of EPSS national, central and Hubs

Risk treatment practices	EPSS Central N = 99		EPSS hubs N = 27		National EPSS N = 126		Pearson chi-Square tests	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Chi-Square	Sig.
Risk Avoidance	2.82	0.71	2.72	0.74	2.8	0.71	18.031	0.054
Risk Control	3.13	0.69	2.56	0.69	3.01	0.73	38.363	0
Flexibility	3.12	0.74	2.91	0.68	3.07	0.73	16.925a	0.076

Source: Owen survey, 2022

Table 4.4.4.2. : HCSC risk Treatment practices of EPSS by National, Central and hubs level

Risk treatment practices	Work area: EPSS National N = 126 Mean	Std. Dev	EPSS Central N = 99 Mean	Std. Dev	EPSS hubs N = 27 Mean	Std. Dev	Pearson Chi-Square Tests: Chi-square	Sig.
A. Risk avoidance measures								
In EPSA, the best risk management strategy is avoidance.	2.66	0.89	2.71	0.85	2.48	1.0	7.766	0.101
Avoidance strategies include the option of not performing an activity that could carry risk at all.	2.79	0.95	2.77	0.97	2.85	0.91	1.394	0.845
Avoiding risks also means losing out on the potential gain that accepting the risk may have allowed.	2.94	0.94	2.98	0.94	2.81	0.96	2.816	.589a,b
B. Risk control measures used								
There is continuous training on risk Management	2.48	1.03	2.62	1.09	2	0.62	15.571	.004*
There are framework contracts in place with suppliers.	3.28	0.97	3.47	0.91	2.56	0.85	24.932	.000a,b,*
The contract management system for risk control has been improved.	2.98	0.83	3.05	0.83	2.74	0.81	6.276	0.179
Supplies insurance is used to manage risks.	3.29	0.87	3.37	0.85	2.96	0.85	25.773	.000a,b,*
C. Flexibility measures								
There is Postponement method used in supply chain flexibility	2.96	0.84	2.99	0.9	2.85	0.6	7.245	0.124
Postponement reduces their dependence on forecasts	3.09	0.84	3.12	0.87	2.96	0.71	3.873	.423a,b
To mitigate risks, the Organization can switch from single to multiple sourcing as needed.	3.17	1.01	3.24	1.02	2.93	0.960	3.903	.419a
Results are based on nonempty rows and columns in each innermost sub table.								
* The Chi-square statistic is significant at the .05 level.								
a More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid.								
b The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.								

Source: Owen survey, 2022

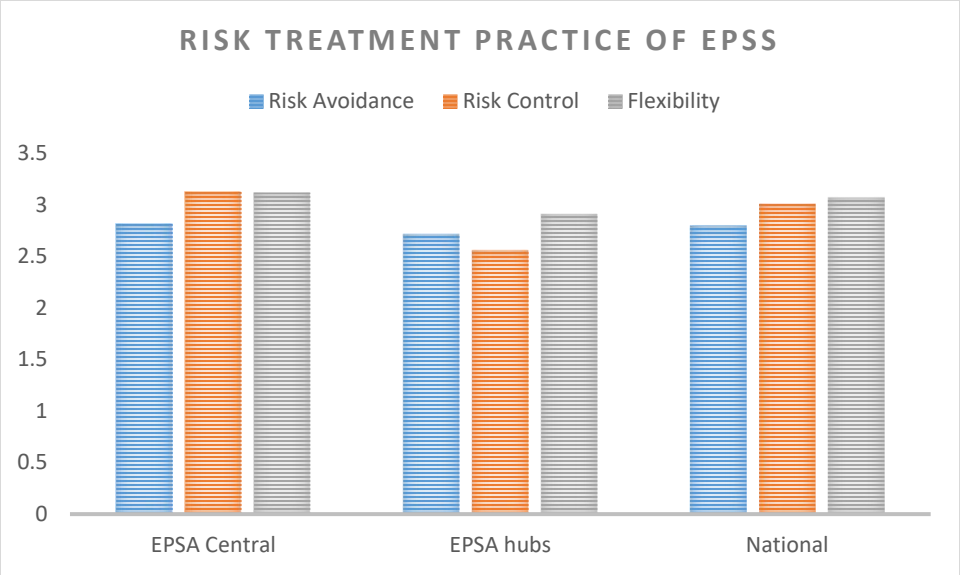


Figure 4.4.4.1. : Comparison of EPSS HCSC risk treatment practices of EPSS nationl,central and hubs

Source: Owen survey, 2022

4.5. The effect of HCSC risks on EPSA's HCSCM performance

Five indicators, namely cost, quality, flexibility, responsiveness, and reliability, are thought to be the best for measuring EPSS HCSCM performance in this research. Respondents are asked to rate the situation of each indicator on a five-point scale, with 1 indicating strongly disagree and 5 indicating strongly agree. Based on the respondents' responses, a mean (M) score of 0-1.50 indicates that the respondents strongly disagree, while a score of 1.5 to 2.50 indicates that they disagree. A mean of 2.50 to 3.50 indicates that respondents were neutral, a mean of 3.50 to 4.50 indicates that respondents agreed, and a mean of more than 4.50 indicates that respondents strongly agreed.

As shown in the two Tables (4.5.1 & 4.5.2) below, majority of respondents are neutral that EPSS's HCSCRM practices improved EPSS's HCSC performance in terms of cost, quality, flexibility, responsiveness, and reliability. This implies that EPSS's current health commodities supply chain risk management practices did not result in the necessary improvement in HCSC performance. There is a similarity between the central EPSS and the hubs in terms of respondents' perspectives on improving HCSC performance across all indicators, with the exception of quality(X2 = 27.037b, P Value = 0.003), where hubs perform significantly better in terms of HCSCRM with

respect to quality. According to various studies, better risk management practices should result in process optimization, increased productivity, and reduced business risk. Furthermore, it should assist health systems such as EPSS in meeting health commodities supply chain management goals such as accessibility, quality, and affordability, which have a significant impact on the country's economic, social, and political effects (Gómez & España, 2020; Jaberidoost *et al*., 2013b). Tamire *et al.,* 2021 also revealed that the majority of respondents agreed that all supply chain performance indicators (delivery dependability, order fill rate, customer satisfaction, speed of delivery, and risk analysis) had shown no change in measuring risk management. Similarly, according to the findings of Wondafrash 2019, the majority of the Construct of operational performance scores an average of 3.00, implying that the operational performance is neutral and requires improvement.

Table 4.5.1. : Summary of HCSCM performance of EPSS by hubs, central and National level

HCSCM performance indicators	**Work area**						**Pearson chi-Square tests**	
	EPSS Central N = 99		**EPSS hubs N = 27**		**EPSS national N = 126**			
	Mean	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	**Chi-Square**	**Sig**
Cost	2.94	0.72	2.97	0.63	2.94	0.70	18.385a	0.302
Quality	2.97	0.71	3.11	0.69	3.00	0.71	27.037b	0.003
Flexibility	3.09	0.69	2.89	0.63	3.04	0.68	11.299c	0.256
Responsiveness	2.98	0.81	2.80	0.79	2.94	0.81	19.077d	0.121
Reliability	3.05	0.70	3.16	0.50	3.07	0.66	30.228e	0.004

a 24 cells (70.6%) have expected count less than 5. The minimum expected count is .21.
b 14 cells (63.6%) have expected count less than 5. The minimum expected count is .21.
c 11 cells (55.0%) have expected count less than 5. The minimum expected count is .21.
d 20 cells (71.4%) have expected count less than 5. The minimum expected count is .21.
e 21 cells (75.0%) have expected count less than 5. The minimum expected count is .21.
Std.dev = Standard deviation

Source: Owen survey, 2022

Table 4.5.2. : Responses gathered on HCSCM performance of EPSS by hubs, central and National level

HCSCM performances	Work area						Pearson chi-square test	
	EPSS Central N = 99		EPSS hubs N = 27		EPSS National N =126			
	Mean	Std.Dev	Mean	Std.Dev	Mean	Std.Dev	X2	Sig.
Cost								
The product's price is reasonable as a result of proper risk management.	3.13	0.94	3.22	0.97	3.15	0.95	2.315	.678a,b
The agency's inventory turnover has improved significantly.	2.95	0.94	3.11	1.05	2.98	0.96	3.733	.443a,b
In comparison to the cost of health commodities, the agency's operational costs are lower.	3.22	1.09	3.11	0.97	3.2	1.07	2.987	.560a
The agency resource utilization is very good	2.63	0.99	2.44	1.09	2.59	1.01	4.26	.372a,b
Stock wastage due quality issues, expiration, damage, and theft is minimized	2.76	1.11	2.96	1.29	2.8	1.15	10.05	.040a,*
Quality								
EPSA provides full delivery on requests and specifications	2.65	0.84	2.3	1.14	2.57	0.92	22.04	.000a,b,*
The agency supplies defect free products	3.15	0.96	3.11	1.05	3.14	0.98	9.742	.045a,b,*
The agency conducts survey to measure the level of customer satisfaction	3.12	1.01	3.93	0.73	3.29	1.01	14.03	.007a,b,*
Flexibility								
EPSA supplies multiple variant products	3.65	0.94	3.41	0.93	3.60	0.94	9.212	.056a,b
The agency deliver new product to market quickly	2.8	0.99	2.63	1.18	2.76	1.03	6.642	.156a,b
The agency utilize outsourcing non-competence	2.82	0.93	2.63	1.01	2.78	0.95	4.263	.234a
Responsiveness								
EPSA improved order fulfilment lead time	3.18	0.88	3.22	0.97	3.19	0.9	3.356	.500a,b
EPSA's delivery meets customers' requirements	2.98	0.98	2.63	1.08	2.9	1.01	5.81	.214a,b
The agency delivers orders on time	3.02	0.94	2.96	1.13	3.01	0.98	6.099	.192a,b
The agency begins complete delivery as requested by the	2.74	1.05	2.37	0.88	2.66	1.02	10.35	.035a,b,*
Reliability								
The agency starts damage-free delivery and has improved delivery performance	3.2	0.95	3.56	0.75	3.28	0.92	5.363	.252a,b
The agency identified potential suppliers	3.09	0.96	3.3	0.78	3.13	0.92	3.987	.408a,b
Product availability improved: Proper execution of clients' order (Perfect order fulfilment)	2.83	0.93	2.67	0.83	2.79	0.91	1.898	.594a
EPSA improved supplier communication	3.24	0.90	3.3	0.67	3.25	0.86	6.498	.165a,b
The agency become resistant to SC risks	2.89	0.92	2.96	0.71	2.90	0.88	3.797	.434a,b
Count for the centeral EPSS is 99, for hubs 23 and for the nationl 126								
Results are based on nonempty rows and columns in each innermost subtable.								
* The Chi-square statistic is significant at the .05 level.								
a More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.								
b The minimum expected cell count in this subtable is less than one. Chi-square results may be invalid.								

Source: Owen survey, 2022

4.5.1. Inferential statistics for HCSC risks, risk management performances and hypothesis testing

4.5.1.1. Multi Collinearity test of independent variable

Table 4.5.1.1.1. Multi Collinearity test of independent variable

Coefficients[a]

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Supply risks	0.490	2.042
	Demand risks	0.422	2.370
	Process risks	0.507	1.971
	Environmental risks	0.841	1.189
	Risk assessment practices of EPSS	0.514	1.944
	Risk treatment practices of EPSS	0.545	1.834
	Barriers in adopting HCSCRM strategies	0.934	1.071

a. Dependent Variable: HCSCM Performance with respect to HCSCRM

Source: Owen survey, 2022

In general, a variance inflation factor (VIF) greater than 4 or tolerance less than 0.25 indicates the possibility of multicollinearity and necessitates further investigation. When VIF exceeds 10 or tolerance falls below 0.1, there is significant multicollinearity that must be corrected (Corporate Finance Institute® (CFI), 2022.). The result in the table above shows that there is no series problem with multi-collinearity between independent variables because the tolerance for all independent variables is greater than 0.1 and all VIF is less than 4 (VIF10). We can conclude from the above table that there is no collinearity in the study's data.

4.5.1.2. Correlation analysis

Correlations quantify the linear relationship between two variables. A correlation coefficient has a value between -1 and 1. Values closer to the absolute value of one indicate a strong relationship between the variables being correlated, whereas values closer to zero indicate little or no linear relationship. According to Mohammed, 2015, the correlation is a commonly used measure of the size of an effect: a value of + 0.1 to +0.29 represents a small effect, a value of + 0.3 to + 0.49 represents a medium effect, and a value of above + 0.5 represents a large effect. Correlation is positive or direct when the values increase together, and negative when one value decreases while the other increases, which is known as inverse or contrary correlation. Correlation can have a value

of 1 if there is a perfect positive correlation, 0 if there is no correlation (the values do not appear to be linked at all), and -1 if there is a perfect negative correlation.

Table 4.5.1.2.1. : Correlation between independent and dependent variables

Correlations

		HCSCM Performance wrt HCSCRM	Supply risks	Demand risks	Process risks	Environmental risks	Risk assessment practices of EPSS	Risk treatment practices of EPSS	Barriers in implementing HCSCRM activities
HCSCM Performance wrt HCSCRM	Pearson Correlation	1							
	Sig. (2-tailed)								
	N	126							
Supply risks	Pearson Correlation	**-.609****	1						
	Sig. (2-tailed)	0.000							
	N	126	126						
Demand risks	Pearson Correlation	**-.624****	.665**	1					
	Sig. (2-tailed)	0.000	0.000						
	N	126	126	126					
Process risks	Pearson Correlation	**-.589****	.549**	.664**	1				
	Sig. (2-tailed)	0.000	0.000	0.000					
	N	126	126	126	126				
Environmental risks	Pearson Correlation	-0.033	.319**	.211*	.240**	1			
	Sig. (2-tailed)	0.714	0.000	0.018	0.007				
	N	126	126	126	126	126			
Risk assessment practices of EPSS	Pearson Correlation	**.606****	-.335**	-.328**	-.291**	0.065	1		
	Sig. (2-tailed)	0.000	0.000	0.000	0.001	0.468			
	N	126	126	126	126	126	126		
Risk treatment practices of EPSS	Pearson Correlation	**.634****	-.246**	-.289**	-.234**	0.110	.664**	1	
	Sig. (2-tailed)	0.000	0.006	0.001	0.008	0.222	0.000		
	N	126	126	126	126	126	126	126	
Barriers in implementing HCSCRM activities	Pearson Correlation	-0.088	0.061	0.130	.219*	0.013	0.043	-0.008	1
	Sig. (2-tailed)	0.327	0.500	0.146	0.014	0.887	0.635	0.929	
	N	126	126	126	126	126	126	126	126

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

*. Correlation is significant at the 0.05 level (2-tailed).

Source: Owen survey, 2022

The correlation coefficient of the six factors measuring the effect of supply chain risks, risk management practices of EPSS and barriers in implementing HCSCRM is shown in the table above, where supply risks, demand risks, process risks and the barriers have a negative impact on EPSS's HCSCM performance, whereas risk assessment and treatment practices have a positive impact on its HCSCM performance. The correlation coefficients (r) for supply risks, demand risks, process risks, and barriers respectively, are -0..609, -0.624, -0.589 and -0.088. Supply, demand

and process risks have a statistically significant negative effect on HCSCM performance at the p0.000 levels. The barriers and Environmental risks correlation with HCSCM performance insignificant.

EPSS risk assessment practices have a positive relationship with HCSCM performance, which is statistically significant with a 99.99 percent confidence level. This is shown in the table above as (r=.606, p0.000), which indicates a true or very high significant correlation between these two variables. EPSS risk treatment practices are also statistically significantly correlated with HCSCM performance (r=.634, p0.000). In a similar vein, Wondafrash 2019 discovered supply risk (r=.424), process risk (r=.584), and demand risk (r=.607). All of these factors were important determinants of supply chain risks and were significant in demonstrating the impact of supply chain risks on operational performance.

Furthermore, the above correlation table shows that the majority of the independent variables are correlated at the p0.000 levels of significance. Except for environmental risks, supply risks, demand risks, and process risks are negatively correlated with EPSS's risk assessment and risk treatment practices. Inferring that improved HCSCRM practices reduce the three risk factors and can improve the Organization's supply chain performance. Risk assessment practice is positively correlated with risk treatment practice (r = 0.664, p0.000), indicating that better risk assessment leads to better risk treatment outcomes.

4.5.1.3. Regression analysis and Hypothesis testing

The process of identifying and evaluating the relationship between a dependent variable and one or more independent variables, also known as predictor or explanatory variables, is known as regression analysis. It answers the question of how much the dependent variable changes when the independent variables change, as well as forecasting or predicting the value of the dependent variable based on the values of the independent variables (Mohammed 2015). The regression was run with supply risks, demand risks, process risks, environmental risks, EPSS risk assessment practices, EPSS risk treatment practices and barriers in implementing HCSCRM as independent variables, and EPSS HCSCM performance as dependent variables. The regression analysis results are presented below.

Table 4.5.1.3.1. : regression model between HCSC risks and risk management performances, and HCSCM performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.845[a]	0.714	0.697	0.31413

a. Predictors: (Constant), Barriers in adopting HCSCRM strategies, Risk treatment practices of EPSS, Environmental risks, Demand risks, Risk assessment practices of EPSS, Process risks, Supply risks

Source: Owen survey, 2022

The above table depicts a relationship between HCSC risks, HCSCRM practices, Barriers in implementing HCSCRM and HCSCM performance. The adjusted R square is 0.697, implying that supply chain risks, HCSCRM implementing barriers and HCSCR assessment, and treatment practices of EPSS can account for 69.7 % of operational performance variation in EPSS. Although there are numerous factors that can explain the variable on HCSCM performance, supply chain risks, barriers and risk management practices of EPSS account for nearly 69.7 % of it. This means that these factors cannot account for 30.4 % of the variation in HCSCM performance. A better result was obtained than in a Wondafrash 2019 study, where the model only explained 44.8 % of the variability in supply chain performance. The Sudanese study yielded a similar result, revealing that the SCM practices variables explained 71.09 % of the variance in performance (Hamid & Ibrahim, 2015).

Table 4.5.1.3.2.: ANOVA Result among HCSC Risks and HCSCRM practices, and Performance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29.111	7	4.159	42.145	.000[b]
	Residual	11.644	118	0.099		
	Total	40.754	125			

a. Dependent Variable: HCSCM Performance with respect to HCSCRM

b. Predictors: (Constant), Barriers in adopting HCSCRM strategies, Risk treatment practices of EPSS, Environmental risks, Demand risks, Risk assessment practices of EPSS, Process risks, Supply risks

Source: Owen survey, 2022

The ANOVA results of multiple regression analysis are shown in the table above. The significance value of 0.000 indicates that the regression relationship is significant in predicting the effects of the independent variables' supply chain risks (supply risks, process risks, and demanding risks), HCSCRM implementation barriers and HCSCRM practices (risk assessment and risk treatment practices) on EPSS HCSCM performance. The F-ratio in the ANOVA table determines whether the overall regression model fits the data well. The F-value is 42.145, which is greater than the F critical, indicating that the model is significant.

Table 4.5.1.3.3.: Regression Coefficients between HCSC Risks, HCSCRM practices, Barriers of HCSCRM implementation and Operational Performance

Coefficients[a]								
Model		Unstandardized Coefficients	Std. Error	Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B		Beta			Lower Bound	Upper Bound
1	(Constant)	3.697	0.352		10.5	0.000	3	4.394
	Supply risks	-0.167	0.044	-0.266	-3.786	0.000	-0.254	-0.079
	Demand risks	-0.101	0.048	-0.158	-2.09	0.039	-0.197	-0.005
	Process risks	-0.123	0.037	-0.23	-3.336	0.001	-0.196	-0.05
	Environmental risks	0.04	0.023	0.092	1.707	0.091	-0.006	0.085
	Risk assessment practices of EPSS	0.151	0.066	0.156	2.276	0.025	0.02	0.281
	Risk treatment practices of EPSS	0.33	0.062	0.355	5.334	0.000	0.208	0.453
	Barriers in adopting HCSCRM strategies	-0.007	0.059	-0.006	-0.113	0.910	-0.123	0.11

a. Dependent Variable: HCSCM Performance with respect to HCSCRM

Source: Owen survey, 2022

Table 4.5.1.3.3.: Summary of hypothesis

	Hypothesis	Beta	Sig.	Decision
H1	The higher the supply risk, the lower the HCSC performance	-0.266	0.000	**Accepted**
H2	The higher the process risk, the lower the HCSC performance	-0.158	0.039	**Accepted**
H3	The higher the demand risk, the lower the HCSC performance	-0.230	0.001	**Accepted**
H4	The higher the environment risk, the lower the HCSC performance	0.092	0.091	Rejected
H5	The higher the risk assessment practice, the higher the HCSC performance	0.156	0.025	**Accepted**
H6	The higher the appropriateness of risk treatment practice, the higher the HCSC performance	0.355	0.000	**Accepted**
H7	The higher the barriers to implement HCSCRM practices, the lower the HCSC performance	-0.006	0.910	Rejected

Source: Owen survey, 2022

The study's objective is to analyze EPSS HCSCRM practices and the identified risks, as well as the risk management practices' effect on the organization HCSC performance, which was tested using multiple regression. The first hypothesis (H1) investigates whether the higher the supply risks, the lower the HCSCM performance of the EPSS. In order to test the H1, the dependent variable HCSCM performance was regressed on predicting variable supply risks. The regression analysis revealed that supply risks predicted HCSCM performance significantly $F(7, 118)= 42.145$, $p<0.01$, indicating that supply risks plays a significant role in the organization's HCSCM Performance variation in the presence of other risk categories, the barriers and HCSCRM practices. The dependent variable HCSCM performance is also regressed on predicting variable demand risks and process risks to test the H2 and H3. Then it is found that both demand risks and process risks significantly predicted HCSCM performance $F(7, 118)= 42.145$, $p<0.01$, Which indicate that demand and process risks can also play a significant role in the organization HCSCM Performance variation ($\beta = -0.101$, $P < 0.01$) and ($\beta = -0.123$, $P < 0.01$), respectively . Similarly HCSCR assessment practices (H5) and treatment practices (H6) play a significant role in HCSCM performance variation ($\beta = 0.151$, $P < 0.05$) and ($\beta = 0.330$, $P < 0.01$) respectively. Which proves that H5 and H6 proven to be right. Hence, Supply, Demand and process risks affect HCSCM performance variation negatively whereas HCSCR assessment and treatment practices positively affect the HCSCM performance variation of EPSS. On contrast Environmental risks, like Tamire *et al.*, 2021, are positively correlated with performance. Environmental (H4) risks and HCSCRM implementation barriers (H7) has no statistical significant role in HCSCM performance variation. Though with no statistical significance HCSCRM implementation barriers have negative effect on the EPSS's HCSCM performance.

4.6. Barriers of Health commodities supply chain risk management implementation

The study also oath to see the barriers affecting the performance of health commodities supply chain risk management. The final section of the questionnaire probed for potential barriers to EPSS's adoption of SCRM. The questionnaire includes a list of potential barriers to SCRM adoption so that respondents can rate their relative strength in preventing SCRM practice from no extent (1) to very great extent (5). As shown in the table and graph below, the main barriers in implementing HCSCRM are organizational barriers (with a grand mean value of 3.53) such as organizational silos, a poor performance-based rewarded system, an inflexible organizational system, and others. The Pearson chi-square test results show that the effect of organizational

barriers at the central EPSS and hubs differs (X2=31.303, P 0.001) implying that it is more sever at the central EPSS than the hubs. Strategical barriers(with a grand mean value of 3.46) such as top management support, non-alignment of strategies with operations, cost containment, and a lack of trust among supply chain members are the second most frequently reported problems in implementing HCSCRM, and there is no significant difference in this problem between the center and the hubs. Technological barriers to implementing HCSCRM (with a grand mean value of 3.36) are a major issue at the hub, but they continue to be an issue at the central EPSS (X2=28.473, P 0.01). Similar to the findings of this study (Table 4.6.2), Mengistu, 2016 identified supplier geographical distance, inadequate technology, poor communication across a supply chain, and a lack of supply chain management knowledge as frequently occurring barriers. Similar to this study, but with statistical significance, collaboration, strategic, technological, and organizational factors influence risk management practices (Sharma & Bhat, 2012).

Table 4.6.1.: Barriers in affecting HCSCRM implementation

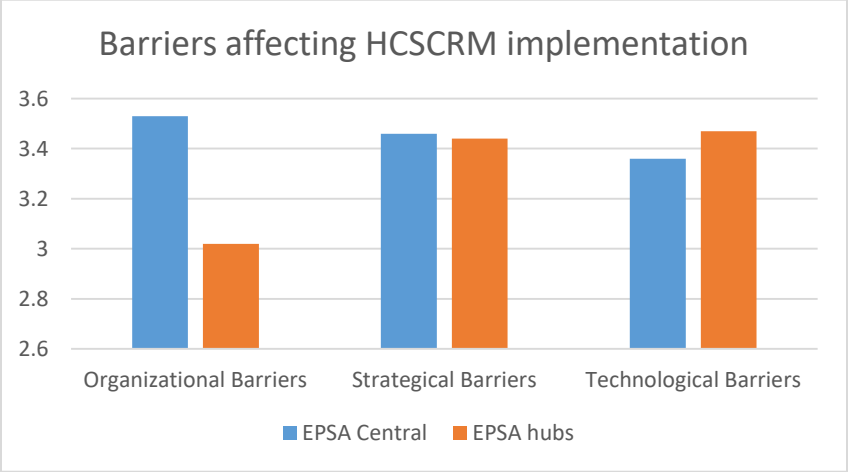
Barriers in adopting HCSCRM i	**Work area**						**Pearson chi-Square test b/n center and hubs**	
	EPSS Central N =99		**EPSS hubs N = 27**		**National EPSS N = 126**			
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Chi-Square	sig.
Organizational	3.53	0.54	3.02	0.58	3.42	0.59	31.303a	0.001
Strategical	3.46	0.59	3.44	0.72	3.46	0.62	19.502	0.147
Technological	3.36	0.66	3.47	1.01	3.38	0.75	28.473	0.008
a 15 cells (62.5%) have expected count less than 5. The minimum expected count is .21.								

Source: Owen survey, 2022

Table 4.6.2.: Barriers in affecting HCSCRM implementation under each category

Organizational Barriers	Work area						Pearson Chi-Square Tests	
	EPSS Central		EPSS hubs		National EPSS			
	N =99		N = 27		N = 126			
	Mean	Std. Dev	Mean	Stv. Dev	Mean	Stv. Dev	Chi-square	Sig.
Organizational silos(business divisions that operate independently and avoid sharing information) affects the agency's HCSC risk management practice	3.61	0.81	3.11	0.75	3.5	0.82	12.318	.015*,b,c
Non-alignment of performance measures to rewards affect risk management	3.69	0.62	3.11	0.93	3.56	0.73	20.065	.000*,b,c
Individual are too busy to work on HCSC risk management	3.35	0.93	2.56	1.12	3.18	1.02	24.154	.000*,b
Inflexible organization systems and Processes to adopt risk management strategies	3.47	0.85	3.3	0.91	3.44	0.86	4.319	.365b,c
Lack of top management support	3.37	0.91	3.33	1.11	3.37	0.95	4.617	.329b,c
Non-alignment of strategies with operations	3.64	0.86	3.63	0.88	3.63	0.86	0.657	.957b,c
Lack of trust among supply chain members	3.44	0.87	3.7	0.82	3.5	0.86	4.372	.358b,c
Cost containment is top priority in EPSA	3.4	0.89	3.07	0.92	3.33	0.9	9.984	.041*,b,c
Technology do not support business processes(risk management)	3.02	1.05	3.33	1.52	3.09	1.17	23.688	.000*,b
Use of outdated (legacy) software in EPSA	3.58	0.77	3.59	1.37	3.58	0.92	28.192	.000*,b,c
Lack of enhanced analytical capabilities	3.65	0.76	3.52	1.01	3.62	0.82	7.085	.131b,c
Lack of forecasting tools for both program and RDF products available on EPSA's pharmaceutical procurement list (PPL).	3.19	0.98	3.44	1.12	3.25	1.01	15.153	.004*,b
** The Chi-square statistic is significant at the .05 level.*								
b More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.								
c The minimum expected cell count in this subtable is less than one. Chi-square results may be invalid.								

Source: Owen survey, 2022



Graph 4.6.1.: Barriers affecting the implementation of HCSCRM
Source: Owen survey, 2022

The final hypothesis (H7) investigates whether the higher the barriers to implementing HCSCRM, the lower the EPSS's HCSCM performance, which has already been disproved in the previous section. The effect is investigated by regressing HCSCRM performance as the dependent variable on predicting variable barriers in HCSCRM implanting. According to the respondents, when other factors influencing HCSCRM practices were present, the barriers predicted HCSCRM performance insignificantly F (1, 124) = 0.102, P>0.05, indicating that HCSCRM barriers do not play a significant role in EPSS's HCSCM Performance variation.

Table 4.6.6.: Correlations analysis between barriers to HCSCM implementation and HCSCM performance

Correlations

		Barriers to Implement HCSCRM	HCSCM Performance
Barriers to Implement HCSCRM	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	126	
HCSCM Performance	Pearson Correlation	-.071	1
	Sig. (2-tailed)	.427	
	N	126	126

Source: Owen survey, 2022

As shown in the above correlation table, the barriers to HCSCM implementation have a detrimental effect on EPSS's HCSCM performance, although with non-statistical significance.

CHAPTER FIVE

5. SUMMARY OF MAJOR FINDINGS, CONCLUSION AND RECOMMENDATION

The chapter is divided into four major sections. These include a summary of the findings, the study's conclusion, recommendations, and implications for future research.

5.1. Summary of Major findings

The researcher sought to assess EPSS's health commodities supply chain risk management practices in terms of risk assessment and treatment. He also attempts to delve deeper into the organization's potential health commodities supply chain risks in order to assess their effect on the organization's HCSCM performance. Finally, the researcher worked to identify the barriers to HCSCRM implementation that the EPSS faces. To achieve these objectives, seven categorical independent variables, namely supply risks, demand risks, process risks, environmental risks, HCSC risk assessment practices, HCSC risk treatment practices, and barriers to implementing HCSCRM in EPSS, and one dependent variable, EPSS HCSC performance, were established, and data were collected from EPSS employees and processed in a quantitative approach, as well as correlation and regression analysis.

This study included 126 participants from both hubs and centers. The study findings revealed that a supplier risks poses a much higher risk in the EPSS supply chain, followed by demand risks, then process risks and at last by Environmental risks. Summary of risk analysis across national, central, and EPSS hubs shows supply risk is a greater concern at the hubs ($\chi 2= 126.000$, $P = 0.000$), whereas demand risk is the priority risk in the central EPSS($\chi 2= 125.000$, $P = 0.000$).

According to the study's findings, the majority of respondents (72.7 %) at the central EPSS and 70.4% at the hubs agreed that risk identification is practiced in their organizations, but less than 37 % at both the central and EPSS hubs believed that the remaining HCSCRM components, such as risk evaluation, analysis, and treatment, are practiced. The result also revealed that majority of respondents are neutral that EPSS's HCSCRM practices improved EPSS's HCSC performance in terms of cost, quality, flexibility, responsiveness, and reliability. This implies that EPSS's current

health commodities supply chain risk management practices did not result in the necessary improvement in HCSC performance.

To determine whether the above results are statistically significant, a correlation and regression analysis was performed. According to the correlation results, supply risks (r = -0.609, P0.000), demand risks (r = -0.624, P0.000), and process risks (r = -0.589, P0.000) have a negative effect on EPSS HCSCM performance, and all risk categories are statistically significant except for environmental risks (r = -0.033, P0.714), which do not. Correlation test results also revealed that HCSCR assessment practices (r =0.606, P0.000) and treatment practices (r = 0.636, P0.000) have a positive very high significance in EPSS HCSCM performance. A regression analysis is run with supply risks, demand risks, process risks, environmental risks, EPSS risk assessment practices, EPSS risk treatment practices, HCSCRM implementation barriers as independent variables and EPSS HCSCM performance as dependent variables to test the hypothesis drawn by this study where one predictor has an effect on the others. H1, H2, H3, H5, and H6 are accepted based on the regression results of the seven hypotheses, while the others are rejected.

Finally, the study discovered that organizational barriers have a greater effect at the central EPSS than at the hubs ($\chi 2$= 31.303, P = 0.001), while technological barriers have the opposite effect ($\chi 2$= 28.473, P = 0.008). With a significance level of F (1, 124) = 0.102, P>0.05, the regression results revealed that the barriers have no effect on the HCSCRM. A correlation analysis, on the other hand, reveals that HCSCRM implementation barriers have a negative impact on EPSS's HCSCM performance, albeit with non-statistical significance (r = -0.088, P0.327).

5.2. Conclusion

Based on the research findings and the study's main objective of assessing effect of HCSCRM practices on EPSS's HCSCM performance, it is concluded that:

The potential health commodities supply chain risks that affect EPSS are prioritized among the 70 risks identified by literature review, expert consultation, and during the pretest, and supply risks pose the greatest risk to the organization, followed by demand risks, process risks, and environmental risks. Exchange rate fluctuation, suppliers' poor logistics performance, volatile/unpredictable demand, forecasting risks, wastage of product, key supplier failure, IT infrastructure problems, market failures, staff lacks technical and managerial skills are the top ten

risks that cause 80% of EPSS disruption, according to the Pareto principle.in that order, with five falling under the supply risk category, three falling under the demand risk category, and two falling under the process risk category. Furthermore, the risk profile between the central EPSS and the hubs is significantly different, with supply risk posing a significant problem at the center and demand risk posing a greater problem at the hubs.

EPSS's overall HCSCRM practice was inadequate. According to the study, EPSS sometimes only applied risk identification process from risk assessment practices and ignored the evaluation and analysis process. Common risk identification methods such as risk estimation, previous risk assessment, brainstorming sessions, risk register and survey methods are only used to a limited extent. This demonstrated that EPSS was only using traditional risk identification methods to a limited extent, while more scientific methods were ignored. Though both the central EPSS and the hubs performed inadequately, there is a significant difference in risk identification practice between the central EPSS and the hubs, with the hubs performing better. Other components of the risk assessment process, such as risk evaluation and analysis, are used to a lesser extent. Risk treatment practices are generally better practiced at the central warehouse than at the hubs.

Based on the correlation result the effect of supply risks, demand risks, and process risks negatively affect the HCSCM performance of EPSS with statistical significance. Environmental risks, the final risk category, have no significant effect on HCSCRM performance. Similarly, regression analysis revealed that in the presence of other variables, the variability of HCSCM performance is statistically predicted by supply, demand, and process risks. Both correlation and regression analysis support the notion that the organization's HCSC risk assessment and treatment practices have a positive influence on HCSCM performance.

Respondents agree on the organizational, strategic, and technological barriers to implementing HCSCRM in the organization. When it comes to implementing HCSCRM in the organization, organizational barriers are more severe at the central EPSS, whereas technological barriers are more severe at the hubs. These barriers are regressed against HCSCRM and HCSCM performance, and the barriers have a negative effect on HCSCM performance but didn’t show effect on HCSCRM implementation in the organization.

5.3. Recommendations

Following the first of the objectives of this paper, which is to analyze potential health commodities supply chain risks, the study prioritizes, analyze and evaluate potential health commodities supply chain risks that affect EPSS, with supply risks coming first and demand risks coming next. Since each risk is identified and prioritized within each category, EPSS should propose methods for managing the identified and prioritized risks. In this study, five of the top ten risk variables are from the supply risks category, and risk treatment strategies such as investing in countries with strong currencies, diversifying supplier base, preparing for the worst with risk treatment plans, and improving supply chain visibility are recommended. Demand risks can be mitigated in part by increasing the capacity of local pharmaceutical manufacturers, which have a distinct advantage in simplifying processes, shortening lead times, and lowering costs. The same should be done for the other prioritized risk categories found in this study to have a significant effect on EPSS's HCSCM performance. Additionally, when developing HCSCRM strategies, the hubs and central EPSS risk differences should be considered.

EPSS HCSCRM practices were also evaluated. EPSS employs a moderate level of risk identification, which is superior to the other risk management process. In the organization, risk analysis and evaluation, as well as risk treatment practices, are used to a limited extent. And it is demonstrated in this study that risk assessment and risk treatment practices have a significant positive effect on HCSCM performance, and thus the organization needs to improve the risk identification since proactive risk identification prior to their occurrence is more economical than dealing with risks once they occur, as well as other process implementations.

The effect of HCSC risks and HCSCRM practices of EPSS on HCSCM performance was also examined. It is concluded that supply, demand, and process risks have a significant negative effect on performance while practices have a significant positive effect. The investigator also discovered through expert communication that the HCSCRM framework was developed in 2021 but has yet to be systematized; thus, EPSS's top management should strengthen its capability of systematizing the plan and begin implementing it at all levels of the organization. It should also focus on the prioritized risks, implement formal risk management tools, and regularly monitor its supply chain from a risk standpoint. This will aid in the development of a resilient health commodities health supply chain system and the reduction of threats.

Finally, the study attempted to identify the major barriers that EPSS faces during HCSCRM implementation, and the listed organizational, strategic, and technological barriers were moderately supported as potential barriers to HCSCRM strategy implementation by participants. Dealing with these barriers is therefore critical in order to establish a better communication system and process visibility through the use of modern technologies, as well as to improve organizational problems in order to avoid organizational silos. It is also recommended to prioritize areas where each barrier has a dominant effect, such as organizational barriers at the central EPSS and technological barriers at the hubs. The MOH should closely monitor the implementation of HCSCRM practices at EPSS; this will help to avoid uncertain supply chain disruptions by resolving currency and budget issues, improving staff capacity, and working on policies and procedures that affect the organization's performance.

5.4. Implication for further research

This study attempts to identify and prioritize HCSC risks that affect EPSS HCSCM performance, examines HCSCRM practice, analyzes their effects, and identifies barriers to EPSS HCSCRM implementation. Other studies, on the other hand, can have a broader scope and involve stakeholders like suppliers, public health institutions, and regulatory bodies like the EFDA. Cause and effect studies can also be used to identify the factors that influence SCRM processes at EPSS or other organizations.

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Annex:

1. Written informed consent

Title: **Effect of health commodity supply chain risk management practices on health commodity supply chain performance: the case of Ethiopian pharmaceutical supply service in Ethiopia.**

Principal investigator: Daniel Teferi

Advisor: Shiferaw Mitiku (PhD)

I. Purpose

You are kindly requested to participate as a respondent in a research project entitled "Health commodities supply chain risk management analysis of Ethiopian Pharmaceutical Supply Service in Ethiopia." The purpose of this study is to assess the supply chain risk management practices of EPSS.

II. Procedure

In this EPSS questionnaire on SCRM practices, I am interested in learning about the respondents' backgrounds as well as specific practices related to risk management communication and consultation, establishing scope and context, risk assessment practices, risk treatment, and monitoring and reviewing SCRM strategies.

The relevant information and comments from the questionnaire will be included in final report. Importantly this report will not contain personal identifying information such as: name, address, birth day, or other identifying information.

After completing the questionnaires I will came back and take it.

III. Voluntary participation and withdrawal

If you are voluntary to participate in this study I will expect you to respond to all questions as much as you can, but your participation is voluntary and you have options not to respond to any of the questions or quit to fill the questionnaire.

IV. Confidentiality

I would like to assure you that your participation as well as denial to respond will not have any associated risks or consequences. And also your participation will not be identified and information you provide will be kept confidential and not reported to others outside the research project in a way that personally identifies you.

You may ask any questions about this project to the researcher or you may contact the following:

1. Mr. Daniel Teferi: email: danielteferi.dt@gmail.com ……Principal investigator
2. Dr. Shiferaw Mitiku : e-mail: shiferaw.mitiku@aau.edu.et ….. Advisor
3. AAU, school of Commerce, department of LSCM: Tel: 011 551 8020 ……. Institution.

"Are you willing to participate in the study?"

If yes, thank and give the questionnaire

If no, thank them and request another worker in the same position as the one who declined to respond and record the result.

Result:

A. Completed ☐
B. Partially filled ☐
C. Refused ☐
D. Others …….

Interviewer's name ……..…….signature …….. Date……

Investigator's signature……..….. Date…….

2. Questionnaire

Introduction

Dear Participants, Thank you for agreeing to take part in this research and for your valuable contributions. I am currently conducting research on the theme "Effect of health commodity supply chain risk management practices on health commodity supply chain performance: the case of Ethiopian pharmaceutical supply service in Ethiopia.", as part of the requirements for a Master of Arts in logistics and supply chain management at Addis Ababa University's School of Commerce. The study's objective is to gain a general understanding of SCRM practices at EPSS.

The study is solely for academic purposes, and your identity will be kept anonymous (no need for names). Please answer truthfully in order to obtain the most accurate result. Thank you very much.

Part I: General information

Please provide your response by ticking the boxes that correspond to your answer or by writing a full response where applicable.

1. Gender Male ☐ Female ☐
2. The highest level of academic achievement you have attained
   - College certificate ☐ Diploma ☐
   - Bachelor degree ☐ Master's degree and above ☐
3. Area of specialization Pharmacy ☐ Biomedical engineer ☐
   - Laboratory ☐ Logistics and supply chain management ☐

Other please specify …..……...

4. How long have you worked in EPSS? Less than 1 year ☐
   - 1-5 years ☐ 6 – 10 year ☐ Above 10 years ☐
5. Current position Officer ☐ Team leader ☐ Director ☐
6. Where do you work? Central EPSS ☐ EPSS hubs_____
7. Please indicate your current directorate
   - ☐ Quantification and market shaping
   - ☐ Tender management

- ☐ Contract management
- ☐ Warehouse and Inventory management
- ☐ Distribution and Fleet management
- ☐ Quality control and assurance
- ☐ IT

If other please specify ……..

Part II: Health Commodities Supply chain risks

1. Please rate the **occurrence, severity, and detection** level of the following Supply Chain risks in EPSS over the last three years on a **scale of 1 to 10** using the failure modes and effects analysis (FMEA) model rating scales listed below.

Occurrence	Severity	Detection	Rating
Risk is **certain**, failure is inevitable (almost every day)	**Hazardous without warning** (at least cause client loss)	**Absolute uncertain** (no known mechanism for detecting the risk)	10
Risk is **very high**, failure is almost inevitable (every 3 day)	**Hazardous with warning** (major client dissatisfaction)	**Very remote** (not feasible or cannot be readily done)	9
High repeated failure(once a week)	**Very high** (high degree of client dissatisfaction)	**Remote** (not feasible or cannot be readily done)	8
High repeated failure(once a week)	**High**(high degree of client dissatisfaction)	**Very low** (no process but manual detection by chance)	7
Moderate occasional failure (once per month)	**Moderate**(some client dissatisfaction)	**Low** (no process but manual detection by chance)	6
Moderate occasional failure (once per month)	**Low** (some client dissatisfaction)	**Moderate** (process double checks but not automated	5
Moderate less occasional failure (once per 3 months)	**Very low**(annoys the client)	**Moderately high** (Not automated but 100% detection)	4
Low relatively few failure (once a year)	**Minor** (annoys the client)	**High** (Not automated but 100% detection)	3
Low relatively few failure (once a year)	**Very minor** (client is unaware)	**Very high** (automated and 100% detection)	2
Remote-failure is **unlikely**	None	**Certain** (automatic "shut-offs")	1

Note: If you believe there are potential risks that have not been identified, please list them in the blank space at the end of each category and rate them 1-10.

You can also skip it if you believe any of the listed risks are not an issue at EPSS.

Occurrence = O **Severity = S** **Detection = D**

S.No.	Health commodities supply chain management risks	O rate (1-10)	S rate (1-10)	D rate (1-10)
A. Supply risk that affect EPSS's SCM performance		**O(1-10)**	**S(1-10)**	**D(1-10)**
A.1.	There are risks associated with single supplier (Sole supplier)			
A.2.	The risks that the Organization encounter by full dependency on key suppliers			
A.3.	There is a difficulty to find supplier. (Supplier unavailability)			
A.4.	Unsuitable supplier location (distance, incur additional cost, unsuitable for transportation)			
A.5.	Key Supplier failures (delay in delivery, quality problems, price, and relationship issues, supplier shutdown, accident, unreliability and instability, theft etc.)			
A.6.	There is problem with supplier selection			
A.7.	There is suppliers' poor logistic performance (delay, transportation problem, not complying with supply schedules, etc.)			
A.8.	There is supplier qualification problems(GMP certificate)			
A.9.	There is Poor supplier flexibility in product variety, (quantities, and lack of stock visibility)			
A.10.	Poor performance of 3rd party service providers			
A.11.	Poor partnership/coordination, communication with supplier			
A.12.	Lead-time to receive items from supplies is prolonged / variable			
A.13.	There are contract and agreement issues(Unclear product specifications, Insufficient insurance amount and occurrence)			
A.14.	Suppliers inability to meet EPSS's demand			
A.15.	Health commodities price volatility/ fluctuations			
A.16.	There is exchange rate fluctuations			
A.17.	Market failures (market shortage, fluctuation in commodity price, etc.)			
A.18.	EPSS experience financial distress/problem			
A.19.	There is low technological level and changes			
	Other……			
B. Demand risk that affect EPSS's SCM performance		**O (1-10)**	**S(1-10)**	**D(1-10)**
B.1.	Volatile/unpredicted demand from customers (seasonal fluctuation, outbreaks, uncertainty, etc.)			
B.2.	Risks in forecasting (lead times variance, product variety, short life cycles, information distortion, exaggeration of demand, Underestimation of quantities/shortages etc.)			
B.3.	Wastage of product (theft, expiry, damage, obsolescence, quality etc.)			
B.4.	Poor visibility of stock along the pipeline			
B.5.	Prolonged ordering cycle time			
B.6.	Cancelation of firm orders by the clients			

B.7.	Distribution channel problems			
B.8.	Delivery capacity of clients order(Risks associated with a client's order's delivery capacity)			
B.9.	Delivery reliability of clients order(Risks associated with the dependability of client order delivery)			
B.10.	Poor communication with customers			
B.11.	Customer services disruption (system not working, not served timely)			
B.12.	Changes in customer need assessment result			
B.13.	Financial risks (Lack of funds, late/absence of payment, currency rate, etc.)			
	Other…			
C. Process risk that affect EPSS's SCM performance		**O(1-10)**	**S(1-10)**	**D(1-10)**
C.1.	Nonstandard practice (customized policies per hubs, lack of common codes, local laws, etc.)			
C.2.	Inappropriate rules that distort demand (JIT delivery, max/min inventory system, etc.)			
C.3.	Regulatory issues (change of standards, drug recalls, quality assurance, etc.)			
C.4.	Government/political intervention that has an impact on EPSS's performance or is inconsistent with Organization policy (Change in priority/focus by the government)			
C.5.	Inappropriate type of contract (mistakes in the document, lack of clear understanding, ambiguous clauses, etc.)			
C.6.	Lack of collaborative planning and forecasting and Poor planning (short term planning)			
C.7.	Export/import restrictions affecting EPSS			
C.8.	Illegal trade and organized crime (contraband, vandalism, corruption, theft, counterfeit, etc.)			
C.9.	Unstable policies (pricing, tariffs, etc.)			
C.10.	Administrative barriers (mismanagement, wrong decisions, excessive procedures, etc.)			
C.11.	Inadequate supply chain actors experience			
C.12.	Low harmony between supply chain actors			
C.13.	Insufficient/poor communications with hubs/health facilities and other customers			
C.14.	Storage/cold chain management problem			
C.15.	Outsourcing key business processes (delay, risk of intellectual property, etc.)			
C.16.	Risks due to reliability (Lack of speed of delivery and compliance to delivery schedule			
C.17.	Lengthy set-up times and inflexible processes			
C.18.	Poor inventory management (poor analysis, expiry, obsolete and excessive inventory, etc.)			

C.19.	Inadequate documentation to track transactions at the Organization			
C.20.	Insufficient supervision to support each other			
C.21.	Picking inaccuracy (medication, packaging, etc.)			
C.22.	Prioritization is not used by the Organization for intervention.			
C.23.	The financial statements of the Organization are not well consolidated.			
C.24.	Poor visibility along the pipeline			
C.25.	Increased operational cost			
C.26.	Failure in resource allocation			
C.27.	Infrastructure unavailability (storage space with acceptable facilities, vehicle, equipment, etc.).			
C.28.	The Organization's technological development and level are both low.			
C.29.	Lack of maintenance for equipment/machine			
C.30.	Failure/malfunction of machine, equipment, electricity, water, facility etc			
C.31.	Local human centered issues (accidents, labor strikes, sabotage, availability...)			
C.32.	Lack of technical and managerial skill of staff (motivation, knowledge, training, turnover, etc.)			
C.33.	IT infrastructure problems (breakdown, system failures, integration disruption, virus, software errors, internet disruption, cyberattacks, etc.)			
	Other….			
D. Environmental Risk that affect EPSS's SCM performance		**O (1-10)**	**S(1-10)**	**D(1-10)**
D.1.	Natural Disaster (flooding, thunder strike, environmental disaster, etc.)			
D.2.	Exceptionally unfavorable/extreme weather			
D.3.	Epidemics/disease outbreak			
D.4.	Manmade disasters (fire, political/civil unrest, terrorist attack, etc.)			
D.5.	Remoteness of site/difficult landscape (Scattered warehouses, hubs etc.)			
	Other……..			

Part III: Health Commodities Supply Chain Risk management practices

1. To what extent does EPSS (your hub) currently use a supply chain risk management process?

☐ No extent (1)
☐ Small extent (2)
☐ Moderate extent (3)
☐ Great extent (4)
☐ Very great extent (5)

2. Which Supply chain risk management processes are employed in EPSS(multiple choice)

☐ Risk identification ☐ Risk analysis

☐ Risk Evaluation ☐ Risk treatment

Part III. 1. Health Commodities Supply Chain Risk Identification practices

1. Risk identification practices

Strongly Disagree = SD Disagree = D Neutral = N Agree = A Strongly Agree = SA

Risk identification practices of EPSS	**SD**	**D**	**N**	**A**	**SA**
EPSS uses a standard process for identifying supply chain risks.					
Supply chain risks are identified by their frequency of occurrence					
All potential supply chain risks are communicated to all parties.					
The Organization record identified risks using risk matrix as a tool					
The Organization uses past lesson for identifying risks					

2. To what extent did EPSS use the risk identification methods listed below?

Methods of risk identification	**Not at all (1)**	**Small extent (2)**	**Moderate extent (3)**	**Great extent (4)**	**Very great extent (5)**
Previous risk assessment					
Developing risk register					
Brainstorming session					
Surveys					
Other……....					

Part III. 2. Health Commodities Supply Chain Risk Analysis practice

Strongly Disagree = SD Disagree = D Neutral = N Agree = A Strongly Agree = SA

Risk analysis practices of EPSS	**SD**	**D**	**N**	**A**	**SA**
The Organization prioritize its main supply chain risks					
EPSS follows standard procedures for supply chain risk analysis					
The level of supply chain risk analysis practice is appropriate for identified risks					
Identified risks are quantified and, analyzed based on the severity of the hazard, the likelihood of occurrence, and detection by the Organization					
The Organization's reporting and communication processes enable effective supply chain risk analysis.					
EPSS integrate all aspects of supply chain risk factor during the assessment					
The Organization's supply chain risk analysis processes are well documented.					

Part III. 3. Health Commodities Supply Chain Risk evaluation practice

Strongly Disagree = SD Disagree = D Neutral = N Agree = A Strongly Agree = SA

Risk evaluation practices of EPSS	SD	D	N	A	SA
The Organization emphasizes the significance of reviewing the continuous evaluation process.					
The Organization is well aware of the supply chain risk evaluation systems' strengths and weaknesses.					
The Organization currently has procedures in place to evaluate supply chain risk and adjust policies accordingly					
The Organization is capable of accurately evaluating the costs and benefits to taking risks					
The Organization follows supply chain risk evaluation procedures correctly					
The Organization integrate all aspects of supply chain risk factor during the evaluation					

Part III. 4. Health Commodities Supply Chain Risk treatment practices

Strongly Disagree = SD Disagree = D Neutral = N Agree = A Strongly Agree = SA

Risk treatment practices of EPSS	SD	D	N	A	SA
A. Risk avoidance measures					
In EPSS, the best risk management strategy is avoidance.					
Avoidance strategies include the option of not performing an activity that could carry risk at all.					
Avoiding risks also means losing out on the potential gain that accepting the risk may have allowed.					
B. Risk control measures used					
There is continuous training on risk Management					
There are framework contracts in place with suppliers.					
The contract management system for risk control has been improved.					
Supplies insurance is used to manage risks.					
C. Flexibility measures					
There is Postponement method used in supply chain flexibility					
Postponement reduces their dependence on forecasts					
To mitigate risks, the Organization can switch from single to multiple sourcing as needed.					

Part IV: The effect of HCSC risks on EPSS's HCSCM performance

Strongly Disagree = SD Disagree = D Neutral = N Agree = A Strongly Agree = SA

	SD	D	N	A	SA

Health commodities supply chain management performance					
A. Cost					
The product's price is reasonable as a result of proper risk management.					
The Organization's inventory turnover has improved significantly.					
In comparison to the cost of health commodities, the Organization's operational costs are lower.					
The Organization resource utilization is very good					
Stock wastage due quality issues, expiration, damage, and theft is minimized					
B. Quality	**SD**	**D**	**N**	**A**	**SA**
EPSS provides full delivery on requests and specifications					
The Organization supplies defect free products					
The Organization conducts survey to measure the level of customer satisfaction					
C. Flexibility	**SD**	**D**	**N**	**A**	**SA**
EPSS supplies multiple variant products					
The Organization deliver new product to market quickly					
The Organization utilize outsourcing non-competence					
D. Responsiveness (Order Delivery Lead Time)	**SD**	**D**	**N**	**A**	**SA**
EPSS improved order fulfilment lead time					
EPSS's delivery meets customers' requirements					
The Organization delivers orders on time					
The Organization begins complete delivery as requested by the clients.					
E. Reliability	**SD**	**D**	**N**	**A**	**SA**
The Organization starts damage-free delivery and has improved delivery performance					
The Organization identified potential suppliers					
Product availability improved: Proper execution of clients' order (Perfect order fulfilment)					
EPSS improved supplier communication					
The Organization become resistant to SC risks					

Part V: Potential barriers that EPSS faces in implementing HCSCRM

1. In your opinion, how capable is EPSS of mitigating key supply chain risks that it is currently facing?

   No extent (1) ☐ Small extent (2) ☐ Moderate extent (3) ☐

   Great extent (4) ☐ Very great extent (5) ☐

2. To what extent do the potential barriers listed below affect EPSS's implementation of SCRM practice?

Strongly Disagree = SD Disagree = D Neutral = N Agree = A Strongly Agree = SA

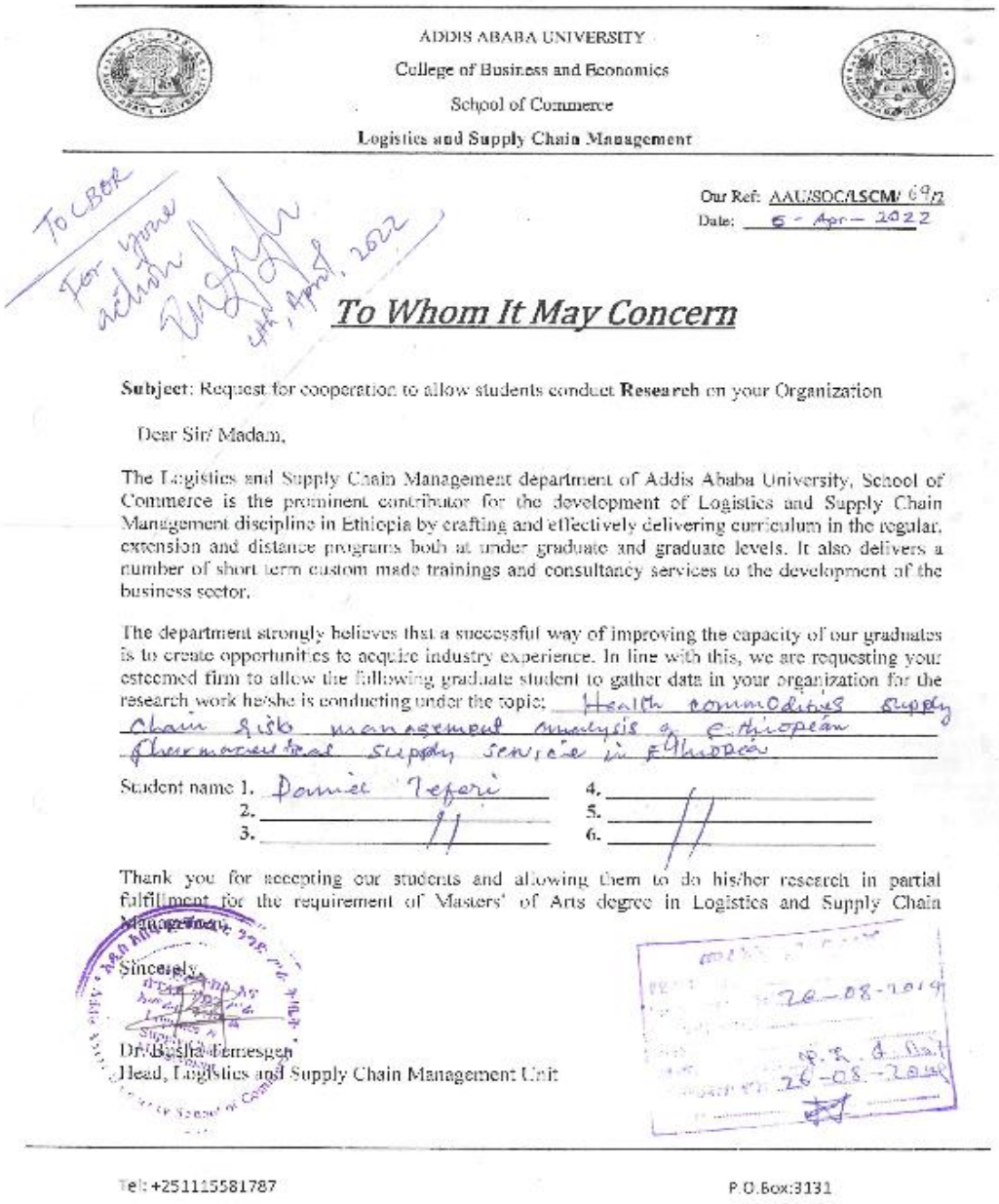
Barriers to implement supply chain risk management strategies	SD	D	N	A	SA
A. Organizational					
Organizational silos(business divisions that operate independently and avoid sharing information) affects the Organization's HCSC risk management practice					
Non-alignment of performance measures to rewards affect risk management					
Individual are too busy to work on HCSC risk management					
Inflexible organization systems and Processes to adopt risk management strategies					
B. **Strategic**	**SD**	**D**	**N**	**A**	**SA**
Lack of top management support					
Non-alignment of strategies with operations					
Lack of trust among supply chain members					
Cost containment is top priority in EPSS					
C. Technological	**SD**	**D**	**N**	**A**	**SA**
Technology do not support business processes(risk management)					
Use of outdated (legacy) software in EPSS					
Lack of enhanced analytical capabilities					
Lack of forecasting tools for both program and RDF products available on EPSS's pharmaceutical procurement list (PPL).					

3. List of EPSS hubs

S.No.	Name of the hubs
1	Adama
2	Addis Ababa
3	Addis Ababa 2
4	Arba minch
5	Assossa
6	Bahir Dar
7	Dessie
8	Dire Dawa
9	Gambella
10	Gondar
11	Hawassa
12	Jigjiga
13	Jimma
14	**Kebridahar**
15	**Mekele**
16	Negele Borena
17	Nekemte
18	Semera
19	**Shire**

Note: Mekele, Shire and Kebridahar hubs are excluded from the study due to security and connection problem by the time of data collection

4. Approval letters from EPSS and AAU School of commerce to conduct the thesis at EPSS for Ethical considerations



ADDIS ABABA UNIVERSITY
College of Business and Economics
School of Commerce
Logistics and Supply Chain Management

To CBOR
For your action
Thank you
6th, April, 2022

Our Ref: AAU/SOC/LSCM/ 69/2
Date: 6 - Apr - 2022

To Whom It May Concern

Subject: Request for cooperation to allow students conduct **Research** on your Organization

Dear Sir/ Madam,

The Logistics and Supply Chain Management department of Addis Ababa University, School of Commerce is the prominent contributor for the development of Logistics and Supply Chain Management discipline in Ethiopia by crafting and effectively delivering curriculum in the regular, extension and distance programs both at under graduate and graduate levels. It also delivers a number of short term custom made trainings and consultancy services to the development of the business sector.

The department strongly believes that a successful way of improving the capacity of our graduates is to create opportunities to acquire industry experience. In line with this, we are requesting your esteemed firm to allow the following graduate student to gather data in your organization for the research work he/she is conducting under the topic: Health commodities supply chain risk management analysis of Ethiopian pharmaceutical supply service in Ethiopia

Student name 1. Daniel Teferi
2. //
3. //
4. //
5. //
6. //

Thank you for accepting our students and allowing them to do his/her research in partial fulfillment for the requirement of Masters' of Arts degree in Logistics and Supply Chain Management.

Sincerely,

Dr. Bisrat Teresegen
Head, Logistics and Supply Chain Management Unit

26-08-2014

Tel: +251115581787 P.O.Box:3131

ቀን
Date 01/09/08/2014 ዓ.ም
ቁጥር
Ref. No. ኢ.መ.አ.ኤ18/5ዳይ/112/14

የውስጥ ማስታወሻ
Office Memo

ለ፡ ግዥ ትንበያና ገበያ ጥናት ዳይሬክቶሬት 2/9/14
ለ፡ ጨረታ አስተዳደር አስተዳደር ዳይሬክቶሬት 2/9/14
ለ፡ መድ/የሕክ/መሣ/ ኮንትራት አስተዳደር ዳይሬክቶሬት 2/9/14
ለ፡ መድ/የሕክ/መሣ/ የመጋዘን አያያዝና ክምችት አስተዳደር ዳይሬክቶሬት 2/9/14
ለ፡ መድ/የሕክ/መሣ/ የስርጭት የተሽከርካሪ ስምሪት አስተዳደር ዳይሬክቶሬት 2/9/14

ከ፡ መድ/የህክ/መገልገያዎች የጥራት ቁጥጥርና ኮንትሮል ዳይሬክቶሬት

ጉዳዩ፡ ትብብርን ይመለከታል፡፡

በትምህርት ሚኒስቴር አዲስ አበባ ዩኒቨርሲቲ College of Business & Economics School of Commerce Logistics & Supply Chain Management በቁጥር AAU/SOC/LSCM/69/12 በቀን 6 April/2022 ዓ.ም በተሰፈ ደብዳቤ. የዩኒቨርስቲው ተማሪ የሆኑት ዳንኤል ተፈሪ የመመረቂያ ጽሁፍ "**Health Commodities supply chain risk management analysis of Ethiopian Pharmaceutical Supply Services in Ethiopian**" በሚል ርዕስ ስለሚሰሩ አስፈላጊውን ትብብር እንዲደረግላቸው ጠይቀዋል፡፡

በዚሁ መሠረት በእናንተም በኩል ትብብር ይደረግላቸው ዘንድ እየጠየኩ፣ በጥናቱ ግለቃለያ ላይ የጥናቱን ውጤት ለኤጀንሲው ለማላመቅ እና አንድ የመረቱትና አንድ የኤለክትሮኒክ ቅጅ (soft copy) እንዲያስረከቡ አሳስባለሁ፡፡

እኔ ስሜ ከታች የገለፀ በጥናቱ መጨረሻ ላይ ውጤቱን ለማላመቅ በፊርማዬ አረጋግጣለሁ፡፡

ዳንኤል ተፈሪ
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ከሠላምታ ጋር
ቅድስ አየለ ገ/ዮሐንስ
የመድኃኒቶች የህክምና መሳሪያዎች
የጥራት ቁጥጥርና ኮንትሮ
ዳይሬክቶሬት ዳይሬ

5. EPSS National Risk identification, evaluation and analysis

Code	Risk category	Risk type	O	S	D	RSV	RPN	Rank	%	Cum
A16	Supply risk	Exchange rate fluctuation	7.06	6.87	5.59	48.55	271.25	1st	2.25%	2.2%
A7	Supply risk	Suppliers' poor logistics performance	6.86	7.01	5.61	48.05	269.64	2nd	2.23%	4.5%
B1	Demand risk	Volatile/unpredicted demand	6.57	7.14	5.73	46.94	268.97	3rd	2.23%	6.7%
B2	Demand risk	Risks in forecasting	6.63	7.00	5.48	46.44	254.71	4th	2.11%	8.8%
B3	Demand risk	Wastage of product	6.93	7.21	5.09	49.93	254.01	5th	2.10%	10.9%
A5	Supply risk	Key supplier failure	6.44	7.13	5.36	45.87	245.75	6th	2.03%	13.0%
C33	Process risk	IT infrastructure problems	6.65	6.79	5.30	45.13	239.26	7th	1.98%	14.9%
A17	Supply risk	Market failurs	6.63	7.00	5.15	46.44	239.23	8th	1.98%	16.9%
A1	Supply risk	Sole supplier	6.56	7.18	5.06	47.14	238.71	9th	1.98%	18.9%
C32	Process risk	Lack of technical and managerial skill of staff	6.13	6.56	5.71	40.17	229.52	10th	1.90%	20.8%
C25	Process risk	Increased operational cost	6.63	6.39	5.34	42.39	226.42	11th	1.87%	22.7%
C24	Process risk	Poor visibility along the pipeline	6.30	6.59	5.40	41.51	224.35	12th	1.86%	24.5%
A12	Supply risk	Prolonged lead time	6.73	6.75	4.87	45.40	221.24	13th	1.83%	26.4%
A18	Supply risk	Financial distress/problem	6.58	6.95	4.71	45.74	215.28	14th	1.78%	28.1%
C10	Process risk	Administrative barriers	6.16	6.11	5.68	37.64	213.87	15th	1.77%	29.9%
B13	Demand risk	Financial risks	6.47	6.93	4.76	44.82	213.41	16th	1.77%	31.7%
A15	Supply risk	Price fluctuation	6.32	6.60	5.10	41.67	212.62	17th	1.76%	33.4%
C23	Process risk	The financial statements of the Organization are not well consolidated.	6.16	6.17	5.54	37.98	210.39	18th	1.74%	35.2%
B5	Demand risk	Prolonged ordering cycle time	6.42	6.39	5.02	41.04	206.18	19th	1.71%	36.9%
A2	Supply risk	Key supplier dependency	5.75	6.46	5.49	37.12	203.87	20th	1.69%	38.6%
C18	Process risk	Poor inventory management	6.10	6.46	4.98	39.38	196.26	21st	1.62%	40.2%
C29	Process risk	Lack of maintenance for equipment/machine	6.28	5.81	5.33	36.47	194.51	22nd	1.61%	41.8%
A14	Supply risk	Supplier inability to meet EPSAs' Demand	5.66	6.35	5.35	35.93	192.19	23rd	1.59%	43.4%
B7	Demand risk	Distribution channel problems	5.58	6.29	5.25	35.11	184.49	24th	1.53%	44.9%
C26	Process risk	Failure in resource allocation	5.95	6.07	5.10	36.14	184.43	25th	1.53%	46.4%
B4	Demand risk	Poor visibility of stock along the pipeline	6.04	6.10	4.90	36.81	180.56	26th	1.49%	47.9%
B10	Demand risk	Poor communication with customers	5.93	6.14	4.95	36.42	180.36	27th	1.49%	49.4%
C22	Process risk	Prioritization is not used by the Organization for intervention	5.33	6.05	5.54	32.21	178.41	28th	1.48%	50.9%

C30	Process risk	Failure/malfunction of machine, equipment, electricity, water, facility	5.67	5.64	5.47	31.98	174.85	29th	1.45%	52.4%
B9	Demand risk	Delivery reliability of clients order	5.61	6.06	5.04	33.98	171.24	30th	1.42%	53.8%
C16	Process risk	Risks due to reliability	5.52	6.06	5.11	33.40	170.72	31st	1.41%	55.2%
C20	Process risk	Insufficient supervision to support each other	6.12	5.51	5.06	33.70	170.66	32nd	1.41%	56.6%
B11	Demand risk	Customer services disruption	5.72	5.96	4.97	34.11	169.45	33rd	1.40%	58.0%
A11	Supply risk	Poor partnership, coordination and communication with supplier	5.25	6.06	5.32	31.81	169.14	34th	1.40%	59.4%
A3	Supply risk	Supplier unavailability	5.37	6.24	5.03	33.52	168.65	35th	1.40%	60.8%
B8	Demand risk	Delivery capacity of clients order	5.74	5.63	5.10	32.33	165.00	36th	1.37%	62.2%
A13	Supply risk	Contract and agreement issues	5.14	6.16	5.17	31.67	163.65	37th	1.35%	63.5%
C28	Process risk	The Organization's technological development and level are both low.	5.75	5.87	4.84	33.79	163.60	38th	1.35%	64.9%
C27	Process risk	Infrastructure unavailability	5.51	6.07	4.84	33.44	161.90	39th	1.34%	66.2%
C1	Process risk	Nonstandard practice	5.57	5.53	5.23	30.82	161.19	40th	1.33%	67.6%
A4	Supply risk	Unsuitable supplier location	5.48	5.70	5.14	31.25	160.72	41st	1.33%	68.9%
A19	Supply risk	Low technological level and changes	5.56	5.79	4.98	32.23	160.40	42nd	1.33%	70.2%
C11	Process risk	Inadequate supply chain actors experience	5.30	5.98	4.94	31.68	156.66	43rd	1.30%	71.5%
C17	Process risk	Lengthy set-up times and inflexible processes	5.64	5.57	4.84	31.44	152.20	44th	1.26%	72.8%
C8	Process risk	Illegal trade and organized crime	4.60	6.33	5.22	29.12	152.05	45th	1.26%	74.0%
C6	Process risk	Lack of collaborative planning and forecasting and Poor planning	5.45	5.83	4.72	31.81	150.19	46th	1.24%	75.3%
C13	Process risk	Insufficient/poor communications	5.20	5.66	5.09	29.42	149.65	47th	1.24%	76.5%
C12	Process risk	Low harmony between supply chain actors	5.37	5.56	5.00	29.85	149.24	48th	1.24%	77.7%
A10	Supply risk	Poor performance of third party providers	5.40	5.40	5.03	29.21	146.98	49th	1.22%	79.0%
C2	Process risk	Inappropriate rules that distort demand	5.31	5.37	5.11	28.49	145.60	50th	1.21%	80.2%
C9	Process risk	Unstable policies	5.06	5.40	5.33	27.32	145.51	51st	1.20%	81.4%
B12	Demand risk	Changes in customer need assessment result	5.37	5.63	4.66	30.19	140.64	52nd	1.16%	82.5%
A9	Supply risk	Poor supplier flexibility	5.76	5.44	4.46	31.32	139.72	53rd	1.16%	83.7%
D4	Environmental risk	Manmade disasters	4.78	5.93	4.92	28.33	139.38	54th	1.15%	84.8%

C31	Process risk	Local human centered issues	5.03	5.50	4.99	27.67	138.15	55th	1.14%	86.0%
C5	Process risk	Inappropriate type of contract	5.11	5.72	4.60	29.25	134.40	56th	1.11%	87.1%
D3	Environmental risk	Epidemics/disease outbreak	4.51	5.90	4.95	26.62	131.82	57th	1.09%	88.2%
A6	Supply risk	Supplier selection problem	4.75	5.48	5.05	25.99	131.19	58th	1.09%	89.3%
C21	Process risk	Picking inaccuracy	5.00	5.56	4.67	27.82	129.81	59th	1.07%	90.4%
C4	Process risk	Government/political intervention	4.75	5.45	4.83	25.88	125.07	60th	1.04%	91.4%
C19	Process risk	Inadequate documentation to track transactions at the Organization	5.13	5.49	4.24	28.16	119.34	61st	0.99%	92.4%
A8	Supply risk	Supplier qualification problem	4.93	5.44	4.45	26.79	119.30	62nd	0.99%	93.4%
C7	Process risk	Export/import restrictions affecting EPSA	4.66	5.18	4.80	24.14	115.93	63rd	0.96%	94.3%
C14	Process risk	Storage/cold chain management problem	4.25	5.94	4.45	25.21	112.23	64th	0.93%	95.3%
B6	Demand risk	Cancelation of firm orders by the clients	4.62	5.02	4.61	23.17	106.83	65th	0.88%	96.1%
C3	Process risk	Regulatory issues	4.48	5.06	4.63	22.67	105.07	66th	0.87%	97.0%
D5	Environmental risk	Remoteness of site/difficult landscape	4.86	4.83	4.25	23.48	99.87	67th	0.83%	97.8%
C15	Process risk	Outsourcing key business processes	4.17	5.21	4.53	21.73	98.46	68th	0.82%	98.6%
D1	Environmental risk	Natural Disaster	2.79	5.40	6.02	15.08	90.70	69th	0.75%	99.4%
D2	Environmental risk	Exceptionally unfavorable/extreme weather	2.94	4.71	5.22	13.88	72.49	70th	0.60%	100.0%

6. EPSS Central Risk identification, evaluation and analysis

Code	Category	Risk type	O	S	D	RSV	RPN	Rank	Cumulative
A7	Supply risk	Suppliers' poor logistics performance	6.88	6.95	5.74	47.80	274.27	1st	2.2%
B1	Demand risk	Volatile/unpredicted demand	6.57	7.11	5.73	46.69	267.40	2nd	4.4%
A16	Supply risk	Exchange rate fluctuation	7.00	6.80	5.46	47.59	260.04	3rd	6.5%
A1	Supply risk	Sole supplier	6.77	7.23	5.28	48.95	258.57	4th	8.7%
C33	Process risk	IT infrastructure problems	6.80	6.76	5.62	45.94	257.99	5th	10.8%
B3	Demand risk	Wastage of product	7.01	7.06	5.20	49.50	257.48	6th	12.9%
B2	Demand risk	Risks in forecasting	6.49	7.04	5.59	45.73	255.42	7th	14.9%
A5	Supply risk	Key supplier failure	6.49	6.99	5.54	45.40	251.30	8th	17.0%
C25	Process risk	Increased operational cost	6.81	6.54	5.65	44.49	251.23	9th	19.0%
C32	Process risk	Lack of technical and managerial skill of staff	6.06	6.49	5.75	39.36	226.24	10th	20.9%

C24	Process risk	Poor visibility along the pipeline	6.17	6.66	5.42	41.08	222.84	11th	22.7%
B13	Demand risk	Financial risks	6.68	6.94	4.80	46.33	222.30	12th	24.5%
A17	Supply risk	Market failurs	6.49	6.88	4.91	44.68	219.33	13th	26.3%
A18	Supply risk	Financial distress/problem	6.71	7.13	4.53	47.83	216.44	14th	28.1%
C10	Process risk	Administrative barriers	6.24	6.05	5.73	37.77	216.32	15th	29.8%
A12	Supply risk	Prolonged lead time	6.58	6.67	4.89	43.84	214.32	16th	31.6%
C29	Process risk	Lack of maintenance for equipment/machine	6.52	5.89	5.47	38.37	210.05	17th	33.3%
A15	Supply risk	Price fluctuation	6.32	6.67	4.98	42.15	209.92	18th	35.0%
C23	Process risk	The financial statements of the Organization are not well consolidated.	6.10	6.10	5.44	37.22	202.65	19th	36.7%
A2	Supply risk	Key supplier dependency	5.62	6.39	5.62	35.91	201.67	20th	38.3%
B5	Demand risk	Prolonged ordering cycle time	6.39	6.32	4.93	40.39	199.08	21st	39.9%
C30	Process risk	Failure/malfunction of machine, equipment, electricity, water, facility	6.01	5.80	5.59	34.85	194.65	22nd	41.5%
B9	Demand risk	Delivery reliability of clients order	5.91	6.33	5.15	37.42	192.79	23rd	43.1%
B10	Demand risk	Poor communication with customers	6.08	6.28	5.03	38.20	192.18	24th	44.7%
C18	Process risk	Poor inventory management	6.02	6.24	5.00	37.58	187.90	25th	46.2%
B7	Demand risk	Distribution channel problems	5.68	6.21	5.28	35.26	186.30	26th	47.7%
C16	Process risk	Risks due to reliability	5.66	6.19	5.27	35.02	184.68	27th	49.2%
C28	Process risk	The Organization's technological development and level are both low.	6.03	6.06	5.05	36.55	184.58	28th	50.7%
A14	Supply risk	Supplier inability to meet EPSAs' Demand	5.39	6.20	5.45	33.45	182.47	29th	52.2%
B4	Demand risk	Poor visibility of stock along the pipeline	5.99	6.17	4.93	36.97	182.23	30th	53.7%
B8	Demand risk	Delivery capacity of clients order	5.99	5.83	5.21	34.91	181.96	31st	55.2%
A3	Supply risk	Supplier unavailability	5.48	6.29	5.26	34.52	181.64	32nd	56.7%
A11	Supply risk	Poor partnership, coordination and communication with supplier	5.34	6.18	5.41	33.03	178.84	33rd	58.2%
C26	Process risk	Failure in resource allocation	5.86	6.03	5.04	35.33	178.07	34th	59.6%
B11	Demand risk	Customer services disruption	5.82	5.98	5.00	34.79	173.96	35th	61.0%
C17	Process risk	Lengthy set-up times and inflexible processes	5.95	5.88	4.97	34.98	173.82	36th	62.4%
C20	Process risk	Insufficient supervision to support each other	6.12	5.55	5.11	33.94	173.50	37th	63.9%
C1	Process risk	Nonstandard practice	5.67	5.69	5.29	32.23	170.57	38th	65.3%
C22	Process risk	Prioritization is not used by the Organization for intervention	5.09	5.98	5.53	30.44	168.20	39th	66.6%
C27	Process risk	Infrastructure unavailability	5.55	6.17	4.86	34.22	166.28	40th	68.0%
A19	Supply risk	Low technological level and changes	5.65	5.82	4.97	32.85	163.27	41st	69.3%
A4	Supply risk	Unsuitable supplier location	5.36	5.65	5.38	30.29	163.05	42nd	70.6%

C11	Process risk	Inadequate supply chain actors experience	5.40	5.91	5.02	31.93	160.31	43rd	72.0%
C8	Process risk	Illegal trade and organized crime	4.73	6.41	5.24	30.32	158.96	44th	73.2%
C12	Process risk	Low harmony between supply chain actors	5.35	5.55	5.24	29.69	155.64	45th	74.5%
C13	Process risk	Insufficient/poor communications	5.24	5.59	5.27	29.28	154.40	46th	75.8%
A10	Supply risk	Poor performance of third party providers	5.37	5.43	5.27	29.20	153.98	47th	77.0%
A13	Supply risk	Contract and agreement issues	5.07	5.83	5.19	29.55	153.44	48th	78.3%
B12	Demand risk	Changes in customer need assessment result	5.72	5.71	4.60	32.63	149.96	49th	79.5%
C21	Process risk	Picking inaccuracy	5.33	5.65	4.77	30.11	143.58	50th	80.7%
C6	Process risk	Lack of collaborative planning and forecasting and Poor planning	5.33	5.75	4.67	30.65	143.05	51st	81.9%
C5	Process risk	Inappropriate type of contract	5.31	5.76	4.65	30.59	142.14	52nd	83.0%
C2	Process risk	Inappropriate rules that distort demand	5.20	5.28	5.15	27.48	141.57	53rd	84.2%
C31	Process risk	Local human centered issues	5.04	5.45	5.03	27.49	138.30	54th	85.3%
C9	Process risk	Unstable policies	5.15	5.25	5.08	27.06	137.48	55th	86.4%
D3	Environmental risk	Epidemics/disease outbreak	4.57	5.95	4.95	27.16	134.44	56th	87.5%
D4	Environmental risk	Manmade disasters	4.70	5.77	4.81	27.09	130.25	57th	88.6%
C19	Process risk	Inadequate documentation to track transactions at the Organization	5.30	5.74	4.21	30.43	128.16	58th	89.6%
A6	Supply risk	Supplier selection problem	4.47	5.28	5.36	23.64	126.79	59th	90.7%
A9	Supply risk	Poor supplier felexibility	5.53	5.24	4.32	28.97	125.23	60th	91.7%
C4	Process risk	Government/political intervention	4.62	5.56	4.75	25.65	121.75	61st	92.7%
C14	Process risk	Storage/cold chain management problem	4.32	6.09	4.52	26.33	118.89	62nd	93.6%
A8	Supply risk	Supplier qualification problem	5.03	5.33	4.28	26.83	114.90	63rd	94.6%
C3	Process risk	Regulatory issues	4.68	4.97	4.68	23.24	108.70	64th	95.5%
B6	Demand risk	Cancelation of firm orders by the clients	4.61	5.12	4.56	23.59	107.46	65th	96.3%
C7	Process risk	Export/import restrictions affecting EPSA	4.54	4.85	4.62	21.99	101.51	66th	97.2%
D5	Environmental risk	Remoteness of site/difficult landscape	4.91	4.80	4.27	23.55	100.64	67th	98.0%
C15	Process risk	Outsourcing key business processes	4.11	5.19	4.59	21.34	97.88	68th	98.8%
D1	Environmental risk	Natural Disaster	2.80	4.99	6.09	13.96	85.04	69th	99.5%
D2	Environmental risk	Exceptionally unfavorable/extreme weather	2.79	4.44	5.05	12.39	62.58	70th	100.0%

7. EPSS hubs Risk identification, evaluation and analysis

Code	Category	Risk type	O	S	D	RSV	RPN	Rank	Cumulative
A17	Supply risk	Market failures	7.15	7.44	6.04	53.21	321.25	1st	2.8%
A16	Supply risk	Exchange rate fluctuation	7.30	7.15	6.04	52.16	314.86	2nd	5.5%
B1	Demand risk	Volatile/unpredicted demand	6.59	7.26	5.74	47.86	274.74	3rd	7.9%
A7	Supply risk	Suppliers' poor logistics performance	6.78	7.22	5.15	48.95	252.01	4th	10.0%
B2	Demand risk	Risks in forecasting	7.15	6.85	5.11	48.98	250.33	5th	12.2%
A12	Supply risk	Prolonged lead time	7.30	7.04	4.81	51.34	247.21	6th	14.3%
C32	Process risk	Lack of technical and managerial skill of staff	6.37	6.78	5.59	43.18	241.47	7th	16.4%
C23	Process risk	The financial statements of the Organization are not well consolidated.	6.37	6.41	5.89	40.82	240.37	8th	18.5%
B3	Demand risk	Wastage of product	6.63	7.74	4.67	51.32	239.49	9th	20.6%
B5	Demand risk	Prolonged ordering cycle time	6.52	6.67	5.37	43.46	233.38	10th	22.6%
C24	Process risk	Poor visibility along the pipeline	6.78	6.33	5.33	42.93	228.94	11th	24.5%
C18	Process risk	Poor inventory management	6.37	7.26	4.93	46.24	227.80	12th	26.5%
A14	Supply risk	Supplier inability to meet EPSAs' Demand	6.63	6.89	4.96	45.67	226.66	13th	28.5%
A5	Supply risk	Key supplier failure	6.22	7.63	4.70	47.47	223.30	14th	30.4%
A15	Supply risk	Price fluctuation	6.30	6.33	5.56	39.88	221.54	15th	32.3%
C22	Process risk	Prioritization is not used by the Organization for intervention	6.19	6.30	5.59	38.94	217.80	16th	34.2%
A2	Supply risk	Key supplier dependency	6.22	6.70	5.04	41.71	210.10	17th	36.0%
C26	Process risk	Failure in resource allocation	6.30	6.22	5.33	39.18	208.94	18th	37.8%
A18	Supply risk	Financial distress/problem	6.11	6.30	5.37	38.48	206.64	19th	39.6%
C10	Process risk	Administrative barriers	5.85	6.33	5.52	37.06	204.53	20th	41.3%
A9	Supply risk	Poor supplier felexibility	6.63	6.15	4.96	40.76	202.29	21st	43.1%
A13	Supply risk	Contract and agreement issues	5.41	7.37	5.07	39.85	202.23	22nd	44.8%
B13	Demand risk	Financial risks	5.70	6.89	4.63	39.29	181.91	23rd	46.4%
C7	Process risk	Export/import restrictions affecting EPSA	5.11	6.41	5.48	32.75	179.51	24th	48.0%
C6	Process risk	Lack of collaborative planning and forecasting and Poor planning	5.89	6.15	4.93	36.21	178.35	25th	49.5%
B7	Demand risk	Distribution channel problems	5.22	6.59	5.15	34.43	177.24	26th	51.0%
D4	Environmental risk	Manmade disasters	5.07	6.52	5.33	33.08	176.40	27th	52.5%
C33	Process risk	IT infrastructure problems	6.11	6.89	4.15	42.10	174.63	28th	54.1%
C9	Process risk	Unstable policies	4.70	5.96	6.22	28.05	174.52	29th	55.6%
B4	Demand risk	Poor visibility of stock along the pipeline	6.22	5.81	4.81	36.18	174.21	30th	57.1%
A1	Supply risk	Sole supplier	5.81	7.00	4.26	40.70	173.37	31st	58.6%

C20	Process risk	Insufficient supervision to support each other	6.11	5.37	4.89	32.82	160.45	32nd	59.9%
C2	Process risk	Inappropriate rules that distort demand	5.70	5.67	4.96	32.32	160.41	33rd	61.3%
B11	Demand risk	Customer services disruption	5.37	5.89	4.85	31.63	153.44	34th	62.7%
A19	Supply risk	Low technological level and changes	5.26	5.70	5.00	30.00	149.99	35th	63.9%
A4	Supply risk	Unsuitable supplier location	5.93	5.89	4.26	34.90	148.64	36th	65.2%
C25	Process risk	Increased operational cost	6.00	5.85	4.22	35.11	148.25	37th	66.5%
C27	Process risk	Infrastructure unavailability	5.37	5.70	4.78	30.63	146.35	38th	67.8%
C29	Process risk	Lack of maintenance for equipment/machine	5.41	5.52	4.81	29.84	143.68	39th	69.0%
C11	Process risk	Inadequate supply chain actors experience	4.93	6.22	4.67	30.65	143.03	40th	70.2%
B10	Demand risk	Poor communication with customers	5.37	5.63	4.67	30.23	141.09	41st	71.5%
A6	Supply risk	Supplier selection problem	5.74	6.19	3.89	35.51	138.08	42nd	72.7%
C31	Process risk	Local human centered issues	5.00	5.67	4.85	28.33	137.47	43rd	73.8%
A11	Supply risk	Poor partnership, coordination and communication with supplier	4.89	5.63	4.96	27.52	136.59	44th	75.0%
C4	Process risk	Government/political intervention	5.22	5.07	5.15	26.50	136.42	45th	76.2%
A8	Supply risk	Supplier qualification problem	4.56	5.81	5.07	26.49	134.41	46th	77.4%
C13	Process risk	Insufficient/poor communications	5.04	5.93	4.41	29.85	131.56	47th	78.5%
C1	Process risk	Nonstandard practice	5.22	4.96	5.00	25.92	129.59	48th	79.6%
C8	Process risk	Illegal trade and organized crime	4.15	6.00	5.15	24.89	128.13	49th	80.7%
C16	Process risk	Risks due to reliability	5.00	5.56	4.52	27.78	125.51	50th	81.8%
A3	Supply risk	Supplier unavailability	4.96	6.04	4.19	29.96	125.39	51st	82.9%
C12	Process risk	Low harmony between supply chain actors	5.41	5.63	4.11	30.44	125.15	52nd	84.0%
D3	Environmental risk	Epidemics/disease outbreak	4.30	5.74	4.96	24.66	122.41	53rd	85.0%
A10	Supply risk	Poor performance of third party providers	5.52	5.30	4.15	29.23	121.24	54th	86.1%
D2	Environmental risk	Exceptionally unfavorable/extreme weather	3.52	5.70	5.85	20.07	117.44	55th	87.1%
C30	Process risk	Failure/malfunction of machine, equipment, electricity, water, facility	4.41	5.07	5.04	22.36	112.65	56th	88.0%
B8	Demand risk	Delivery capacity of clients order	4.81	4.93	4.70	23.72	111.56	57th	89.0%
D1	Environmental risk	Natural Disaster	2.78	6.89	5.74	19.14	109.85	58th	90.0%
C5	Process risk	Inappropriate type of contract	4.37	5.59	4.41	24.44	107.72	59th	90.9%
B12	Demand risk	Changes in customer need assessment result	4.07	5.33	4.89	21.73	106.23	60th	91.8%

B9	Demand risk	Delivery reliability of clients order	4.52	5.04	4.63	22.76	105.37	61st	92.7%
B6	Demand risk	Cancelation of firm orders by the clients	4.67	4.63	4.81	21.60	104.02	62nd	93.6%
C15	Process risk	Outsourcing key business processes	4.37	5.30	4.33	23.15	100.30	63rd	94.5%
C28	Process risk	The Organization's technological development and level are both low.	4.74	5.19	4.07	24.58	100.15	64th	95.3%
D5	Environmental risk	Remoteness of site/difficult landscape	4.67	4.96	4.19	23.16	96.93	65th	96.2%
C3	Process risk	Regulatory issues	3.78	5.37	4.48	20.29	90.92	66th	97.0%
C14	Process risk	Storage/cold chain management problem	3.96	5.37	4.22	21.28	89.86	67th	97.7%
C19	Process risk	Inadequate documentation to track transactions at the Organization	4.48	4.59	4.33	20.58	89.19	68th	98.5%
C17	Process risk	Lengthy set-up times and inflexible processes	4.52	4.44	4.37	20.08	87.77	69th	99.3%
C21	Process risk	Picking inaccuracy	3.78	5.26	4.30	19.87	85.36	70th	100.0%

8. Tentative work plan of the study

Table: Work schedule for Health commodities supply chain risk management analysis of Ethiopian Pharmaceutical Supply Organization from Feb 2021- July, 2022 Addis Ababa, Ethiopia.

No.	Tasks to be performed	Period	Personnel assigned to the task
1	Finalizing research proposal	October 29- January 19	Principal investigator Advisor
2	Incorporate comments and submit final proposal to program unit	January 28	Principal investigator
3	Proposal defense	February 02 - 05, 2022	Principal investigator Advisor, Assigned examiners
	Proposal Modification Upon Examiner Comments	Till February 20, 2022	Principal investigator
2	Securing Clearance	Feb 21-22, 2022	Principal investigator, School of Commerce
3	Recruitment and training of data collectors. Orientation of authorities of EPSS	February 23- 24, 2022	Principal investigator
7.	Pre-test and review of questionnaire	Feb 25-28, 2022	Principal investigator
8.	Data collection	March 1-7, 2022	Data collectors and principal investigator

9.	Data entry and cleaning	March 8 -13, 2022	Data clerk and principal investigator
10.	Data analysis and write up	March 13- April 21, 2022	Principal investigator
11.	Submission of first draft of report	April 21	Principal investigator
12.	Feedback or comments	Till May 01, 2022	Advisor
13.	Submission of second draft of report	May 14, 2021	Principal investigator
14.	Feedback or comments	Till May 21, 2022	Advisor
15	Final write up and submission of final document approved by advisor	May 31, 2022	Principal investigator
16.	Thesis defense	June 05 to June10, 2022	Principal investigator
17	Submission of final thesis booklet & soft copy in CD to the School of Commerce Library	June 15 - June 20, 2022	Principal investigator