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DEDICATION

I dedicate this thesis to my loving husband and my two boys for nursing me with love and affection and their dedicated partnership for success in my life. Above all more thanks goes to my supervisor Doc Chari for being for patient with me through my study as l was pregnant and to friends who became family.

DECLARATION

I declare that this dissertation is my own original work and all sources used have been properly acknowledged. I have followed all formatting guidelines and requirements set by the educational institution for the submission of this dissertation.

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Thank you all for your contributions to this research endeavor.

ABSTRACT

The major thrust of this study was to analyse how the Zimbabwe‘s health sector can build supply chain resilience within in the wake of pandemics.. To achieve this, the study tested three hypotheses linked to supply chain resilience strategies using 122 respondents from the Zimbabwe’s public health sector institutions in Harare, Zimbabwe. Four supply chain resilience strategies namely supply chain resilience, supply chain visibility, supply chain flexibility and supply chain collaboration of supply chain resilience tested were supply chain visibility, supply chain flexibility and supply chain redundancy were tested against supply chain resilience. Data was collected quantitatively using questionnaires to a sample of 122 respondents selected through the probability method of simple random sampling. The data were analysed through inferential statistics of exploratory factor analysis and confirmatory factor analysis. Using the results of data analysis, the study concluded that demonstrated that supply chain redundancy, visibility, flexibility and collaboration have positive significant effect on supply chain within Zimbabwe‘s health sector in the wake of pandemics. The study also recommends that public health institutions should work to achieve supply chain visibility through sharing adequate quality information in the right quantity at the right time with partners in the supply chain and using information technology to enhance connectivity had positive effect on supply chain resilience in order to overcome supply chain disruptions in the event times of pandemic outbreaks.
Furthermore, it is recommended that firms within Zimbabwe‘s health sector should use supply chain collaboration strategies to increase their resilience. These strategies should be in place so that when the supply chain is distorted by risks such as global pandemic like the recent Covid – 19 pandemics, firms within Zimbabwe‘s health sector will be able to withstand these distortions. In order to ensure that they can handle supply disruptions and crises brought on by pandemics, the report also suggests that public health institutions strengthen the flexibility of their supply chains through flexible supply bases, flexible transportation, and flexible processes.

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter introduces the subject under study by highlighting the background from which the study emanates from, the objectives of the study and the statement of hypotheses. In addition, the significance of this study is also highlighted in this chapter. The chapter also point out the scope of the study which includes the delimitations and the limitations of the study and how the researcher tried to mitigate the limitations. Assumptions of the study as well as definition of key variables used in the study are also included. The chapter closes with a chapter summary.

1.1 Background of the study

The COVID-19 pandemic that hit the whole world between 2019 and 2021 has tested the effectiveness of 20 years of research, debate and planning on supply chain resilience (Dubey, 2021). Business continuity plans that companies thought were robust have proved seriously deficient (Ketokivi & Schroeder 2021). At a global glance, statistics from a global statistics compilation organisation, Statista show that the effects of supply chain disruptions is alarming.

Over the past ten years, supply chains worldwide have faced an increasing number of dangers, endangering the operations of several companies (Casson, 2018). Supply chains are intricate webs of businesses that are always in flux, which makes unforeseen disruptions possible. Actually, according to executives, supply chain risk poses the biggest threat to their companies (FM Global 2022). Supply chain structuresare subject to a growing number of risks that stem from various sources. These risks can have an unpredictable and severe influence on supply chain structures, posing a danger to their performance outcomes over the short and long terms. Risk analysis hastherefore become a significant event in the majority of businesses (Hertz & Thomas, 2019). It has become evident to managers that in order to achieve their organisational goals, supply chains must function effectively and efficiently (FM Global, 2017). Consequently, the primary goal of contemporary supply chain management has been to create a supply network that can foresee risks, react to them swiftly and affordably, and recover to a state of equilibrium following

disruptions (Hohenstein, 2020). This calls for creating robust supply networks. According to Jutter and Maklan (2019), supply chain resilience is predicated on the idea that while some risks cannot be avoided, businesses may manage the possibility of supply chain disruptions by establishing a robust supply chain. This ensures that they continue to provide their services or products to their customers (Ambulkkar et al, 2019; Scholten & Schilder, 2020).

In order to accurately represent the underlying complexity and dynamic of the supply chain, managers must possess the appropriate mindset or model. The ability of businesses to distribute their goods has been impacted by a variety of high-profile incidents in recent years as well as ongoing issues like terrorism, earthquakes, political unrest, fuel crises, and disease (Chen et al, 2018; Sodhi, 2016; Mandal, 2014; Sigh et al 2020). The necessity for businesses to create robust supply chains is demonstrated by the potential effects of disruption on their operations and supply chains. This is especially true in light of the extreme circumstances that have led to supply chain collapses that have never fully recovered (Carvalho, 2019; Xu et al, 2014).

As noted by Dubey (2021), the recent supply chain disruptions caused by the COVID-19 pandemic which has unsettled the whole world's supply chain affecting all sectors of the economy, is a testimony for the need to build resilient supply chains in thewake of pandemic. COVID-19 as the most recent pandemic caused numerous shocks to the world's supply chain and as a result, business plans that were thought to be robust showed serious deficiencies (Ketokivi & Schroeder; 2021). Pandemics such as Covid-19 are an example of a high impact probability low probability events that are beyond the scope of many organisation's supply chain risk radar and resilience planning. Thus, they may catch organisations unaware. These pandemics, as witnessed by COVID-19, may be global, prolonged and may consists of major shocks to logistical systems.

Recent research on COVID-19's effects on supply chains has demonstrated that, even after pandemic-related disruptions, performance can still be improved (Dubey, 2021). Therefore, the purpose of this study is to evaluate how Zimbabwe's health sector may create robust supply chains in the event of a pandemic. This is important because pandemic recurrence isnot completely ruled

out. There is historical evidence that these pandemics will persist. Benedictov (2018) and Tumpey (2020) claim that pandemics and epidemics have historically occurred in Europe during the Middle Ages, a time when high mortality rates were noted.

The 1918–1919 Spanish influenza pandemic, on the other hand, also claimed more than 30 million lives globally. These outbreaks can occasionally be caused by natural causes, as in the case of the H1N1 virus outbreak, which the World Health Organisation estimates has spread to more than 214 countries worldwide and is responsible for a staggering 18,114 human fatalities (http://www.who.int/crs/2010_05_28/en/index.html). HIV, cholera, smallpox, and polio are a few other illnesses that continue to seriously jeopardise global supply networks. A number of other epidemics that have recently surfaced have also resultedin multiple infections and fatal illnesses, including SARS in 2003, H1N1 in 2009, Ebola in 2014, MERS-Cov (Middle East respiratory syndrome corona virus) in 2014, and the most recent COVID-19 in 2019.

Profit-oriented organisations tend to increase operational efficiency, eliminating wastage to improve their position in the market. Healthcare organisations find themselves in a tough spot, mostly because they must focus on cost reduction and increasing revenues to provide continuously improved healthcare services. Depending on the country, Healthcare organisations can be either public or private. Although public Healthcare organisations generally do not have to worry about bankruptcy, they still have the compromise to serve the taxpayer with the utmost service level.

One way to succeed is to develop the ability to anticipate, adapt, respond, and recover, making the supply chain less susceptible to risks (Ali, Mahfouz, and Arisha 2017). In this sense, healthcare supply chain risk management (HCSCRM) is an essential building block of healthcare supply chain resilience (HCSCRes), which contributes to healthcare supply chain performance (HCSCP). An increase in global scale disasters can generate disgraceful results and disruptions and make researchers pay greater attention to SCRM (Chowdhury et al. 2019). Recently,

COVID-19 pandemic has generated disruptions, reinforcing the urge of generating resilience for healthcare supply chains.

Risk analysis should consider the whole supply chain to provide satisfactory results (Juttner, Peck, and Christopher 2003; Waqas et al. 2019). A healthcare supply chain (HCSC) is a supply chain where all the companies must be driven by the objective of offering Healthcare and saving lives (Abdulsalam et al. 2015; Rakovska and Stratieva 2018).

HCSC has additional risks such as long waiting times for a medical appointment, Labib et al. 2019). COVID-19 taught an important lesson: if healthcare supply chains break, all other supply chains break. In this sense, generating resilience in healthcare supply chains mean reducing uncertainties with fast decision-making, generating adaptability that allows the system to reconfigure itself and improve availability of hospital beds, respirators, and life support drugs.Supply chain risks happen due to several reasons like disruptions to material flows, information flows, knowledge flows, and control and coordination flows (Ancarani and Di Mauro 2011). Today's globalised, leaner and Just-in-Time.

Supply Chains are more vulnerable to natural and man-made disasters (Soni and Jain 2011). The lack of supply chain coordination during disruptions may cause the bullwhip and ripple effects downstream in the SC (Dolgui, Ivanov, and Rozhkov 2020). In addition, all mankind has been experiencing such disruptions, as the COVID-19 pandemic advances and healthcare supply chains fail to fulfil the demand for treatment. To manage supply chain risks it is crucial to generate supply chain resilience. In the supply chain context, a SC must be resilient to disturbances to achieve competitiveness (Barroso, Machado, and Machado 2010). Barroso, Machado, and Machado (2011) and Carvalho, Azevedo, and Cruz Machado (2012) affirm that Supply Chain resilience is a matter of survival. Moreover, SCRes constitutes a very efficient way of dealing with the inevitable ruptures and even predicting when the risks will occur (Mancheri et al. 2019). According to Riley et al. (2016), for hospitals, a shortage of supply or unanticipated demand spike can lead to catastrophic consequences beyond poor in stock metrics. When a hospital experiences an unanticipated demand spike or

supply shortage, supply managers must have the means to alter and/or reconfigure the supply chain (Riley et al. 2016). Considering supply chain risks, ruptures caused by epidemics/pandemics have been neglected by SCRM literature. The COVID-19 pandemic, for example, led all countries to experience severe shortages of respirators and beds. Due to the lack of sustainable practices and damage dealt to the environment, pandemics may become more frequent. In this sense, supply chains should be more resilient to respond to healthcare demand quickly. The development of vaccines generates additional supply chain challenges. The healthcare supply chains must deal with an overwhelming demand for raw materials such as syringes and needles meaning that managers must generate resilience to increase production and distribution capacity.

Oke and Gopalakrishnan (2009) identify the pandemic risk as a natural disaster mentioning the avian flu, while Mavi, Goh, and Mavi (2016) classify as an exogenous social risk. However, whether a pandemic is a natural disaster, or its causes can be traced to human behaviour can be debated. Vanvactor (2011) affirms that pandemics are unexpected events that require preparedness and mitigation strategies, which is a more proactive approach comparing to Oke and Gopalakrishnan (2009). Ivanov and Dolgui (2020) is the only SCRM study that proposes a digital supply chain to generate resilience during the COVID-19 pandemic. Nevertheless, the literature lacks a framework that comprises the particularities of SCRM applied to healthcare.

Building robust supply networks in the light of these findings is undeniable, as these pandemics had a significant influence on the supply chains of most firms. Furthermore, as previously mentioned, there has been a rise in infections that have the potential to become pandemics in recent decades.

Medicines and medical supplies are considered among the most critical human health commodities and are vital for patients worldwide. Medication unavailability adversely affects the community`s health. The vital role of medicines and medical supplies is undeniable in improving the health services` functions at different levels, and the availability of medicines and medical supplies indicates the quality of health services. Lack of medicines and medical supplies could be a more significant

problem during disasters. Disasters could affect predicting the amount of medicine and medical supplies and on-time procuring, particularly in developing settings. While the provision of medicines and medical supplies is one of the critical priorities in developing countries, disruption in their supply, including the flow of medical and pharmaceutical supplies as a critical outcome, could be more highlighted during disasters. From the managerial perspective, disruption of the medication supply chain can have serious consequences. Companies often lose revenue and market share when other supply chains are disrupted. In contrast, disruption in the medication supply chain can endanger many people's lives. For this reason, continuity of operations in health services and supply chains is vital. Tis becomes important when the community is involved in significant health problem, including an infectious disease (for example, respiratory pandemics, such as the flu, etc.), an industrial accident (such as the release of large amounts of toxic substances in urban areas, etc.), a natural disaster (including earthquake, food, etc.), or a terrorist incident (e.g., bomb blast, war, etc.) .

Compared with other pandemics, PHEICs have tremendous negative impacts on the SC, especially owing to the prevalence of globalization today, the SC industries of all countries are tightly intertwined. The division of labor in this global value chain scheme, while efficient, is vulnerable to PHEICs. These SC disruption risks have raised interest in society, and scholars have started to conduct academic research on SC risks, SC strategy, and sustainability under PHEICs.

In SC risk management, many researchers focus on risk identification, risk types, risk factors, risk management, and risk mitigation. There are two types of risk: one is uncertainty risk and the other is disruption risk, which affects the robustness, resilience, and sustainability of the supply chain. In addition, academic researchers have increasingly been interested in the significance of SC strategies during PHEICs, involving factors such as sustainable SCM, SC risk management, and SC resilience management. Interestingly, before 2009, scholars mainly studied food SC and food security against the background of PHEICs. Hu, et al. (2023) compared the similarities and differences in supply chain management in PHEICs between China and the United States, highlighting the great changes that have occurred in

this field. Moreover, scholars have also broadened their research scope by covering diverse industries such as manufacturing SC, service SC, and healthcare SC. Besides this fact, the traditional SC concentrates on the process of production, transportation, distribution, and sale, while under PHEICs, more attention has been paid to the SC network structure, remanufacture, recovery, and innovation management. Especially for PHEICs in recent years, the research directions related to emerging SCM, such as SC reconstruction, SC optimization, SC digital transformation, and sustainable SC, have deeply engaged the attention of SC practitioners and researchers. Some scholars have made contributions to this field. For instance, Queiroz, et al. (2019), Chowdhury, et al. (2020), Sajjad (2021), Qrunfleh, et al. 2020) focused on COVID-190 s impact on SC recovery and resilience. In particular, Cardoso, et al. (2020), Das and Roy (2020), Rejeb, et al. (2020) focused on the analysis of the literature related to food SC in the context of COVID-19. Pournader, et al. (2020), Spieske and Birkel (2020) concentrated on SC risk management during the COVID-19 pandemic. All these review articles have contributed to SC research in the context of pandemics. However, the existing research lacks a panoramic view of SC topics in the PHEIC context, i.e., from the perspective of SC disruptions, SC recovery strategies, and SC sustainability integration.

In addition, most of the articles are based on the study of SC in a single field, and there is a lack of research on SC across domains and basic domains such as daily consumption and healthcare. Moreover, most of the existing review studies are focused on COVID-19, while there is a lack of studies on a larger pandemic of the same magnitude. These are the current research gaps in this field. This study fills those gaps. To fill these research gaps, we try to describe the status quo, construct an integrative framework of the supply chain management in PHEIC-related fields through which the existing literature is systematized, and propose future research opportunities and new perspectives in rethinking the supply chain management during PHEICs. To this end, some main research questions (RQs) are proposed: RQ1: What are the research profiles of the studies evaluating supply chain management in PHEIC-related fields, including publication trends, influential authors, contributing countries, and subject categories? RQ2: What have been the

main themes of this research topic in the past severe years? RQ3: Which direction does the supply chain industry tend toward when facing a PHEIC? To answer these research questions, we adopted bibliometric and content analysis methods to explore the research status, hotspots, and future research directions in this field, which reveal a panorama of supply-chain-related research in PHEICs and re-examine SC issues on a global scale.

The main contributions of this study are as follows: Firstly, this study broadens the focus to different PHEICs rather than COVID-19 alone, enriching Processes 2023, 11, 713 3 of 18 the research on the impact of PHEICs in different periods on the SC. Secondly, this study explores an SC analysis framework in the context of the pandemic, including SC disruption, strategies, and sustainability, which reveals and integrates the existing literature on SC disruption, disruption recovery, reconstruction, digital intelligence, optimization, and sustainability, aspects that are missing in the previous literature. Third, this paper prompts a rethinking of the supply chain characteristics before and after a pandemic and explains the reconstruction and upgrading of SCs from a new perspective. This contributes to further research on SCs during a pandemic and provides SC managers with a practical approach to dealing with SC disruptions and improving the sustainability of SCs in this context.

1.2 Statement of the problem

Despite the availability of extent literature on strategies for improving the resilience of supply chains within the health sector, outbreak of pandemic diseases such as COVID-19 which caused serious disruptions to supply chains proved to be a test for most manufacturing industries in Zimbabwe. Most of these companies performed poorly as it took time for them to respond to supply chain disruptions. In this regard, ithas been observed that these companies lack knowledge and appreciation on how to build resilient supply chains when confronted by similar situations which may shake the whole supply chain. Thus, a major question that needs to be answered is –*How can Zimbabwe's health sector build resilient supply chains in the wake of pandemics?"*.

1.3 Research objectives

The broad objective of this study is analyse how the Zimbabwe‘s health sector can build supply chain resilience within in the wake of pandemics.

- To establish the significance of supply chain redundancy in building supply chainresilience for Zimbabwe‘s health sector in the wake of pandemics.
- To determine the significance of supply chain visibility in building supply chain resilience within Zimbabwe‘s health sector in the wake of pandemics.
- To investigate the significance of supply chain flexibility in building supply chainresilience within Zimbabwe‘s health sector in the wake of pandemics.
- To assess the significance of supply chain collaboration in building supply chainresilience within Zimbabwe‘s health sector in the wake of pandemics.

1.4 Research hypotheses

The study hypothesized that: -

- **H_1**- Supply chain redundancy is significant in building supply chain resilience for Zimbabwe‘s health sector in the wake of pandemics.

- **H_2** - Supply chain visibility is significant in building supply chain resilience within Zimbabwe‘s health sector in the wake of pandemics.

- **H_3**: Supply chain flexibility is significant in building supply chain resilience within Zimbabwe‘s health sector in the wake of pandemics.

- **H_4**: Supply chain collaboration is significant in building supply chain resilience withinZimbabwe‘s health sector in the wake of pandemics.

1.5 Significance of the study

1.5.1 To the academic world

According to Sheffi and Rice (2018) and Zsidisin and Wagner (2020), there hasn't been much research done on the connections between different supply chain strategies. This study is important since it will fill the knowledge gap and advance the field of academia.

1.5.2 To the health sector

Given the likelihood of pandemic recurrence, this study is essential for advising management on the best ways to create resilient supply chains that can resist the shocks these outbreaks would generate.

1.5.3 To the supply chain management field

This study provides the empirical basis for building supply chains in the health sector that are resilient to disruptions caused by pandemics.

1.5.4 To the researcher

The study serves as a research skill sharpening opportunity for the researcher as well as providing a deep understanding of the field of supply chain management.

1.6 Assumptions of the study

The study assumed that: -

1. The data will be gathered from the respondents through their own free will without any coercion or bribe.
2. The information provided by the respondents will be unbiased, true and factual to the best of their knowledge. This is important especially given the fact that it is practically impossible to validate each and every piece of information supplied by the respondents.
3. The population sample to be used by the researcher will be the actual representationof the whole target population.

1.7 Delimitations of the study

The scope of the study is as follows:

1. **Geographical Scope**

The research was carried out in Zimbabwe and will only focus on that country's

health system. It is a fact that Zimbabwe is among the nations with varying macroeconomic and geopolitical situations; hence, geographic considerations should be taken into account while extrapolating the study's findings..

2. **Conceptual Scope**

   This study's conceptual focus is on supply chain resilience for Zimbabwe's health sector in the face of pandemic-related disruptions. The researcher is well aware that supply chain disruptions might result from hazards other than pandemics, necessitating supply chain resilience.

3. **Research participants**

   In this study, research participants also serve as delimitations. The study will only include supply chain and logistics experts working in Zimbabwe's health sector. This study is limited by their inability to fully comprehend some supply chain managementchallenges.

1.8 Limitations of the study

Just like any other research, this study will also characterised by some limitations. Some of the major ones are:

1. Since the study entails collection of data that concern supply chain resilience strategies, some respondents may consider the information strategic and may not be willing to share it publicly. However, the researcher will make sure that the research questionnaires have an introduction of the purpose of the research so as to ensure respondents understood why they will be asked to share the information.
2. The study will be conducted in the post Covid-19 era and most of the responses provided by the respondents may be biased towards Covid-19 response strategies. This is because the study will be a cross sectional survey which means that a longitudinal survey could be suffice.

1.9 Definition of key terms

Supply Chain- refers to the network of organisations, people, activities, information and resources involved in delivery of a product or service to a consumer
Supply chain flexibility is defined as the ability of organisations to restructure their supply chain operations and align their strategies to meet the needs of their

customers (Tiwari, 2020).

Supply chain redundancy- is the vital and serious utilization of extra stock that can be conjured in an emergency situation to enable the supply chain to adapt to the situation (Aghaei et al, 2017)

Supply chain collaboration- is defined as the way in whch organisations share useful and vital information in supply chain management (Douglas, 2021)

Supply chain visibility - Involves understanding of supply chain vulnerability and planning for such events and requires being able to discern the possibility of disruptions by interpreting events (Datta et al 2019).

Supply chain robustness - is the ability of a supply chain to resist change by being proactive and anticipating disruptions before they occur (Durach et al, 2017)

Supply chain agility- is the ability of the supply chain to respond rapidly to changes (Ali, 2017).

1.10 Outline of the dissertation

This study consists of five chapters. The first chapter of this dissertation served as the introduction and background of the study. It covered the research objectives, statements of hypotheses, significance of the study, research assumptions, delimitations and limitations of the study as well as provided some definitions to key variables that were used in the study.

The second chapter laid out the discussions about the review of the theoretical, conceptual and empirical literature. This involved the review of some theories or concepts that suited this study as well as review of what previous studies found about the topic under study. The third chapter focused on presenting the methodology that was followed in conducting the study. In this chapter, the research philosophy, research design and the research strategy is presented. It also presents a discussion on the population of relevance and how a sample which was used in the study was arrived at. Data collection and analysis procedures and how it was presented is also found in this chapter.

Chapter four is concerned about data presentation, analysis and interpretation as well as discussion of the results. The last chapter which is chapter five is a conclusion chapter with a summary of major findings, conclusions and implications of the study to the various stakeholders identified as to which the study is significant to.

1.11 Chapter Summary

The chapter introduced the study and its purpose by highlighting the background of the study as well as the objectives that the researcher aimed to achieve. Statement of the hypotheses that guided this study were also presented as well as the significant of the study to various stakeholders. The delimitations and limitations of the study were also presented in this chapter together with the assumptions and definition of the key terms used in the whole dissertation. The following chapter is concerned about reviewing literature on the subject under study.

Chapter Two
Literature Review

2.0 Introduction

This chapter presented a review of the literature that informed this study. It focused on the theoretical aspect, conceptual framework and the empirical literature review. The last part of this chapter presented the research gap

2.1 Theoretical framework

According to Prakash et al. (2020), the majority of studies that looked at and described supply chains in the health industry found that eight theories were often used. These include information theory, stakeholder theory, institutional theory, socialexchange theory, resource-based theory, resource dependence theory, and transactional cost theory. Three more theories that are pertinent to supply chain resilience were found in an existing literature survey conducted for this study: the control theory, the theory of constraints, and the grey system theory. Together, these three theories will serve as the foundation for this study's theoretical literature evaluation.

2.1.1 The Control Theory

Modern production and logistics systems, supply chains, and Industry 4.0 networks are challenged by increased uncertainty and risks, multiple feedback cycles, and dynamics. Control theory is an interesting research avenue which contributes to further insights concerning the management of the given challenges in operations and supply chain management. In the frameworks of risk management, dynamics, and resilience, control theory approaches can be considered as tools to tackle the issues of performance achievement under uncertainty with respect to bullwhip and ripple effects. Control Theory has been widely used for studying multi-stage, multiperiod dynamic systems. A broad range of Control Theory application to business and economics can be explained by a rigorous quantitative basis for feedback-based and optimal control policies including differential games and stochastic systems, stability of controlled processes and non-linear systems, controllability and observability, and adaptation. These tools can be applied for a wide range of systems, from discrete linear to stochastic non-linear systems with both stable and dynamically changing structures. Control Theory can also be

applied for analysis of equilibria of resource consumption and system output.

2.1.2 Theory of constraints

Controlling the inventory is part of Supply Chain management. For preventing inventory stock out situations sufficient inventory need to be maintained in the supply chain. This is crucial as if at any time insufficient inventory occurs the customers will move out to competitors and getting them back will be a tedious process. Things like poor forecasts and the fluctuations in the inventory need to be considered while stocking the inventory in supply chain. In the case of Supply Chain Management, there are factors in the logistics apart from manufacturer and suppliers.

The various process involved in the Supply Chain Management is expensive and complicated at the same time. The components in the supply chain depend on each other and maintain the continuous flow of money and materials. The real value of the product is calculated once the customer is satisfied.

The Theory of Constraints solution establishes advantage when there is more availability of stock or dramatic reduction due to damages when the flow of the materials and components is interrupted by shortage or surplus. Along with Theory of Constraints, the delay in time after the consumption which is followed by the delivery also needs to be considered in Supply Chain Management.

The inventory stocked at the locations need to be monitored by setting an upper limit which will be closely related to the maximum amount of consumption within the prescribed time frame. This also ensures that no additional inventory is made and stored which is more than the required levels. The theory of constraints, takes a holistic (or system of systems) approach to managing an organization. The underlying assumption of the theory is that a system can be no stronger than its weakest parts — they represent constraints to the organization as a whole. The theory of constraints is defined as follows:

A constraint is anything that prevents the system from achieving more of its goal.

There are many ways that constraints can show up, but a core principle within the theory of constraints is that there are not tens or hundreds of constraints. There is at least one and at most a few in any given system. Constraints can be internal or external to the system. An internal constraint is in evidence when the market demands more from the system than it can deliver. If this is the case, then the focus of the organization should be on discovering that constraint and following the five focusing steps to open it up (and potentially remove it). An external constraint exists when the system can produce more than the market will bear. If this is the case, then the organization should focus on mechanisms to create more demand for its products or services. The concept of the constraint in Theory of Constraints differs from the constraint that shows up in mathematical optimization. In theory of constraints, the constraint is used as a focusing mechanism for management of the system. In optimization, the constraint is written into the mathematical expressions to limit the scope of the solution (X can be no greater than 5)."

The five focusing steps mentioned in that explanation (as provided by the AGI-Goldratt Institute white paper) are identify the constraint, decide how to exploit the constraint, subordinate and synchronize everything else to the above decisions, to improve the performance of that same value-chain, continue, elevate the performance of the constraint; and if in any of the above steps the constraint has shifted, go back to Step 1.

Proponents of a strong sales and operations planning (S&OP) process, whether they know it or not, are also proponents of the theory of constraints. A good S&OP process helps break down silos and improves information sharing and corporate alignment — which are also goals that emerge from the theory of constraints. The AGI- Goldratt Institute white paper (2010) likens the theory of constraints to the diagnostic and treatment program used in medicine. Before you begin treating the patient, you have to diagnose what's wrong with them, design a plan for treating the ailment, and then execute that plan. According to the white paper, TOC is used to improve the health of an organization. The working principle of TOC provides a focus for a continuous improvement process (Rahman, 1988); TOC antecedents are

rooted in the development of enterprise resource planning (ERP) computer software systems. A software package developed by Goldratt and others during the late 1970s to early 1980s (Oglethorpe et al, 2013) was based upon dynamic analysis of proprietary algorithms, a system of rules, steps and metrics transacted to accomplish specific goals. This software package, originally known as optimized production timetables (Goldratt, 1980), but which later became optimized production technology (OPT), Goldratt illustrated the concepts of OPT in the form of a novel, The Goal, Goldratt and Cox, (1984), According to Goldratt (1990), managers are required to make three generic decisions while dealing with constraints. These are: what to change; what to change to and how to cause the change and he prescribes a set of five tools in the form of cause-and-effect diagrams. To understand the concept as a whole, we propose the same methodology as Shams-ur Rahman, (2002), where he used a system approach known as the thinking process from theory of constraint not only to identify critical success factors in supply chain management, but also to understand causal relationships between these factors and to conclude with a global framework that "not only to identify the critical success factors in a supply chain, but also the causal relationships between these factors.

Management can use these relationships to develop growth strategies for their companies. "Shams-ur Rahman (2022). The health-care sector is one such industry whereby researchers and professionals have begun to pay attention to the supply chain as a strategic area for cost efficiencies and quality improvements (Kwon, Kim, & Martin, 2016). The healthcare sector has undergone significant changes in the past decade. Most recently, the COVID-19 pandemic has accelerated healthcare industry change, causing increased shortages and lowered speeds of delivery of medical supplies and equipment as organizations and governments struggle to curb the spread of the virus (World Health Organization, 2017). In Zimbabwe, lack of resources to train the hospital management committees on effective supply chain strategies and shortages of drugs, staff, and limited bed capacities, respectively, are some of the reported challenges (Okedi & Adungo, 2021; Matheshe & Inimah, 2017). Masaba et al. (2020) are in agreement with these studies, citing a lack of sufficient human, physical, and financial resources in the country's health care sector, hampering effective supply chain agility. The pandemic has placed new

pressures on healthcare delivery systems, most of them attributed to supply chain disruptions, inadequate healthcare staff and infrastructure, and other related global inequities (Deloitte, 2021).

The healthcare supply chain entails the manufacturing of health resources such as equipment and drugs and distributing them to healthcare providers and patients in a timely manner. The availability of medical equipment and drugs is correlated with effective healthcare service delivery (Zamzam et al., 2021). In general, healthcare organizations face the unavailability of medical equipment due to delays in delivery, supply chain risks, unaffordability due to financial constraints, poor information systems, and a lack of resilience and responsiveness. Besides availability, adequate equipment and drugs also enhance timely and cost-effective healthcare service delivery (Ogundele & Olafimihan, 2009). Supply chain resilience has become an issue of concern in the health care sector nationally.

According to the Kenya National Commission for Human Rights (KNCHR, 2017), resilient supply chains in hospitals provide the ability to cope with stress from any factors in their environments and manage to maintain functionality in spite of unexpected or disruptive events. Zimbabwe government have a right to ensure that their population has access to fast, efficient, and affordable health care. However, in pursuit of this agenda, there have been concerns about poor service delivery among county hospitals, as occasioned by a lack of medical supplies and a shortage of human resources (KNCHR, 2017). The Global Fund (2021) reports that 28% of orders in public hospitals face delays of more than 30 days, thereby creating poor service delivery in the public health care sector. Despite significant effort from governments to improve the state of public health in Zimbabwe, the health sector of the country is still marred by key challenges such as a lack of sufficient human, physical, and financial resources, which hamper effective supply chain agility (Masaba et al., 2020). One of the common challenges within hospitals is delayed deliveries of medical equipment that inhibit effective service delivery in the population (The Global Fund, 2021).

2.1.3 The grey systems theory

Grey System Theory is a new cross-sectional discipline founded in 1982 by a famous Chinese scholar Professor Deng Julong. It uses the color depth to describe

the clear degree of information, i.e. with the "black" means that information is unknown, with the"white" means the information entirely clear; with "grey" means part of the information clear, part of the information is not clear. Accordingly, the system information completely clear called "white system", the system information unknown called "black system", some information is clear, the partial information not explicit system known as the "grey system".

Modeling idea of grey system theory is a not very clear, the lack of information grey system from grey to white from the structure, model and relationship. With the uncertainty system of "partial information is known, some information is unknown," the "small sample", and the "poor information" for the study, and on the basis of information coverage, seeks practical rules through the sequence, which is characterized by "little data modeling", mainly through the "partial" information known to generate, develop, extract valuable information to achieve a correct understanding and effective control of the system behavior. Universal uncertainty about the poor information system of grey system theory, determines the new theory has a very broad prospects of development.

Theory of grey system suggests that the subjective judgement provided by the experts has some uncertainties due to incomplete and inadequate information (Kaviani et al., 2019). The theory of the grey system (Deng, 1982) is emerged to address these uncertainties present in subjective judgement (Yang et al., 2021; Liu et al., 2012). Therefore, the grey set theory is used to cope with the imprecision and uncertainty inherent in the judgement because most qualitative data obtained are subjective.

This study employs the grey systems theory to deal with the subjective data provided by the expert team. Information is categorised into three categories in grey systems: white for specific information, grey for inadequate information and black for entirely unknown information (Liu et al., 2012; Kaviani et al., 2019).

2.1.4 Healthcare supply chain

Disruptive innovations such as digitalisation and Industry 4.0 influence the development of new paradigms, principles, and models in supply chain management (SCM) (Ivanov, Dolgui, and Sokolov 2019). Since digital technology influences SCM and SCM is influenced by disruption risks, it is logical to expect

interrelations between digital technology and SC disruption risk management (Ivanov, Dolgui, and Sokolov 2019). Industry 4.0 and SC 4.0 are concepts that still require more formal definition and are becoming a Panacea. Although a Fully automated SC can generate efficiency and minimise several risks, it may as well create others. For example, it is charging the devices (battery autonomy). Additionally, it requires a considerable amount of initial investment, high-qualified workforce, among other features. As a clear example of 4.0 technology applied to healthcare supply chain Tseng et al. (2018) suggest a blockchain as the base of the data flow of drugs to create transparent drug transaction data and improve the healthcare supply chain performance. Software, hardware and Radio Frequency Identification (RFID) technology to strengthen the track and trace of drugs in the supply chain and are considered relatively mature and easy to adopt (Mackey and Nayyar 2017). Blockchain technology could create an encrypted, distributed, and immutable data ledger with the possibility of being applied in the healthcare sector, including sharing of information with stakeholders while ensuring data integrity and protecting patient privacy (Tseng et al. 2018). Literature still lacks studies concerning more 4.0 technologies applied in healthcare supply chain although there is some evidence.

2.1.5 Influence of Supply Chain Resilience on Healthy Service Delivery

Research on supply chain resilience and service delivery also reveal conflicting findings with some reporting significant, while others reporting the insignificant relationship between the two variables. A study by Jüttner and Maklan (2011) investigates supply chain resilience from the perspective of the global financial crisis that was experienced at the beginning of the millennium. The study sought to research on supply chain resilience and draw empirical connections with key concepts in supply chain risk management and vulnerability. The researchers collected data from three global companies; a wood wholesaler, chemicals and cables suppliers and used a mixed method approach whereby the researchers conducted semi structured interviews with employees within these companies as well as analyzed internal documents. The findings of the study revealed that both supply chain risk management and supply chain vulnerability categories were significant for supply chain resilience. Supply chain resilience, in itself was also significant for supply chain performance. The significance of supply chain resilience is also affirmed by an Indian study in the manufacturing sector intended to investigate how supply chain

resilience affects performance in the manufacturing sector. Kumar and Anbanandam (2020) approach the study by focusing on supply chain risk management culture as a moderating factor that influences supply chain resilience and eventually, organizational performance. The study used data that was collected through surveys administered high-ranking professionals within Indian manufacturing firms. The findings revealed that resilience had a statistically significant relationship with firm performance. At a regional level, there is a parallel pattern in result findings whereby scholars report mixed results about supply chain resilience and supply chain performance. In Nigeria, Olaleye et al., (2021) focus on tertiary institutions to investigate factors that build their supply chain resilience. The research seeks to demonstrate whether innovation positively influences firm resilience and agility and whether agility is a mediating factor between innovation levels and resilience of tertiary firms in Nigeria. The researchers carried out the study through administering survey questionnaires to members of top management within 5 universities in Nigeria. The findings of the study revealed a positive insignificant relationship between supply chain resilience and firm performance. The importance of supply chain resilience is however, demonstrated through a study in Ghana by Asamoah et al. (2020). The research is contextualized in small and medium enterprises within the country. Studied alongside, customer-oriented perspectives and social network relationships, the study seeks to investigate whether supply chain resilience has a significant effect on the performance of businesses. The study relied on data which was collected through surveys that were administered to 110 small businesses in Ghana, each represented by a single respondent in a managerial position. The findings revealed that there was a positive significant relationship between supply chain resilience and customer-oriented performance. Therefore, the researchers conclude that supply chain resilience mediates the relationship between social network relationships, customer-focused services and thus, overall organizational performance. Studies in Kenya have also documented empirical evidence regarding the influence of supply chain resilience on performance. Ndiema and Muli (2021) sought to investigate how supply chain resilience affects performance in the Kenyan retail industry. Supply chain resilience was operationalized and measured using supply chain recovery, flexibility, robustness and the use of Vendor-Managed Inventory systems. A multiple regression analysis revealed that recovery, flexibility, robustness and the use of vendor managed inventory systems, all operationalized as

measures of supply chain resilience accounted for a significant change in the performance of the retail stores A similar study had been conducted in Kenyan sector to investigate the influence of supply chain resilience. The study by Kariuki (2018) focuses on hospitals categorized by the National Health Insurance Fund as providing inpatient and outpatient services. The main research objective was to investigate whether supply chain strategies within the selected hospitals had an influence on their performance. The researchers administered surveys to 264 supply chain officers within 770 Kenyan hospitals. A regression analysis was conducted on the collected data and the results revealed that there is a positive significant relationship between supply chain resilience and organizational performance in the health sector. Studies have been conducted on supply chain resilience and performance and they have indicated positivity and significance (Asamoah, Agyei-Owusu & Ashun, 2020; Jüttner & Maklan, 2011; Kumar & Anbanandam, 2020; Ndiema & Muli, 2021; Kariuki, 2018). However, a Nigerian study depicted an insignificant relationship between Supply Chain Resilience and performance (Olaleye et. al., 2021) hence prompting further research on Supply Chain Resilience and Service Delivery in the Public Health Care Sector in Western Region, Kenya.

2.2 Conceptual framework

Numerous scholars have explored the topic of supply chain resilience. For example, Christopher and Peck (2004) developed the idea of a resilient supply chain, while Lakovou et al. (2007) presented an analytical methodological framework for the best possible design of a robust supply chain. Although supply chain resilience isn't frequently measured in the literature, certain research have quantified it. The investigator will draw guidance from a range of literature sources that delineate supply chain resilience indicators while crafting the conceptual framework for this investigation. According to Sigh et al. (2020), a robust supply chain is indicated by a number of variables. These include public-private partnerships, supply chain network design, supply chain risk management (SCRM) culture, corroboration, agility, flexibility, robustness, redundancy, sustainability, visibility, IT capability/information sharing, security, Velocity, Adaptability, Awareness/sensitiveness, Market position, and risk control/revenue sharing. A more thorough analysis of the literature, however, revealed four key factors that influence

supply chain resilience. These are robustness,visibility, redundancy, and flexibility. Three of these factors—supply chain visibility, supply chain flexibility, and supply chain redundancy—are the focus of this study. In conclusion, a number of studies have demonstrated that flexibility, visibility, and cooperation are key components of resilient supply chains. These concepts are frequently found in hierarchical structures in publications that concentrate on literature reviews and surveys (Chowdhury & Quaddus 2017), which show which principles have a direct impact on supply chain resilience. These ideas show depth, that is, what components make up redundancy, flexibility, and visibility, or they show scope, that is, what part do these elements play in them.

. The conceptual framework for this study is as shown below.

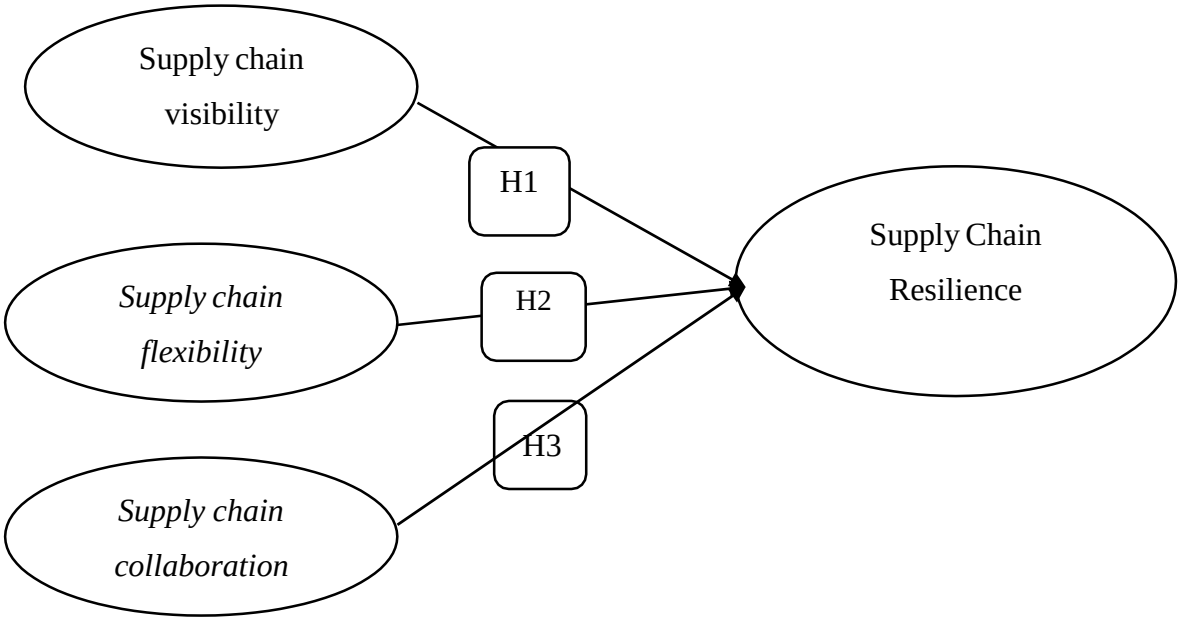

Figure 2. 1 Conceptual framework for antecedents of supply chain resilience

2.2.1 Supply Chain Resilience

Scholars conceptualize supply chain resilience as the ability of an organization to cope with stress from any factors in its environments and manage to maintain functionality, in spite of the unexpected or disruptive events (Alfarsi et al., 2019). Organizations manage to stay resilient because of capabilities that they develop over time. In supply chain, resilience is majorly reactive. Reactive resilience, on the other

hand, entails reacting after a disruptive event occurs. Reactive supply chain resilience is largely characterized by speed of response and recovery (Alfarsi et al., 2019). Building supply chain resilience begins with being quick to recognize a problem. A problem may result from external risks driven by upstream and downstream activities, such as demand, environmental, supply, business and regulatory risks, or it may be internal, such as due to personnel, manufacturing operational and process risks as well as, quality planning and control risks (Blackhurst et al., 2005). Second, companies should be able to develop an appropriate recovery plan.

Third, the companies should redesign their supply chains to align to resilience needs. After strategy formulation, it is important that organizations implement them through matching their cultures and structures to their new goals. Discussions about supply chain resilience have taken center during the recommended as a suitable strategy to remain resilient and responsive in the face of the pandemic, however, larger firms are better placed to practice risk management strategies efficiently (Konstantinou et al., 2021). Buffers have been recognized as an important aspect of enhancing supply chain resilience (Rajesh 2018; Carvalho & Cruz-Machado, 2011). Buffering refers to the ability to maintain enough supplies or resources as a safety net within agile supply chains networks (Carvalho & Cruz-Machado, 2011). There are three main types of buffers that can be used to create sustained supply chain resilience- inventory, time and capacity buffers.

Inventory buffers include the safety stocks that organizations can keep to respond to demand changes or delays in delivery and maintain customer satisfaction (Rajesh, 2018). Time buffers refer to allowing for extra time to allow for decision making and taking action to cater for any unforeseen variability. Capacity buffers refer to utilizations of operations below their maximum level to cater for changes in demand, delays or stoppages. Multisourcing is yet another recognized indicator of supply chain resilience. Multisourcing entails the spreading of risk across various suppliers by having alternative supply sources (Hohenstein et al., 2015). Having multiple sourcing can be a shock absorber for organizations experiencing short term disruptions. Together with other strategies such as having risk mitigation inventory, relying on multiple suppliers increases the absorptive capacity of organizations

allowing them to cope with the effects of disruptions along the supply chain (Hosseini, Ivanov & Dolgui, 2019).

An organization's risk management culture is also a significant indicator of supply chain resilience. Organizational culture comprises of the beliefs, attitudes and norms in a firm and as reflected in the shared objectives and goals. Essentially, culture differentiates one group of people from another. Organizational culture may either demonstrate a likelihood to be open to change or prefer stability (Kumar & Anbanandam, 2020). The occurrence of risks produces change within organizations requiring the players to depict risk-tolerant cultural behavior and attitudes that supports risk management. The different cultures towards risk affect organizational performance through influencing its ability to cope with perturbations in the supply chain (Chunsheng et al., 2020).period of COVID19 pandemic. Some of the new risks that came with the pandemic include changes in demand with preference for some increasing as others decrease, changes in customer behavior as the use of internet purchasing increased, creation of new customers through a reprioritization of needs, lock down initiatives that led to the need to seek for alternative suppliers and work from home requirements that changed organizational work structures, and thus their output (Ivanov & Das, 2020). These trends disrupted the supply chain activities on both upstream and downstream phases. Supply chain velocity is recommended as a suitable strategy to remain resilient and responsive in the face of the pandemic, however, larger firms are better placed to practice risk management strategies efficiently (Konstantinou et al., 2021).

Buffers have been recognized as an important aspect of enhancing supply chain resilience (Rajesh 2018; Carvalho & Cruz-Machado, 2011). Buffering refers to the ability to maintain enough supplies or resources as a safety net within agile supply chains networks (Carvalho & Cruz-Machado, 2011). There are three main types of buffers that can be used to create sustained supply chain resilience- inventory, time and capacity buffers. Inventory buffers include the safety stocks that organizations can keep to respond to demand changes or delays in delivery and maintain customer satisfaction (Rajesh, 2018). Time buffers refer to allowing for extra time to allow for decision making and taking action to cater for any unforeseen variability. Capacity buffers refer to utilizations of operations below their maximum level to cater for

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2.2.2 Visibility

Visibility into the healthcare supply chain sector enables decision-makers to address risks and ensure target capabilities are accomplished in the event of disruption. Data-driven transparency should provide an end to-end view of pharmaceutical and medical suppliers. This can be achieved by mapping suppliers by tier to identify vulnerabilities within the supply chain and pinpoint potential risk exposures in the ways that products are developed, delivered or stored. By employing data from both internal and external sources and evaluating them against resilience metrics in the areas of data security, finance, operations, organizational maturity, regulation, reputation and structure, both the visibility of the supply chain and resilience against disruption can be strengthened. Visibility in this sense does not pertain to real-time data on where supplies are at any given time. Supplies are constantly being shifted

from manufacturing sites to storage facilities to other warehouses before being delivered to the consumer. Visibility between the data and clearly defined targets (e.g., geographical need for the product), are interdependent to achieve one aspect of resilience. For example, the capabilities of medical supply companies are defined by the amount of product that can be produced and delivered in the given amount of time to improve visibility. So, the private and public sectors can collaborate to create analytic models and diagnostic testing to generate disruption scenarios, quantify risks associated and devise appropriate responses for visibility into the supply chain. By doing so, private and public stakeholders can help to improve existing risk mitigation and response efforts while also providing an opportunity for public-private collaboration that can be used to inform future information partnerships. Additionally, this effort can help to shape policymakers; ideas of what investing in supply chain resilience entails and the importance of and perspectives on data-sharing in related policy. As previously noted, members of the healthcare supply chain have a vast range of ideas of what supply chain resilience entails. Policymakers will likely not be as well informed about supply chain issues or efforts to improve its resilience. A pilot project emphasizing displaying the importance of joint visibility measures can demonstrate the complexity and importance of information coordination on the supply chain.

According to Cheng et al. (2017), supply chain visibility is a vague notion with many different meanings offered in the literature. As a result, many companies find it difficult to operationalise it. Butter (2020) highlights this concept has become a buzzword in recent years. As a result, several researched have spurred to try and define it (Caridi et al, 2020).

According to Cheung et al (2017), there are a lot of confusion on the definitions of supply chain visibility. As a result, there are a lot of confusions and misconceptions for organisations as they try to achieve supply chain visibility. Although there are three distinct interpretations of supply chain visibility, Zhang et al. (2018) argue that this is not surprising given that each of them differs from the others in important ways. Below is a discussion about them. Some studies approach the idea of supply chain visibility from a purely logistical perspective. For instance, supply chain visibility was defined by one researcher, Fontanella (2017), as the transparent view of time, place, status, and content. It is obvious from this definition that the emphasis is on actions connected to inventories.

By focusing on information exchange, Lamming (2017) and Swaminatha and Tayur (2018) create the notion of supply chain visibility. According to these authors, supply chain visibility refers to the capability of accessing or exchanging information throughout the whole supply chain. Similar to this, Tohamy et al. (2020) assert that supply chain visibility essentially refers to having access to or being able to observe crucial information regarding the logistics supply chain. In contrast to the first orientation, which concentrated on the depths of insights into the logistics system, the definitions of the second orientation of supply chain visibility tend to lay a greater emphasis on the requirement for companies to be able to exchange and access information. This viewpoint emphasizes the importance of information while delving deeply into the properties of information.

Regarding this issue, Bartlett et al. (2020) noted that an increase in information availability could give the impression that something is more visible than it actually is. The supporters of this strategy emphasize that relevance of the information supplied, not volume of information shared, is what determines visibility in the supply chain. In this situation, information properties like correctness, timeliness, and reliability are crucial, as well as how easily accessible the information is (Bailey & Pearson, 2017, Closs et al 2018; Gustin et al, 2020).

As observed by Barratt and Oke (2017), supply chain visibility is likely to produce outcome of information sharing among the supply chain trading partners. Thus, information sharing should be observed as the activity that results in achieving supply chain visibility (Ibid). this implies that information sharing is a requirement for supply chain visibility. In this regard, the level of visibility to be achieved will be determined by the characteristics of the information sharing and the volume of the information shared.

Contrarily, Cheung et al. (2017) argue that sharing knowledge and having solid connections and relationships are insufficient for achieving visibility. They are not the only prerequisites to ensuring sufficient supply chain visibility (ibid). Actually, according to these authors, information sharing is a two-party activity that involves the generator and the user or recipient of the information. They go on to say that most of the time, researchers simply pay attention to the parts they are sharing, forgetting that visibility is important from the perspective of the receiver. In this

view, no visibility can be noted without correct, readable and accurate information irregardless of the amount shared. Thus, duality of supply chain visibility is important (ibid). The definition of supply chain visibility by Tohamy et al (2020) presented above, is also in alignment with this though it further expresses the need to have information with the correct properties aligned to the user's specific needs. Essentially, the information had to meet the needs of the receiver for it to provide visibility. This proves that the information is highly context-sensitive (Cheng et al, 2017).

Proof suggesting that supply chain visibility positively affects the overall performance of supply operations is abound with a large support from journals and articles claiming that supply chains with high visibility have many advantages. Some researchers such as Maghsoudi and Pazirandeh (2016), Chopra and Meidl (2020) have found that supply chain visibility has the capacity to improve the operational effectiveness of organisations. Barratt and Barratt (2021) as well as Maghsoudi and Pazirandeh (2016), Chopra and Meidl (2020) also found supply chain visibility effective in responsiveness while Van der Vaart and vaDonk (2018), Caridi et al (2019) found it effective in the overall organisational performance.

McCrea (2015) and Barratt and Oke (2017) also concluded that organisations that has high supply chain visibility are able to gain competitive advantage over their rivals. There is also increased research that proves that supply chain visibility enhances the level of coordination with supply chain (Barrat and Barratt (2020). Patnayakuni et al also noted that supply chain visibility improves resource allocation, while Mentzer et al (2019) and Yao and Drasner (2018) assert that it can improve resource planning resulting in efficiency. Whang (2021) and Caridi et al (2020) posit that supply chain visibility improves decision-making even in complex environments.

Noteworthy is to realise that supply chain visibility with real time information updates helps organisations to respond to major problems (such as the bullwhip effect) that destruct most supply chains (Holweg et al, 2021). The result is that small variations in consumer demands that propagate through the supply chain are improved at each level of the chain (Steinfield et al, 2021). At the end, the supply chain demand become unsynchronised leading to pileup of inventory and stockouts (Holweg et al, 2021). Real time access to data will enable the actors within the supply

chain to access the independent demand and make plans accordingly avoiding being fooled by distorted demand signals that may be noticed from the supply chain ((Holweg et al, 2021). Companies or organisations can thus, reduce their inventory level, reduce stock-outs and lead time throughout the entire chain ((Huang & Gangopadhyay, 2019; Chopra & Meidhl, 2018; XU et al, 2019). By this, costs of the whole supply chain such as transport costs and inventory holding costs are reduced (Ross et al, 2019). Thus, supply chain visibility increases accuracy in budgeting (Lee et al, 2020; Yu et al, 2021). The sharing of information in real time among the supply chain partners will reduce the relationship challenges and allow the reconfiguring of the supply chain (Mason-Jones & Towill, 2017; Wei & Wang, 2020). In addition, process control can also be improved by enhancing supply chain visibility in order to address issues of integrity like product diversion, theft or distribution of counterfeit (Clark et al, 2021; Hara et al, 2017).

Thus, the study hypothesized that *Supply chain visibility is significant in building supply chain resilience within the public health sector in Zimbabwe in the wake of pandemics.*

2.2.3 Supply Chain flexibility

Flexibility is the ability to adopt different positions in order to respond to an abnormal circumstance as well as rapidly adapt to changes in supply chain. There are a number of flexibility practices that enhances supply chain resilience that can be extracted from literature. These includes flexible supply chain base, postponement, flexible manufacturing, flexible transportation, among others. A number of researchers such as Sheffi et al, (2015); Tang, (2016); Choi and Krause (2018); Stecke and Kumar (2019); Tomlin (2018); Zsidisin et al, (2019); Pettit et al, (2018); Xiao (2018) and Ishfaq (2022) are convinced that flexibility is a precursor for supply chain resilience as it creates prompt adaptability in times of turbulences as well as rapid response and recovery.

Flexibility has been a major topic in research for decades and the new focus is that it has been analysed along with the flexibility other supply chain partners and therefore, on the supply chain resilience. To this end, Duclos et al (2020) even defined flexibility in supply chain as flexibility dimensions required by all supply

chain participants to successfully respond to volatile demands of customers. According to Steven and Springs (2017), supply chains should not be viewed as a single entity in future supply chain architectures.

They contend that flexibility includes both external and internal elements, including those that are essential to intra- and inter-firm flexibility. These were noted by a number of authors, including Das (2021), who also suggested integrated capacity, distribution, and input supply flexibility in mixed integer supply chain planning model. Wang et al. (2017) also mentioned outsourcing and vertical integration. Ahlet et al. (2020) suggested creating long-term capacity pools. All of these tactics can reduce supply and demand volatility and enhance market responsiveness.

An key instrument for responding to environmental uncertainties is supply chain flexibility.

This is also supported by a definition of supply chain flexibility provided by Lummus et al in 2021, which states that supplier flexibility is defined as the ability of the supplier to reconfigure the supply chain, altering the supply of goods in response to demand uncertainty. Flexibility makes it easier to react more quickly during uncertain times, which has a good impact on supply chain flexibility. Flexible suppliers are able to go above and above what may be expected of them. A Tomlin (2017) model compared a dependable and unreliable supplier who each supplied a particular product to a corporation and had an impact on the best disruption management approach of a firm. Milner and Kouvelis (2015) identified flexibility in terms of order quantity for flexible procurement contract and timing in a single period inventory model. The authors concluded that order quantity and timing flexibility reduces supply chains costs.

In designing flexible supply chain, Das (2021) considered a pool of affiliated suppliers with the sole need to fulfil increases in supply order which could otherwise no be fulfilled by high quality suppliers only. This mitigates side risk in supply chain. Thus, it was suggested that Supply chain flexibility is significant in building supply chain resilience within the health sector in Zimbabwe in the wake of pandemics.

2.2.4 Supply chain Collaboration

According to Petitt et al. (2018), the ability to collaborate effectively with other entities for the benefit of both parties in a variety of contexts, such as anticipating,

deferring, and risk sharing Aligned strategies, collaborative forecasting, information sharing, integrated, and optimized logistics are all practices that improve supply chain collaboration. Collaboration, according to Tomlin et al. (2016), can lessen uncertainty, promote transparency, and make it easier to create and share knowledge about supply chain risks and uncertainties. According to Bhakshi et al. (2017), supply chain partners can cooperate to share costs and increase resilience. It also guarantees supply chain recovery (Ghadge et al, 2017). For instance, teamwork can make it easier for businesses to recover from disruptions by pooling resources and other complementary capabilities (Scholten et al, 2019). The ability of supply chain partners to support one another during disruptive events and to offer flexible, coordinated responses aids businesses in building supply chain resilience (Jutter et al, 2021). Therefore, this study hypothesized that: Supply chain collaboration is significant in building supply chain resilience within the manufacturing sector in Zimbabwe in the wake of pandemics.

2.3 Empirical Literature Review

On the empirical front, studies by Park (2013) Azadeh et al. (2014), Rice and Caniato (2013) (Ehrenhuber et al. 2015) will be discussed highlighting their finds and the methodologies they use. Studies have been done on the supply chain resilience and service delivery of organizations in the United States of America, France, Nigeria, South Africa, Pakistan, among others.

2.3.1 The Impact of Visibility on supply chain resilience

McCrea (2015) and Barratt and Oke (2017) also concluded that organisations that has high supply chain visibility are able to gain competitive advantage over their rivals. There is also increased research that proves that supply chain visibility enhances the level of coordination with supply chain (Barrat and Barratt (2020). Patnayakuni et al also noted that supply chain visibility improves resource allocation, while Mentzer et al (2019) and Yao and Drasner (2018) assert that it can improve resource planning resulting in efficiency. Whang (2021) and Caridi et al (2020) posit that supply chain visibility improves decision making process even in complex environment.

2.3.2 The Impact of Supply Chain flexibility on supply chain resilience

Zineb et al (2018) studied the impact of supply chain risk management strategies on supply chain resilience in Moroccan manufacturing industry using a quantitative method with a sample of 233 companies and found that redundancy practices had no significant impact on supply chain resilience. On the contrary, their study established that increased flexibility and collaboration were considered key factors in enhancing supply chain resilience.

Flexibility has been discussed in a lot of studies and vast empirical research is available. Jack and Raturi (2022), Zhang et al (2019) and Claycomb et al (2020) conducted different studies in different settings on flexibility and supply chain resilience. Data was collected through questionnaires for understanding manufacturing flexibility. They found that flexibility helps in achieving supply chain resilience.

Graves (2018) also analysed the effects of process, stock and volume flexibility on supply chain resilience in North America and found that the more flexible the company is in terms of stocks and processes, the more it can be in withstanding disruptions caused by unlikely events. In this study, quantitative method were used in gathering data and a sample of 500 companies across North America were sampled.

A study by Denehly et al (2019) assessing supply chain resilience in mindful humanitarian organisations concluded that collaboration, flexibility and redundancy were drivers of supply chain resilience. The study was conducted in Europe basing of humanitarian organisation only and adopted a mixed method.

Similarly, a study by Kushwaha et al (2018) in India on how companies could achieve resilience singled out flexibility as the key factor for achieving flexibility. Another study by Eddine et al (2017) in Morocco using the theory of constraints found that redundancy and visibility were necessary for achieving supply chain resilience.

2.3.3 The Impact of Supply chain Collaboration on supply chain resilience

Ali, Nagalingam, and Gurd (2018) highlight the importance of having robust collaboration mechanisms with government agencies. Resilient SC must develop good quality management systems (Ali, Nagalingam, and Gurd 2018; Wang et al. 2013; Zapalac 2007; Sullivan et al. 2016; Griffith 2015; Borelli, Orru, and Zedda

2015). In Healthcare organisations, robust quality management systems often include accreditation or other quality certificates (Ali, Nagalingam, and Gurd 2018; Zapalac 2007; Mobarek et al. 2006; Sullivan et al. 2016).

A study by Chaudhuri, Boer, and Taran 2018; Soni & Jain 2021 concluded that there should be collaborative approaches with key customers and ey suppliers, e.g. risk/revenue sharing, long-term agreements in line with other studies by Lambert, Emmelhainz, and Gardner (2021); Chaudhuri, Boer, and Taran (2018); Iakovou, Vlachos, and Xanthopoulos (2022); The study also found that another essential feature is system coupling with key customers and key supplier)s, e.g. vendor managed inventory, just-in-time, Kanban, continuous replenishment (Frohlich and Westbrook 2001; Chaudhuri, Boer, and Taran 2018; Cagliano, Grimaldi, and Rafele 2016; Vereecke and Muylle 2016; Chaudhuri, Boer, and Taran 2018).

Ellinger et al. (2015) also found that the key to public health supply chain performances lies in Supply Chain Integration which includes processes that allow firms to achieve efficiency through collaborative information exchange and coordination between internal activities and external partners. This qualitative study used purposive sampling. The limited information sharing and collaboration limit the visibility of risks to some practitioners generating the need to provide a more holistic view by studying the processes involved as an integrated system (Vilko and Hallikas 2012). Tang (2006) defines SCRM as the management of supply chain risks through coordination or collaboration among the supply chain partners to ensure profitability and continuity; nevertheless, the author understands that collaboration and coordination are outset premises for SCRM. Supply chain integration is a response that companies develop to manage an increased level of complexity (Wiengarten et al. 2016)

2.4 Research Gap Analysis

Two research gaps were unearthed during literature review. These pertain to geographical locations in which the existing researches are limited to and the conceptual delimitations of these studies (literature gap). Recent research such as Carvalho et al. (2019) and Brandon-Jones et al. (2020) has focused on the significance of supply chain resilience as a strategy for surviving the negative consequences of disruptive events. Even though studies emphasising on supply chain resilience have ballooned recently, the majority of these studies have only given attention to defining and highlighting the importance of the concept of supply chain resilience as well as identifying its main features. There is currently available literature that outlines ways for boosting supply chain resilience through flexibility

and redundancy. However, there is glaring evidence that there has been little investigation into how these methods interact. For example, some scholars such as Sheff and Rice (2019), Zsidisin and Wagner (2020) opined that these strategies are independent while others such as Juttner & Maklan (2018) and Johnson et al (2017) contend that they are interrelated with outcomes either supplementing or opposing each other. Thus, it becomes imperative to look at supply chain resilience systematically. Investigating supply chain resilience especially in the wake of pandemics was one such important task given the lack of attention this area has received. Again, previous studies have also paid much attention on high profile catastrophic event such as attacks by terrorists, rail crashes, global financial crises, Harican Katrina, among others (Jutter & Maklan, 2021; Urciuoli et al, 2019; Johnson et al, 2018; Scholten et al, 2020). Similarly, other work focusing on large scale disasters can also be found (for example, works by Day, 2014, Saenz & Revilla, 2014) but none has focused on disruptions caused by global pandemics despite history showing evidence of recurrence of such pandemics. The fact that supply chains should be able to deal with chronic and repeating disruptions and threats make this study essential to cover the literature gap. To date empirical studies reported on supply chain resilience against pandemics are very few with those few that have conducted focusing mainly in Europe, Asia and America (for example, Zsidisin & Wagner, 2020; Golgeci & Ponomarov, 2020; Scholten & Schilder, 2021) leaving the developed countries unrepresented. This was also confirmed by a recent systematic literature review conducted by Tukumuhambwa (2015) on 91 articles on supply chain resilience which concluded that the 91 articles were restricted to only 19 articles and in addition, the most empirical studies were found to have been conducted in developed countries like Western Europe and North America. This is despite the fact that emerging nations are the major consumers of goods produced elsewhere in the world and constitute a sizable portion of the global supply chains (Chika et al, 2021). As evidenced by the catastrophic consequences of their failures, they are also extremely vulnerable to disruptions of the global supply chains. Additionally, there are reasons to believe that poor nations have been hardest hit by supply chain disruptions.

Additionally, current research on supply chain resilience appears to favor product forgers (Stevenson & Busy, 2018), which creates a major vacuum in the body of knowledge on developing nations. For instance, there are claims that the introduction

of fake medications into the pharmaceutical supply chain led to the deaths of more than 192000 persons in China and Nigeria, respectively, and 200 and 2500 in 1995. (Chan et al, 2020). Developing countries are more susceptible to supply chain risks such as rebel operations, political unrest, violence, and corruption, among others, according to Lakovou et al. (2017) and Transparency International (218). For instance, in 2011, violent protests were caused by manufacturing being badly hampered by a disturbance in the chain of supply for gasoline and raw materials in Uganda. Therefore, it is crucial to focus on increasing supply chain resilience in developing nations because they are globally integrated and any disruption in the chain could have negative effects elsewhere (Pereira et al, 2019; Kim et al, 2015; Levalle & Nof, 2019). Furthermore, supply chain disruptions in developing nations typically affect people more than they do elsewhere.

More specifically, a large body of empirical research on supply chain resilience has focused on identifying the antecedents or enablers, practices, skills, and capabilities of supply chain resilience, which are the factors that make it easier to establish supply chain resilience. Hohenstein et al. (2018) argued that all of these can be referred to as supply chain strategies and that they also take into account all the broad concepts of supply chain resilience strategies for improving flexibility, creating redundancy, enhancing visibility, and improving supply chain agility. Information sharing and resource reconfiguration are two other specific methods mentioned in the literature that are collectively referred to as "collaboration" and "flexibility," respectively (Brandon-Jones et al 2018; Ambulkar et al, 2019).

Therefore, it is evident that the causes of supply chain resilience are either poorly understood or not understood at all. Additionally, there is a lack of theoretical support for the existing frameworks or models. This survey-based study aims to fill this gap by investigating the causes of supply chain resilience following pandemics

2.5 Chapter Summary

This chapter presented a review of the literature related to supply chain resilience. Theoretical views of the concept of supply chain resilience were reviewed followed by the conceptual framework and lastly the empirical review of literature. In addition, the chapter also highlighted the gap that this study aims to close. The next

chapter looked at the methodologies used in conducting the study.

Chapter Three

Research Methodology

3.0 Introduction

This chapter presented a detailed description of the methodologies that were used in conducting this study. These methodologies include the research philosophy, the research design, target population, sampling methodologies, data collection as well as the presentation of the data. The chapter also describes how issues of ethical consideration during the study were observed.

3.1 Research Philosophy

The study submitted to the positivist research philosophy in order to gather quantitative data. The positivist philosophy was adopted since the researcher assumed that knowledge regarding supply chain resilience can only be measured using reliable designs (Bryman & Bell, 2017; Saunders et al., 2018). There was no need to interpret or discover the underlying meanings of supply chain resilience.

3.2 Research Paradigm

As a result of adopting the positivism philosophy, the researcher, was convinced that the knowledge of supply chain resilience can be measured using scientific methods which resulted in the use of the deductive approach. Saunders et al (2018), asset that a deductive approach is where the existing theories are used to formulate hypotheses.

3.3 Research Design

The study aimed at explaining the how companies can build supply chain resilience in the wake of disruptions caused by pandemics. The study considered resilience practices and endeavoured to establish the links between these identified resilience practices and supply chain resilience. Thus, a descriptive survey research design was adopted since it is the only research design that can be used to establish the association between variable (Lewis, 2018).

3.4 Target Population

The study was carried out in the Harare, Zimbabwe and focused on the country's referral hospitals within greater Harare. The target population for this study was employees with clinical roles within the three referral hospitals in Greater Harare. That is Parirenyatwa Hospital, Harare Hospital and Chitungwiza Hospitals. The target population for this study consisted of public health institutions in Zimbabwe. Study participants in the approach of Strauss and Corbin (2019), participants should be selected based on their experiences in the process under study. Therefore, based on the nature of the process and the study's main purpose, the primary participants were selected from those involved in the medication supply chain with sufficient experience in Bastani et al. (2023) 16:99 natural disasters. These consisted of 984 participants.

3.5 Sampling

In line with the objectives of this particular study, the researcher opted to collect information from a sample which would be a true representation of the target population so as to fulfil the requirements of the study. As such, the researcher used simple random sampling to select 284 respondents from a target population of 984.

3.5.1 Sample Size

A sample, according to Chiromo (2016), is a tiny fraction of a population chosen for observation and analysis. According to Saunders et al. (2016), a sample is a subset or component of a larger population. Yamane (1967) created a sampling technique that the researcher relied on to determine the sample size for this study using the following formula: The study relied on this formula for calculating sample size since it provided an easy formula for calculating sample size.

The formula is depicted as below:

Sample size $\boldsymbol{n} = \dfrac{\boldsymbol{N}}{\boldsymbol{[1+N(e)\text{^}2]}}$

Where *N = Population*

e= 0.05 – 95% confidence level

n= is the required sample size

e = allowable error term When the values were substituted in the formula

Using the formula above, the sample population was selected as below: n = 984 1+0.052(984) = 284

Therefore, from a population of 984, a sample of 284 respondents was used.

Table 3. 1: Target Population strata

Strata	Parirenyatwa Hospital	Harare Hospital	Chitungwiza Hospital
Doctors	13	20	14
Nurses	15	15	10
Clinical Officers	80	54	63
Total	108	89	87

3.6 Research Instruments

For the study to achieve its objectives, a survey was conducted companies in greater Harare area using a questionnaire that was developed. The questionnaire which formed the research instrument for this study was constructed using the constructs generated and adopted from previous studies such as (Park, 2011; Ponis & Kronis, 2012; Simatupang & Sridharan, 2019; Petit, 2018; Pujawan, 2014; Manuj & Sahin, 2019; Schmitt, Snyder & Shem, 2010; Sheffi, 2015; Tang &Tomlin, 2018). The questionnaire consisted of 24 items that measured the four constructs of the independent variable and 6 items that measured the dependent variable. In addition, the questionnaire was divided into two major sections with the first section soliciting about the demographic data of respondents while the second section measured the constructs of the study according to the objectives of this study. A five-point Likert scale was used to measure the constructs of the dependent and the independent variable. The scale ranged from 1= strongly disagree up to 5 which is strongly agree. Items showing 3 indicated that respondents neither agreed nor disagreed.

3.7 Data Collection Procedure

Data for the study was collected using emails that were sent to the respondents through a survey monkey application. The first stage consisted of gathering the emails of the procurement professionals from the manufacturing companies in Harare. This was achieved through referrals. The researcher used snowballing method of getting all the email addresses of the procurement officials. First, contact was made with the procurement and logistics professionals known to the researcher and they were asked to supply the addresses of those known to them until all the procurement and logistics managers' email addresses were obtained. For those companies were the snowballing failed, the researcher had to physically or telephone the procurement departments of these companies, explain the why the information was required and then ask for the email addresses of the procurement official. The Survey Monkey was preferred because of its ability to send reminders for those who would not have responded as well as easy management.

3.8 Data Analysis

Data analysis, according to Saunders et al. (2016), is the capacity to deconstruct data and make clear the nature of the individual components and their interrelationships. Quantitative data analysis techniques were utilized in this study to add context to the data that was gathered for it. For this study, quantitative data were analyzed using IBM's SPSS program. Both descriptive and inferential statistics were employed. Means and standard deviations made up descriptive statistics, while exploratory factor analysis made up inferential statistics. While inferential statistics helped the researcher make predictions more easily from the results, descriptive statistics were performed to help create a better understanding of the results. Figures, pie charts, and bar graphs were used to show the data. For categorical data, logistic regression and bivariate correlation were also utilized to assess the study's hypotheses.

Exploratory factor analysis was done on the four model variables. The number of component factors was also determined using Varimax rotation. Items with communalities under 0.4 according to Hair et al. (2018) and factor loadings exceeding 0.3 on a single component were excluded from measurement. In chapter four of this study, the exploratory factor analysis's final findings are provided. When an item was

regarded to be one-dimensional, it signified that it measured only one underlying construct.

3.9 Validity and Reliability

In research studies, the two aspects of validity and reliability of the instruments used for data collection are very important (Saunders et al, 2016). In order to achieve these, the following were done. The study measured the validity of the research instrument for its content and construct validity

3.9.1 Validity

According to Saunders et al. (2016), validity is the degree to which data collection techniques or methodologies effectively capture the variables they were designed to, or the degree to which research results actually pertain to the claims made in them. According to Haralambos and Holborn (2016), statistics are reliable if they give an accurate picture of the subject under study. A fundamental idea in all studies is validity. It discusses if "the instruments, processes, and data" in a study are adequate (Leung, 2015). It also includes the accuracy of the results, the applicability of the conclusions, and the acceptability of the selected approach in the specific situation (Saunders, Lewis and Thornhill, 2015). Internal Consistency is defined as a measurement of the causal connection between the variables and the findings is internal validity (Gibbert et. al., 2018). Internal validity must be ensured by looking at the occurrences from a variety of angles, each of which is grounded in a separate scientific field, to make sure that no other researcher can come along and say, "Wait a minute. There's a completely different reason why this occurred (Carlile & Christensen, 2014). Structured questionnaires and secondary data were utilized in this study to gather information since they can be verified.

The study used factor analysis to test for construct validity which demonstrated if the items selected adequately reflected the constructs /phenomena of the study. Cronbach Alpha was used to test reliability of the research instrument and all the coefficients of the variables were above 0.7 meaning they were good. The data was then coded and analyzed and the results presented in the form of charts, graphs and tables and done per the objective of the study. The study conducted a simple regression analysis and the model is as below:- $Y = \alpha + \beta X + \varepsilon$ Where: Y = Public Health sector supply chain resilience α = constant β = Slopes of regression for the

independent variables X= Supply Chain flexibility, supply chai collaboration and supply chain visibility.

The respondents were chosen to ensure a wide variation in terms of experiences, skill sets, and positions in order to address the internal validity of the study. The goal was to get a comprehensive picture of the study field that included many different angles and points of view. Five logistics managers were requested to comment on whether or not the constructs were appropriate after being asked to study the items by four academicians. Some of the items were adjusted based on their feedback, while others were adopted. The topics brought up in talks and interviews were contrasted with those identified in the literature and the data already acquired from Zimbabwean manufacturing enterprises. The internal validity was further improved by the utilization of a wide range of literature, where data was gathered from various journals, books, reports, presentations, and internal documents.

The researcher made the decision to develop a chain of evidence using many sources of information in order to attain construct validity and to establish appropriate operational measures for the ideas under study. The degree to which a procedure allowed for an accurate observation of the subject under study is known as construct validity (Denzin & Lincoln, 2019). In essence, it assesses how effectively a study explores the topics it purports to explore (Gibbert et al, 2018). The researcher made few of her own observations, preferring to let the participants' own perspectives confirm the results. Yin (2017) asserts that research based on surveys and case studies has historically come under fire for failing to establish a thoughtful set of measurements and relying instead on subjective assessments. When information is acquired via structured surveys, the impact of this problem is especially diminished. Because of the structure's clarity, it is impossible for respondents to veer off the original question and introduce flaws (Collins & Hussey, 2014). The questionnaires included comparable questions that were asked throughout the industry to various logistics and supply chain managers with various roles and responsibilities in order to strengthen the construct validity of this study And responsibilities in order to ensure that all the answers they provided were in alignment as well as accurate.

Construct validity of this study was also increased through triangulation method as opined by Denscombe (2020). In this case, the same phenomenon was studied using different methods as referred to b Yin (2017). In addition, pilot testing of the questionnaire was also done on a sample of ten respondents to ensure that it was understandable to the respondents. Pilot testing also enabled the researcher to modify some of the constructs and remove ambiguity of some statement.

Triangulation in the form of researcher triangulation also ensured that external validity was achieved. In this case, the researcher used two emails with the survey monkey to reduce participation bias from the respondents since the researcher thought that she may be well known to a number of logistics and supply chain management professionals in the manufacturing industry in Zimbabwe. Based on Saunders et al (2015), Participation bias among respondents might be caused by their perception of the In order to counteract this effect, the introduction on the questionnaire was very open with the purpose of the study so that the respondents would understand the precise scope of the research study.

3.8.2 Reliability

Nachmias & Nachmias define reliability as an instrument's capacity to deliver the same outcomes each time it is used (2016). On the other hand, reliability and accuracy are related, according to Leedy and Ormrod (2016). This implies that the findings will be identical if an other researcher does a study using the same instrument.

Constructs of the instrument were subjected to the Cronbach's Alpha test for reliability. In this case, the study adopted the recommendation from Bryman and Bell (2018) which states that Cronbach's Alpha values of 1 shows a perfect reliability and that of 0 shows a no reliability. As a result, a Cronbach's Alpha value of 0.7 was considered to be the acceptable level basing on Goerge and Mallery's (2019) recommendations. The results of the Cronbach's Alpha tests are presented in chapter four.

Both data and investigator triangulation were also done to ensure reliability of the study. Bryman (2018) asserts that triangulation involves the use of more than one approach to the investigation of a research question to improve confidence in the findings. Multiple data sources were also used to ensure the data collected was more informative,

comprehensive and credible. Investigator triangulation was achieved by using two teams to collect data. Triangulations also helped in achieving both the reliability and validity of the research instrument.

3.9 Ethical Considerations

According to research viewpoints, ethics refers to one's behaviour being suitable in light of people whose rights are affected by the research (Saunders et al, 2016). This study takes into account all concerns regarding participant privacy, informed permission, voluntary participation, maintaining the confidentiality of the data individuals gave and maintaining their anonymity, as well as the impact of involvement on how the data will be utilized. By agreeing with participants on the topic of maintaining the confidentiality and anonymity of participant's responses and providing guarantees to the participants, problems connected to the aforementioned ethical difficulties were resolved. Prior to the distribution of the surveys, permission was also acquired from the relevant authorities.

3.9.2 Informed Consent

Informed consent is the primary tenet on which research is conducted. Informed consent, as defined by Fouka and Mantzorou (2012), is when a respondent clearly and manifestly expresses their assent while giving information "knowingly, voluntarily, and intelligently." One method for preserving a respondent's autonomy is informed consent. The freedom to self-determination in any action based on a personal plan is known as autonomy (Easterby-Smith and Thorpe, 2013). The respondents were made aware of their ability to freely choose whether or not to accept or decline full participation in the study, as well as their right to choose which questions they would like to answer.

3.9.3 Respect for anonymity and Confidentiality

Respect for the respondent's dignity is directly tied to the aspects of confidentiality and anonymity. Fouka and Mantzorou (2012) claim that anonymity is protected when a respondent's identity cannot be connected to their individual responses. The respondent's confidentiality must be handled if the study is unable to guarantee anonymity. The study maintained the confidentiality and identity of the responders. All returned questionnaires were only utilized for the research and discarded once the data

had been analyzed and the research report had been written. Respondent identities were not required to be on the questionnaires.

3.9.4 Respect for Privacy

"An individual's freedom to select the time, extent, and general circumstances under which private information is communicated with while being kept from others," according to Akaranga and Makau (2016), is the definition of privacy. A privacy invasion typically occurs when someone shares their private information with others without their knowledge or consent, which may include their views, ideas, records, and attitudes. The researcher will hold the respondents' private responses and personal data in confidence and use it only to further the study in order to protect their privacy.

3.10 Chapter Summary

The research methodology employed for this study was summarized in this chapter and the extent reached to the research design, sampling techniques, instruments for the research, research participants and how data will be analysed. Ethics were also taken into account during the gathering of data. The subsequent chapter concentrates on the analyzation, examination and apprehension of the findings.

Chapter Four

Results and Discussion

4.0 Introduction

This chapter included information gathered from respondents via questionnaires. The next steps are the data analysis and a discussion of the conclusions. The response rate data is displayed first, and then descriptive statistics about the respondents' demographic information and the study's goals. The final section of the chapter includes a presentation of inferential statistics..

4.1 Response Rate

Out of the 284 questionnaires given to participants, 228 were returned, resulting in an effective response rate of 80%. Nonetheless, valuable data were obtained from 79% of the questionnaires. As per Trochin et al. (2018), who proposed that a survey response rate of more than 76 percent is considered satisfactory, this was deemed sufficient to proceed with the investigation.

4.2 Demographic Profile of the respondents

The respondents' demographic profiles are presented in the following table.

Table 4. 1 Demographic profile of respondents

Respondents' demographic characteristics	*Frequency*	*Percentage*
Gender		
-Male	157	68.75%
-Female	71	31.25%
Position		
Doctors	85	37.5%
Nurses	24	10.41%
Clinical officers	119	52.09%
Duration of employment		
Less than one year	5	5.2%
Between 1- 3 years	9	9.37%
4- 6 years	29	30.2%
7-9 years	42	43.75%
More than 9 years	11	11.4%

4.3 Inferential Statistics

4.3.1 Exploratory Factor Analysis

Exploratory factor analysis was performed on the four model-related variables in this study using SPSS 25.0. The results were also rotated using Varimax to ascertain the number of component factors. Items with communalities less than 0.4 were for a sample of 98, whilst items with factor loadings more than 0.3 on multiple components were not taken into account for the measuring scale. (Hair and others, 2016). The structure of the four components, as established by the results of the exploratory factor analysis, is displayed in the following table. As per Hair et al. (2018), the findings indicate that every item is unidimensional, signifying that they evaluate the identical construct. Furthermore, all of the constructions' Cronbach Alpha values were found to be higher than 0.7, as advised by Nunnaily (2019)..

Table 4. 2 ***Factor Structure of the Constructs***

Constructs	**Components**				**Cronbach Alpha**
	1	**2**	**3**	**4**	
RED3	.893				0.934
RED2	.836				
RED1	.820				
RED4	.799				
RED5	.735				
RED6	.676				
COL2		.722			0.795
COL3		.665			
COL5		.610			
FLEX2			.842		0.747
FLEX3			.723		
FLEX6			.714		
VIS3				.894	0.820
VIS2				.843	
VIS5				.818	

Extraction method: PCA; Rotation Method: Varimax with Kaiser normalization; KMO 0.832; Bartlett's Test of sphericity = 0.000; Total variance explained 67.275; rotation

has converged after 5 iterations

4.3.2 Confirmatory Factor Analysis

Data analysis also involved the use of structural equation modeling's partial least squares. Partial least squares techniques are appropriate for data analysis for small samples, as the sample used in this instance, according to Ringle et al. (2015). It was therefore justified to apply structural least squares approaches. Using this method, the measuring model was first looked at to assess the constructs—supply chain visibility, cooperation, resilience, and flexibility—that were chosen for the study in terms of their convergent validity, internal consistency, and discriminant validity. This is consistent with Ringle et al. (2015), who noted that a model for assessing discriminant validity, internal consistency, and convergent validity is the partial least squares. According to Nunnaily (2019), a measure's internal consistency is guaranteed if its dependability is higher than 0.7. Consequently, the Cronbach's Alpha test and composite reliability were used for the reliability tests. From the results shown below, it is evident that all four constructions' composite reliabilities and Cronbach's Alpha values are appropriate for confirming the data's internal consistency.

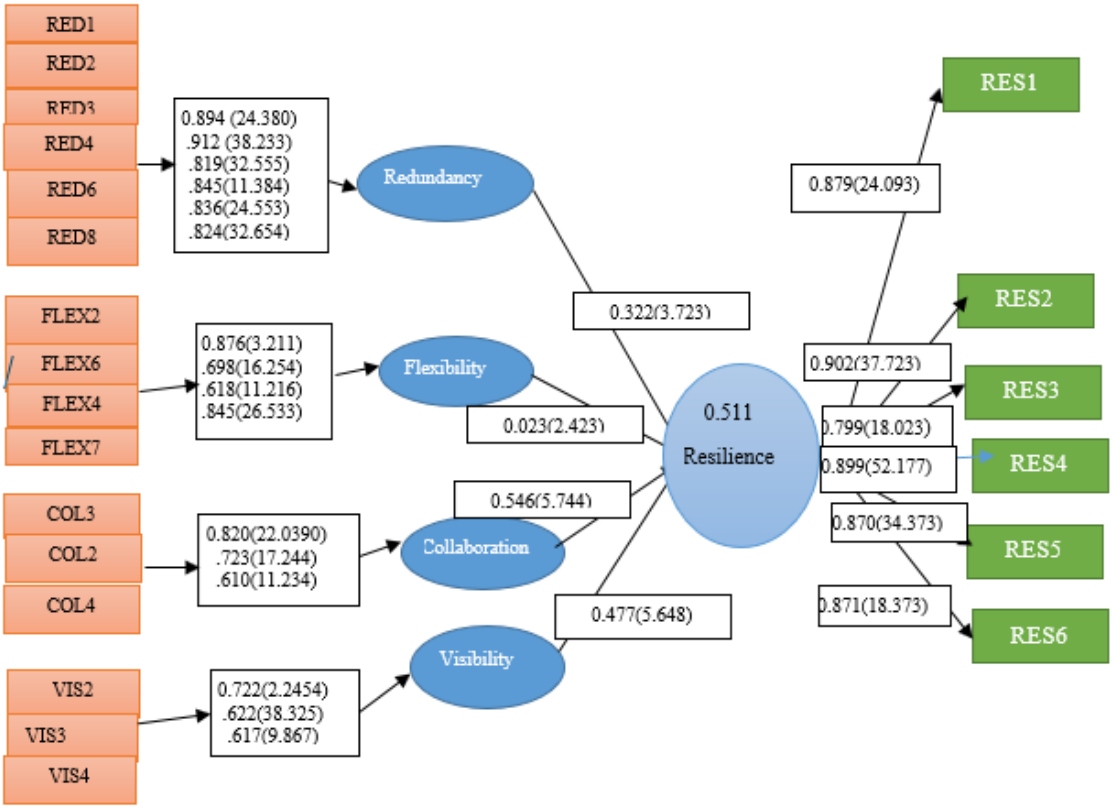

Figure 4. 1 Results of Bootstrapping procedure

4.3.3 Test for reliability and Convergent Validity

Fornell (2017) states that when each construct's AVE is more than 0.5, the constructs' convergent validity is verified. Therefore, all of the constructs included in this investigation showed evidence of convergent validity, as indicated by Table 4.3 below, which shows that the average variance extracted (AVE) varies from 0.659 to 0.746;

Table 4. 3 Reliability and Convergent Validity

	Cronbach's Alpha	**Composite Reliability**	**Average Variance Extracted (AVE)**
Collaboration	0.799	0.880	0.712
Flexibility	0.749	0.855	0.658
Redundancy	0.820	0.890	0.727
Visibility	0.753	0.866	0.746
Supply Chain Resilience	0.938	0.949	0.722

4.3.4 Discriminant Validity

According to Hair (2016), discriminant validity is demonstrated when no item loads highly on any other construct, all constructs have square roots larger than all average variance extracted (AVE) cross correlations, and each item has an item loading greater than 0.6 on its respective construct. Additionally, the diagonal values are displayed in the results, bolstering the discriminant validity. As a result, it is rather clear that these items have better relationships with their linked constructions than they do with the other constructs. Therefore, the discriminant validity of the measuring tests is asserted. The following two tables show the results of the discriminant validity.

Table 4. 4 cross correlations test for discriminant validity

	Redundancy	***Flexibility***	***Visibility***	***Collaboration***	***Resilience***
Redundancy	0.844				
Flexibility	0.244	0.192			
Visibility	0.377	0.266	0.852		
Collaboration	0.651	0.322	0.142	0.351	
Resilience	0.443	0.477	0.361	0.412	0.851

Table 4. 5 Average Variance Extracted

	Redundancy	***Flexibility***	***Visibility***	***Resilience***
COL2	0.809	0.192	0.387	0.466
COL3	0.876	0.183	0.290	0.376
COL5	0.846	0.248	0.194	0.376
FLEX2	0.255	0.796	0.262	0.381
FLEX3	0.093	0.756	0.2017	0.388
FLEX6	0.242	0.883	0.821	0.153
VIS2	0.276	0.144	0.894	0.306
VIS3	0.361	0.267	0.840	0.297
VIS5	0.306	0.355	0.285	0.870
RED1	0.409	0.342	0.244	0.902
RED2	0.422	0.299	0.250	0.799
RED3	0.333	0.457	0.360	0.899
RED4	0.443	0.402	0.278	0.871

RED5	0.473	0.462	0.278	0.812
RED6	0.450	0.467	0.231	0.796
RED7	0.419	0.499	0.283	0.711

4.3.5 Hypotheses Test

The study aimed to investigate the hypothesised relationship between supply chain resilience, supply chain visibility, supply chain collaboration, and supply chain flexibility as put out by Hair et al. (2018), as well as the proposed structural model. The four constructs used in this investigation were as follows. The data R^2 and the determined path coefficient (β) are displayed below..

Table 4. 6 Regression Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.285[a]	.081	-.064	1.681

a. Predictors: (Constant), Redundancy, Flexibility, Collaboration, Visibility

From the results show on the above table, it is clear that the R^2 was greater that 0.1. As postulated by Croutsche (2012), the R^2 has to be greater than 1 to confirm the hypothesis. The significant of the path coefficients were tested as stipulated by Chin et al (2018) using the bootstrapping procedure prosposed by Efron and Tibshirani (2016). Efron and Tibshirani (2016) proposed that a path coefficient is deemed to be significant if its t-statistics value is more than 1.96 (p<1%), 2.57 (p<5%) or 1.64 (p<10%). The results for output the (β) and R squared are presented in Table 4.4 above.

The above results indicate that the coefficient of determination which is the R squared is 0.511 for the endogenic latent variable supply chain resilience. This means that 51,10 percent of supply chain resiliency is explained by supply chain flexibility, supply chain redundancy and supply chain visibility. This inner model posits that supply chain flexibility has the has the strongest influence on supply chain resilience (β=0.546). this was followed by supply chain visibility (β=-.331). The path relationships were also considered to have a statistically significant with t-values of 5.843 and 3.834 respectively. In addition, the hypothesis that supply chain redundancy has an effect on

supply chain resilience was also statistically significant with a β = 0.324, t value of 3,432. Thus, the study results confirmed all the hypotheses as tabulated below:

Table 4. 7 Results of Hypotheses Tests

Hypothesis	**Path (β)**	**T-Value**	**Supported/Not Supported**
H_1- Supply chain redundancy is significant in building supply chain resilience for Zimbabwe's health sector in the wake of pandemics.	0.324	3.432	Supported
H_2 - Supply chain visibility is significant in building supply chain resilience within Zimbabwe's health sector in the wake of pandemics.	0.337	3.834	Supported
H_3 -Supply chain flexibility is significant in building supply chain resilience within Zimbabwe's health sector in the wake of pandemics.	0.547	5.843	Supported
H_4: Supply chain collaboration is significant in building supply chain resilience within Zimbabwe's health sector in the wake of pandemics.	0.254	3.674	Supported

4.4 Chapter Summary

This chapter presented data and analysis that was done to the collected data. The analysis was followed by discussion of the results. The first part of the chapter was concerned about analysing the demographic profiles of respondents followed by descriptive and inferential statistics. Response rate is also discussed in this section.

Chapter Five

Summary, Conclusion and Implications

5.1 Summary

The major thrust of this study was to analyse how the Zimbabwe‘s health sector can build supply chain resilience within in the wake of pandemics.. To achieve this, the study tested three hypotheses linked to supply chain resilience strategies using 122 respondents from the Zimbabwe’s public health sector institutions in Harare, Zimbabwe. Four supply chain resilience strategies namely supply chain resilience, supply chain visibility, supply chain flexibility and supply chain collaboration of supply chain resilience tested were supply chain visibility, supply chain flexibility and supply chain redundancy were tested against supply chain resilience. Data was collected quantitatively using questionnaires to a sample of 122 respondents selected through the probability method of simple random sampling. The data were analysed through inferential statistics of exploratory factor analysis and confirmatory factor analysis. Using the results of data analysis, the study arrived at the following conclusions:

5.2 Conclusion

This study analysed the impact of supply chain visibility, supply chain redundancy, supply chain flexibility and supply chain collaboration on supply chain resilience in a bid to investigate how Zimbabwe‘s health sector could build supply chain resilience in the wake of Covid 19. In order to achieve the objectives of the study, hypotheses linked to supply chain resilience were tested using inferential statistics. Overally, the study demonstrated that Zimbabwe‘s health sector is often unable to detect early of how pandemics cause disruptions and mitigate the effects of the resultant problems as well as resume operations by reconfiguring the supply chains. From the results of the findings, it is concluded that:

5.2.1 The impacts of supply chain redundancy on supply chain resilience within the Zimbabwe‘s health sector in the wake of pandemics..

This study demonstrated that supply chain redundancy has positive significant effect on supply chain within Zimbabwe‘s health sector in the wake of pandemics. Redundancy is achieved through keeping buffer stock (extra inventory) in different parts of the supply chain so as to help cope with distortions, contracting a backup supplier of the supply chain to help in coping with distortions, designing a certain level

of excess capacity in some key nodes of the network of the supply chain to cope with distortions, using strategic and selective spare capacity and inventory of the supply chain to cope with distortions, making use of multiple suppliers to cope with distortions, using extra supply chain facilities to cope with distortions, using local suppliers to cope with distortions, splitting orders to cope with distortions as well as using suppliers that are close in order to cope with distortions.

5.2.2 The impact of supply chain visibility on supply chain resilience within the Zimbabwe‘s health sector in the wake of pandemics..

Regarding the impact of supply chain visibility on supply chain resilience chain resilience within Zimbabwe‘s health sector in the wake of pandemics. The study proved that supply chain visibility through sharing adequate quality information in the right quantity at the right time with partners in the supply chain and using information technology to enhance connectivity had positive effect on supply chain resilience. Thus, in conclusion, the study proved the hypothesis that supply chain visibility positively affects supply chain resilience within Zimbabwe‘s health sector

5.2.3 The effect of supply chain collaboration on supply chain resilience within the Zimbabwe‘s health sector in the wake of pandemics.

The study concluded that public health institutions can achieve level of resilience when faced with supply chain disruptions in the wake of pandemics by aligning their strategies with other players within their supply chain, using collaborative planning and forecasting, sharing information with other supply chain partners as well as integrating and optimising logistics processes. From the results obtained in this study, it was proved that supply chain collaboration helps Zimbabwe‘s health sector to build supply chain resilience especially when faced with supply chain disruptions from pandemics.

5.2.4 The effect of supply chain flexibility on supply chain resilience in the chain resilience within the Zimbabwe‘s health sector in the wake of pandemics.

This study demonstrated that flexibility helps companies to build supply chain resilience. The results of the study show that flexibility is key to overcome supply chain distortion caused by pandemics within Zimbabwe‘s health sector. Thus, the study proved the hypothesis that *Supply chain flexibility has a positive significant influence on supply chain resilience within Zimbabwe‘s health sector*. Flexibility is achieved through postponement as a way of creating prompt adaptability during turbulence,

flexible supply base to allow prompt adaptability during turbulence, using flexible transportation to create prompt adaptability during turbulence, using flexible production to create prompt adaptability during turbulence, using postponement to allow rapid response and recovery and using flexible supply base to allow rapid response and recovery.

5.3 Implications

The study recommends that public health institutions should increase supply chain redundancy by keeping buffer stock (extra inventory) in different parts of the supply chain so as to help cope with distortions, contracting a backup supplier of the supply chain to help in coping with distortions, designing a certain level of excess capacity in some key nodes of the network of the supply chain to cope with distortions, using strategic and selective spare capacity and inventory of the supply chain to cope with distortions, making use of multiple suppliers to cope with distortions, using extra supply chain facilities to cope with distortions, using local suppliers to cope with distortions, splitting orders to cope with distortions as well as using suppliers that are close in order to cope with distortions.

The study also recommends that public health institutions should work to achieve supply chain visibility through sharing adequate quality information in the right quantity at the right time with partners in the supply chain and using information technology to enhance connectivity had positive effect on supply chain resilience in order to overcome supply chain disruptions in the event times of pandemic outbreaks.

Furthermore, it is recommended that firms within Zimbabwe‘s health sector should use supply chain collaboration strategies to increase their resilience. These strategies should be in place so that when the supply chain is distorted by risks such as global pandemic like the recent Covid – 19 pandemics, firms within Zimbabwe‘s health sector will be able to withstand these distortions.

In order to ensure that they can handle supply disruptions and crises brought on by pandemics, the report also suggests that public health institutions strengthen the flexibility of their supply chains through flexible supply bases, flexible transportation, and flexible processes.

5.4 Implications for further studies

Thus, it is recommended that in future, research should be carried out using supply chain analysis constructs recommended by (Takamumbwa et al, 2015). In addition, the data for this study consisted of responses from single respondents in the public health institutions which attracts a lot of limitations. This may result in some inaccuracy which may cause possible bias from the responses. Therefore, it is recommended that a similar study with multiple responses from other sectors such as humanitarian sector may enhance the accuracy of the conclusions. This may be useful for the enrichment of the emerging disciplines of supply chain risk management and supply chain resilience. Moreover, the study was only limited to supply chain visibility, supply chain redundancy and supply chain flexibility. Collaboration which is also one of the most important pillars of supply chain resilience was not considered. Thus, a study incorporating supply chain collaboration will be most useful in future to determine supply chain resilience in times of pandemics.

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Appendix 1- Survey Questionnaire

Survey Questionnaire Consent Letter

Dear Respondent
My name is ……., a Masters student in Purchasing and Supply Chain Management at BUSE. I am carrying out master's research entitled: **Antecedents of supply chain resilience in the public health sector in Zimbabwe in Partial Fulfilment of the Master of Commerce in Purchasing and Supply Chain Management Degree**. The research project targets all the procurement officers in the health sector in Zimbabwe.
I therefore kindly solicit your assistance to provide answers to the set of questions provided. In case you have any questions and wish to have a detailed account of this study please contact me at .....@gmail.com

- You will be anonymous, and all answers will be confidential.
- Information obtained through this exercise will be strictly used for academic purposes.
- Your participation is voluntary, and you are free to withdraw at any time without giving any reason.

Thank you, Yours faithfully

……

Survey Questionnaire

Please indicate how strongly you agree or disagree with each statement by ticking in the appropriate box. These statements are ranked from 1= Strongly agree; 2=Agree; 3= Neutral; 4= Agree and to 5=Strongly Agree. The survey questionnaire should take approximately 15 minutes to complete.

SECTION A- Demographic attributes

(Please tick the appropriate)

1. Age:

   18-24 years ☐

   25-30 years ☐

   31-36 years ☐

   Above 36 years ☐

2. Sex:

   Male ☐

   Female ☐

3. Period of involvement in supply chain management field

   1-3 years ☐

   4-6 years ☐

   7-9 years ☐

   Above 9 years ☐

4. Educational qualifications.

   O' level ☐

   A' Level ☐

   Diploma ☐

   Undergraduate ☐

   Post-graduate ☐

5. Position held

   Logistics manager ☐

   Supply chain manager ☐

   Managing Director ☐

   Other ☐

SECTION B:

Supply chain redundancy

Statement regarding Supply chain Redundancy	**1**	**2**	**3**	**4**	**5**
Our organisation keeps buffer stock (extra inventory) in different parts of the supply chain so as to help cope with distortions					
Our organisation contracts a backup supplier of the supply chain to help in coping with distortions					
Our organisation designs a certain level of excess capacity in some key nodes of the network of the supply chain to cope with distortions					
Our organisation uses strategic and selective spare capacity and inventory of the supply chain to cope with distortions					
Our organisation makes use of multiple suppliers to cope with distortions					
Our organisation uses extra supply chain facilities to cope with distortions					
Our organisation makes use of local to cope with distortions					
Our organisation splits orders to cope with distortions					
Our organisation uses suppliers that are close in order to cope with distortions					

Supply chain visibility

Statement regarding Supply chain Redundancy	**1**	**2**	**3**	**4**	**5**
Our organisation shares information with partners in the supply chain					
Our organisation achieves high level of visibility through information					

Our organisation understands that information sharing is a crucial prerequisite for any organisation that wants to improve their level of supply chain resilience					
In our organisation, it is understood that simply transmitting data between business partners will not achieve the sought after outcome of strong relational ties					
Our organisation ensures that information shared is quality information for it to achieve visibility.					
Our organisation makes sure that exchanged information comes in the correct quantity					
Our organisation ensures that the exchanged information comes in adequate quality					
Our organisation uses information technology to enhance connectivity and support supply chain resilience					
Our organisation uses connectivity to achieve supply chain resilience.					

Supply chain flexibility

Statement regarding Supply chain flexibility	**1**	**2**	**3**	**4**	**5**
Our organisation uses postponement as a way of creating prompt adaptability during turbulence.					
Our organisation uses flexible supply base to allow prompt adaptability during turbulence.					
Our organisation uses flexible transportation to create prompt adaptability during turbulence.					
Our organisation uses flexible production to create prompt adaptability during turbulence.					
Our organisation uses postponement to allow rapid response and recovery.					

Our organisation uses flexible supply base to allow rapid response and recovery					

Supply Chain Collaboration

Statement regarding Supply chain collaboration	**1**	**2**	**3**	**4**	**5**
Our organisation's strategies are aligned with other companies in our supply chain.					
Our organisation uses collaborative planning and forecasting.					
We share information with other supply chain partners					
Our organisation has integrated and optimised logistics process.					
We do collaborative training for our employees					

Supply chain Resilience

Statement regarding Supply chain resilience	**1**	**2**	**3**	**4**	**5**
Resilience enable firms to seek ways to anticipate, absorb and gain equilibrium state after being disturbed.					
Ability to prepare for the unpredictable risk events					
Ability to respond quickly to potential disruptions					
Ability to recover from them and return to its original state or new more desirable state after being disturbed.					
Supply resilience strategies involve increasing flexibility.					
Supply chain redundancy helps in creating supply chain resilience					
Forming collaborative supply chain relationships helps in supply chain resilience.					

Thank you