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ROLE OF THE FOURTH INDUSTRIAL REVOLUTION IN ACHIEVING SUPPLY CHAIN RESILIENCE: A CASE OF THE PHAMACEUTICAL INDUSTRY DURING COVID-19

BY

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I, **KIRSTY MUTUVA**, hereby certify that this project is a unique work of mine that has never been published or presented to another college or university.

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Dedications

To my family and friends

Abstract

The Fourth Industrial Revolution (4IR) is characterized by the convergence of digital, physical, and biological technologies, resulting in transformative changes across various industries. One area where the 4IR holds significant potential is in achieving supply chain resilience. In today's dynamic and uncertain business environment, supply chain resilience has become a strategic imperative for organizations to effectively respond to disruptions and maintain operational continuity. This dissertation aims to explore and analyze the role of the Fourth Industrial Revolution in enhancing supply chain resilience. The main findings of the linear regression using flexibility performance as the dependent variable indicate a positive and significant relationship between real time information and flexibility performance. At 1 percent level of significance, real time information positively affect response time by around 18%. The results shows that is very important to improve flexibility performance by improving the real time information. The research used both qualitative and quantitative methodologies.

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

The Fourth Industrial Revolution (4IR) is characterized by the convergence of digital, physical, and biological technologies, resulting in transformative changes across various industries. One area where the 4IR holds significant potential is in achieving supply chain resilience. In today's dynamic and uncertain business environment, supply chain resilience has become a strategic imperative for organizations to effectively respond to disruptions and maintain operational continuity. This dissertation aims to explore and analyze the role of the Fourth Industrial Revolution in enhancing supply chain resilience.

Since worldwide trade has increased and global markets have become more interlinked, modern enterprises need more than just financial, human, and environmental resources to succeed. Within the framework of the 4IR mandate in the current IT age, digital transformation is defined as digitizing or digitalizing the business in a way that installs and uses ubiquitous sensing and communication capabilities to capture the current states of the systems. According to Menezes et al. (2019), this is consistent with advanced analytics, which enables the use of recent inputs to forecast and prescribe near-term future outcomes.

The idea behind the supply chain is based on the development of a value chain network made up of distinct functional organizations dedicated to offering resources and data in order to fulfill the goals of effective supplier management and components flow (Lau & Lee, 2000).In order to improve the long-term performance of each company as well as the supply chain as a whole in a well-integrated and highly effective business model, supply chain management (SCM) comprises a set of approaches and practices that effectively integrate suppliers, manufacturers, distributors, and customers (Chopra and Meindl, 2001).The planning and management of all sourcing and procurement, conversion, and logistics management activities, as well as coordination and cooperation with channel partners, are all included in supply chain management, according to the definition provided by the Council of Supply Chain Management Professionals (CSCMP).

SCM and associated tactics are vital to a manufacturing company's performance. This is true because there is a direct correlation between the price and quality of products and services acquired and the price and quality of goods and services sold. As a result, the SCM places a high value on supply chain strategies such supplier selection and procurement (Hartley and Choi, 1996; Degraeve et al., 2000). Other well-known SCM strategies include lean techniques to enhance internal business operations in accordance with just-in-time (JIT) supply principles (Burgess et al., 2006; Cigolini et al., 2004).

The core concept of supply chain management (SCM) is the integration of an organization's internal processes with those of its suppliers and customers. Web-based systems help businesses create strong customer and supplier integration for inventory management, demand forecasting, and customer and supplier relationship management in light of the increasing use of the internet (Frohlich and Westbrook, 2002).

Every economic activity involves some level of risk, which must be managed by every business based on its size and mode of operation. Without effective risk management, no organization can last over the long term. This is because businesses now have to contend with considerably more obstacles than they did in the past because of the growing and more obvious interconnection of the economy, technology, and law. It would be expected that depending on an organization's size or industry sector, its internal control and risk management systems would differ from one to the next. Therefore, it makes sense to presume that every company has internal control mechanisms and a robust risk management framework in place to aid in achieving its objectives.

These are essential to the smooth operation and daily management of a business and help an organization reach its goals. By controlling risk at the supply chain level, we can identify any possible risks to the chain as a whole, to the organizations in it, and particularly to the logistics resources-people, infrastructure, and suprastructure as well as the flow of goods, services, and information. While the supply chains of different businesses vary, most companies' supply chains share the risk of realizing their intended supply chain.

A supply chain interruption brought on by anticipated and unanticipated circumstances has a negative impact on any organization's performance. Any company's risk of not having enough raw materials for production will have a significant impact on fulfilling client orders, which

will lower sales and lower earnings. Many organizations still lack a supply chain risk management program, despite the significant impact that supply chain disruptions have on their bottom lines. This program involves identifying potential risks within an organization's supply chains and developing mitigation strategies and contingency plans for supply chain risks that could negatively impact the organization's performance. Thus, in order to boost supply chain efficiency and effectiveness, organizations must clearly understand all of the risks associated with supply chains as well as all of the uncertainties in providing value to consumers. Supply chain managers should then develop effective mitigation methods.

Supply chain resilience, or SCR, is becoming more and more important to an organization's survival and expansion in light of the previously unheard of rates of opportunities and threats in the pharmaceutical While it is about continuously matching and optimizing a number of interconnected supply chain and logistics processes to enhance the situational awareness of the present and future statuses of the networks, SCR is thought to encompass critical roles that far exceed responding to an ad hoc crisis (AlBanna et al., 2022, 2023).

Zimbabwe, like many other countries, faces significant challenges in achieving supply chain resilience due to various disruptions, uncertainties, and inefficiencies in its supply chain processes. The Fourth Industrial Revolution (4IR), with its transformative technological advancements, holds the potential to revolutionize supply chain management and enhance resilience. However, the specific challenges and opportunities related to the adoption and integration of 4IR technologies in the context of Zimbabwe's supply chains remain relatively unexplored especially in the pharmaceutical industry.

1.1 Statement of the problem

There is lack of understanding regarding the role of the Fourth Industrial Revolution in achieving supply chain resilience in Zimbabwe’s pharmaceutical industry. There is a need to investigate and analyze how the adoption and integration of 4IR technologies, such as AI, IoT, big data analytics, robotics, and block chain, can address the challenges faced by Zimbabwean supply chains and enhance their resilience in the same industry. This includes understanding the current state of supply chain resilience in Zimbabwe, identifying the barriers and enablers for adopting 4IR technologies, and exploring effective strategies and best practices for leveraging these technologies to enhance supply chain resilience. According to Menezes et al. (2019), this is consistent with advanced analytics, which enables the use of recent inputs to

forecast and prescribe near-term future outcomes. By addressing this problem statement, the research aims to provide valuable insights and recommendations to policymakers, industry practitioners, and supply chain managers in Zimbabwe. The findings will help inform decision-making processes, facilitate the adoption of appropriate 4IR technologies, and enable the development of robust and resilient supply chains that can effectively navigate disruptions, improve operational efficiency, and support the economic growth and sustainability of Zimbabwe.

1.2 Objectives of the study

i. To find out the effect of the fourth industrial revolution in achieving supply chain resilience in the pharmaceutical industry in Zimbabwe during the COVID-19.
ii. To provide recommendations on the supply chain resilience means in the pharmaceutical industry during a shock in an economy.

1.3 Research Questions

i. Does the fourth industrial revolution has effect in achieving supply chain resilience in the pharmaceutical industry in Zimbabwe during the COVID-19.
ii. What are the recommendations on the supply chain resilience means in the pharmaceutical industry during a shock in an economy.

1.4 Significance of the Study

The significance of studying the role of the Fourth Industrial Revolution (4IR) in achieving supply chain resilience in Zimbabwe's pharmaceutical industry is as follows:

Enhancing Access to Medicines: The pharmaceutical industry plays a critical role in ensuring the availability and accessibility of essential medicines. However, supply chain disruptions, such as stockouts, counterfeit drugs, and inefficient distribution, can hinder access to medicines. By exploring the role of 4IR technologies in supply chain resilience, this study can provide insights into how the pharmaceutical industry in Zimbabwe can leverage these technologies to improve supply chain efficiency, reduce stockouts, and ensure timely access to quality medicines for the population.

Mitigating Health Risks: A resilient pharmaceutical supply chain is essential for mitigating health risks and emergencies. The COVID-19 pandemic highlighted the vulnerabilities and challenges faced by supply chains in responding to sudden surges in demand and disruptions. By studying the role of 4IR technologies, this research can identify strategies and technologies that can help the pharmaceutical industry in Zimbabwe better respond to health emergencies, enhance supply chain visibility, and improve coordination and distribution of critical medications, vaccines, and medical supplies.Quality Assurance and Patient Safety: Supply chain disruptions and inefficiencies can compromise the quality and safety of pharmaceutical products. Counterfeit drugs and substandard medications pose significant risks to patient health. By leveraging 4IR technologies such as blockchain, IoT, and AI, the pharmaceutical industry in Zimbabwe can enhance traceability, authentication, and quality control measures. This study can shed light on the potential benefits of these technologies in ensuring the integrity of the pharmaceutical supply chain and protecting patient safety.

Industry Competitiveness and Innovation: The adoption of 4IR technologies can enhance the competitiveness and innovation capacity of the pharmaceutical industry in Zimbabwe. By embracing digital transformation and leveraging technologies such as big data analytics and AI, pharmaceutical companies can optimize inventory management, forecast demand more accurately, and improve operational efficiency. This study can provide insights into successful implementation strategies and best practices, enabling the industry to stay competitive and innovative in a rapidly evolving global market.

Policy Recommendations and Future Planning: This study can provide policymakers in Zimbabwe with evidence-based insights and recommendations for policy formulation and strategic planning. Understanding the role of 4IR technologies in achieving supply chain resilience can inform the development of policies and regulations that foster the adoption and integration of these technologies in the pharmaceutical industry. This can lead to a supportive environment for innovation, investment, and collaboration, ultimately strengthening the resilience of the pharmaceutical supply chain in Zimbabwe.

To the Author

The research is crucial to the researcher because it sheds light on how important it is to ascertain the role of the Fourth Industrial Revolution in achieving Supply Chain Resilience in Zimbabwe's pharmaceutical industry. Additionally, this study will deepen the student's

understanding of how all these affect economic growth. The study will also improve the student's analytical abilities by coming up with practical suggestions that affect Zimbabwe's economy.

To the University

The fact that this research will expand the university's e-learning resources and enhance the university's reputation makes it crucial for Bindura University's educational mission. By analyzing the results, the research institutions will gain from this study. Researcher will assess the suggestions to see whether the Fourth Industrial Revolution plays a role in achieving supply chain resilience in Zimbabwe's pharmaceutical industry. Other research institutions will pursue the suggested topics of additional research to expand their understanding of supply chain management.

Policy Makers

Policymakers in both the private and public sectors will gain from this study's conclusions and suggestions, which they can utilize to improve the Supply Chain Resilience in zimbabwe's pharmaceutical industry. The identification of variables that contribute to supply chain resilience and the recommendation of mitigation solutions can enhance the performance of both public and private entities.

1.5 Assumptions

i. Primary data collection will not be biased.
ii. The study will be completed on the stipulated time set by the department.
iii. Findings from the research will be bias free.
iv. There will no spurious regression.
v. Dataset used in this research is accurate and reliable.

1.6 Definition of Terms

1.6.2 Supply chain

It is a system of organizations, people, activities, information, and resources involved in transferring a good or service from a supplier to a client, according to Lyson (2006). Natural resources, raw materials, and component parts are transformed through supply chain operations into a final product that is shipped to the final consumer.

1.6.4 Supply chain Risks

Supply Chain Risk is defined by Kersten et al. (2006) as the potential harm that an event within a company, its supply chain, or its environment could cause to negatively impact the business processes of multiple companies involved in the supply chain. This harm is measured by the probability of the event occurring.

Supply chain resilience

Supply chain resilience refers to the ability of a supply chain to anticipate, respond to, and recover from disruptions or disturbances while maintaining its core functions and delivering value to customers. It involves the capacity of a supply chain to withstand and adapt to unexpected events such as natural disasters, supply disruptions, market fluctuations, geopolitical issues, and other uncertainties.

Supply chain resilience goes beyond traditional risk management practices, which primarily focus on mitigating risks and minimizing their impact. Resilience emphasizes the ability to bounce back, reconfigure, and recover quickly and effectively in the face of disruptions. It involves proactive strategies, robust processes, and agile operations to ensure continuity, minimize disruptions, and protect the overall performance and sustainability of the supply chain.

1.6.5 Fourth Industrial Revolution

The Fourth Industrial Revolution (4IR) refers to the ongoing technological transformation characterized by the fusion of digital, physical, and biological technologies. It represents a new era of rapid technological advancements that are fundamentally reshaping industries, economies, and societies.

The term "Fourth Industrial Revolution" was coined by Klaus Schwab, the founder and executive chairman of the World Economic Forum, to describe the convergence of several disruptive technologies and their impact on various aspects of human life. The 4IR is marked by the integration of technologies such as artificial intelligence (AI), robotics, the Internet of Things (IoT), big data analytics, blockchain, virtual reality (VR), augmented reality (AR), and advanced manufacturing techniques.

The 4IR is characterized by the following key features:

Connectivity and Digitalization: The 4IR is driven by the widespread connectivity of devices, systems, and people through the internet and other communication networks. It involves the digitization of processes, data, and interactions, enabling seamless connectivity and real-time information exchange.

Automation and Artificial Intelligence: The 4IR is marked by the increasing use of automation technologies and AI-powered systems that can perform tasks traditionally done by humans. This includes machine learning, natural language processing, computer vision, and autonomous systems that can analyze vast amounts of data, make decisions, and perform complex tasks.

Cyber-Physical Systems: The 4IR blurs the boundaries between physical and digital realms through the integration of cyber-physical systems. These systems combine physical components with digital sensors, actuators, and connectivity, enabling the monitoring, control, and optimization of physical processes in real-time.

Data-driven Decision Making: The 4IR emphasizes the use of data as a valuable resource for decision-making. With the proliferation of sensors and connected devices, massive amounts of data are generated, which can be analyzed to derive insights, make predictions, and optimize processes.

Disruptive Business Models: The 4IR has the potential to disrupt traditional business models and create new opportunities. It enables the emergence of platform-based businesses, sharing economies, personalized experiences, and innovative value propositions.

1.7 Delimitations

i. The research utilise primary data only.
ii. The study is mainly for the Zimbabwean economy only.

1.8 Limitations

Gathering primary information and data for the research is expensive. This may lead to a small sample to be used. However the researcher will be guided by the standard sampling procedures for instance using the Krejcie & Morgan (1970) as right sample size will be drawn from the population.

1.9 Chapter summary

The research issue was presented in this chapter along with explanation of its background, research problem, objectives, research questions, research hypothesis, significant of the study, delimitations and limitations. There will be five primary chapters in this study. The gap analysis and literature review (both theoretical and empirical) linked to the area of emphasis will be covered in the following chapter.

CHAPTER TWO

LITERATUTURE REVIEW

2.0 Introduction

This chapter covers five sections which are theoretical review, empirical studies, conceptual framework and hypothesis development, gap analysis, and a chapter summary. It also he chapter proceeds to examine the empirical evidence, consisting of studies conducted by other researchers on the topic. It also presents a detailed conceptual framework and hypothesis development. Finally, the chapter concludes with a gap analysis and a summary of its contents.

2.1 Theoretical Framework

This section presents the theoretical literature review.

2.1.1 Disruptive Innovation Theory

Disruptive Innovation Theory was introduced by Clayton Christensen in 1995 and it explores the impact of disruptive technologies on industries and businesses. Disruptive innovation refers to the process by which a new technology or business model enters the market and disrupts existing industries or markets by providing simpler, cheaper, or more convenient solutions. Christensen distinguishes between sustaining innovations and disruptive innovations. Sustaining innovations improve existing products or services in established markets, targeting the needs of mainstream customers. Disruptive innovations, on the other hand, initially serve niche markets or lower-end customers with simpler, more affordable, or more accessible offerings.

Disruptive innovations often start by addressing the needs of customers who are underserved by existing solutions. These innovations gain traction in niche markets and gradually improve over time, eventually capturing larger market segments and displacing established players. The technology adoption life cycle describes the stages of market acceptance for disruptive innovations, including early adopters, early majority, late majority, and laggards. Established companies face the "Innovator's Dilemma" when disruptive innovations emerge. They are often focused on serving their existing customers and improving their existing products, which leaves

them vulnerable to disruptive technologies that initially cater to different customer segments or offer lower performance. Incumbents may ignore or underestimate the disruptive potential, leading to missed opportunities or even the downfall of established companies.

Disruptive innovations often disrupt existing value networks and business models. They introduce new ways of creating, delivering, or capturing value that challenge traditional industry norms. Incumbent companies that are deeply entrenched in their existing value networks and business models may struggle to adapt to the changes brought about by disruptive technologies.

In the context of the Fourth Industrial Revolution and supply chain resilience, Disruptive Innovation Theory highlights the potential impact of emerging technologies on supply chains. Technologies like artificial intelligence, big data analytics, robotics, and the Internet of Things have the potential to disrupt traditional supply chain practices, enabling new ways of managing inventory, optimizing logistics, and enhancing customer experiences. By adopting and leveraging these disruptive technologies, companies can increase their supply chain resilience by improving efficiency, responsiveness, and adaptability to changing market dynamics. However, it's important to note that not all Fourth Industrial Revolution technologies are inherently disruptive. Disruption occurs when these technologies are applied in innovative ways to create new business models or serve new customer needs. It requires a mindset of continuous innovation, experimentation, and a willingness to challenge existing practices within the supply chain.

2.1.2 Digital Transformation Theory

The theory was proposed by Claude Shannon in the 1950s. Digital Transformation Theory focuses on the process of leveraging digital technologies to transform business operations and create value. It recognizes the fundamental shift brought about by the Fourth Industrial Revolution, where digital technologies such as artificial intelligence, big data analytics, cloud computing, the Internet of Things (IoT), and others are integrated into various aspects of business activities, including supply chain management.

Digital transformation theory emphasizes a holistic approach to leveraging digital technologies. It involves integrating digital technologies across the entire organization, including supply chain functions, rather than implementing isolated digital initiatives. It recognizes that digital transformation requires changes in processes, culture, talent, and

organizational structures. Digital Transformation Theory recognizes the importance of focusing on customer needs and experiences. By leveraging digital technologies, companies can gain better insights into customer preferences, behaviors, and demands. This enables the design and delivery of personalized and seamless customer experiences throughout the supply chain, from order placement to delivery and post-sales support.

Digital Transformation Theory emphasizes the use of data and analytics to drive decision making. Digital technologies enable the collection, analysis, and interpretation of vast amounts of data from various sources within the supply chain. By leveraging advanced analytics, companies can gain actionable insights, make informed decisions, and optimize supply chain operations for improved efficiency and resilience. Digital Transformation Theory recognizes the need for agility and flexibility in the face of rapidly changing market dynamics. Digital technologies enable companies to respond quickly to market disruptions, demand fluctuations, and supply chain risks. By embracing digital platforms, automation, and real-time information exchange, companies can enhance their ability to adapt and make timely adjustments within the supply chain.

Digital Transformation Theory emphasizes the importance of collaboration and connectivity across the supply chain ecosystem. Digital technologies facilitate seamless communication, information sharing, and collaboration among supply chain partners, including suppliers, manufacturers, distributors, and customers. This enables improved coordination, visibility, and responsiveness, enhancing supply chain resilience.

Digital Transformation Theory recognizes that digital transformation is an ongoing process. It requires a culture of continuous innovation and experimentation, where companies are open to exploring new technologies, business models, and ways of working. This mindset enables companies to stay ahead of the curve, adapt to emerging trends, and drive continuous improvement within the supply chain. In the context of achieving supply chain resilience, Digital Transformation Theory highlights how digital technologies can be leveraged to create more agile, responsive, and efficient supply chain operations. It enables companies to proactively identify and address disruptions, optimize inventory and logistics, enhance collaboration, and deliver superior customer experiences. By embracing digital transformation, companies can build resilient supply chains capable of withstanding and recovering from disruptions more effectively.

2.1.3 Network Theory

This theory was proposed by Bower in 1981. Network Theory, also known as Network Science or Graph Theory, is a branch of mathematics and computer science that studies the structure, behavior, and properties of interconnected systems. In the context of supply chains, Network Theory focuses on understanding the relationships, interdependencies, and flows among supply chain partners, entities, and resources.

In Network Theory, a network is composed of nodes (also called vertices) and edges (also called links or connections). In the context of supply chains, nodes represent various entities, such as suppliers, manufacturers, distributors, retailers, and customers. Edges represent the relationships, connections, or flows between these entities, such as material flows, information flows, or financial transactions. Network Theory emphasizes the interconnected nature of supply chains. It recognizes that supply chains consist of multiple entities that are interdependent and rely on each other for the flow of goods, services, and information. Changes or disruptions in one part of the network can propagate and impact other nodes and edges within the supply chain.

The topology of a network refers to its structure and pattern of connections. In supply chains, the network topology represents the configuration and relationships among supply chain partners. Common network topologies in supply chains include linear supply chains, hub-and-spoke networks, and complex multi-tiered networks. The topology affects the efficiency, robustness, and resilience of the supply chain. Network Theory measures centrality and connectivity to understand the importance and influence of nodes within a network. In supply chains, nodes with high centrality, such as major suppliers or distribution centers, play critical roles in the flow of goods and information. Connectivity measures, such as the average path length or the clustering coefficient, provide insights into the efficiency and resilience of the network.

The small world phenomenon suggests that networks tend to have short average path lengths, allowing for efficient communication and information diffusion. In supply chains, this means that well-connected networks enable faster response times, better coordination, and improved supply chain resilience in the face of disruptions.Theory considers the resilience of networks, which refers to their ability to withstand disruptions, adapt, and recover. Resilient supply chain networks have redundant connections, alternative routes, and backup nodes to mitigate the impact of disruptions. Network Theory helps identify critical nodes, vulnerable edges, and

potential single points of failure within the supply chain network, facilitating the development of robustness and resilience strategies.

By applying Network Theory to supply chains, companies can gain insights into the structure, behavior, and vulnerabilities of their supply chain networks. This understanding can inform decision-making processes, such as supplier selection, network design, risk management, and resilience planning. It enables companies to optimize the configuration and connectivity of their supply chains, enhancing their ability to adapt, respond, and recover from disruptions while maintaining efficient operations.

2.1.4 Resource-Based View (RBV): The RBV theory

This suggests that a firm's unique resources and capabilities can influence its performance and competitive advantage. In the context of supply chain risks, SMEs with effective risk management strategies and resilient supply chain networks may be better equipped to mitigate disruptions and maintain performance. The Resource-Based View (RBV) is a theoretical framework that focuses on the internal resources and capabilities of a firm as the primary drivers of its competitive advantage and performance. It suggests that a firm's unique resources, which are valuable, rare, difficult to imitate, and non-substitutable (VRIN criteria), can lead to sustained competitive advantage and superior performance.

Resources refer to the tangible and intangible assets owned, controlled, or accessible to a firm. Tangible resources include physical assets like machinery, technology, and financial capital, while intangible resources encompass intellectual property, brand reputation, knowledge, and organizational culture.

Capabilities are the firm's ability to utilize its resources effectively to perform specific activities and tasks. They represent the firm's capacity to integrate, coordinate, and deploy resources to achieve strategic objectives. Capabilities can be in the form of technological expertise, managerial skills, innovation processes, supply chain management, and marketing capabilities.

Competitive advantage is the superior performance and market position achieved by a firm compared to its competitors. It stems from the firm's ability to leverage its unique resources and capabilities, creating value for customers and outperforming rivals. Competitive advantage can manifest in various forms, such as cost leadership, product differentiation, or a combination of both.

The VRIN criteria are used to evaluate the strategic value of resources. According to RBV, resources that meet all four criteria (valuable, rare, difficult to imitate, and non-substitutable) have the potential to generate sustained competitive advantage. Valuable resources contribute to customer value creation, rare resources are not easily available to competitors, resources that are difficult to imitate prevent replication, and non-substitutable resources have no close alternatives.

RBV recognizes the importance of dynamic capabilities, which refer to a firm's ability to adapt, innovate, and reconfigure its resources and capabilities to respond to changing market conditions and seize new opportunities. Dynamic capabilities enable firms to sustain competitive advantage over time by continuously adjusting their resource base to match evolving competitive landscapes.

RBV has several implications for strategic management and organizational practices:

Resource Identification and Development (RBV) encourages firms to identify and develop unique resources and capabilities that can provide a competitive advantage. Firms must assess their resource portfolio, identify gaps, and invest in acquiring or developing resources that align with their strategic objectives.

Resource Heterogeneity and Imitation Barriers: RBV suggests that firms can gain a competitive advantage by possessing resources that are difficult to imitate or replicate by competitors. This emphasizes the need for firms to build capabilities and resources that are rare, valuable, and not easily duplicated, creating barriers to imitation.

Resource Allocation and Strategy Formulation: RBV emphasizes the importance of aligning resources and capabilities with the firm's strategic goals. It guides firms in making decisions regarding resource allocation, investment priorities, and strategic choices to leverage their distinctive competencies and gain a sustainable competitive advantage.

Long-term Perspective: RBV takes a long-term perspective by focusing on the development of unique resources and capabilities. It recognizes that competitive advantage is not easily achieved or sustained in the short term, requiring continuous investment, innovation, and adaptation to changing market conditions.

RBV has been influential in shaping strategic management thinking, particularly in understanding the sources of competitive advantage and the role of firm-specific resources and capabilities.

2.1.5 Resilience Theory

Resilience theory focuses on an organization's ability to adapt and recover from disruptions. SMEs that exhibit resilience in their supply chain management practices, such as flexibility, redundancy, and agility, are better positioned to withstand supply chain risks and maintain performance levels. Resilience Theory is a multidisciplinary theoretical framework that focuses on understanding how individuals, communities, and systems can effectively adapt, recover, and thrive in the face of adversity, shocks, and disturbances. It seeks to explain why some individuals or systems are better able to bounce back and maintain functionality in the face of challenges, while others struggle or experience long-lasting negative effects.

Resilience refers to the capacity of individuals, communities, or systems to withstand, adapt to, and recover from adversity. It encompasses the ability to bounce back, maintain functionality, and even grow stronger in the face of challenges. Resilience is not a fixed trait but rather a dynamic process influenced by multiple factors.

Adaptive Capacity: Adaptive capacity is a central concept in Resilience Theory. It represents the ability of individuals, communities, or systems to adjust, learn, and respond effectively to changing circumstances and stressors. Adaptive capacity involves factors such as flexibility, learning, social capital, diversity, and the availability of resources and options for adaptation.

Complex Systems Perspective: Resilience Theory takes a complex systems perspective, recognizing that individuals, communities, and ecosystems are interconnected and influenced by multiple interacting factors. It considers the interactions and feedback loops between different components of a system and examines how changes in one part of the system can have ripple effects throughout the system.

Multiple Pathways and Trajectories: Resilience Theory acknowledges that there are multiple pathways and trajectories of resilience. Different individuals, communities, or systems may employ diverse strategies, resources, and adaptive responses depending on their unique circumstances, characteristics, and context.

Panarchy: Resilience Theory incorporates the concept of panarchy, which refers to the nested, hierarchical relationships between different scales and levels of organization. It recognizes that resilience operates at multiple scales, from individuals to communities, organizations, and larger socio-ecological systems. Changes and disruptions at one level can affect the resilience and dynamics of other levels.

Resilience Theory identifies various factors that influence resilience across different levels of analysis:

Individual Factors: Individual factors include personal characteristics, coping strategies, self-efficacy, optimism, problem-solving skills, and emotional intelligence. Personal resilience can be influenced by factors such as genetic predispositions, early life experiences, social support networks, and access to resources and opportunities.

Community Factors: Community factors encompass social networks, social capital, trust, collaboration, community cohesion, and collective action. Communities with strong social ties, supportive institutions, and effective governance structures are often more resilient in the face of challenges.

Organizational Factors: Organizational factors include leadership, organizational culture, communication, adaptability, learning capacity, and resource availability. Resilient organizations are characterized by flexible structures, diverse skill sets, effective crisis management strategies, and the ability to learn from past experiences.

Socio-Ecological Factors: Socio-ecological factors recognize the interdependence between human systems and the natural environment. Resilience is influenced by factors such as ecosystem health, resource availability, climate change, land use practices, and the capacity to manage environmental risks and vulnerabilities.

Resilience Theory has been applied in various fields, including psychology, sociology, disaster management, community development, and environmental sustainability. Some practical applications include: Resilience Theory provides insights for designing disaster management systems that focus on building preparedness, response capabilities, and recovery strategies that enhance resilience at individual, community, and organizational levels. Resilience Theory guides community development approaches that foster community empowerment, social capital, and the creation of supportive environments that enable communities to better withstand and recover from adversity. Resilience Theory informs strategies for building organizational resilience, including crisis management plans, flexible structures, diversification of resources, and the development of adaptive capacities to respond to disruptions. Resilience Theory contributes to understanding the resilience of socio-ecological systems and guides efforts to promote sustainable development, manage natural resources, and address the impacts of climate change.

Resilience Theory offers a valuable perspective for understanding how individuals, communities, and systems can effectively navigate challenges and adapt to changing circumstances. By identifying the factors that enhance resilience, researchers and practitioners can develop strategies and interventions to promote resilience and well-being in various contexts.

2.2 Empirical Literature Review

This section presents the empirical literature by basically analysing some researches which were done and are related to the topic under discussion.

Raj (2023) looked at how supply chain management in the Delhi National Capital Region (NCR) was affected by Industry 4.0. The incorporation of digital technologies into supply chain and production procedures is what defines Industry 4.0. The study looked at how companies in Delhi NCR are implementing technology like blockchain, artificial intelligence, and the Internet of Things in their supply chains. The study also looked into the possibilities and difficulties that Industry 4.0 brings to supply chain management in the area. The study's conclusions gave Delhi NCR businesses advice on how to use Industry 4.0 technologies in their supply chain management plans.

The focus of Adnan et al. (2022) was supply chain resilience and I4. Due to the extraordinary problems facing today's global supply chain (SC), traditional SC resilience (SCR) is insufficient. Following the advent of Industry 4.0 (I4.0), investing in digital SCR (DSCR) based on I4.0 technologies may improve an organization's capacity to identify, prevent, respond to, and recover quickly and effectively from disruptions. In order to pinpoint possible research gaps and directions, their work does an extensive literature assessment on the interactions between SCR, I4.0, and investment (INV). It is revealed the integration of SCR-I4.0-INV as a complex and multifaceted process that requires holistic approaches. Some research gaps include the need for empirical studies on DSCR impacts, the role of organizational culture in supporting digital transformation, and investment and resilience trade-offs. This research provides insights for decision-makers and policymakers seeking to develop strategies for promoting resilient SCs in the digital transformation era.

Koskin Vladimir & Nguyen Thi Thuy Van (2021)’s main purpose of study was to identify and analyse the impact of Industry 4.0 and the related technologies on the supply chain management

as well as to provide recommendations for the Small and Medium sized enterprises. Their research primarily relied on the quantitative research data for the analysis. The secondary data was used in the research has been gathered from internet articles and books. Their results showed that the industry 4.0 has a significant impact on the supply chains and that the technologies of the fourth industrial revolution allow for the supply chains to operate in real time with as little as possible human disruption, however, at the current moment Industry 4.0 was found that at its infancy and the level of implementation is still small. The SMEs and large enterprises have different methods of implementing f technologies and the number of resources available thus the methods for implementation are different.

Sinha et al (2022) focused on Industry 4.0 tools by industrialists to improve the overall performance of their industry is a clear indication that supply chain performances can also be improved by adopting these tools. The breakout of pandemic COVID-19 necessitated researchers to ponder over the avenues of this adoption on a priority basis. This chapter aims to highlight the potential ways of integrating Industry 4.0 tools in supply chain activities to resolve the issues and challenges stimulated by the pandemic. The relevant tools of Industry 4.0, such as cloud computing, Internet of Things, augmented/virtual reality, big data analytics, artificial intelligence, and blockchain architecture, have been examined for comprehending their potential application in supply chain management. It also analyzes the role of these technologies in improving flexibility, supported by agility, transparency, and autonomous decision-making capabilities (smartness) in a supply chain, which helps in facing the challenges that arose in demand, supply, logistics, and production due to COVID-19.

Moreover, the ever-changing customer preferences and volatile demand have made the industrialists focus on the flexibility of the supply chain to adjust under such scenarios. In response to the need for flexibility and especially in times of disruptions, such as the current one caused by the COVID-19 pandemic, the supply chain needs to be empowered by new technologies capable of mitigating risk in real-time scenarios. Therefore, this chapter elaborates on the importance of flexibility in supply chain management and gives insight into the challenges produced in the supply chain by COVID-19 and the solutions that Industry 4.0 can provide. Furthermore, some technological limitations have also been discussed. The present study concludes that the new technologies may contribute to developing an efficient and more flexible supply chain, to face any disruptive challenges, resulting in increased global competitiveness.

Barata (2021)'s paper unfolds the ongoing fourth revolution of supply chains (4SC) and proposes guidelines for future research. The review of sixty-five literature reviews follows three stages: bibliometric analysis of Industry 4.0, its synergies with supply chain transformation, and state-of-the-art assessment. 4SC is a context-bound technological change driven by organizational and cultural priorities, aiming to create more sustainable networks to serve the customers and support responsible decisions in the supply lifecycle. The proposed framework can assist future literature reviews and digital transformation proposals for 4SC that need to frame their context and incorporate functions to endure change.

Tortorella (2021)'s study aimed at identifying the contribution of Industry 4.0 (I4.0) integration into supply chains (SCs) to the enhancement of SC resilience. Their methodology involved scoping review which was conducted so that the relevant literature on SC resilience, and I4.0 integrated into SC management was examined. Third findings were: (1) empirical validation of the contribution of I4.0 ICTs to SC resilience; (2) explore the role of processing-actuation technologies in enhancing restorative capacity; and (3) integration between I4.0 ICTs and omni-channel strategy as a means to resilience development at consumer and retail levels. The literature on the design of resilient smart SCs is far outnumbered by works reporting applications of I4.0 ICTs at different SC tier levels. However, the authors' scoping review organizes the information available on these themes, setting the ground for the development of new theoretical propositions.

Frederico et al (2021) study aimed at investigating the impact of I4.0 technologies and their interoperability on supply chains (SCs) performance and how the integration of such technologies and their interoperability can create pathways for SCs resilience post-COVID-19. This was of paramount importance in the context of COVID-19 as the investigation around I4.0 technologies provided relevant insights on how SCs may better respond to unexpected situations like the current pandemic with the use of digital technologies. A survey research method was designed based on some constructs extracted from the literature regarding the main disruptive technologies, interoperability, elements of supply chains processes (SCPs) performance such as integration, collaboration, transparency, efficiency, responsiveness and profitability. The data were collected from March to July 2020 from different regions of the world when the peak of the first wave of the pandemic had occurred. The survey resulted in 115 valid responses. The study used a combination of descriptive, correlation and multiple regression methods to analyse the data. The study indicated that disruptive technologies

significantly impact SCPs performance (integration, collaboration, responsiveness and transparency) and their resilience. The findings did not support the notion that these technologies improve the efficiency of SCs, a significant contrast to the existing literature. Our findings also refute the existing understanding that interoperability moderates the impact of disruptive technologies on SCPs performance and enhancing the resilience of SCs. However, the findings show that the integration of I4.0 technologies and their interoperability has a positive impact on SCPs profitability.

Caroline Wanjiru Munyuko (2015) researched about the effects of supply chain risk management on organization performance for Andy Forwarders Company. The population for the research included staff at Andy forwarders and logistics services. The research methodology included both primary and secondary data, both interviews and questionnaires were used, questionnaires being the main instrument of data collection. The researcher used questionnaire Tables, bar graphs and pie charts were used during the analysis using the statistical of science package software in order to come up with accurate analysis and presented in tabular and graphical methods. The results obtained showed that there was a direct link between supply chain risk management and organization performance.

2.3 Research Gap

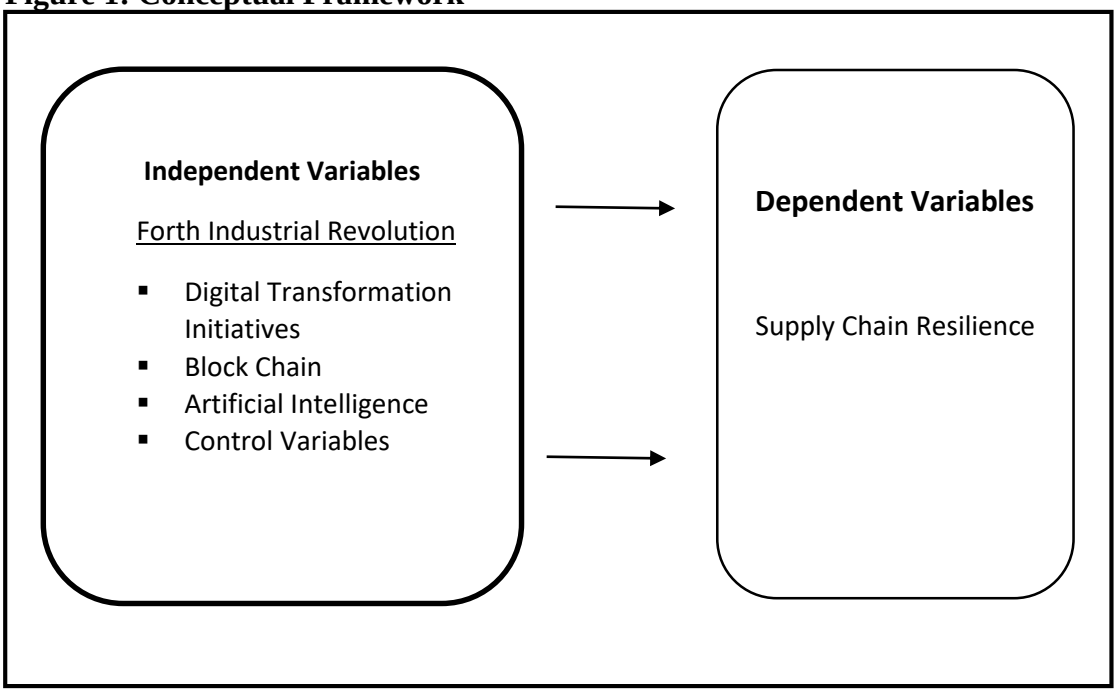
There is lack of understanding regarding the role of the Fourth Industrial Revolution in achieving supply chain resilience in Zimbabwe's pharmaceutical industry. There is a need to investigate and analyze how the adoption and integration of 4IR technologies, such as AI, IoT, big data analytics, robotics, and block chain, can address the challenges faced by Zimbabwean supply chains and enhance their resilience in the same industry. By addressing this problem statement, the research aims to provide valuable insights and recommendations to policymakers, industry practitioners, and supply chain managers in Zimbabwe. The findings will help inform decision-making processes, facilitate the adoption of appropriate 4IR technologies, and enable the development of robust and resilient supply chains that can effectively navigate disruptions, improve operational efficiency, and support the economic growth and sustainability of Zimbabwe.

2.4 Conceptual Framework

The conceptual framework presented in Figure 1 predicts that the forth industrial revolution will either positively or negatively supply chain resilience in the pharmaceutical industry in

Zimbabwe. The dependent variable is the supply chain resilience and the forth industrial revolution elements as indicated in figure 1 are the independent variables.

Figure 1: Conceptual Framework



2.5 Chapter Summary

This chapter presented five sections: a theoretical review, empirical studies, conceptual framework and hypothesis development, gap analysis, and a chapter summary. Additionally, the chapter delved into the theoretical review, which encompasses an explanation of reverse logistics on profitability theories and corporate image within the manufacturing sector. Moreover, the chapter proceeded to examine the empirical evidence, consisting of studies conducted by other researchers on the topic. It also presents a detailed conceptual framework and hypothesis development. Finally, the chapter concludes with a gap analysis and a summary of its contents. The next chapter is the methodology section.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter provides a detailed explanation of the methodology employed to investigate the role of the Fourth Industrial Revolution (4IR) in achieving supply chain resilience in the pharmaceutical industry during the COVID-19 pandemic. The research aims to explore how the adoption of 4IR technologies and strategies has influenced the resilience of pharmaceutical supply chains in the face of unprecedented challenges posed by the pandemic

3.1 Research design

A comprehensive approach to gathering information for an evidence-based research effort is called research design (Neuman, 2018). According to Azevedo et al., it serves as a guide for empirical research that focuses on certain issues and objectives (2011). The research methodology utilized in this study was a case study. The researcher was able to present a thorough analysis as a result. This is consistent with Rebolj's (2017) assertion that case studies enable researchers to gather comprehensive and pertinent data and analyze the operation of causal meanings.

3.2 Research Approach

In order to quantify and explain the impact effect of forth industrial revolution on supply chain reliance, the study used a mixed research technique. It was also helpful to establish a sample size using both quantitative and qualitative survey methods in order to do statistical analysis.

3.2.1 Deductive approach

Using an existing theory as a foundation, a deductive approach entails formulating a hypothesis and then creating a research plan to test it (Wilson, 2010). Deductive reasoning, then, is the process of reasoning from the specific to the general. To find out if this relationship or link does exist under more general conditions, a deductive design may be used. The theory's propositions can be used to generate hypotheses, which are used to explain the deductive process. Stated differently, the deductive technique involves drawing conclusions based on premises or assertions. Gulati (2009) argues that induction starts with observations and looks

for a pattern within them, whereas deduction starts with a predicted pattern that is checked against data. The following benefits of the deductive technique are: it may be used to quantify concepts, explain causal relationships between concepts and variables, and, to some extent, generalize research findings. The inductive approach is a substitute for the deductive technique.

A deductive research approach investigates an established theory or phenomenon and determines whether it makes sense in the conditions at hand. It has been observed that the deductive method most closely adheres to the logic path (Babbie, 2010). A new hypothesis follows from the reasoning that begins with a theory. Through the presentation of observations that either support or refute the hypothesis, this one is put to the test. Moreover, deductive reasoning differs from inductive reasoning in that it proceeds from the general to the specific. Stated differently, inductive investigations do not address hypotheses in any way, but the deductive approach entails formulating hypotheses and testing them throughout the study process. According to Wilson (2010), the researcher develops a set of hypotheses at the outset of a study using a logical technique. Subsequently, pertinent research techniques are selected and used to evaluate the hypotheses and determine their veracity.

The following steps of the deductive methodology were used in the study: drawing conclusions from theory, putting the hypothesis into practical words and suggesting connections between two particular variables, and verifying the hypothesis by using an appropriate technique. These are quantitative techniques, such regression and correlation analysis, mean, mode, and median, among others, that are used to examine test results and determine if the theory is supported or refuted. It is crucial to compare study findings with those from the literature review while analyzing test results.

3.2.2 Inductive approach

As a result of observations, ideas are put forth at the conclusion of the research process using the inductive approach, also known as inductive reasoning (Pelissier, 2008). Inductive research entails looking for patterns in observations and using a set of hypotheses to generate theories and explanations for those patterns. It is crucial to emphasize that using an inductive approach to formulate research questions and objectives does not imply ignoring theories. The inductive approach does not preclude the researcher from using pre-existing theory to construct the research topic to be addressed; rather, its goal is to develop meanings from the data set obtained

in order to uncover patterns and links to build a theory. The foundation of inductive reasoning is experience-based learning. To draw inferences (or develop theories), patterns, similarities, and regularities in experience (premises) are noted.

Inductive reasoning starts with in-depth observations of the outside world and progresses to more abstract concepts and generalizations. According to Snieder and Larner's (2009) argument, an inductive technique involves starting with a topic and working your way through the research process to find preliminary links and create empirical generalisations. Since there are no hypotheses to be developed in the early phases of the research and the researcher cannot be certain of the kind and extent of the research findings until the study is finished, this strategy was not taken into consideration because it did not match the study well.

3.3 Research paradigm

A model, approach, or procedure for conducting research is referred to as a research paradigm (Bird, 2010). Stated differently, a research paradigm is a collection of presumptions, attitudes, and guidelines that direct the course of research in a given topic or field. It offers a structure for comprehending and addressing research issues as well as for gathering, analyzing, and interpreting data. Various research paradigms provide unique viewpoints and methods, influencing the way knowledge is created overall. The three widely accepted research paradigms are as follows:

Positivist Paradigm: The positivist paradigm is based on the idea that measurement, experimentation, and objective observation are the best ways to acquire knowledge. It tries to demonstrate causal links between variables and places a strong emphasis on the application of quantitative methodologies. In their pursuit of genuine and dependable knowledge, positivist researchers often uphold the values of objectivity, reproducibility, and generalizability. The interpretivist paradigm, which is often referred to as the constructivist or qualitative paradigm, is centered on comprehending the personal interpretations and meanings that people ascribe to their experiences. It places a strong emphasis on social interactions, context, and the subjectivity of reality. In order to investigate the complexity of human experiences and occurrences, interpretivist researchers use qualitative techniques like observations, interviews, and textual analysis.

The pragmatic paradigm aims to integrate positivist and interpretivist methods, depending on

the environment and research subject. It acknowledges their respective merits. Researchers that follow the pragmatic paradigm are interested in doing useful research to address real-world issues. The study has a set of values, beliefs, and concepts which theories and practices can operate. To obtain a thorough grasp of the research issue, they may employ a mixed methods approach, mixing quantitative and qualitative approaches. As a result, pragmatism is the paradigm that was derived. This is because, rather than relying on presumptions about the nature of knowledge, it is focused on finding practical solutions to real-world problems.

3.4 Population

Nueman (2011) states that the population is the total number of suitable elements. The population is the researcher's group of interest, and it is from this group that the study's findings were extrapolated (Parker 2012). The study population is drawn from the pharmaceutical companies in Zimbabwe.

3.4.1 Target population of the Study

Interviews and questionnaires were used by the researcher in collecting qualitative data. Focus Group Discussions and Key Informant Interviews were used to collect qualitative data.

3.5 Sample size Determination

The sample size was determined using Krejcie and Morgan (1970) model. This means the minimum sample required to a true representation of the population is 269 respondents for the quantitative data from a population of around 933.

3.6 Sampling Method

A sample encompasses elements of the population considered for the definite inclusion in the research (Creswell, 2012). Sampling benefited this study as it enabled feasibility. The process of sampling convoluted non-probability together with the probability sampling methods, this allowed the researcher to use both own personal judgment and statistics of who to take in the sample.

3.6.1 Sampling Techniques

Probability sampling methods were used for quantitative data collection whilst non-probability sampling was used for qualitative data collection.

3.7 Data Collection Sources, Instruments and Methods

3.7.1 Data Collection Source

Primary data was collected using semi-structured questionnaires. Primary data was collected to allow the researcher to control the amount of error for accuracy to be made (Kumar, 2005).

3.7.2 Data Collection Instruments and Methods

3.7.2.1 Questionnaires

A questionnaire is tool of data gathering containing a series of standardised questions in line to the study subject be completed in writing by the participants as a systematic compilation of questions that are aimed at a sample of population from which relevant and reliable information is desired Bloomberg (2011) weighs in and describe a questionnaire as a framework which encompasses a set of questions as well as gauges architecture to generate primary data. In this regard the respondents read and interpret the questions and write down answers for themselves, with some help if need be. The researcher used both open-ended and closed questions. These were engaged as they are ideal in administering them in limited time. The respondents were made to fill in the details and this type of a tool was directed at the general public. A Likert type scale was used in scoring responses in the questionnaire, as these ranged from either yes and no or One (1) up to Five (5) with the respondents ticking on appropriate response. These technique was advantageous as it enabled the researcher to explore and expose data which is found within the mind, heart and feelings by the people. The open and closed ended questions helped in enabling the study participants to fully express oneself, these also were answered in the same framework so that they could be comparable with one another. Correspondingly, Parker (2016) describes the Likert scale as measure of the responses used in questionnaires to retrieve the gravity of agreement by participants to a given subject matter.

3.7.2.2 In-depth Interviews

An interview is a face-to-face interaction between two or more individuals with a specific goal in mind (Myers and DeWall, 2015). Through one-on-one interviews, this data collection strategy allows the researcher to gain valuable insights as people are more willing to share their thoughts and throw light on certain issues. The researcher avoided distortions such asking leading questions in an attempt to get rich data which boosts validity and reliability from the participants. An interviewer should be properly trained to get information from respondents (Singleton and Straits, 2010).

3.8 Data Analysis

Data is presented in three forms namely descriptive, diagrammatic and tabular. A simple linear regression is also used for quantitative data analysis. These presentation approaches are helpful and effective as they help the study to communicate important takeaways, gives valuable information and guide important business decisions (Yin, 2019). Over and above these data presentation procedures are relevant to the study as they are useful for translating facts and statistics into actionable knowledge.

3.9 Model

3.9.1 Multiple Regression Model

A simple linear regression model was used to analyze the relationship between supply chain resilience (dependent variable) and the fourth industrial revolution variables. The model specification is presented below:

$$ScmResil = \boldsymbol{a} + \boldsymbol{b1}\ TechAdop + \boldsymbol{b2}\ DigTransIn + \boldsymbol{b3}\ BlockCh + \boldsymbol{b4}\ ArtInt + \boldsymbol{b5}\ YrsOper + error\ term$$

Where:

ScmResil= supply chain resilience and the variable is the dependent variable

TechAdop= Technological Adoption

DigTransIn= Digital Transformation Initiative

BlockCh= Block Chain

ArtInt= Artificial intelligence

YrsOper= years of operation of the organisation

The dependent variable is resilience. The dependent variables are Technological Adoption, Digital Transformation Initiative, Block Chain, Artificial intelligence and years of operation of the organisatio. **a , b1, b2, b3, b4,** and **b5** are parameters. The error term is also included in the equation.

3.10 Validity and Reliability of Results

Reliability, according to Joppe, is the degree of consistency of results throughout time (Golafshani, 2003). Using Cronbach's Alpha, the researcher assessed the results' dependability (Sekaran and Bougie 2019). In order to make sure that the questionnaire's questions matched the study's goals, the researcher conducted content validity. Additionally, a pilot study was carried out to evaluate the study's face validity. The purpose of the pilot study was to examine the perceived validity and reliability of the questionnaire and ensure that it is modified in the event that respondents voice any concerns.

3.11 Ethical and Legal Considerations

The researcher complied with all legal and ethical requirements. It was crucial to get informed consent before gathering information or interviewing people participating in disaster relief efforts. The aim of the study, possible risks and benefits, and the freedom to discontinue participation at any moment without repercussions were all clearly communicated to the participants. Ensuring the confidentiality and privacy of participants is crucial. The investigator made certain that all personally identifiable data was anonymised and securely stored. Individuals were under no pressure or coercion to engage in the research; participation was entirely voluntary. It was made very clear that participation is completely voluntary and that declining to take part will not have any unfavorable effects.

Furthermore, no one else's study was copied or plagiarized. Taking someone else's words or ideas and passing them off as your own is plagiarism (Ezikiel, 2008). The section of references included a list of all the references for the literature and structure used in this investigation. Thus, the researcher conducted the study in its entirety.

3.12 Chapter Summary

The study's approach for conducting data collection procedures was examined in this chapter. This section also establishes the study's target population and sample strategies. The procedures for gathering and analyzing data were covered in detail in this chapter, along with the ethical guidelines that were followed. Results are presented in the next chapter.

CHAPTER IV

DATA ANALYSIS AND RESULTS PRESENTATION

4.0 Introduction

This chapter presents a thorough summary of the findings, conclusions, and contributions that have been made, responding to the main aim of the research, which is the role of the fourth industrial revolution in achieving supply chain resilience: a case of the pharmaceutical industry during covid-19. This chapter not only summarizes the findings, but also offers an analysis of the data and their correlation with prior researches conducted on the same subject.

4.1 Descriptive data analysis

Table 1 presents the descriptive statistics of the main variables examined in this study. The dependent variable supply chain resilience and was measured using a Likert scale ranging from 1 to 5, with 1 being the minimum value and 5 being the maximum value. The mean value for the variable supply chain resilience is 4.01, whereas the mean value for the variable Technologies Adoption is 3.73. The independent variables are Technologies Adoption, Digital Transformation Initiatives, Block Chain, Artificial Intelligence with values ranging from a minimum of 1 to a maximum of 5, with mean values of 3.73, 4.03, 3.75, 4.26, respectively. Year of Operation has a minimum of 1 and a maximum of 33 years and a mean of 8.08. The study utilized a total of 269 observations, as shown in table 1. The next section presents the correlations results.

Table 1: Descriptive Statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
supply chain resilience	269	1	5	4.01	1.363
Technologies Adoption	269	1	5	3.73	1.343
Digital Transformation Initiatives	269	1	5	4.03	1.226
Block Chain	269	2	5	3.75	.738
Artificial Intelligence	269	1	5	4.26	1.119
Year of Operation	271	1	33	8.08	5.470

4.2 Correlation Matrix

Table 2 displays the relationships among several pairs of variables utilized in this study using the correlation matrix. The table shows the absence of multicollinearity across all explanatory factors. However, the dependent variable, Supply Chain Resilience exhibits strong correlations with all independent variables, indicating the existence of a causal relationship between Supply Chain Resilience and Technologies Adoption, Digital Transformation Initiatives, Block Chain, Artificial Intelligence are 90%, 67%, 84%, 70%, 84%, 70% respectively.

Table 2: Correlation matrix with flexibility performance as the dependent variable

		1	2	3	4	5	6
1	Supply Chain Resilience	1.000					
2	Technologies Adoption	0.897	1.000				
3	Digital Transformation Initiatives	0.672	0.025	1.000			
4	Block Chain	0.835	0.081	0.033	1.000		
5	Artificial Intelligence	0.703	0.056	0.087	0.056	1.000	
6	Year of Operation	0.850	0.046	-0.342	0.021	0.046	1.000

4.3: Linear regression model results

The main simple linear regression results are presented in table 4.10 with the dependent variable as Supply Chain Resilience.

4.5.1 Linear Regression Model

In statistics, linear regression model is a linear approach which is modelling the relationship between a dependent variable and one or more independent relationship. The equation of a linear regression is Y=a+bX. Here X represent independent variable and Y represent dependent variable. At 5% level of significance the linear regression estimates the statistical relationship. The hugeness of relationship between dependent and independent variable is determined by correlation coefficient (R). Coefficient of ascertainment R-square the Percentage changes in dependent variable being narrated by the changes in independent variables take measure information about levels of mutability within a regression model.

The fit of a model and overall significance of the relationship between variables is determined by P-value. To analyze the collected data, SPSS software was used.

4.10: Linear regression model results

Table 3.10: Linear regression model results with response time as the dependent variable

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Supply Chain Resilience	Supply Chain Resilience	Supply Chain Resilience	Supply Chain Resilience	Supply Chain Resilience	Supply Chain Resilience
Technologies Adoption	0.163**	0.134*				
	(0.0564)	(0.0342)				
Digital Transformation Initiatives	0.317**		0.267***			
	(0.0456)		(0.053)			
Block Chain	0.091*			0.089***		
	(0.0344)			(0.053)		
Artificial Intelligence	0.092**				0.084***	
	(0.0456)				(0.053)	
Year of Operation	0.134*					0.102***
	(0.0344)					(0.053)
Constant	9.465***	9.464***	8.453***	9.465***	8.166***	9.464***
	(0.534)	(0.242)	(0.242)	(0.534)	(0.343)	(0.242)
Observations	271	271	271	271	271	271
R-squared	0.664	0.624	0.686	0.356	0.543	0.742

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Dependent variable is Supply Chain Resilience

The principal findings of the linear regression using supply chain resilience as the dependent variable are shown in Table 4.10. A regression analysis was used to establish the relationship between supply chain resilience and the independnent variables Technologies Adoption, Digital Transformation Initiatives, Block Chain, and Artificial Intelligence. As presented in table 4.10, the findings indicate a positive relationship between supply chain resilience and the dependent variables. At 5 percent level of significance, Technologies Adoption positively affect supply chain resilience by around 16%. This means a marginal change in Technologies Adoption will have a positive change in supply chain resilience by around 16%.

Same table shows that the relationship between supply chain resilience and Digital Transformation Initiatives. As presented in table 4.10, the findings indicate a positive

relationship between supply chain resilience and Digital Transformation Initiatives. At 5 percent level of significance, Digital Transformation Initiatives affect supply chain resilience by around 31%. This means a marginal change in the Digital Transformation Initiatives variable will have a positive change in supply chain resilience by around 31%. These results are consistent with previous writers, (Huang et al, 2023; Hsu et al 2022; Alvarenga et al, 2023; Barata et al 2021, and Frederico et al 2023).

Additionally, a regression analysis was also used to establish the relationship between supply chain resilience and Block Chain. As presented in table 4.10, the findings indicate a positive relationship between supply chain resilience and Block Chain. At 10 percent level of significance, Block Chain positively affect supply chain resilience by around 9%. This means a marginal change in the Block Chain variable will have a positive change in supply chain resilience by around 9%.

Table 4.10. A regression analysis was used to establish the relationship between supply chain Artificial Intelligence. As presented in table 4.10, the findings indicate a positive relationship between supply chain resilience and Artificial Intelligence. At 5 percent level of significance, Artificial Intelligence positively affect supply chain resilience by around 9%. This means a marginal change in Artificial Intelligence will have a positive change in supply chain resilience by around 9%.

Lastly, a regression analysis was used to establish the relationship between supply chain resilience and Year of Operation. As presented in table 4.10, the findings indicate a positive relationship between supply chain resilience and Years of Operation. At 10 percent level of significance, Year of Operation positively affect supply chain resilience by around 13%. This means a marginal change in Year of Operation variable will have a positive change in supply chain resilience by around 13%. These results are consistent with previous literature, (Huang et al, 2023; Hsu et al 2022; Alvarenga et al, 2023; Barata et al 2021, and Frederico et al 2023). The adoption of Industry 4.0 technologies, such as the Internet of Things (IoT), blockchain, and advanced analytics, has enhanced visibility and transparency across pharmaceutical supply chains.This improved visibility enabled better real-time monitoring of supply and demand, allowing companies to anticipate and respond to disruptions more effectively during the pandemic.

Automation, robotics, and additive manufacturing (3D printing) associated with Industry 4.0 have increased the flexibility and agility of pharmaceutical production and logistics.This

allowed companies to quickly adapt their operations to changing market demands and supply chain challenges during the COVID-19 crisis.

Improved Collaboration and Coordination:Advanced digital technologies, like cloud computing and collaboration platforms, facilitated seamless information sharing and coordination among supply chain partners in the pharmaceutical industry.This enhanced collaboration enabled more effective decision-making and joint problem-solving to mitigate the impact of the pandemic on the supply chain.

The implementation of Industry 4.0 technologies, such as predictive analytics and digital twinning, helped pharmaceutical companies build more resilient and diversified supply networks. This allowed them to quickly identify and address vulnerabilities, as well as rapidly source alternative suppliers and reroute shipments during the COVID-19 disruptions.

The integration of Industry 4.0 capabilities, like simulation and rapid prototyping, enabled pharmaceutical companies to accelerate the development and production of critical medical supplies and COVID-19 vaccines. This responsiveness and innovation played a crucial role in the industry's ability to address the urgent healthcare needs during the pandemic.

4.5 Chapter Summary

This chapter presented the findings from the research on the impact of supply chain visibility of flexibility performance. The results provided a comprehensive overview and analysis of the findings obtained from the research study. The main results indicates that supply chain visibility positively and significantly affect flexibility performance. The next chapter presents the summary, conclusion and policy recommendations related to the results obtained.

CHAPTER V

SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.0 Introduction

This chapter provides a concise overview of the main discoveries from the research on the role of the fourth industrial revolution in achieving supply chain resilience: a case of the pharmaceutical industry during covid-19.

5.1 Summary of the study

The chapter begun with an introduction to the topic of supply chain visibility and its importance on improving flexibility performance. It highlights the devastating impact of Cyclone Idai in Zimbabwe and the subsequent challenges faced by humanitarian organizations in providing relief efforts. The second chapter focused on the existing literature related to supply chain visibility and flexibility performance in the humanitarian context. It explored the theoretical and empirical literature review, and the conceptual framework guiding the study. The research gap was also presented in the same chapter.

The third chapter outlined the research methodology employed in the study. It describes the research design, data collection techniques, and the sample size and selection process. The chapter also explained the data analysis methods utilized, including statistical techniques and qualitative analysis, and in this case, the the linear regression method and the qualitative analayis. The fourth chapter presented the results and shows that disaster preparedness, supply chain agility and cross sectorial collaboration all positively affect organisational performance of the humanitarian organisations. The performance was measured using the response rate and delivery flexibility.

5.2 Conclusion

The study aimed to find the on the role of the fourth industrial revolution in achieving supply chain resilience: a case of the pharmaceutical industry during covid-19. Using the linear regression model, the research concluded that the fourth industrial revolution positively affect supply chain resilience in the pharmaceutical industry.

5.3 Policy recommendations

The following policy measures are recommended:

Invest in Advanced Manufacturing Technologies

Encourage pharmaceutical companies to adopt emerging technologies like additive manufacturing, robotics, and artificial intelligence to increase production flexibility, enhance supply chain visibility, and automate processes. This can help mitigate disruptions and improve responsiveness.

Promote Digital Transformation

Incentivize the digitalization of pharmaceutical supply chains through policies that support the integration of technologies like blockchain, IoT, and predictive analytics. This can enhance end-to-end supply chain transparency, enable real-time data sharing, and improve demand forecasting.

Develop Agile and Modular Supply Chains

Implement policies that encourage pharmaceutical companies to design their supply chains to be more agile and modular. This can involve strategies like dual-sourcing, nearshoring, and building redundancy into the system to increase flexibility and resilience.

Strengthen Public-Private Partnerships

Foster closer collaboration between the government and the pharmaceutical industry to facilitate information sharing, coordinate emergency response, and jointly develop strategies to enhance supply chain resilience during crises.

Improve Supply Chain Risk Management

Require pharmaceutical companies to conduct comprehensive risk assessments and develop robust contingency plans to mitigate the impact of disruptions. This can include policies that mandate the stockpiling of critical materials and the diversification of supplier networks.

Invest in Workforce Upskilling

Develop policies that support the reskilling and upskilling of the pharmaceutical workforce to ensure they have the necessary skills to leverage emerging technologies and adapt to the changing industry landscape.

Enhance Supply Chain Transparency

Implement regulations that mandate increased supply chain transparency and traceability, enabling better visibility and improved decision-making during crises.

Promote International Collaboration

Encourage global cooperation and harmonization of regulatory frameworks to facilitate the cross-border movement of pharmaceutical products and raw materials during emergencies.

Provide Financial Incentives

Consider offering tax credits, subsidies, or other financial incentives to pharmaceutical companies that invest in supply chain resilience-building initiatives, such as the adoption of Industry 4.0 technologies.

Strengthen Domestic Manufacturing Capabilities

Develop policies that support the development of domestic pharmaceutical manufacturing capabilities, reducing reliance on global supply chains and enhancing self-sufficiency during crises.

5.4 Suggestion for further study

As area for further study, the extension of this research could increase the sample size and include other regions and sectors.

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Appendices

Research Questionnaire

ROLE OF THE FOURTH INDUSTRIAL REVOLUTION IN ACHIEVING SUPPLY CHAIN RESILIENCE: A CASE OF THE PHAMACEUTICAL INDUSTRY DURING COVID-19

Operations

Thank you for taking the time to participate in this research study investigating the impact of supply chain visibility on flexibility performance in disaster relief operations. Your valuable insights and experiences will contribute to a deeper understanding of the dynamics of supply chain management during critical humanitarian efforts, such as those undertaken in response to Cyclone Idai in Zimbabwe. Your responses will help identify critical success factors,

challenges, and recommendations for improving supply chain resilience and responsiveness in future disaster scenarios.

Please tick the appropriate boxes and provide any additional comments or insights where applicable. Your participation is voluntary, and all responses will remain confidential. Your input is highly appreciated and will be instrumental in advancing knowledge in the fields of disaster management and supply chain resilience.

Thank you for your valuable contribution to this research endeavor.

Warm regards

KIRSTY MUTUVA

Section A

1.1 Nature of Organisation

Local	
National	
International or global	

1.2 Length of operation of the firm in years

Less than 10 years	
10-20 Years	
21-30 Years	
31-40 Years	
More than 40 Years	

1.3 Experince in Years …….

Part A: Supply Chain Resilience

Indicate the extent to which you agree or disagree.

Use a scale of 1. Strongly agree 2. Agree 3. Not sure 4. Disagree 5. Strongly disagree

	ICT Adoption items	**1**	**2**	**3**	**4**	**5**

	Digital Transformation Initiatives positively affect supply chain resilience					
	Block Chain positively affect supply chain resilience					
	Artificial Intelligence positively affect supply chain resilience					
	Nature of Organization positively affect supply chain resilience					
	Organizational Experience positively affect supply chain resilience					

Part B

In your opinion rating from 0 to 100% , to what extent do you think forth industrial revolution affect supply chain resilience……%