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UNIVERSITY OF GHANA
COLLEGE OF HUMANITIES



**SUPPLY CHAIN RESILIENCE: STRATEGIES AND IMPACT ON SUSTAINABLE
OPERATIONS AMONG GHANAIAAN MANUFACTURERS**

BY

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**THIS THESIS IS SUBMITTED TO UNIVERSITY OF GHANA, LEGON IN PARTIAL
FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MPhil IN
OPERATIONS MANAGEMENT DEGREE.**

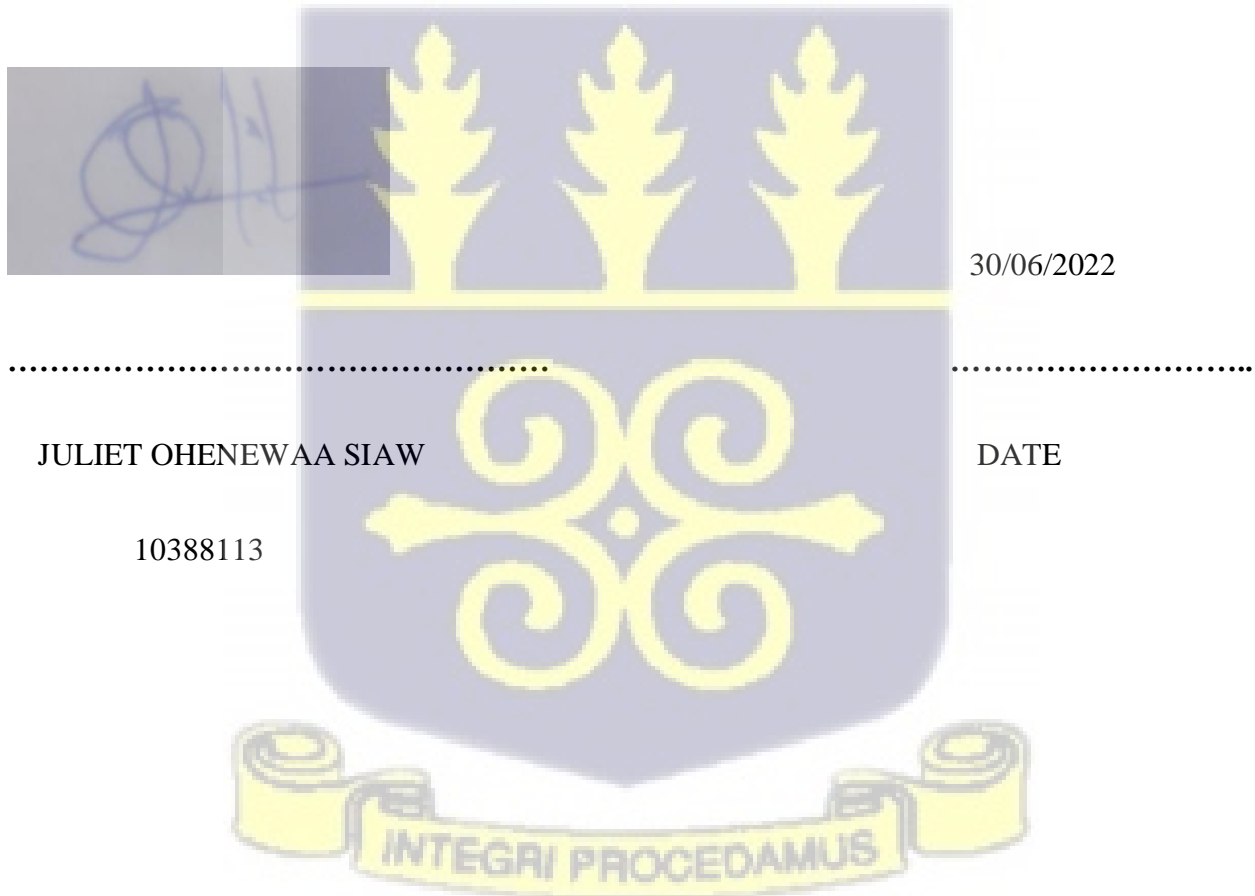
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JUNE, 2022

DECLARATION

I, Juliet Ohenewaa Siaw, do hereby declare that this thesis is the results of my own work produced under supervision and has not been presented by anyone for any academic award in this or any University. All references used in the work have been fully acknowledged.

I bear sole responsibility for any shortcomings.



CERTIFICATION

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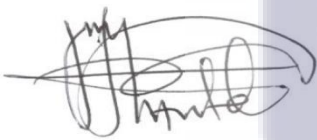


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DEDICATION

This work is dedicated to God Almighty and my family for their support and encouragement throughout my education.



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I thank the Almighty God for the gift of life, good health, strength and for seeing me through the programme successfully. My profound gratitude goes to my supervisor, Dr. Joshua Ofori-Amanfo, for his guidance and expert advice throughout the research process. Indeed, you are a teacher and a mentor. Your patience, constructive comments and reviews are greatly appreciated. Also, I thank Dr Anthony Afful-Dadzie, my co-supervisor for his insightful suggestions. Their support and contribution have really shaped the work. I am grateful to the entire faculty members of the OMIS department.

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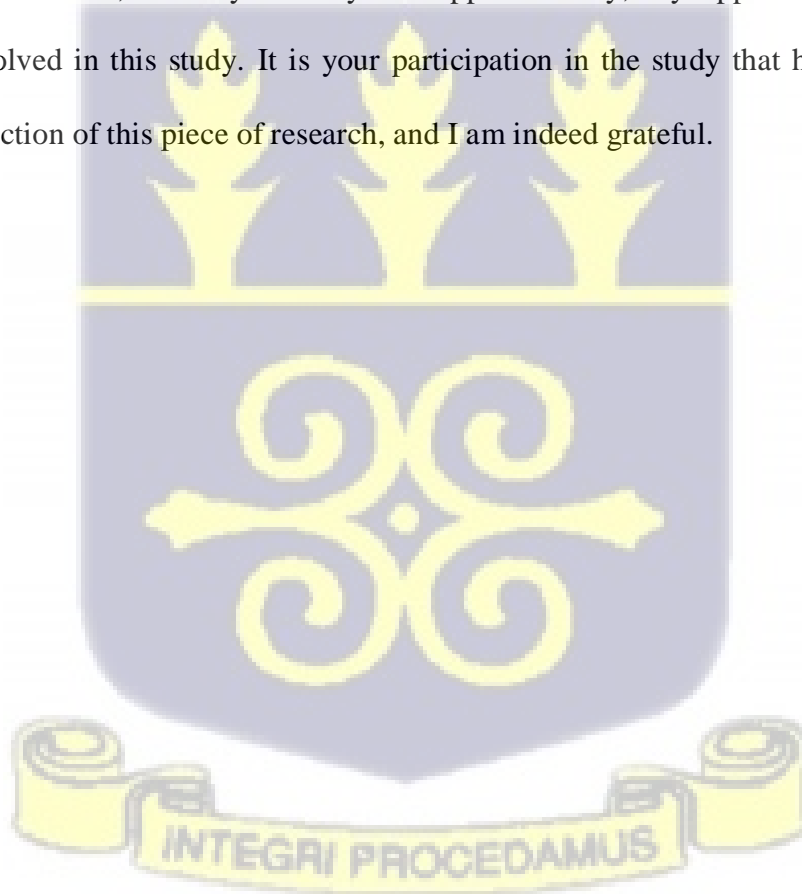
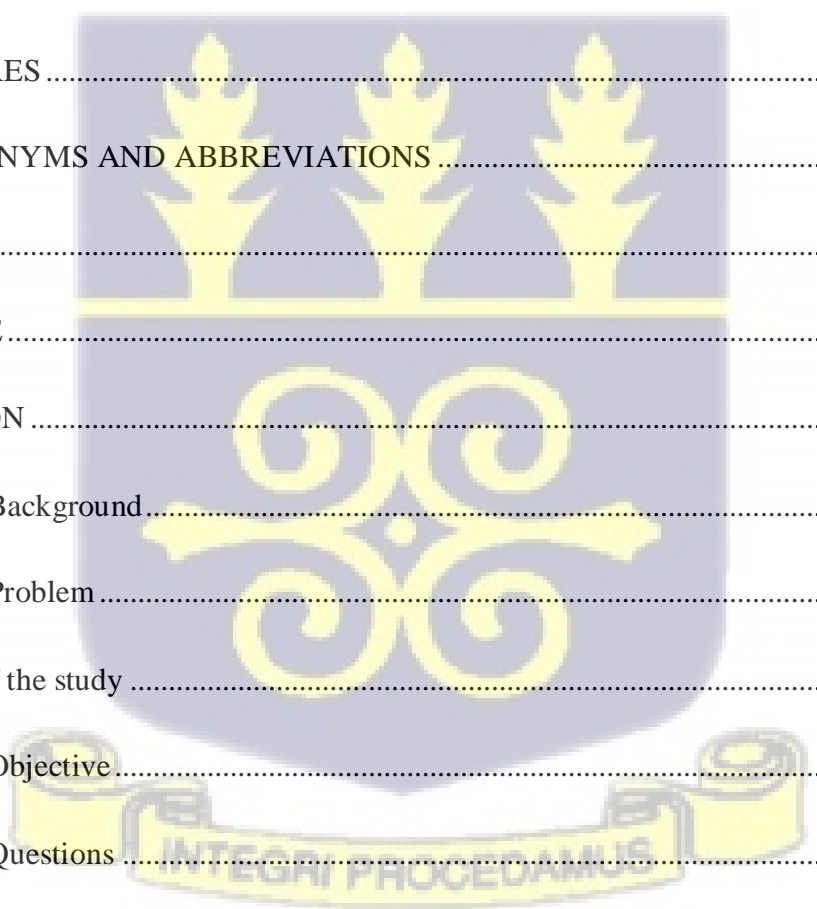
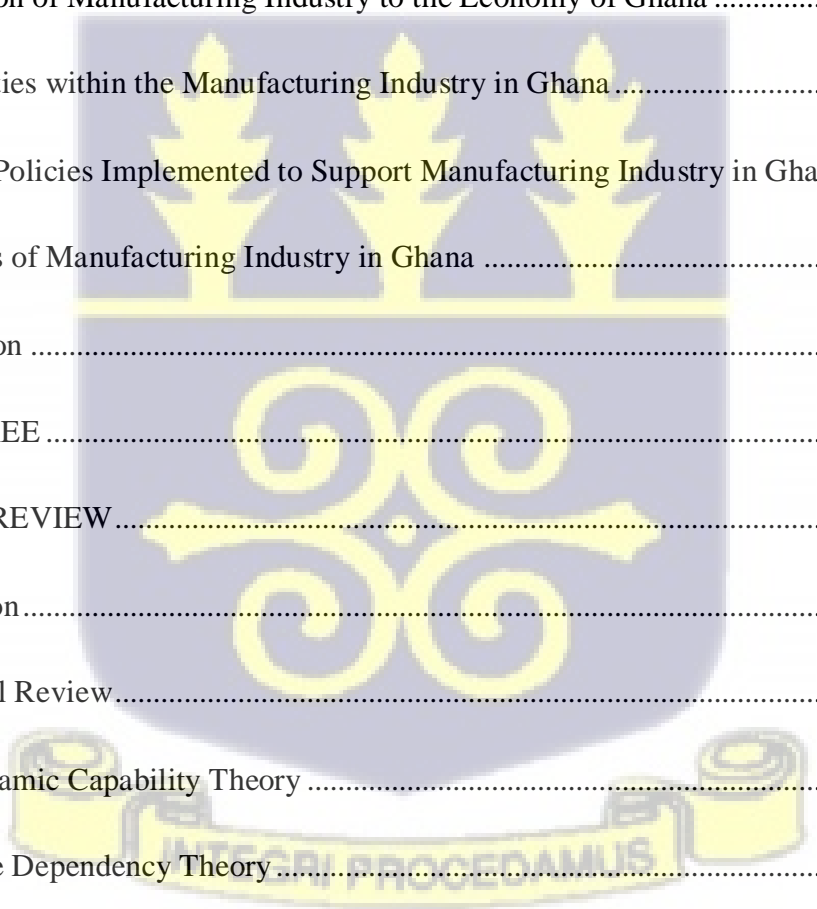


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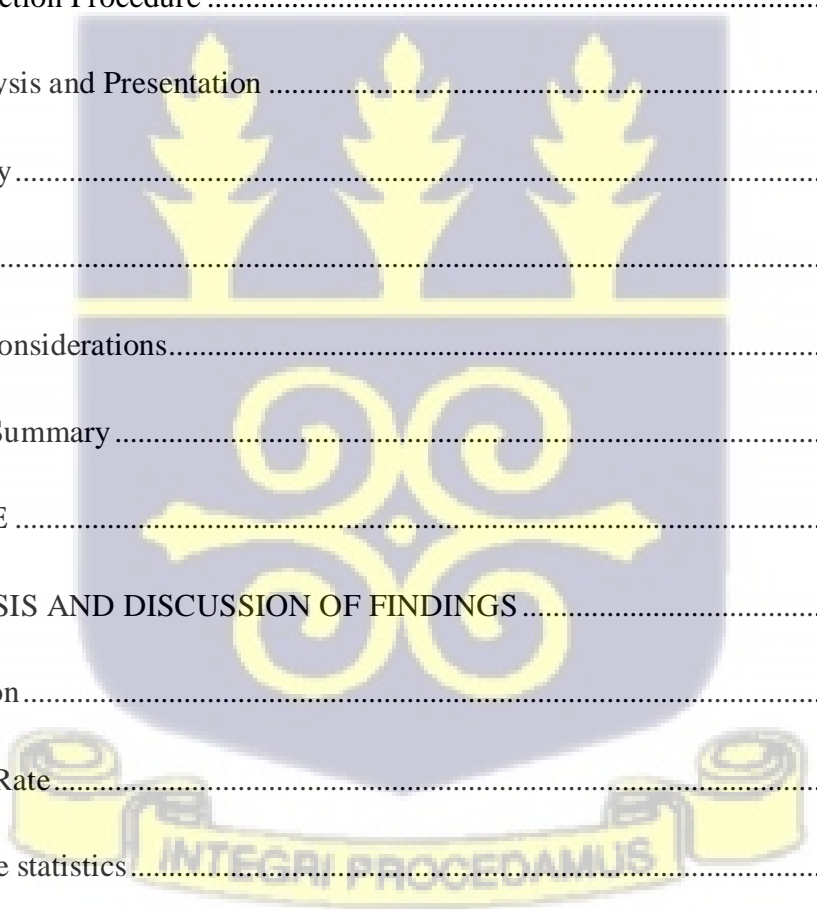


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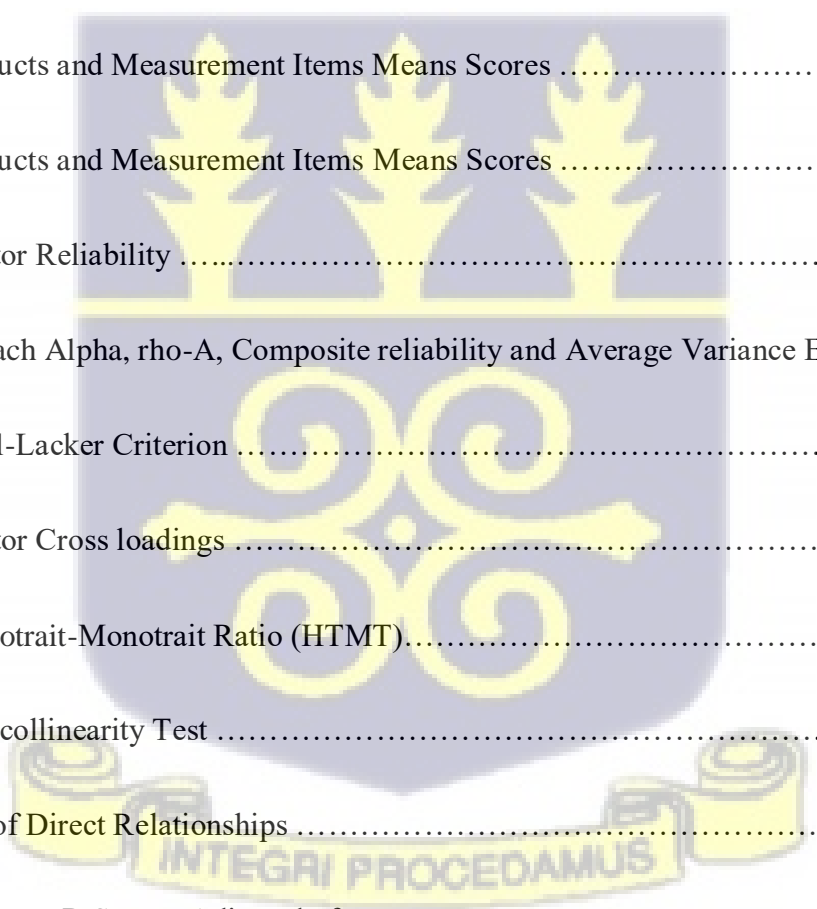


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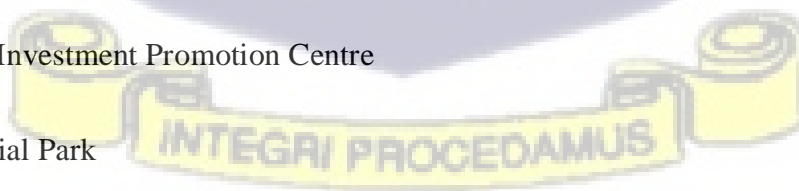
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LIST OF ACRONYMS AND ABBREVIATIONS

GDP	Gross Domestic Product
SCR	Supply Chain Resilience
UNDP	United Nations Development Programme
GSS	Ghana Statistical Service
ISI	Import Substitution Industrialisation
ERP	Economic Recovery Programme
SAP	Structural Adjustment Programme
GIC	Ghana Investment Centre
TIP	Trade and Investment Programme
BAF	Business Assistance Fund
ISSER	Institute of Statistical, Social and Economic Research
ISIC	International Standard Classification of Industries
GLSS	Ghana Living Standard Survey
ACET	Africa Centre for Economic Transformation
GIPC	Ghana Investment Promotion Centre
IP	Industrial Park
SEZ	Special Economic Zones
EDAIF	Export trade, Agricultural and Industrial Fund



MOTI Ministry of Trade and Industry

AGI Association of Ghana Industries

DCV Dynamic Capability View

RBV Resource Based view

RDT Resource Dependency Theory

PLS-SEM Partial Least Square Structural Equation Modelling

EFA Exploratory Factor Analysis

CFA Confirmatory Factor Analysis

AVE Average Variance Extract

SPSS Statistical Package for the Social Sciences

SEM Structural Equation Modelling

HTMT Hetrotrait-monotrait

HND Higher National Diploma

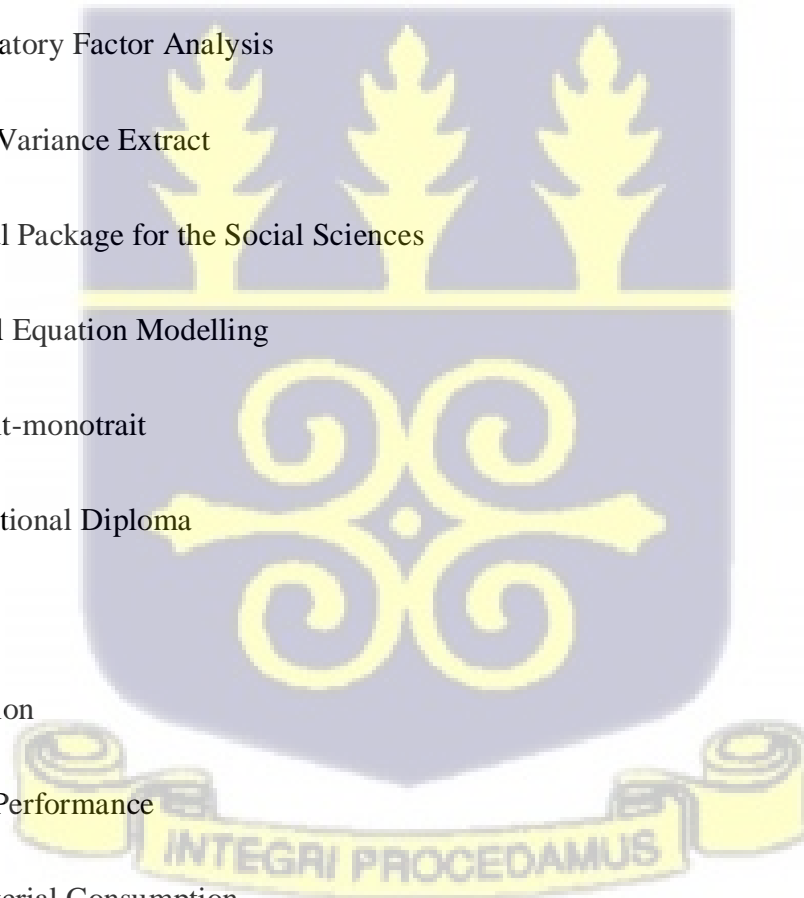
Ag Agility

Col Collaboration

FP Financial Performance

RMC Raw Material Consumption

IS Information Sharing



Red Redundancy

EWB Employee Wellbeing

SRMR Standardized Root Mean Square Residuals



ABSTRACT

In recent times, firms' supply chains are increasingly faced with disruptions and uncertainties. The ability of firms to effectively respond to these disruptions is crucial for their survival. Thus, firms are required to build resilience capacity into their supply chains. The adoption of resilience and sustainability practices have become of paramount importance to firms in enhancing the performance of their supply chains performance in this turbulent business environment.

This study examines the resilience strategies adopted by manufacturing firms in Ghana and determines the impact of these strategies on the sustainable operations of these firms. The purpose of this study is to examine the resilience strategies of manufacturers and ascertain the extent to which manufacturing supply chains are resilient and also to evaluate the impact of the resilience strategies adopted on the sustainable operations of manufacturing firms in Ghana.

The study employed a quantitative approach with data collected from 186 of manufacturing firms through questionnaire. Purposive sampling was applied in selecting respondents. The Statistical Package for Social Sciences (SPSS) and Partial Least Square- Structural Equation Modelling (PLS-SEM) was used to analyse the data. The study found out that manufacturers are indifferent towards the environmental uncertainties affecting their supply chains. The result further establishes that manufacturers largely do employ agility and redundancy as resilience strategies to enhance their sustainable operations. Also, the results from the data analysis reveal that agility and financial performance have a positive significant relationship. While agility has a positive but insignificant relationship with employee wellbeing and raw material consumption. The results further indicate that redundancy do influence financial performance, employee wellbeing and raw material consumption. Furthermore, collaboration had a negative relationship with financial performance but positive relationship with employee wellbeing and raw material consumption, but

these effects are statistically insignificant. Likewise, there was a positive significant relationship between information sharing and financial performance, while a positive insignificant relationship was exhibited between information sharing and employee wellbeing and raw material consumption. The study recommends that owners/managers of manufacturing firms should adopt resilience strategies to minimize supply chain disruptions. Again, managers should strengthen their internal practices within firms as the first priority to use in dealing with environmental uncertainties.



CHAPTER ONE

INTRODUCTION

1.0 Research Background

In today's turbulent and dynamic world, businesses are faced with different risks and uncertainties (Agarwal, Seth and Agarwal, 2020). The business world is ever-changing and managing this change is a critical success factor for businesses and a key concern for management (Wieland and Wallenburg, 2013). The increasing uncertainties and risks that characterize business activities make the supply chain vulnerable (Yu *et al.*, 2018). Businesses around the globe are faced with uncertainties such as terrorist attacks, political instability, competitions, risks caused by disasters, pandemics and many others all of which have the potential to disrupt the supply chain.

These uncertainties are termed environmental uncertainties because it is caused by factors embedded within the external environment of a firm (Ganbold and Matsui, 2017). Environmental uncertainties are classified based on three sources; supply, demand and technological uncertainties (Ganbold and Matsui, 2017). Supply uncertainty refers to the degree of variation and irregularity of the suppliers' product quality and delivery performance (Li & Lin, 2006). Examples of supply uncertainty relates to the quality of incoming materials and supplier lead times. These supplier's uncertainties may cause postponement or halt a firm's operations leading to poor customer service delivery. Demand uncertainty on the other hand denotes the degree of variation and changeability of a customer's demand and taste (Li & Lin, 2006). Some examples include variability in customer demands and customer quality and delivery requirement. Also, technology uncertainty is defined as the level of variation and changeability in technology in an industry (Ganbold and Matsui, 2017). Unpredictability of technology development in a particular industry is an instance of

technological uncertainty. These uncertainties can affect the performance of an organisation as well as its continuity.

Supply chain disruptions have major economic impact. Each year, it is projected that almost three quarters of organisations in the world experience a supply chain disruption of some kind (BCI, 2018). The frequent occurrence of supply chain disruptions requires some degree of resilience to be built into the management of supply chains. In managing the risks of disruptions, firms need to build some capabilities across their value chains to prepare for and quickly recover from such disruptions when they occur. This preparedness lays the foundation for supply chain resilience (Ponomarov and Holcomb, 2009). Supply chain resilience has been variously defined in the literature. Ponomarov and Holcomb (2009) define resilience as the ability of the supply chain to anticipate, respond to, and recover from unforeseen occurrences by preserving operational continuity at desirable levels of connection and control over structure and function. Other researchers such as Carvalho, Barroso, Machado, Azevedo, and Cruz-Machado (2012) also define resilience as system's ability to return to its original state or to a different state or more desirable state after being disrupted. Kumar and Anbanandam (2020) similarly define supply chain resilience as an anticipatory ability in which businesses can predict and adapt to shocks and while responding, recovering and ultimately learning from them.

Supply chain resilience has been suggested by both academics and practitioners to be a capability to counter risks from supply chain disruptions (Ali & Gölgeci, 2019). The concept of supply chain resilience has been labelled as a managing tool for supply chain disruptions and risks (Adobor & McMullen, 2018; Petit et al., 2010). Resilience is a capability that helps in reducing internal and external disruptions by planning, preparing and taking decisions ahead of any crisis.

Supply chain resilience is considered essential in business continuity and sustainable supply chain management (Linnenluecke, 2017) and is mainly concerned with reducing the impact of disruptions by identifying resilience strategies that allow supply chains to respond and recover quickly to at least its original state (Christopher & Peck, 2004; Sheffi & Rice, 2005; Zsidisin, Petkova, & Dam, 2016). Resilience in supply chains serves as a means to reduce risks and vulnerability in the supply chain.

The literature has identified strategies such as flexibility and agility as a step towards developing capability in supply chain resilience (Christopher & Peck, 2004; Tomlin, 2006; Yang, Pan, & Ballot, 2017). The current study examines collaboration, agility, redundancy and information sharing as supply chain resilience strategies. Collaboration in supply chain relates to two or more independent firms working closely together to plan and execute supply chain operations toward a common goal (Cao *et al.*, 2010). Examples of collaborative activities include jointly developing strategic plans and resource sharing. Agility is a resilience strategy that enables an organisation to quickly react to environmental changes (Christopher and Peck, 2004; Ponomarov and Holcomb, 2009). Redundancy involves the tactical and selective use of inventory and additional capacity that is needed in time of crisis be it deficiency in demand or supply. Some forms of redundancy comprises of safety stock, deliberate use of multiple or back up suppliers (Sodhi, Son, & Tang, 2012; Tomlin, 2006). Also, information sharing deals with sharing of knowledge about products or key issues across the supply chain.

The continuity and sustainability of operations is key to the success of every firm. In recent times, the buzzword in business vocabulary is sustainability (Famhinia & Jabbahzadeh, 2016). Sustainability fosters supply chain resilience in different ways; when businesses are threatened with operational sustainability either through environmental, social or economic dimensions,

capability in supply chain resilience can enable firms to recover quickly to their original state or even better. Building supply chain resilience also promotes continuity of businesses. The adoption of the above strategies may improve firms' performance leading to sustainability of firms.

There are three dimensions of sustainability; these are economic, environmental and social dimensions (Miller and Engemann, 2019). Environmental sustainability deals with firms focusing on reducing wastages such as carbon footprints, packaging waste and the total effect on the environment. Arguably, lessening the amount of raw material usage have positive impact on a firm's financial performance (Beattie, 2019). Social sustainability involves maintaining the wellbeing of employees and the society at large. Economic sustainability concerns the profitability of the firm; for every business to be sustainable, it has to be profitable (Beattie, 2019). This study focuses on all the three sustainability dimensions (economic, social and environmental) measured in terms of financial performance, employee wellbeing and raw material consumption respectively. The three dimensions are focused on because it is suggested that to achieve a sustainable development, all of the three dimensions of sustainability needs to be promoted (Ilic-Krstic, Ilic and Avramović, 2018).

Literature on supply chain resilience has largely been on modelling. For instance, Wankmüller and Seebacher (2015) developed a model on supply chain design and redundancy; Agarwal et al. (2020) modelled supplier chain enablers for effective resilience; a model on risk readiness and planning was also developed by (Tukamuhabwa *et al.*, 2015). The literature therefore has some empirical research on supply chain resilience. However, there is scarcity of literature on the various strategies as a whole required in building supply chain resilience. Similarly, little has been done on the impact of supply chain resilience strategies on firms' performance.

Additionally, the manufacturing sector contributes to the development of economies in both developed and developing countries. This sector also provides job opportunities to people and generates revenue to governments through taxes. In 2017, the manufacturing sector in Ghana contributed GH¢26, 860 million to the Gross Domestic Product (GDP) which was equivalent to 11.3% in 2017, whereas in 2018, the sector's contribution increased to GH¢31,441 million representing 11.3% of the GDP in 2018 (GSS; AGDP Report, 2019). Additionally, the manufacturing sector in Ghana in the first quarter of 2020 contributed 12.2% to the GDP of the country (GSS; QGDP Report, 2020).

In view of the contributions of the manufacturing sector to the Ghanaian economy, strategies need to be developed to minimize any form of disruptions that can potentially befall the sector. The ability to react, adapt and set up crisis management mechanisms to help control uncertainties is of paramount importance to manufacturing operations. Arguably, in order for firms to sustain their operations, investment into supply chain resilience is critical (World Economic Forum, 2020).

Against this backdrop, this study seeks to investigate the strategies adopted by manufacturing firms to develop their supply chain resilience capability and the effect of resilience capability on their sustainable operations.

1.1 Research Problem

Businesses are expanding widely due to globalization resulting in extensions in their supply chains. The extension in business operations globally exposes firms to increasing high levels of uncertainties and this exposure leads to unpredictable disruptions. Business risk factors causing supply chain disruptions are both present internally within the organization as well as externally within the business environment. Some of the internal risk factors include technology issues such as outdated software, personnel management which includes shortage of employees or poor morale.

Some of the external risk factors include natural disasters such as earthquake, tsunami, floods, fire outbreaks which normally have adverse effect on the performance of firms and their production capacity.

Studies exist on supply chain resilience in different dimensions. A study conducted by Ganbold and Matsui (2017) examined the impact of different types of environmental uncertainties on supply integration with the purpose to discover the role of supply chain integration in environmental uncertainty reduction. Beckman, Haunschild, and Phillips (2004) also proposed two types of uncertainties based on uncertainty level: firm specific and market based. Firm specific is internal and controllable while the market-based is external. Literature has looked at environmental uncertainties, and attempted to classify and determine the sources in supply chains (Duncan, 1972) but there has been less attention on the various environmental uncertainties affecting the manufacturing supply chains which the current study examines.

More so, models have also been developed to assess supply chain resilience (Cardoso *et al.*, 2014). Additionally, Aguila and ElMaraghy (2019) proposed an evaluation framework for quantifying supply chain resilience and network topology. Other researchers have also identified elements that constitute supply chain resilience. For instance, Soni, Jain, and Kumar (2014, p. 14) identified 14 elements forming supply chain resilience comprising “agility, collaboration, visibility, risk management culture, adaptive capability, risk and revenue sharing, trust among players, information sharing, sustainability, corporate social responsibility, information security, supply chain structure, strategic risk planning, and knowledge sharing”. There is however a dearth of literature on the various resilience strategies adopted by manufacturers to remain resilient. The need to understand these strategies has partly necessitated the current study.

Furthermore, studies examining the relationships between supply chain resilience and sustainable operations are scarce in the literature. Although the two concepts have received some literature attention, not much is known on the relationships that exists between them. Miller and Engemann (2019) investigated supply resilience and sustainability but the study focused on resilience categories (Risk management, Coordination, Good practices and Architecture) instead of the resilience strategies being examined in this study (agility, information sharing, redundancy and collaboration). Studies on supply chain resilience have also been given less attention in the literature within the context of developing countries, especially Ghana.

Manufacturing firms contribute immensely to every nation's development in that products are manufactured to serve the needs of consumers and contributes to the national GDP (Bawakyillenuo, Akoto, Ahiadeke, Aryeetey, & Agbe, 2013). Manufacturing activities include food processing, production of drinks and beverages, clothing and textiles, soap and detergent and brewery. Nevertheless, these operations are associated with risks and uncertainties, making them vulnerable and susceptible to disruptions. As a result of supply chain disruptions, there is the need for firms to be resilient in their supply chains to minimize the effect of disruptions on the firm's performance.

Disaster management is keen in this era of disruption, hence supply chains need to manage their disasters. In managing disasters, most literature makes mention of four sequential stages of disaster management which includes: preparedness, response, mitigation and recovery (Kumar & Harvey, 2013). Planning and preparedness are crucial to respond to emergency situations. Zobel (2010) points out that disaster response and recovery should involve organisations, social and environmental dimensions to make effective decision.

This study is subsequently intended to establish the resilience strategies being employed by manufacturers, focusing on these strategies: collaboration, information sharing, agility and redundancy and determine the impact that these strategies may have on the sustainable operations of firms.

1.2 Purpose of the study

The general objective of this research sought to explore resilience strategies of manufacturers and ascertain the extent to which manufacturing supply chains are resilient as well as the impact of resilience strategies adopted by manufacturing firms on their sustainable operations.

1.3 Research Objective

The study seeks to achieve the following objectives:

1. Determine the key environmental uncertainties affecting manufacturing supply chains.
2. Ascertain the resilience strategies adopted by manufacturing firms to enhance their supply chain performance.
3. Examine the relationships between supply chain resilience strategies and firms' sustainable operations.

1.4 Research Questions

In order to achieve the objectives of the study, the following research questions will be addressed:

1. What are the key environmental uncertainties affecting manufacturing supply chains?
2. What supply chain resilience strategies are adopted by manufacturing firms to enhance their supply chain performance?

3. What relationships exist between supply chain resilience strategies and sustainable operations of firms?

1.5 Significance of the study

The significance of the study is classified into theory/research, practice and policy.

To theory, the study adds to existing store of knowledge on supply chain resilience. It emphasizes on the resilience strategies that is used to minimise the shocks from supply chain disruptions. The study will also help in discovering the extent to which supply chain resilience strategies influence the sustainability of manufacturing operations.

Concerning practice, this study will inform supply chain managers and practitioners as well as advisory boards about supply chain resilience strategies that are best to employ to achieve excellent firm performance and sustainable operations. The study will offer some understanding to business operations in Ghana especially the manufacturing firms, on the essence of effectively adopting supply chain resilience strategies as a tool for business continuity. Customers being shareholders in the manufacturing industry will continue to demand improvement in the lead time and availability of products on the market; this study will inform manufacturing firms about strategies needed for survival, competition and growth which are dependent on the firm meeting the needs of the customer. The study will provide insights to guide managers in the development of resilience strategies to hedge against unforeseen supply chain disruptions.

Lastly, with regards to policy, policy makers and players in the manufacturing sector such as the government, Association of Ghana Industries will be informed with insights from the study to guide the development of appropriate policies promoting sustainable operations among manufacturers. This study will also help policy makers to develop appropriate and applicable

policies that will be used to deal with supply chain disruptions. Policy makers will also be informed about the crucial areas of concern in the manufacturing industry that policies need to be directed.

1.6 Research scope and Delimitation

This study considers a sample size of 269 manufacturing firms in Ghana. The study is limited to manufacturing firms in Ghana because they are significantly affected by supply chain disruptions. The study focuses on food processing, textiles and clothing, pharmaceuticals and soap and detergent manufacturing firms. The key variables being investigated in the study includes supply chain resilience strategies (collaboration, information sharing, agility and redundancy) and sustainability (economic, social and environmental).

1.7 Organization of the study

In order to ensure consistency of workflow, the study is organized into six chapters.

Chapter One: This chapter introduces the research. It entails the research background, research problem, purpose of the study, objectives of the study, the research questions, significance of the study, the scope and delimitation of the study and organisation of the study.

Chapter Two: This chapter is titled the context of the study and presents the overview as well as the context of the manufacturing industry in Ghana.

Chapter Three: This chapter covers a critical review of the relevant literature on supply chain resilience, supply chain resilience strategies, environmental uncertainties affecting firms' supply chains and sustainable manufacturing operations.

Chapter Four: chapter four looks at the methodology of the study. It discusses the study population, the sampling technique, sampling size determination, data collection technique and how the data was analysed.

Chapter five: This chapter presents the data analysis and discussion of findings.

Chapter Six: This chapter presents the summary of findings, conclusions and recommendations.



CHAPTER TWO

THE CONTEXT OF THE STUDY

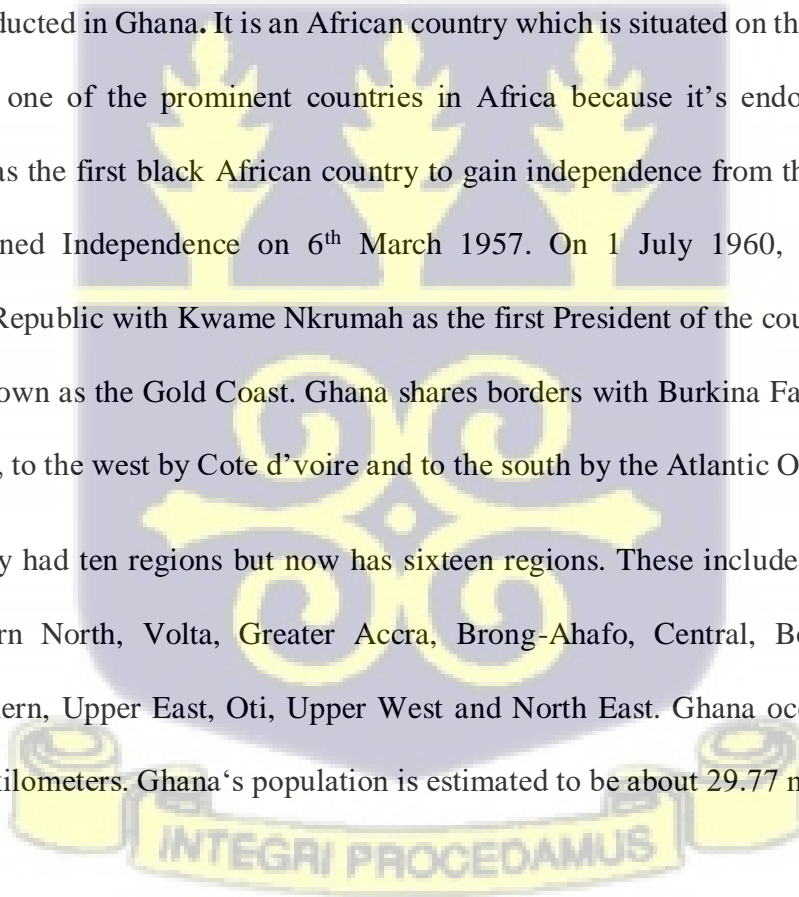
2.0 INTRODUCTION

This chapter gives an overview of the manufacturing industry in Ghana. Specifically, the chapter will discuss the evolution of the manufacturing industry, the current overview of the manufacturing industry, contributions of the manufacturing industry to the economy of Ghana, opportunities in the manufacturing industry, industrial policies as well as some challenges confronting the industry.

2.1 Overview of the Study Area

The study is conducted in Ghana. It is an African country which is situated on the coast of the Gulf of Guinea. It is one of the prominent countries in Africa because it's endowed with natural resources and was the first black African country to gain independence from the British colonial rule. Ghana gained Independence on 6th March 1957. On 1 July 1960, Ghana became a commonwealth Republic with Kwame Nkrumah as the first President of the country. The country was formerly known as the Gold Coast. Ghana shares borders with Burkina Faso to the north, to the east by Togo, to the west by Cote d'voire and to the south by the Atlantic Ocean.

Ghana previously had ten regions but now has sixteen regions. These include Eastern, Ashanti, Western, Western North, Volta, Greater Accra, Brong-Ahafo, Central, Bono East, Ahafo, Savannah, Northern, Upper East, Oti, Upper West and North East. Ghana occupies the area of 238,533 square kilometers. Ghana's population is estimated to be about 29.77 million.



Ghana is the world's second largest cocoa producer after Ivory Coast, and Africa's biggest gold miner after South Africa. It is one of the continent's fastest growing economies and has made major progress in economic development and stable democratic governance (UNDP, 2021).

2.2 The Manufacturing Industry

The manufacturing industry refers to an industry that is involved in the processing of items and indulge in either creation of new commodities or in value addition (Addo, 2017). A manufacturing firm can also be described as businesses that is involved in the manufacturing and processing of products according to the National Association of manufacturing (USA). Additionally, according to a German Economist Alfred Weber (1909) the manufacturing industry is seen as an industrial production, whereby raw materials are transformed into finished goods on a large scale. The North American Industry Classification System defines manufacturing industry as “establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products” (NAICS 31-33). More so, the Ghana Statistical Service (GSS) (cited in Addo, 2017) has also defined the concept of manufacturing through its industry survey as a process that involves production of goods and services.

2.3 Evolution of the Manufacturing Industry in Ghana

The industrial sector of Ghana after independence has evolved from an import substitution industrialisation (ISI) strategy to private sector-led industrialisation. The industrial sector in 1957 was small and made up of only domestic manufacturing industry which contributed less to the economy of the country. During the colonial era, the industrial sector was underdeveloped because much attention was on extraction of raw materials in the country (Ghana) whiles the country depended on manufactured products imported from Britain (Ackah, Adjasi and Turkson, 2014).

Industrialisation was seen as a major factor for modernization and development under the Kwame Nkrumah led administration. The import substitution strategy was seen as a tool to promote local production of goods and products which would help boost the economy of Ghana. Hence, infrastructure development was greatly invested in by the government to aid in production of raw materials into finished goods. The ISI strategy was not adopted for only industrialisation but to also aid in the provision of basic needs to people, offer employment opportunities among others (Killick, 2010).

As a result of the implementation of the ISI strategy, State Owned Enterprises were established for the production of consumer goods and a significant growth was seen in domestic manufacturing in the 1960's. Also, due to the Import Substitution Industrialisation strategy, the GDP of the manufacturing industry increased from 2% in 1957 to 9% in 1969. The total output of manufacturing increased tremendously in the 1960's, the growth rate increased to 13% per annum and the share to the total industrial sector also increased from 10% in 1960 to 14% in 1970 and this resulted in increased in employment by 90% in the 1970s (Ackah, Adjasi and Turkson, 2014). Nevertheless, the projection of economic growth as per the increase in the industrial output in the 1960s did not manifest as envisioned. But, during this period, GDP declined from 4.8% in 1961 to 1.1% in 1966. Several factors have been enumerated as the cause of the decline of the GDP (Ackah, Adjasi and Turkson, 2014). These factors include decline in agricultural and forestry output according to Ghana Economic Survey, 1996 and the fact that import Substitution Industrialisation strategy can also be a cause as claimed by Steel (1972).

In the 1970s, the ISI strategy began to face some structural bottlenecks as the then Busia-led government had interest in private enterprise establishment against the State-Owned Enterprises. As a result of ensuring freer operation of market force, the Ghanaian economy began to face

balance of payment issues (Killick, 2010). During this period, the agriculture and services sector contribution to the real GDP increased from 47.7 % and 31% in 1975 to 55.6% and 35.8% in 1984, respectively, whereas the industrial sector share declined almost by half from 21% in 1975 to 11.1% in 1984. The decline in the industrial sector was mainly due to the manufacturing industry contribution from 13.9% in 1975 to 7.6% in 1984 (World Bank, 1985b).

Amidst all these challenges, the economic recovery programme (ERP) was introduced in April 1983 as part of the structural adjustment programme (SAP) to amend all the deterioration in the Ghanaian economy as well as rebuild the social and productive infrastructure. Under the SAP, many economic policy reforms were introduced to correct all macroeconomics imbalances. These reforms included taxation system, a declaration of new investment code (PNDC Law 116), creation of the Ghana Investment Centre (GIC), privatization of state-owned enterprises and abolition of the import licensing system (Nyanteng, 1993).

According, to Ackah et al. (2014) the introduction of the economic recovery programme (ERP) had a positive impact on the industrial sector in general but mainly on the manufacturing industry. The manufacturing industry experienced a tremendous growth, thus 12.7% on average over the period 1984 to 1988. The growth of the manufacturing industry was attributed to the following reasons: modernization and expansion of industries, trade policy reforms, provision of technical and financial assistance for industrial recovery. The Ghanaian industrial sector continually gained improvement especially the manufacturing subsector as additional reforms were added after the economic recovery programme reform policy in the 1990s. Some of these policies included the trade and investment programme (TIP), and the Business Assistance Fund (BAF). The current government has also introduced the One – District – One Factory initiative as a strategy to drive expansion of the industrial sector, particularly, manufacturing.

2.4 Contribution of Manufacturing Industry to the Economy of Ghana

According to the Institute of Statistical, Social and Economic Research (ISSER, 2007), Ghana's economy is made up of three main sectors: agriculture, service and industry. The agricultural sector consists of sub-sectors of cultivation of vegetables, cereals, fruits among other crops. Secondly, the service sector consists of sub-sectors, finance, government services, transport, and communication. Also, the manufacturing industry comprises of the following sub-sectors; paper, food processing, soap and detergent, cement, machinery, textiles and garments, pharmaceutical and machinery production (ISSER, 2007). This study focuses on the food processing, textiles, pharmaceutical and soap and detergent firms because these sub-sectors' supply chains are more exposed to global disruptions.

The manufacturing industry is a sub-sector of industry and consists of 16 out of 33 sub-sectors in the international standard classification of industries (ISIC). With reference to the Ghana industrial census 2003, there were 26,088 manufacturing establishments employing about 243,516 people. Of the 243,516 people engaged, 159,066 were males while 84,336 were females. The census also presented regional distribution of the establishments. Greater Accra region dominated with the highest number of establishments (6,764) followed by the Ashanti Region (6,487). These two regions accounted for 50% of the total number of manufacturing establishments in Ghana. The central (9.7%) and Eastern (11.4%) regions had more establishments than the other regions (GSS, 2006). Also, according to the 2003 industrial census, almost 50% of the manufacturing employees were apprentices or unskilled workers. Professional and managerial staff accounted for 5% and 40% were skilled workers respectively.

The main drivers of GDP growth in the first quarter of 2020 were Information & Communication and Manufacturing. Ghana's GDP in the first quarter of 2020 (January to March) was 4.9% and

manufacturing industry contributed 0.60%. The manufacturing sub-sector recorded lower growth rate of 5.0% in the first quarter of 2020 as compared to 5.6% in the same period of 2019 (GSS, 2020).

The manufacturing industry has been confirmed by various empirical research as the engine of economic growth of both developed and developing countries (Wells and Thirlwall, 2004; Timmer and de Vries, 2007; Tregenna, 2011; Olamide and Oni, 2016; Cantore *et al.*, 2017) This hypothesis “engine of growth hypothesis” was first tested by (Kaldor, 1996) and it is now known as the Kaldor’s first law.

Can Ghana’s manufacturing industry be referred to as the engine of economic growth? The Ghanaian manufacturing industry over the years has contributed immensely to the country’s Gross Domestic Product (GDP) and the development of the economy at large. The Table 2.1 below shows the contributions of the industry sector and manufacturing subsector to the GDP of Ghana.

Table 2.1: GROSS DOMESTIC PRODUCT (GDP) at Current Market prices by Economic Activity (GH¢ Million)

YEAR	2013	2014	2015	2016	2017	2018
INDUSTRY	43,104	53,767	57,155	60,709	78,015	94,770.3
MANUFACTURING	14,523	17,605	20,506	23,922	26,860	31,441
GDP current	123,650	155,433	180,399	214,050	248,226	289,988

Source: Ghana Statistical Service (GSS) 2019.

Table 2.1 shows that between 2013 and 2018, the manufacturing industry has contributed significantly to the Gross Domestic Product of Ghana. It can be seen that the industrial sector as well as the manufacturing subsector's contribution to GDP from 2013 (GH¢ 43,104 and GH¢14,523) to 2018 (GH¢94,770.3 GH¢31,441) respectively has increased consistently.

To add to the above, the sector provides employment to people to aid in good standard of living. According to the Ghana Living Standards Survey Round 6 (GLSS 6), the manufacturing industry engages 9.1 percent of people (15 years and above) (GSS, 2014).

More so, manufacturing firms do undertake social developments such as building of schools, library, marketplaces, and provision of portable water among others as part of their corporate social responsibility.

2.5 Opportunities within the Manufacturing Industry in Ghana

The manufacturing industry in Ghana has a range of opportunities and potentials for expansion and growth. Adarkwah and Santuoh (2018 p. 73), suggested that, to identify opportunities in the manufacturing industry, it is vital to:

- 1. Examine what export-oriented free zones companies and foreign direct investors are doing.*
- 2. Analyse export data for products in which Ghana has strong comparative advantage.*
- 3. Review Ghana's productive structure to identify high –value products that can use technologies and skills similar to those currently deployed in already successful product lines.*

The Ghana Economic Transformation case study, an Africa Centre for Economic Transformation (ACET, 2012) working paper, identified some opportunities for the manufacturing industry.

The study stated that the main focus of investment promotion for the Ghana Investment Promotion Centre (GIPC) was the textiles and garment, food and agro-processing and pharmaceuticals and drugs and this denoted that the expansion of the manufacturing sector is of priority for the GIPC. There is both domestic and international market for the products of these sub-sectors if value is added to their end products. It was also noted that the pharmaceutical manufacturing firms can dominate the petrochemical industry by focusing on manufacturing drugs that will treat major tropical diseases and infections.

The government of Ghana has launched multifaceted programmes to promote industrialisation in the country. Some of the programmes include National Industrial Revitalisation Programme, which was launched in 2017, and this focuses on providing funds for industrial firms. Not only funds are provided under this programme, but technical assistance and business development service as well. Also, Special Economic Zones (SEZs) and industrial parks (IPs) are established, and manufacturing industries are beneficiaries of this development. The core aim of the (SEZ) and (IPs) initiative is to establish one SEZ or IP in each of the regions and seek for international and domestic investors. Currently, the government has designated and acquired tracts of land for Special Economic Zones to be developed. Examples of these sites are the 5000-acre Greater Kumasi Industrial City and SEZ, Tema Export Processing Zone, Sekondi Export Processing Zone (2000), Builsa Agro Processing Park (3000 acres) (Oxford Group, 2021).

2.6 Industrial Policies Implemented to Support Manufacturing Industry in Ghana

Industrialisation is considered as a major priority for developing countries including Ghana, hence long- term industrial development plans that promote skills and resources development are initiated to help curb industrial development challenges. There have been several policies initiated by the Ministry of Trade and Industry to ensure sustainable and industrial development. In the

quest to promote industry growth in Ghana, the Ghana Industrial Policy was established in June 2010. The Industrial Policy was developed to provide some form of guidelines for implementation of government industrial development itinerary to focus mainly on competitiveness, growth and diversification of the manufacturing sector in Ghana (UNIDO, 2013). Also, the industry policy is to provide better quality products for consumption, increase employment and fair-priced (Ackah, Adjasi and Turkson, 2014).

As part of the industry policy, an Industrial Sector Support Programme (2011-2015) was established by the government to affect the implementation of the policies which is guided by the ministry of Trade and Industry. The policies embedded in the Industrial Sector Support Programme are grouped into four major policy thematic areas which include production and distribution, technology and innovation, incentives and regulatory regime and cross –cutting issues (Ministry of Trade and Industry, 2016).

Similarly, the Export Trade, Agricultural and Industrial Development Fund (EDAIF) was initiated by the government in 2016 which is being monitored by the Ministry of Trade and Industry (MOTI). The EDAIF was primarily established to finance the growth and promotion of non-traditional exports, however, the EDAIF Act, 2011(Act 823) extended it support to finance agricultural and agro-processing development. The EDAIF provides financial assistance to export-oriented manufacturers (Nti, 2015).

There are several opportunities that the manufacturing industry in Ghana offers, hence, investors and entrepreneurs should direct their skills and resources into this sector. The government has established various initiatives such as the National Industrial Revitalisation Programme and many others as well as policies such as the Ghana Industrial Policy to serve as a support system to

encourage engagement in manufacturing activities and also part of the effort towards promoting and sustaining the industry.

2.7 Challenges of Manufacturing Industry in Ghana

Manufacturing industries operate in a highly competitive environment as they are sometimes subject to intense global competitions. These competitions comes in a form of production technologies, new materials and development of new technologies and mostly firms rely on increased productivity and strategies such as flexibility and agility in order to cope with the challenge (Mamasioulas, Mourtzis and Chryssolouris, 2020). Golub, Mbaye, Ceglowski, & Prasad (2015) argue that high relative labour costs are also a contributing factor for lack of competitiveness of manufacturing firms in Sub-Saharan Africa.

In a study conducted by Adarkwah, Ahudey and Santuoh (2018), five key challenges faced by the manufacturing industry in Ghana were enumerated. These include:

1. Competition from imported Goods; it is believed that most of the items that are manufactured in the country are also imported from other parts of the world such as Europe and these goods are comparatively cheaper and of good quality. The imported goods are cheaper because the exporters obtain subsidies from their government. For the same quality products, some Ghana-made products are more expensive than the imported goods because manufacturers are faced with challenges as limited skills, over-staffing and high cost of input.
2. Excessive Taxes, Levies, and Fees; Materials and parts used in manufacturing are mostly imported and heavy taxes are imposed on these inputs. These levies and taxes have huge effect on imported goods. Charges that are imposed on a consignment includes import duties, processing fee, ECOWAS levy, destination inspection fee, Export development

and investment levy. Some items even attract additional levies such as environmental levy and excise duty. More so, agencies such as the Environmental Protection Agency, Fire Service and Factory Inspectorate are believed to impose various charges for annual certificates and various violations when they visit the various manufacturing premises to conduct inspections.

3. Energy Crisis and Unit pricing; this has to do with power outages and expensive electricity tariffs. Currently, there is an ongoing energy rationing where power is switched off anytime by the electricity company of Ghana. This has compelled manufacturers to acquire generators for back up supply of power for their daily operations. This has made some manufacturers to reduce their operating hours as well as their staff due to the energy crisis leading to low-capacity utilisation and eventually high cost of production.
4. Funding and Interest Rate; most manufacturers lack access to long-term capital. Some of these manufacturers seek to expand their businesses but cannot get access to capital for investments. They acknowledge the EDAIF initiative, but more institutions are needed to assist in finance-related issues. One additional challenge is high interest on loans. According to the Association of Ghana Industries (AGI), interest rate on loans from commercial banks ranges from 35% to 40% while micro-finance companies charges range from 60% to 80%.
5. Lack of commitment on the part of Ghanaian governments; most of the key informants in Adarwah et al., (2018) felt government lacks commitment to manufacturing. They believed that the various challenges of the manufacturing firms have been discussed with government, but nothing has been done about it. Also, some of government policies have

adverse effect on the manufacturing firms. For instance, importation of used clothes has detrimental effect on textile industry growth.

In a similar vein, the president of the Association of Ghana industries (AGI) Nana Owusu Afari in an interview in 2013 made mention of some challenges that affect the growth of industries in Ghana. These were infrastructure challenges, energy deficit, road network problems, water crisis and also our education system needs improvement. He further added that skills development and entrepreneur training should be included in the curriculum (Marcopolis; Ghana Report, 2013).

Enu & Havi, (2014), suggested that some factors are detrimental to the growth of manufacturing sub-sector in Ghana, High depreciation of the value of the cedi, obsolete machinery and equipment, high inflation rate, high utility charges and among others. To add, there has been low manufacturing growth as a result of firms not taking advantage of agglomeration (Jedwab, 2013).

These challenges as discussed, among others seem to affect manufacturing performance in Ghana, thereby limiting the rate of growth and the industry's contribution to the national economy.

2.8 Conclusion

In conclusion, the manufacturing sub-sector contributes significantly to the economy of Ghana and wellbeing of individuals in the country through the contributions it makes to the Gross Domestic Product of Ghana and provision of employment to individuals. There appears to be opportunities in the industry that entrepreneurs and other businesses can take advantage of. However, some factors such as high labour cost, interest rate, excess taxes, competitive market, limited skills, bad road networks, energy and water crisis, inadequate infrastructure among others are believed to be hindrance to the growth of the manufacturing industry in Ghana.

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

Supply chain resilience is perceived as a managing tool for supply chain disruptions and risks. The growing concern of curbing supply chain disruptions has triggered arduous research into resilience concept. This chapter, therefore, seeks to provide insight into the impact of supply chain resilience on manufacturing firms' supply chain performance, sustainability and some of the uncertainties that affect the firms' supply chains through a critical review of the literature. The review of the literature is presented in two blocks of theoretical and empirical reviews. The chapter also presents the conceptual framework developed for the study, depicting the relationship between the dependent and independent variables.

3.1 Theoretical Review

A theory is defined by Kerlinger and Lee (2000, p. 11) as “a set of interrelated constructs (concepts), definitions, and prepositions that present a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena”. Theories present ways of studying concepts or variables concerning a phenomena in order to discover or examine research problem's answer (Boateng, 2018). Theories also provide explanation to concepts that underpin a phenomenon. With respect to this study, the dynamic capability view (DCV) and resource dependency theory constitute the theoretical foundations of the study. These theories make emphasis on capabilities and strategies to respond to uncertainties and environmental changes. Therefore, these theories best fit the current study since the main

purpose of the study is to investigate the uncertainties that affect manufacturing firms and capabilities and strategies used to respond to these uncertainties.

3.2.1 The Dynamic Capability Theory

The Dynamic Capability View (DCV) main premise is a firm's ability to integrate, build and reconfigure internal and external competencies to respond rapidly to environmental changes and uncertainties and to design new value-creating strategies (Teece, Pisano and Shuen, 1997; Eisenhardt and Martin, 2000). The DCV is an extension of the Resource Based View (RBV) (Barney, 1991) as cited in (Chowdhury & Quaddus, 2017). The basis of the Resource Based View is for firms to develop capabilities to overcome complexities and to gain competitive advantages. But, the RBV lack proper explanation of capabilities when dynamic changes ensue in the midst of uncertain environments (Chowdhury & Quaddus, 2017). Hence, the DCV addresses this gap by planning to respond to the uncertainties (Eisenhardt and Martin, 2000). The DCV has six functions; renew, recombine, redeploy, replicate, retrench and retiring of resources. The dynamic capability is not only for creating resources but also to eliminate resources when the need arises (Peteraf and Maritan, 2007). The more a firm's dynamic capabilities are developed, the greater its chances of success.

Resilience as a tool to manage disruptive events can be analysed through the DCV as the theory focuses on explaining a firm's capability to adapt, integrate and reconfigure their internal and external resources to respond to uncertainties. According to the DCV, firms need to be proactive in perusing changes in the environment and finding strategies to adapt to such changes (Teece, Pisano and Shuen, 1997). The theory commensurate with this study on supply chain resilience strategies to adapt and respond to environmental uncertainties and disruptions of the supply chain.

Again, the DCV makes emphasis on reconfiguring resources to respond to uncertainties during turbulent times when a firm needs to survive.

Chowdhury and Quaddus (2017, p. 188) argues that “supply chain should have the reactive capability to reconfigure resources and capabilities to recover quickly from disruptions”. This study’s main focus is to determine the supply chain resilience strategies that are being employed by firms to recover quickly from disruptions and return to their initial state or even better. Therefore, the DCV has been applied in the study to examine how firms can exploit their internal and external capabilities to overcome the effect of supply chain risks and disruptions.

3.2.2 Resource Dependency Theory

The focus of the Resource Dependency theory (RDT) is to explain how dependence on external resources to the organization correlates to network exchanges, organisation’s main activities and results (Prasad, Zakaria and Altay, 2018). Resource Dependence Theory is also seen as a theory of power and influence, in that, it stems from external constraints and resource dependence. The theory postulates that the dependence on a critical resource influences organization’s decisions and it is associated with the kind of dependency situation (Nienhueser, 2008). The Resource Dependency theory is used as a prospect in understanding external organisational relationships (Drees and Heugens, 2012). The survival of every organization is of paramount importance; hence, strategies are put in place to achieve this objective. According to the Resource Dependence theory, organisations can survive when they are able to acquire and maintain resources. The Resource dependency theory posits that organisations are affected by their environment and in a bid to manage this dependencies, organisations find ways to collaborate with other organisations to survive (Hillman, Withers and Collins, 2009).

Firms can strengthen their collaboration and inter- coordination between the partners of their supply chain when resource dependence is adopted and recognized during supply chain uncertainties (Paulraj and Chen, 2007). This theory falls in line with the study since it considers the environmental influence on organization's actions, performance and business continuity.

3.3 Supply Chain Resilience

Supply chain resilience (SCR) enables firms to quickly respond to uncertainties and disruptions and in the course of sustaining operations, available resources and capabilities are reconfigured (Piprani, Mohezar and Jaafar, 2020). The concept of resilience is multi-dimensional and multidisciplinary (Ponomarov and Holcomb, 2009) and has been defined by many scholars such as Bonanno (2004), Masten (2014) and Yehuda, Flory, Southwick, & Charney (2006). Some researchers states that there is no consensus on the definition of supply chain resilience in the supply chain resilience literature (Spiegler, Naim and Wikner, 2012; Tukamuhabwa *et al.*, 2015). However, most researchers are of the same opinion that the concept of resilience is context and situation-dependent (i.e. Psychological, Social etc.) (Kaviani *et al.*, 2020).

In literature, resilience is generally defined as the ability of the supply chain to bounce back or recover to its normal state or even better when interrupted by disruptions. Resilience according to Klibi, Martel, and Guitouni (2010) refers to the avoidance of threatening disturbance. Others also define resilience as the ability of a system to return to its initial state or to a different or more desirable state after it has been disturbed (Carvalho, Barroso, Machado, Azevedo, & Cruz-Machado, 2012). Similarly, the concept of resilience is seen as a means for supply chain to recover quickly and less costly from disruptions originating from natural disasters (such as floods, earthquakes and tsunamis), medical emergencies (such as COVID- 19, H1N1 flu), technological

failures (software failures, system disruptions), disruptions from workers such as strike actions, misinformation sharing along the chain (Melnik *et al.*, 2014).

Schmitt and Singh (2011) also define resilience as the ability of a firm to sustain operation and recover quickly in the face of disruption. Pettit, Fiksel, and Croxton (2010) also sees resilience as the ability to adapt, grow and survive in the face of adversity. Wieland and Wallenburg (2013) viewed resilience as “the ability of a supply chain to cope with change”. In a more recent study, supply chain resilience is defined as the ability of supply chains to promptly respond to disruptions and restore operations to their pre-disruptive state or to an enhanced state (Piprani, Mohezar and Jaafar, 2020).

3.4 Evolution of supply chain resilience

Supply chain resilience arose from a bigger resilience concept from other disciplines including ecology, sociology, psychology and management studies (Ponomarov and Holcomb, 2009). From the field of ecology, the concept was used to study how living systems bounce back from disturbance. Sociologists and psychologists investigated what makes individuals and communities resilient after impediments and also management studies looked at the role of personal resilience in organizational leadership (Adger, 2000; Bonanno, 2004). The supply chain resilience concept gained attention in the early 2000s after the works of Christopher and Peck (2004) and Sheffi and Rice (2005) were published. However, the concept was well known in other disciplines.

It is purported that the application of resilience to supply chain management arose from the indication that the business environment is becoming more tempestuous (Hamel and Välikangas, 2003) and the rise of global supply chain and disruptions keep affecting the supply chain (Hendricks and Singhal, 2005). Also, the realization that the traditional risk management techniques had deficiencies in its ability to foster more resilient enterprises contributed to the

stimulation of resilience application in supply chain management (Pettit, Croxton, & Fiksel, 2019). Attention was given to the concept of supply chain resilience in the early 2000s after publications of research on supply chain resilience by Christopher and Peck (2004) and Sheffi (2005). Since then, several publications have been made on the concept of resilience in the supply chain management literature.

3.5 Supply Chain Resilience Strategies

Several authors have explored principles/ strategies / enablers that make supply chain to be resilient. There are different terminologies used by scholars when it comes to factors that help build supply chain resilience, some use elements, enablers, capability and antecedents. Strategies are employed by many firms to prepare for, respond and recover quickly from supply chain disruptions and any environmental uncertainties (Ali, Mahfouz, & Arisha, 2017). Strategies can be classified into three major categories; concurrent, proactive and reactive (Hollnagel, 2011).

Proactive strategies are referred to as capabilities and preparations that are needed in pre-disruption phase (Ponomarov and Holcomb, 2009; Ambulkar, Blackhurst and Cantor, 2015). Concurrent strategies correlates to first- response abilities and rapid reactive thinking that are used during disruptions phase to deal with disturbances (Hollnagel, 2011). Reactive strategies on the other hand, refer to the various competencies that are required in the post-disruption phase in order to bounce back from disruption and recover to the original or desired state (Schmitt and Singh, 2011; Btandon-Jones *et al.*, 2014).

Strategies can also be classified without taking into consideration when it should be deployed, these includes; examining the actors involved and this has to do with whether a strategy is deployed by a single firm or collaboratively with other members of the chain (Scholten and Schilder, 2015)

and examining whether a strategy support robustness and/or agility of supply chain to threat (Wieland and Wallenburg, 2013).

It is conceived from the concept of supply chain resilience that not all risks are avoidable (Jüttner and Maklan, 2011; Hohenstein *et al.*, 2015) hence, by building a resilience capability, supply chain disruptions can be managed and be responded to quickly. In responding to this disruptions, many strategies are proposed in improving the resilience of supply chains. Hohenstein *et al.* (2015) pointed out that improving flexibility, creating redundancy, improving supply chain agility, building collaborative supply chain relationships and enhancing visibility can be considered as supply chain resilience strategies. Christopher and Peck (2004) reported that supply chain reengineering, collaboration, agility and supply chain risk management culture are the main principles for supply chain resilience.

Agarwal, Seth, and Agarwal (2020) argue that flexibility, redundancy, agility, collaboration, information sharing, visibility are the most identified characteristics in the extant literature in building supply chain resilience.

Likewise, Soni, Jain, and Kumar (2014, p. 14) identified 14 elements forming supply chain resilience “agility, collaboration, visibility, risk management culture, adaptive capability, risk and revenue sharing, trust among players, information sharing, sustainability, corporate social responsibility, information security, supply chain structure, strategic risk planning, and knowledge sharing”. Similarly, Ponomarov and Holcomb (2009, p. 129) discussed the following elements as supply chain resilience builders “agility, responsiveness; visibility; flexibility/redundancy; structure and knowledge; reduction of uncertainty, complexity, reengineering; collaboration; integration, operational capabilities, and transparency”.

Several supply chain resilience strategies have been identified in the literature; however, agility, redundancy, collaboration and information sharing are focused on in this study. These strategies were selected because they appear to be the most cited and dominant strategies established in the literature (Ponis and Koronis, 2012; Hohenstein *et al.*, 2015; Tukamuhabwa *et al.*, 2015).

3.6 Hypothesis Development

3.6.1 Agility

Agility is a concept that emerged to address how firms can operate and develop in an ever-changing and tempestuous environment. The agility concept aids firms to be proactive in their businesses (Ismail, Poolton and Sharifi, 2011). Agility is a resilience strategy used to face environmental changes quickly with conforming organisational actions (Christopher and Peck, 2004; Ponomarov and Holcomb, 2009). Agility is defined as “the ability of a supply chain to rapidly respond to change by adapting its initial stable configuration” (Wieland & Wallenburg, 2012, p. 890). The supply chain is said to have two dimensions: a proactive dimension that deals, and reactive dimension that deals with agility.

According to Christopher & Peck (2004), agility is determined by two essential factors which are visibility and velocity. Visibility is related to the ability to track and trace goods through a system along the whole supply chain. Velocity on the other hand deals with flexibility and adaptability during disruption. Factors such as communication, cooperation and integration have influence on agility (Wieland and Wallenburg, 2013). Agility is considered to be among dominant strategies which helps to realize resilient supply chain as the concept evaluates the ability to quickly respond to changing conditions in the environment (Christopher & Peck, 2004; Tukamuhabwa, Stevenson, Busby, & Bell, 2015).

Agility, also, serve as a risk management strategy that aid firms to deal with actual or potential supply chain disruption rapidly (Braunscheidel & Suresh, 2009; Sodhi, 2014). There are different types of agility; technology agility and process agility (Ismail, Poolton and Sharifi, 2011). Technology agility has to do with the ability to quickly adapt to current technologies in the system. Process agility is the ability to redesign and reconfigure a business process in response to environmental changes.

With the above discussions on agility as strategy to quickly respond to sudden changes, it can be argued that firms' that adopt agility performs better than their peers in terms of financial performance. The linkage between agility and firms' financial performance was examined in previous studies and it was established that there is a significant relationship between agility and firms' financial performance (Li, Wu, Holsapple, & Goldsby, 2017; Musa & Nyoman Pujawan, 2018). Also, agility indirectly influences firm's performance through risk management performance (Liu *et al.*, 2018) and cost efficiency (Yang, 2014). Therefore, the following hypothesis is formulated.

H_{1a}: Agility in supply chains influences a firm's financial performance.

The effect of agility practices on sustainability (Economic performance, Social performance and environmental performance) has been examined and it was found out that there was a significant relationship between the two constructs (El-Khalil and Mezher, 2020). Agile practices are perceived to have higher impact on sustainability. Cadden, Cao, Treacy, Yang, & Onofrei (2021) posits that improvements of agility practices will cause a change in improving the dimensions of sustainability (social, economic and environmental). Also, Goldman et al. (1993) as cited in (El-Khalil & Mezher, 2020) suggested that agile manufacturing is divided into dimensions. In their view, an agile manufacturing entails acknowledging the significance of employees in firms by

developing their education skills, training and proper workplace. The following hypothesis is proposed in light of the aforementioned.

H_{1b}: Agility in supply chains influences a firm's employee wellbeing.

The integration of agility and sustainability is beneficial due to its ability to reduce the impact of raw material consumption on the environment. Agile practices aim at effectively and efficiently utilizing resources to improve performance (Chen, 2017). Similarly, practicing sustainability leads to reduction of waste such as raw materials. Hence, agile practices in firms are perceived to influence sustainability. Therefore, the following hypothesis is proposed.

H_{1c}: Agility in supply chains influences a firm's raw material consumption.

3.6.2 Redundancy

Redundancy is another strategy for improving supply chain resilience. Christopher & Peck (2004) posits that redundancy encompasses the tactical and selective use of inventory and additional capacity that is needed in time of crisis be it shortage of supply or increase in demand.

Redundancy is recommended as an effective strategy that is used in creating resiliency and also serve as a tool for rapid recovery from supply chain disruptions (Sheffi & Rice, 2005). Alternatively, redundancy relates to keeping resources in reservation for use in case of any disruptions. Examples of forms of redundancy includes; use of multiple suppliers, deliberate low capacity utilization, safety stock, over capacity, additional or back up suppliers (Sheffi & Rice, 2005; Sodhi, Son, & Tang, 2012; Tomlin, 2006). Kamalahmadi, Shekarian, & Mellat Parast (2021) indicated that firms can deal with disruptions and increase their responsiveness in times of crisis by creating redundancies across their supply chain.

According to Fraccascia, Yazan, Albino, and Zijm (2020) redundancy in supply chain refers to number of suppliers that a firm have for its product or service. It is suggested that firms can manage the risk of their disruption affecting their suppliers by adopting a multiple sourcing strategy for their inputs or raw materials (Behzadi, O’Sullivan, Olsen, Scrimgeour, & Zhang, 2017; Hohenstein et al., 2015; Kamalahmadi et al., 2021; Tang, 2006; Tang & Tomlin, 2008). Hence, when one supplier fails to deliver, the firms can fall on another for its raw materials or parts supply.

Shekarian, Nooraie, and Parast (2020) conducted a literature review on the various resilience strategies and the study showed that redundancy is among the most important supply chain resilience strategies that is responsive to cope with supply chain disruptions. Also, Ratick, Meacham, and Aoyama (2008) conducted a study by developing a set cover location model for a supply chain that relies on emergency backup and storage facilities and used the distance minimisation of the separation distance between the facilities as performance measure. The researchers concluded that redundancy is a powerful strategy that helps firms to be responsive to supply chain disruptions. Additionally, Tan, Cai, and Zhang (2020) found out in their study that a strategy of redundant capacity aids a supply chain network to have lower-time-to-recover and back up supply chain strategy has the lowest cost among all the strategies. Their study was about using simulation –based analysis for decision makers to determine the strategies that best fit in building resilience supply chain network.

Every firm aims at achieving a high financial performance; hence strategies are adopted to realize this goal. Redundancy as a resilience strategy was link to financial performance to ascertain the kind of relationship that exist between the two. The result shown a significant relationship (Musa and Nyoman Pujawan, 2018). Therefore, a hypothesis is proposed to be tested.

H_{2a}: Redundancy in supply chains influences a firm’s financial performance.

The wellbeing of employees contributes to the survival and growth of businesses. Hence, measures need to be in place to see to its manifestation. Considering redundancy as one of the resilience strategies to reduce disruption will in turn create a conducive atmosphere for employees in firms. This assertion of redundancy having impact on employee's wellbeing implies there exist a relationship between these two constructs. Thus, the study intends to examine the relationship between redundancy and sustainability emphasizing on employee wellbeing.

H_{2b}: Redundancy in supply chains influences a firm's employee wellbeing.

Redundancy, as a resilience strategy, is used to manage uncertainties. The adoption of redundant strategy requires utilisation of resources to create safety stocks and buffer stocks. Redundancy as used for minimising uncertainties results in sustainability of firms. Firms' demand of raw materials envisage the influence of redundancy on its consumption. Hence, a hypothesis is proposed to be tested.

H_{2c}: Redundancy in supply chains influences a firm's raw material consumption.

3.6.3 Information Sharing

Information sharing is an important instrument for the continuity of every business and key strategy to dealing with supply chain disruptions. Christopher and Peck (2004) asserted that in reducing risk and disruption in supply chains, members of the chain should exchange information. This practice will aid in building resilient supply chain. Information sharing also helps to identify potential problems in the supply chain (Macdonald *et al.*, 2018). Information sharing as a strategy also relates to other strategies such as collaboration. Collaboration can only take place when each member of the supply chain receives relevant and coherent information efficiently and effectively. Blackhurst, Dunn, and Craighead (2011) did a multi-case analysis and found six out of seven

enterprises highlighted the need for effective communication in order to minimize the impact of disruptions through information sharing.

Knowledge is now a primary resource in today's world in the economic sense, whereas production factors such as labour, raw materials and capital have become secondary resources (Demirel and Goc, 2013). Information sharing is among the most important element of coordination between partners along the supply chain. Efficiency of the supply chain can be increased through the application of information sharing by balancing production (Lee and Whang, 2000). In literature, some studies aimed at examining the effect of information sharing on firms' performance. Baihaqi and Sohal (2013) in their study tested the relationship between information sharing and organization's performance. Also, Şahin and Topal (2019) examined the relationship between information sharing and financial performance of firms and established that there is a direct positive relationship between the two. Cook, Heiser and Sengupta (2011) suggested that there is a significant relationship between information sharing and firm's performance. Hence, a hypothesis is formulated to test the relationship between the two constructs.

H_{4a}: Information sharing between supply chain partners influences a firm's financial performance.

Information sharing is seen as an instrument that benefit employees and firms as a whole (Campbell, Erkens and Loumioti, 2014). Shared information among partners and employees improves their performance leading to overall business performance. Hence, this study proposes the hypothesis below to test the relationship between information sharing and employees' wellbeing in the manufacturing industry in Ghana.

H_{4b}: Information sharing between supply chain partners influences a firm's employee wellbeing.

Accurate and timely information sharing among partners enhances their raw material utilisation effectiveness. Thus, information sharing is seen as a tool in managing firms' resources. The higher the level of accuracy in information shared among partners, the higher the efficient use of resources. Therefore, the study intends to test the relationship between information sharing among supply chain partners and firms' raw material consumption.

H_{4c}: Information sharing between supply chain partners influences a firm's raw material consumption.

3.6.4 Collaboration

Collaboration is considered as one of the most important strategy in building resilience strategy in literature (Ahmed & Sobuz, 2019; Christopher & Peck, 2004; Jüttner & Maklan, 2011; Pettit, Croxton, & Fiksel, 2013). Cao, Vonderembse, Zhang, and Ragu-Nathan (2010) argue that supply chain collaboration is a strategy used in building competitive advantage in recent times, and involves firms leveraging on the ideas and resources of their suppliers and customers, coordinating and sharing information across the supply chain (Caridi, Cigolini, & De Marco, 2005; Lejeune & Yakova, 2005; Verwaal & Hesselmann, 2004).

Collaboration in supply chain relates to two or more separate firms working diligently together to plan and execute supply chain operations toward a common goal than can be achieved in isolation (Cao *et al.*, 2010). Collaboration is described by Richey (2009, p. 623) as the "glue that holds supply chain organisation in a crisis together". In a survey conducted by Soni *et al.* (2014), collaboration was ranked second among 14 enablers of supply chain resilience which makes this strategy a powerful one in building resilience. Barratt (2004) cited that mutual benefit, risk sharing and rewards are the foundation of collaboration. Daugherty *et al.* (2006) added that collaboration

relates to developing strategic plans together, information sharing among firms and coordinating operations.

Cao et al. (2010) links collaboration to collaborative activities of resource-sharing, generation of ideas together, joint decision making, collaborative communication and similarity of goals. More so, collaboration in supply chain facilitates the development of interactions among partners, joint planning and communication that is needed for preparation towards reducing the impact of supply chain disruptions by responding rapidly to any such occurrences (Whipple and Russell, 2007).

Zacharia and Mentzer (2004) noticed that firms do not have all their required resources and at times manufacturing some of these resources are not attainable. Hence, firms need to collaborate with other partners of the supply chain to help curb shortage of resources. Also, collaboration as a strategy is needed because its absence have adverse effect on togetherness of partners of the supply chain and development of other strategies as well (Cao and Zhang, 2011). In the opinion of Jüttner and Maklan (2011) and Ponomarov and Holcomb (2009), supply chain resilience cannot be attained unless all firms in a supply chain collaborate and respond to disruptions jointly in case of any such occurrence. This denotes that collaboration in supply chain is vital in supply chain resilience. Jain, Kumar, Soni, and Chandra (2017) and Li, Fan, Lee, and Cheng (2015) added that high level of collaboration can assist in lessening disruptions. Gold, Seuring, and Besk (2010) stated that collaboration can reduce overall cost and uncertainty.

The relationship between collaboration as a supply –chain strategy and sustainability has been empirically investigated in earlier studies. Cao and Zhang (2011) established that collaborative relationship built among firms improves management performance. Also, Chin, Tat, & Sulaiman (2015) investigated the relationship between collaboration and sustainable performance in green supply chain management and found out that there is a significant link between these constructs.

Additionally, Min et al. (2005) posit that collaborative relationship among supply chain partners in firms increase profitability and efficiency of these firms. LEE and HA (2020) examined the influence of supply-chain collaboration on sustainable supply chain management performance and revealed that collaboration has a positive impact on sustainable performance. Musa and Nyoman Pujawan (2018) also makes emphasis that there is a significant correlation between collaboration and firms' financial performance. On the contrary to earlier findings on the impact of collaboration on performance including financial performance of firms, Blome, Paulraj, and Schuetz (2014) study suggested that supply chain collaboration does not have direct impact on sustainability as well as the financial performance of firms. Accordingly, collaboration is expected to have an impact on firms' performance, hence the following hypothesis is formulated.

H_{3a}: Collaboration between supply chain partners influences a firm's financial performance.

Currently, the firms' focus on performance has changed. The focus on increasing economic performance primarily with regards to achieving success in overall market strength and assets has changed due to global environmental demands. Hence, attention has been shifted to environmental and social performance while achieving economic performance as well in order to attain a higher level of sustainability performance (Carter and Rogers, 2008). Additionally, in order to achieve long-lasting competitive advantage that aids in firms' sustainable operation, it requires economic, social and environmental prowess of the firm (Paulraj, 2011). Therefore, the following hypothesis will be tested.

H_{3b}: Collaboration between supply chain partners influences a firm's employee wellbeing.

Environmental collaboration entails cooperating with suppliers to improve waste reduction initiatives and achieving environmental objectives (Paulraj, 2011). Previous studies find support

for the positive impact of environmental collaboration on environmental performance as well as sustainability (Flynn, Huo and Zhao, 2010; Gimenez, Sierra and Rodon, 2012; Schoenherr and Swink, 2012). Therefore, the following hypothesis is proposed.

H_{3c}: Collaboration between supply chain partners influences a firm's raw material consumption.

3.7 Sustainable Operations

Sustainability is generally defined as the capacity to continue activities or processes for an undefined time period (Ilic-Krstic, Ilic, & Avramović, 2018). The term sustainability is defined by many scholars such as Stoddart (2011), Ben-Eli (2015) and Basiago (1998), but, the most used definition was developed in 1987 by Brundtland Commission formally known as the World Commission on Environment and Development (WCED) and it states that “sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs” (Miller & Engemann, 2019, p. 252).

Sustainability management is a process of directing a company towards achieving its goals (Schaltegger *et al.*, 2014). Sustainability management takes into account environmental factors, social aspects of organisational activities as well as economic performance (Seuring and Müller, 2008). It is argued that sustainability should be part of supply chain management (Pagell and Shevchenko, 2014).

Sustainability has three pillars: economic, social and environmental. Economic dimension of sustainability helps to save money by reducing waste. Examples include optimizing of profits, and reverse logistics. Social dimension on the other hand, relates to sustainable behaviour that benefits stakeholders of a company and this includes workers, thus, promotion of wellbeing. Environmental dimension has to do with reduction of waste (Miller and Engemann, 2019). This includes reducing

a firm's carbon footprint, improving the surrounding environment of the workplace, improving the basic needs such as water and air in the working environment as well as the surrounding community (Rezaee *et al.*, 2019).

3.7.1 Economic Dimension of Sustainability of Firms

The economic dimension of sustainability has to do with the economic benefits realized by firms as well as the profits earned and long-term viability of financial resources (Sloan, 2010). According to Sloan (2010), this dimension goes beyond the internal generated returns or profits earned by a particular firm and some of the various indicators of this dimension cannot be easily measured. Sloan (2010) further grouped factors that are used in measuring economic dimension of sustainability into four categories; this includes Economic performance, Financial health, Market and structure and Institutions/ Systems. Economic performance relates to the capability of the firm to perform its operations effectively as well as the market value of the firm. Examples of indicators of economic performance are Productivity, Order fill lead time, Market value and Product defect rate. Financial health has to do with the well-being of a firm in terms of financial resources. Examples of indicators for financial health includes Return on working capital and Profitability ratio. Market and structure; refers to the formation of the supply chain and the measurement metrics for this category includes Market share, Degree of vertical integration and the breadth of customer base. Institutions / Systems on the other hand refers to both internal and external systems, activities, procedures relating to economic aspect of firms. The measurement metrics: quality management system used by firms and Regulatory compliance.

3.7.2 Social Dimension of Sustainability of Firms

Relating to the social side of a sustainable operation, it is expedient that the human capital of the firm is developed. Social sustainability is achieved by improving and providing fair and favorable

conditions of service to labour in firms and those who are indirectly affected by the firm's performance. Sloan (2010) continued to group the performance indicators for social sustainability into three categories: Workplace, Community and Institutions/ Systems.

Workplace has to do with internal human capital. Examples of measurement items are employees' wages, opportunities for career development and health benefits. Community refers to people outside the firm and example of measurement metrics is product liability. Institutions/Systems refers to the procedures and systems that relate to the social dimension. Examples of social metrics; Health and safety measurement system in use and Regulatory Compliance.

3.7.3 Environmental Dimension of Sustainability of Firms

Environmental sustainability can be achieved by reducing the ecological footprint of a firm. Labuschagne, Brent, and van Erck (2005), Handfield, Sroufe, and Walton (2005) and Sloan (2010) identified some factors that are associated with environmental sustainability. These factors include air resources – which has to do with the amount of pollution a firm contribute to air quality effect. Examples of measurement items; emissions, use of ozone depleting substances. Water resources – this has to do with a firm's impact on both quantity and quality of water, thus total usage as well as toxic discharges and pollutants. Examples of measurement items; water used and reuse. Land resources also refers to impact of firm on usage of land. Example of measurement items; land fill waste. Minerals and energy resources- use of non- renewable minerals and energy resources. Example of measurement items; total energy used. Materials – the type of material used, and the quantity of the material used. Examples of measurement items; hazardous material content and raw material consumption.

This study focuses on firm performance, employee wellbeing and raw material consumption as measurement items related to economic, social and environmental dimensions of sustainability respectively.

3.8 Disaster Management

The term “disaster” refers to “a serious disruption of the functioning of society, causing a widespread human, environmental, material losses which exceed the ability of the affected people to cope only using its own resources” (United Nations, 1992, p. 21). Disasters can be man-made or natural. Disasters have significant impact on supply chain performance, and hence, the need to manage their occurrence and effects on supply chains.

In managing disasters, four key stages are widely suggested in literature; mitigation, preparedness, response and recovery (Kumar & Harvey, 2013; Shareef *et al.*, 2019; Damoah, 2021). The period between preparedness and recovery is crucial in managing disaster. Mitigation stage has to do with taking structural and non- structural measures to limit the adverse effect of disasters. Preparedness involves undertaking activities such as keeping inventory, engaging multiple suppliers to ensure effective response to disasters. Response on the other hand, refers to the support or the aid given during or after a disaster. Recovery stage entails the actions and decision to restore the original state of the supply chain.

3.9 Related Empirical Research

This section reviews the empirical studies on the concept supply chain resilience sustainability. The review focuses on uncertainties that affect supply chain, various resilience strategies employed by firms, works on resilience and sustainability and findings that are vital and prominent to this study.

3.9.1 Environmental Uncertainties Affecting Manufacturing Supply Chain

Bae (2017) investigated the link between perceived environmental uncertainty, supply chain integration and performance. The study also tested direct, indirect and total effects among the variables. The study considered firms that have made foreign direct investment in China; hence the study population was Korean manufacturing firms in China. Data was collected through questionnaire and 208 firms were used for the study. The study identified four dimensions of environmental uncertainties affecting the supply chain. These were: munificence, dynamism, hostility and heterogeneity. Structural equation modelling was used to analyse the relationships among the variables. The study concluded that there is a negative effect of perceived environmental uncertainty on performance.

Ganbold and Matsui (2017) examined the impact of environmental uncertainty on supply chain integration initiatives drawing on the resource-dependence theory. The study classified environmental uncertainties based on three sources: supply, demand and technology uncertainties. Under each of the sources, examples were enumerated. Supply uncertainty (delivery dependability, quality of incoming materials, lead time and supplier's engineering level), demand uncertainty in terms of timing, volume mix and place and technology uncertainty (obsolescence of technology).

A quantitative approach was used for the study. Data for the study was collected through a survey with 108 manufacturing firms in Japan and the survey instrument was mailed to the various firms.

Analysis of data was done using structural equation modeling through partial least square approach. Smart PLS version 3.1.3 was used for the data analysis. The study contributed to the knowledge base and provided empirical support for resource-dependency theory. The findings supported the notion of resource-dependency theory which states that under condition of

uncertainty, firms attempt to interact closely with their supply chain partners to manage unfavorable outcomes of such uncertainties.

Yu, Cadeaux, Luo, Qian, and Chen (2018) offer understanding on how consistency between objective and perceived environmental uncertainty might affect supply chain flexibilities. Case study approach was adopted. Four cases were selected in two different manufacturing industries in China. The study measured perceived environmental uncertainties in terms of munificence and instability and environmental uncertainty was analysed from two dimensions: demand uncertainty and competition uncertainty. The case analysis presented different effects of environmental uncertainty on supply chain flexibility.

3.9.2 Supply Chain Resilience and Supply Chain Performance

A resilient supply chain network not only enable firms to absorb disruption through their available resources and capabilities, but also to speedily and return to normal conditions (Pettit et al., 2013). Evidently, from literature the longer a firm takes to respond to any turbulence, the greater the damage it causes (Gunasekaran, Subramanian and Rahman, 2015) and this can be detrimental to a firm's performance.

Piprani et al. (2020) examined the influence of supply chain integration (SCI) on supply chain performance using supply chain resilience as a mediating variable between the SCI and supply chain performance of large –scale manufacturing firms in Pakistan. A quantitative approach was employed, and questionnaire survey was used for data collection. The study took into account the supply chain resilience as a single dimension and incorporated quick response to disruptions, firm's connectedness with partners, preparedness of the supply chain for unforeseen events and the maintenance of control mechanism as measuring items for supply chain resilience. Data for the study was collected from 182 manufacturing firms in Pakistan and the Structural Equation

Modeling (SEM) was employed by using the partial least square method (SMART PLS version 3.2.7) for assessment of the inter relationship among the different latent variable and other analysis. The study concluded that supply chain integration significantly has influence on supply chain resilience and supply chain resilience improves and have impact on supply chain performance. But the association between supply chain integration and supply chain performance was not linear, rather determined by the levels of supply chain resilience.

Similarly, Chowdhury, Quaddus, and Agarwal (2019) investigated how supply chain resilience enhances the performance of supply chain of organisations in an operating context by focusing on two variables (supply chain relational practices and network complexities). The study used the mixed method research approach (qualitative and quantitative approaches). Data for the study was collected through a survey questionnaire of 274 apparel manufacturers and their suppliers in Bangladesh for the quantitative approach, while in-depth interviews with 15 supply chain managers from apparel manufacturers, accessory producers and buying agents was conducted for the qualitative approach. The study adopted flexibility, redundancy, visibility and collaboration as supply chain resilience sub-constructs. Data was analysed by using Hayes PROCESS enabled multiple regression and structural equation modelling. The study revealed that supply chain relational practices and network complexities moderated the link between supply chain resilience and supply chain performance. Also, the study further revealed that there is a relationship between supply chain resilience and supply chain performance and it via the interaction effect of supply chain relational practices and network complexities. The findings suggested that the supply chain resilience, which comprises of flexibility, redundancy, visibility and collaboration, has a significant positive relationship with supply chain performance. This indicated that increased supply chain resilience strengthens supply chain performance.

Ruiz-Benítez, López, and Real (2018) conducted a survey to investigate the relationship and links between lean and resilient supply chain practices and their impact on supply chain performance. Data was obtained from experts in the aerospace manufacturing sector through face-to-face interviews and survey questionnaire was administered as well. A total of 15 experts relating to a total of 14 aerospace manufacturing plants participated in the study. The aerospace manufacturing sector was chosen because both lean and resilient supply chain practices is of paramount importance to the sector.

The study used twelve resilient practices;

1. Use of control information system
2. Communication and information sharing with suppliers
3. Flexible supply base
4. Real option
5. Establishment of agreement between supply chain partners
6. Improve visibility, collaboration, coordination and understanding with suppliers
7. Maintaining excess capacity in productions, storage, handling and/or transport
8. Enforce security
9. Contingency planning
10. Disaster Recovery Planning
11. Alternative transportation routing
12. Visible transportation

Interpretive Structural Modelling (ISM) approach was employed in order to identify relationships among the various lean and resilience supply chain practices and supply chain performance metrics through a single systematic framework. The ISM model disclosed that lean supply chain practices

act as drivers for resilient supply chain practices. The study found out that resilience practices aid in recovery when faced with turbulence and improve performance but implementing it in parallel with lean practices can improve operational and economic performance of the supply chain. The study also found out that lean practices lead to higher performance improvement than resilient practices and this is as a result of the resilient supply chain practices not exerting influence over all the supply chain performance metrics used in the study as it occurred with the lean practices.

Altay, Gunasekaran, Dubey, and Childe (2018) examined the effects of supply chain agility and supply chain resilience on supply chain performance under the moderating effects of organizational culture. The study used the dynamic capability view (DCV) to conceptualise their theoretical models. Proposed hypotheses were examined using partial least squares and 335 responses were gathered from respondents in Indian organizations using questionnaires. The study suggested redundancy, robustness, collaboration, integration, flexibility are effective resilience strategies. The results indicated that supply chain agility and supply chain resilience are two important capabilities of supply chain and have significant influence on supply chain performance.

Donadoni et al. (2019) provides advance theoretical and managerial understanding around the management of supply chain disruptions. The study used two-stage process, the first stage focused on academic experts in the supply chain resilience field to help pinpoint major disruptions, strategies resilience metrics and industries that supply chain resilience of utmost concern. This stage was followed with the second stage with practitioners from automotive, food and electronics industries. Qualitative approach was used for the study and data were gathered from panel of academics and practitioner experts. 23 and 43 views were obtained from academic professionals and practitioner experts respectively. The study discovered several disruptions that affect supply chains: Network issue, Insolvency in supply chain, Demand-issue side, Quality incident, Natural

disasters, among others. Redundancy, Business continuity planning, Flexibility, Collaboration, Supply chain design and many others were suggested resilience strategies used to mitigate supply chain disruptions.

3.9.3 Supply Chain Resilience and Sustainability

Mehrjerdi and Shafiee (2021) examined sustainability and resilience in a close loop supply chain using multiple sourcing and information sharing strategies. Data were gathered from specialists and experts, who were asked to identify the impact of supply chain strategies on resilience. The resilience strategies employed for model development of resilient supply chain were information sharing and multiple sourcing. A multi-integer programming model was formulated for a closed-loop supply chain. The three dimensions of sustainability namely, economic (reducing total cost), social (job opportunities) and environmental (energy consumption, water consumption, emitted pollutants) dimensions were considered for the study. The results of the study highlighted the importance of combining resilience and sustainability in closed-loop supply chain.

3.10 Conceptual Framework

According to Camp (2001), a conceptual framework refers to a structure that best explains the natural progression of the phenomenon to be studied. The framework gives an explanation to how the research problem would be explored and also it depicts the various activities the researcher intends to carry out in the study. Additionally, the framework aids in specifying and defining the concepts within the problem of the study (Luse, Mennecke and Townsend, 2012). The framework also provides a picture or visual of how the ideas in the research are related (Adom, Hussein and Adu-Agyem, 2018). This study seeks to find out how supply chain resilience strategies have impact on sustainable operations. Hence, the independent variable consists of the resilience strategies and the dependent variables are the dimensions of sustainable operation.

The resilience strategies adopted for the study include agility, information sharing, redundancy and collaboration and also three dimensions of sustainability are used to measure the sustainable operations of firms. Under the three dimensions which are economic, social and environmental, three criteria are examined: financial performance, employee wellbeing and raw material consumption respectively.

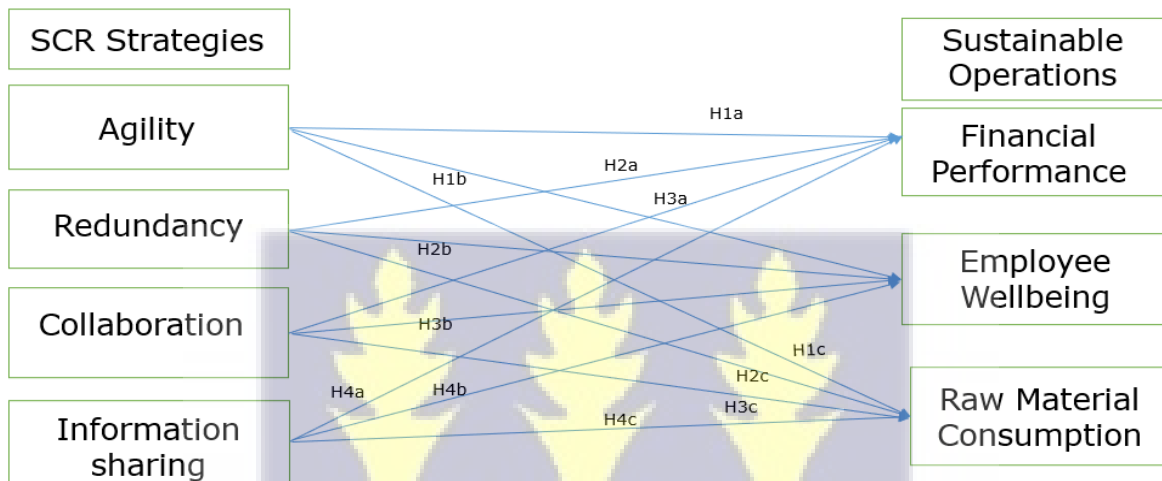


Figure 3.1: Conceptual framework

3.11 Summary of Reviewed literature

The purpose of this chapter was to provide an understanding of supply chain resilience, its strategies and impact on sustainable operations within the manufacturing firms. In summary, this chapter provided the empirical and theoretical review of the study. The empirical review pertains to the concept of supply chain resilience. It further reviewed the various strategies adopted by firms, the environmental uncertainties that affect firms' supply chain, dimensions of sustainability. The theoretical review highlights two main theories the Dynamic Capability View (DCV) and Resource Dependency Theory (RDT).

CHAPTER FOUR

RESEARCH METHODOLOGY

4.0 Introduction

This chapter presents the methodology of the study. It explains the methods used to achieve the objectives of the study. According to Taylor and Bogdan (1984), research methodology is defined as the way in which the researcher assesses and looks for solutions to the research problems. Again, Jansen and Derek (2020) defines research methodology as the practical ‘how’ of any given piece of research. It basically means how a research is designed to ensure reliable and valid results. The key methodological issues discussed in this chapter include the research approach, research design, the research population, the sample size, sampling techniques, data collection instrument, data collection procedure, data analysis and ethical considerations.

4.1 Research Approach

A research approach is a plan that gives guidelines on how a study should be conducted systematically and efficiently. Quantitative (structured), qualitative (unstructured) and mixed method research are the three major techniques to research (Boateng, 2018; Clark, Creswell, Green, & Shope, 2008). Qualitative approach tends to “explore meanings, attitudes, values and beliefs people associate with a phenomena in order to establish understanding, rather than to test a relationship” (Boateng, 2018, p. 25). This approach is used when describing the nature of a problem, issue or phenomenon. The quantitative approach is defined “as a formal, objective and systematic process to describe and to test relationships and examine cause and effect interactions among variables” (Burns & Grove, 1993, p. 777). The mixed methods approach tends to combine both quantitative and qualitative approach to conduct research.

As this study involves explaining causal relationships between resilience strategies and sustainable operations, it therefore required the collection and analysis of quantitative data. Hence, the quantitative approach is employed to address the research questions. A quantitative study is described as a research approach explaining a phenomenon by collecting numerical data that are analysed using statistical approaches (Aliaga & Gunderson, 2000). With quantitative approach, a researcher employs strategies of inquiry such as surveys and experiments and data which can be analysed statistically is collected (Clark *et al.*, 2008). The quantitative approach is employed in the current study to measure the extent to which supply chain resilience strategies do impact on sustainable operations of manufacturing firms in Ghana.

4.2 Research Design

The research design can be considered as the structure of the study and constitutes the blueprint for the collection, measurement and analysis of data. It can be described as the “Glue” that holds all the elements of the study together (Akhtar, 2016). Research design is defined as a master plan that indicates the strategy for how a research is to be conducted (Kothari, 2004). It can also be defined as “a plan that involves a set of decisions regarding what topic is to be studied among which population with which research methods for what purpose” (Babbie, 2004, p. 112). Research design also serves as a guide and makes it possible for smooth sailing of the various research procedures to achieve maximum results with a minimum effort and time. Additionally, it boosts the validity of data for a given research problem (Mohajan, 2017).

Depending on the goal of the research, it might be classed as exploratory, explanatory and descriptive. It is envisaged that the purpose of the research can sometimes be more than one, depending on the research questions being asked. Thus, it can be explanatory and at the same time exploratory in nature. Exploratory research aims to investigate a topic about which little is known

or on which little study has been conducted, either in context or on the research topic in that context (Boateng, 2018). Exploratory research does not try to provide the final and conclusive answers to research questions, but just to explore the research topic with varying level of depth (Boru, 2018). Therefore, the premise of exploratory research is to tackle new problems or topic on which little or no research has been done (Brown and Lilford, 2006). Descriptive research on the other hand, seeks to systematically describe phenomenon, situation or problem. It usually ask the ‘what’ question (Boateng, 2018). Also, descriptive research paints a picture of a situation, person or events or demonstrate how things are connected and how it naturally occurs (Moizer, 2007), Explanatory research seeks to understand a phenomenon, situation or problem. It usually enquires as to ‘how’ and ‘why’ a certain phenomenon occurs, or whether there is link a between two or more components that cause a phenomenon (Boateng, 2018). The main focus of explanatory research is gaining more insight and familiarity on a research area and for the goal of developing hypothesis or outlining a problem for more precise investigation (Akhtar, 2016). It is conducted to discover and report some relationships among different aspect under study (Boru, 2018).

In conducting explanatory research, the researcher needs to identify the study problem and formulate questions and hypothesis to aid in data collection. This study is explanatory in nature as it tries to explain the resilience strategies of manufacturers and ascertain the extent to which manufacturing supply chains are resilient as well as the impact of resilience strategies adopted by manufacturing firms to enhance their sustainable operations.

4.3 Study Population

The study population is the group of individuals or participants in a study. This study focuses on manufacturing industry in Ghana. The manufacturing subsectors considered for the study include pharmaceutical industry, textiles and clothing, food processing and soap and detergent. The

participants in this study comprises of owners/managers, general managers, operation managers and supply chain and procurement managers of the sampled manufacturing firms. According to the Integrated Business Establishment Survey (IBES) 2015, the manufacturing establishments in Ghana amounted to 99,437.

4.4 Sample Size

A sample is a subset of the target population that has been chosen for study participation (Boateng, 2016). Sample size has effect on the precision of the representation of the population. In determining the sample size for the study, the formula proposed by Cochran (1963) was used. Cochran's formula is ideal for populations that are large, and a representative sample is needed.

Cochran formula is given as:

$$n_o = \frac{Z^2 pq}{e^2}$$

Where;

n_o denotes the required sample size

Z (1.64) denotes the critical value selected at a confidence level of 90%.

p (0.5) denotes the estimated maximum variability of the population.

e (0.05) denotes the desired precision level

q (1-P)

$$\text{Hence, } n_o = \frac{(1.64)^2 (0.5)(1-0.05)}{(0.05)^2} = 269$$

The sample size considered for the study is 269 manufacturing firms in Ghana based on the Cochran formula for sample size determination. As part of the effort to identify the minimum sample size of 269, the researcher used a multiple search approach, including emails search, face-to-face identification and LinkedIn. The search results is summarized in Table 4.1 below. The LinkedIn was unlimited because the survey link was shared on various professional LinkedIn platforms such Ghana Association of Industries.

Table 4.1: Distribution schedule of questionnaire

Medium of distribution	Number of questionnaires distributed
Emails	101
LinkedIn	Unlimited
Face- to-face	118

4.5 Sampling Technique

Researchers find it difficult at times to study all the element within a given population due to reasons such as time constraints, logistical constraints, and unavailability of respondents and other compelling reasons. Hence, there is the need to go through some methodical procedure to select only some of the elements within the population for the study and this is referred to as sampling. Sampling involves selecting a representative subset of the population called sample and it makes research precise and efficient (Showkat and Parveen, 2017). A sample was drawn from the total

population of manufacturing firms in Ghana. Convenience sampling was used to select the firms. The firms were selected based on their availability. Also, the study is limited to manufacturing firms in Ghana.

This study employed the non-probability sampling technique, and the purposive sampling technique was selected for the study. Non-probability sampling is a sampling technique in which samples are selected through a process without giving equal chance to each element in the population. According to Boateng (2018), purposive sampling involves selecting a sample based on the researcher's judgment about some suitable characteristics required of the sample. Purposive technique is employed in this study to select owners /managers, general managers, operations managers, supply chain and procurement managers from whom the data was collected. Purposive sampling was employed because this sampling technique allows a researcher to select respondents that have suitable characteristics needed to answer the research question being asked.

4.6 Sources of Data and Data collection

Data can be grouped into primary and secondary data. The study relied on primary source of data. Primary source of data is a first-hand data gathered by the researcher. The primary data is obtained from owners/managers, general managers, operations managers and supply chain and procurement managers from the various selected manufacturing firms who had the required information to respond to the questionnaire. The instrument used in gathering primary data was a questionnaire. The questionnaire sought information on the various uncertainties that affect the firms' supply chains, the resilience strategies adopted by the firms to deal with supply chain disruptions and how these supply chain resilience strategies affect sustainability of their operations.

4.7 Data Collection Instrument

In preparation of the questionnaire instrument, the research questions informed its design. The questionnaire was developed from constructs and measurement items which were largely adapted from literature. The questionnaire was made up of two parts. The first part sought information about the demographic profile of the respondents and the firms. Demographics such as the gender, age, educational qualification, position held in the firm, the number of employees in the firm and how long the firms have been in existence. The second part sought information on the key constructs of the research, thus the supply chain resilience strategies (agility, information sharing, redundancy and collaboration) and the three dimensions of sustainability (economic, environmental and social). The second part of the questionnaire was further divided into three sections; Section A obtained responses for supply chain resilience strategies that are adopted by firms to enhance their supply chain performance; Section B was developed to enquire about the dimensions of sustainable operations embraced by the firms and Section C asked about the key environmental uncertainties affecting firms' supply chains. A 5-point Likert Scale was developed for all the research variables where **1=Strongly Disagree**, **2 =Disagree**, **3 =Neutral**, **4 =Agree**, **5= Strongly Agree**. Table 4.1 below shows the resilience strategies, dimensions of sustainability and factors of environmental uncertainties that were measured, number of items under each construct and the sources where they were taken.

Table 4.2: Questionnaire Instrument

Construct	Number of items	Sources of the items
Agility	7	Muricho & Muli, (2021)
Redundancy	7	Park, (2011)

Collaboration	7	Muricho & Muli, (2021)
Information Sharing	6	Park, (2011)
Financial Performance	5	Abeysekara et al., (2019)
Employee Wellbeing	5	Pradhan & Hati, (2019)
Raw Material Consumption	5	Costa et al., (2020)
Supply Uncertainty	5	Chen & Paulraj, (2004); Qi et al., (2011)
Demand Uncertainty	6	
Technology Uncertainty	5	

4.8 Data Collection Procedure

The data collection instrument used in this study is questionnaire. The self-administered questionnaire is used because of the large sample size. One questionnaire was administered to one of the positions deemed appropriate to respond. These included owners/managers, general managers, operations managers, supply chain and procurement managers in the Food processing, Textiles and Clothing, Pharmaceuticals and Soap and Detergent sub-sector of the manufacturing industry. Only one respondents per firm was required. The numbers of the industries were not predetermined, it was followed by the analysis of the work.

An introductory letter from the University of Ghana Business School accompanied the distributed questionnaires. The purpose of the letter was to introduce the researcher as well as the purpose of the study to the firms to facilitate access. The researcher personally met some of the respondents to administer the questionnaire, survey links were shared on LinkedIn and sent via emails to some respondents. Where respondents that were approached physically completes the questionnaire instantly, the completed questionnaire were collected immediately. However, in cases where the

respondents couldn't complete the questionnaire immediately due to busy schedule or some other important issues, some days were given to them to respond to the questionnaire. Follow-ups were made to respondents who could not complete the questionnaire instantly through phone calls, emails and personal visits.

After the collection of responses from respondents, close examination of responses was done in order to determine and confirm those that were not properly completed. Poorly completed questionnaires were not used in the study. This resulted in a total of 202 responses received from respondents. Of the 202 responses, 16 incomplete responses were discarded.

Accordingly, all reported statistics and analysis were based on a sample of 186 manufacturing firms. Although the target population was not met, this is similar to other surveys that targeted owners and managers (Ganbold & Matsui, 2017; LEE & HA, 2020; Sanders & Premus, 2005). The data collection lasted for a period of two months, from June to July, 2021.

4.9 Data Analysis and Presentation

Data analysis refers to the process of probing, cleaning, transforming and modelling the collected data into meaningful information that provides a suitable response to the research question (Clark *et al.*, 2008). The raw data was edited to ensure consistency and identify non-answered questions. The edited data were analysed using the Statistical Package for the Social sciences (SPSS) version 26 software and Partial Least Square Structural Equation Modelling (PLS-SEM). The SPSS was used to analyse the descriptive data and the Structural Equation Modelling technique was used to measure the linear relationship among the independent and dependent variables. SEM is a technique to “specify, estimate, and evaluate models of linear relationships among a set of observed variables in terms of generally smaller number of unobserved variables” (Shah & Goldstein, 2006, p. 149). The PLS –SEM was adopted for the study because it takes into account

measurement errors and reduces the amount of unexplained variance (MacKenzie, 2001; Sarstedt, Ringle and Hair, 2017). SEM has the ability to test all hypothesized relationships in structural model simultaneously (Nunkoo and Ramkissoon, 2012). PLS-SEM easily integrates reflective and formative measurement and also, allows for the modelling of mediating variables (Golob, 2003). SEM is also considered as an appropriate tool to incorporate Exploratory Factor Analysis (EFA), Confirmatory Factor analysis (CFA) and Path analysis for several activities.

4.10 Reliability

According to Drost (2011, p. 106), reliability is the “extent to which measurements are repeatable when different people perform the measurement on different occasion, under different conditions, supposedly with alternative instruments which measure the construct or skill”. Hair et al. (2010) also defined reliability as a measure of consistency between multiple measurements of a variable. Drost (2011) posits that two types of error affect the reliability of data from research instruments: namely random error and systematic error. Random error is mostly seen as a noise in measurement hence ignored, however, systematic error is seen as bias in measurement and needs to be corrected to generate better results of sample. There are different methods of measuring reliability, and these includes: test –retest reliability, split-half reliability, inter- rater reliability and internal consistency reliability. The internal consistency reliability within the instruments and questions were tested using Cronbach’s alpha and the composite reliability with 0.70 or higher is accepted (Sarstedt, Ringle and Hair, 2017).

4.11 Validity

Validity indicates whether the test results are measuring the proper items for the test’s intended purpose (Livingston *et al.*, 2018). This study employed the convergent and discriminant validity test. The convergent validity refers to the degree to which the scores of a formatively measured

construct correspond with the scores of another construct expressing the same concept (Cheah *et al.*, 2018). Discriminant validity refers to the degree to which a measure does not measure or discriminates the construct it is not designed to measure (Edwin, 2019). The items and constructs were taken through the convergent and discriminant validity test. The convergent validity is assessed by using the Average Variance Extracted (AVE) measure. The rule of thumb states that the accepted threshold should be 0.50 or higher in evaluating the convergent validity (Fornell&Larcker, 1981). Also, Indicator Cross loadings and Hetrotrait-momotrait (HTMT) are used to assess the discriminant validity of the constructs. The threshold for indicator Cross loadings is 0.7 or higher and Hetrotrait-monotrait (HTMT) threshold is less or equal to 0.85 or 0.95, above this threshold indicates absent of discriminant validity (Henseler, Ringle and Sarstedt, 2015).

4.12 Ethical Considerations

Ethics are referred to as guidelines or sets of principles for good professional practice, which serve as a guide for researchers in conducting research study (Bloor and Wood, 2006). The study ensured that information provided by respondents were kept confidential. The researcher sought the consent of the respondents and informed them that the questions being asked were for academic and research purpose only. The respondents were briefed on the rationale of the study, what is required from them and why the study is being conducted. Also, the selected respondents participated voluntarily in the study. Additionally, the respondents were assured of the utmost anonymity and confidentiality regarding any data provided.

4.13 Chapter Summary

This chapter presented the research method that was used to undertake the study. The research method aided in answering the research questions being asked in the study. The chapter considered the research approach, research design, the research population, the sample size, sampling

techniques, data collection instrument, data collection procedure, data analysis and ethical consideration of the study. The research approach chosen for this study is quantitative approach and it is defined as a formal, objective and systematic method for describing and testing relationships, as well as examining cause and effect interactions among variables (Burns & Grove, 1993). The study focused on the manufacturing industry in Ghana and questionnaire was the data collection instrument used. The Statistical Package for the Social sciences (SPSS) version 26 software and Partial Least Square Structural Equation Modelling (PLS-SEM) were the analytical tools considered for the study.



CHAPTER FIVE

DATA ANALYSIS AND DISCUSSION OF FINDINGS

5.0 Introduction

This chapter presents the data analysis and discussion of findings of the study. The main sections covered in this chapter are the descriptive statistics of the demographic characteristics of respondents, firms and constructs, model assessment and discussion of findings. The demographic characteristic of respondents' looks at the gender, age, level of education, position and number of years spent in the firm. This is followed by the characteristics of the firms sampled for the study looking at the manufacturing sub-sector, annual sales, number of employees and years of operating. Next is the environmental uncertainties affecting manufacturing supply chains with emphasis on supply uncertainty, demand uncertainty and technology uncertainty. Next is the discussion of the resilience strategies adopted by Ghanaian manufacturers and the focus is on agility, redundancy, collaboration and information sharing. The chapter further presents the reliability and validity tests on the research variables. The measurement model and structural model assessment are presented. Also, the hypotheses tests on the relationships among the research variables are presented. Finally, discussion of the major findings concludes the chapter.

5.1 Response Rate

The data was collected from 269 manufacturing firms (food processing, clothing & textiles, pharmaceutical and soap & detergent) in Ghana. The researcher issued out a total of 269 questionnaires. Out of the total, 118 questionnaires were shared via emails of firms, 101 through face-to-face medium and 50 using the LinkedIn platform. A total of 202 responses were retrieved from respondents. Of the 202 responses, 16 incomplete responses were discarded. As a result, all

reported statistics and analysis are based on a sample of 186 manufacturing firms. The response rate for the various medium of questionnaire distribution are reported in Table 5.1 below.

Table 5.1: Response Rate

Medium of distribution	Number of questionnaires distributed	Returned questionnaires	Response rate (%)
Face- to -face	118	85	72.03
Emails	101	66	65.35
LinkedIn	50	35	70.00
Total	269	186	69.14

Therefore, the overall response rate obtained for the study was 69.14%. This response rate is acceptable as Baruch & Holtom (2008) posits that, a response rate that is above 50% is considered to be good for data analysis.

5.2 Descriptive statistics

This section presents the demographic statistics of the respondents (gender, age, level of education, position and number of years spent in the firm), characteristics of firms (annual sales, number of employees and years of operating) and also, descriptive statistics of the study constructs.

5.2.1 Demographic Characteristics of Respondents

Table 5.2 presents the frequency and percentages of demographic characteristics of respondents. The total number of Owner/managers, General managers, Operations managers, Supply chain/Procurement managers and Procurement / Logistics officers were 186.

Regarding gender, Table 5.2 shows that out of the 186 respondents 107 representing 57.5% were males, 79 representing 42.5% were females and this suggests that males dominate in the manufacturing sub-sector that were sampled. This finding may be attributed to women taking less interest in manufacturing (Hale, 2013) and rather being keen on the pink profession such as nursing and teaching (Liben, Bigler and Krogh, 2001).

Also, the result on age indicates that, 5.9% of the respondents were between the ages of 18-24, 32.8% were between the ages of 25-34. Respondents between the ages of 35- 44 were the highest representing 40.3%. Additionally, 13.4% were between the ages of 45-54. Respondents within the age bracket of 55-64 constituted 5.9% and 1.6% of the respondents were above 65 years. Findings on respondents' ages shows that majority of the Owner/managers, General managers, Operations manager, Supply chain/Procurement managers and Procurement / Logistics officers are in their youthful and early adult ages. This evidence appears to confirm the 2010 Population and Housing Census conducted by the Ghana Statistical Service which reported that the majority of Ghanaians falls within the youth (20-34 years) and the early adulthood (35-44 years) (GSS, 2010).

With regards to the educational level of respondents, Table 5.2 shows that the majority of respondents representing 56.5% indicated that they have HND/Degree education. This is followed by postgraduate education representing 39.2% whilst secondary education represented 3.2%. The least was 1.1% representing those who chose others, but respondents failed to state them. The results also show that most of the respondents were managers of the various firms; Owner/managers, General managers, Operations managers, Supply chain/Procurement managers representing 22.6%, 22.0%, 14.5% and 17.2% respectively. The other respondents were Procurement /logistics officers representing 23.7%.

Finally, Table 5.2 demonstrates the working experience of respondents. Most respondents had over 1 year work experience representing 90.3% and 9.7% had less than a year working experience. Respondents with less than a year, 1-5years, 6-10 years and above 10 years accounted for 9.7%, 51.1%, 22.0% and 17.2 respectively

Table 5.2: DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

	Frequency	Percentage (%)	Cumulative Percent (%)
Gender			
Male	107	57.5	57.5
Female	79	42.5	100.0
Total	186	100	
Age			
18-24	11	5.9	5.9
25-34	61	32.8	38.7
35-44	75	40.3	79.0
45-54	25	13.4	92.5
55-64	11	5.9	98.4
> 65	3	1.6	100.0
Total	186	100	
Level of Education			
Secondary	6	3.2	3.2
HND/ Degree	105	56.5	59.7
Postgraduate	73	39.2	98.9
Others	2	1.1	100.0
Total	186	100	
Position			
Owner/Manager	42	22.6	22.6
General Manager	41	22.0	44.6

Operations Manager	27	14.5	59.1
Supply Chain/ Procurement Manager	32	17.2	76.3
Procurement/ Logistics Officer	44	23.7	100.0
Total	186	100	
No. of years spent in Firm			
Less than a year	18	9.7	9.7
1-5	95	51.1	60.8
6-10	41	22.0	82.8
> 10	32	17.2	100.0
Total	186	100	

Source: Field Data (2021)

5.2 Characteristics of firms

The study sought to find out the various sub-sectors of manufacturing that the firms sampled belonged to, the number of employees, annual sales and years of operating experience of firms.

Table 5.3 presents a summary of the results.

Table 5.3: DEMOGRAPHIC PROFILE OF FIRMS

	Frequency	Percentage (%)	Cumulative Percent (%)
Subsectors			
Food processing	84	45.2	45.2
Pharmaceutical	37	19.9	65.1
Textiles and Clothing	31	16.7	81.7
Soap and Detergent	34	18.3	100.0

Total	186	100	
Number of employees			
< 50	71	38.2	38.2
50-100	82	44.1	82.3
101-250	20	10.8	93.0
251-500	9	4.8	97.8
> 500	4	2.0	100.0
Total	186	100	
Annual Sales			
< 1 million	52	28.0	28.0
1-5 Million	57	30.6	58.6
6-10 Million	37	19.9	78.5
11-50 Million	18	9.7	97.8
> 100 Million	4	2.2	100.0
Total	186	100	
Years of operating experience of Firm			
< 1 year	15	8.1	8.1
1-5 years	50	26.9	34.9
6-10 years	35	18.8	53.8
11-15 years	34	18.3	72.0
16-20 years	30	16.1	88.2
> 20 years	22	11.9	100.0
	186	100	

Total

Source: Field Data (2021)

As presented in Table 5.3 out of the 186 respondents, 45.2% which was the highest percentage indicated that their firms were under food processing sub-sector of manufacturing industry. Next, 19.9% were pharmaceutical firms and 18.3% represented Soap and Detergent sub-sector. Finally, textiles and clothing represented 16.7%.

Concerning the number of employees, the study found out that a good number of the firms had between 50-100 employees, representing 44.1%. Also, 38.2% of respondents indicated they had less than 50 employees. The other percentage of responses constituted firms with employees above 100. Further, the study revealed the annual sales of the various sub-sectors. It was discovered that firms with annual sales between GhC1,000,000 - GhC5,000,000 represented 30.6%, 28.0% had annual sales less than GhC1,000,000, 19.9% had annual sales between GhC6,000,000 - GhC10,000,000, 9.7% had sales between GhC11,000,000 - GhC50,000,000 while 2.2% were above GhC100,000,000.

It was also observed that 15 respondents representing 8.1% indicated that their firms have been in operation for less than a year. 26.9% responded that they have been in operation between 1-5 years. The rest of the respondents indicated that their firms have been in operation for over 5 years.

Descriptive statistics of study constructs

The researcher sought the views of respondents on the study constructs. Table 5.4 presents the mean scores and standard deviation of environmental uncertainties constructs constituted by supply uncertainty, demand uncertainty and technology uncertainty. The supply uncertainty construct had an overall mean score of 3.17. On a Five –point Likert scale, mean scores below 2.5

suggests that respondents disagreed, mean scores between 2.5 and 3.5 suggests that respondents are indifferent and mean scores above 3.5 suggests that respondents agreed to the assertion. The result suggests that Owners/managers, General managers, Supply chain / Procurement officers and Operations managers are indifferent as to whether supply uncertainty affects manufacturing supply chains.

Similarly, the demand uncertainty construct obtained an overall mean score of 2.87 and this implies that respondents were indifferent about manufacturing supply chains experiencing demand uncertainty.

With regards to the technology uncertainty, Owners/managers, General managers, Supply chain / Procurement officers and Operations managers were indifferent about whether manufacturing supply chains are affected by technology uncertainty, with technology uncertainty having overall mean score of 3.11 and standard deviation 0.88. These measurement items: the cost of investing into new technologies in the industry and the capability of firms being abreast with technological changes in order to remain competitive may have contributed to this result.

Table 5. 4: Constructs and Measurement Items Means

Constructs	Min.	Max.	Mean	SD
Supply Uncertainty				
Our suppliers are not consistent in meeting our requirement	1	5	3.16	0.90
Our suppliers provide us with raw materials of inconsistent quality	1	5	2.50	0.85
The price our raw materials and component parts changes frequently	1	5	3.41	0.86
We have capacity issues with suppliers of raw materials for major products	1	5	3.29	0.87
We do extensive inspection of materials from our suppliers before accepting them for use	1	5	3.42	0.90
We face frequent delays from our key suppliers	1	5	3.23	0.85
Average Mean			3.17	0.87
Demand uncertainty				
Our demand fluctuates drastically from week to week	1	5	2.84	0.81

Customer requirement for our products changes drastically from time to time	1	5	2.89	0.90
Our master production schedule has a high percentage of variations in demand	1	5	3.11	0.81
Our requirement for raw material supply varies drastically from week to week	1	5	3.05	0.88
The volume and/or composition of our customers' demand is difficult to predict	1	5	3.17	0.85
We can hardly keep to our demand forecast due to frequent demand changes	1	5	3.18	0.87
Average mean			2.87	0.85
Technology Uncertainty				
Our production technology changes frequently	1	5	2.72	0.84
Our industry is characterised by rapidly changing technology	1	5	2.74	0.95
The rate of technology obsolescence in our industry is high	1	5	2.59	0.77
If our firm do not keep up with changes in technology, it will be difficult to remain competitive	1	5	3.67	0.87
The cost of investing into new technologies in our industry is high	1	5	3.84	0.95
Average mean			3.11	0.88

Source: Field Data (2021)

Table 5.5 presents the mean scores and standard deviation of supply chain resilience strategies construct, constituted by agility, redundancy, collaboration and information sharing. The agility construct had an overall mean score of 3.76 and this implies that Ghanaian manufacturers in food processing, textiles and clothing, pharmaceuticals and soap & detergent sub-sectors employ agility in order to minimise supply chain disruptions and uncertainties. Changing product quality based on customer needs and adjusting delivery schedules based on customer needs may have been the measurement items that contributed to this result. However, firms having sufficient logistics system in demand response fairly aid in employing agility as resilience strategy.

Concerning redundancy as a resilience strategy, an overall mean score of 3.52 was recorded and this suggests that manufacturers agree to employing redundancy as a resilience strategy. Firms sourcing from multiple suppliers to minimise the likelihood of supply chain disruptions can be

considered as the measurement item that contributed to this situation. But surveyed manufacturers fairly agreed on their firms underutilizing capacity to serve as a cushion to absorb unexpected increase in demand.

With collaboration as a resilience strategy, the overall average score obtained was 3.43 which indicates that manufacturers in Ghana are relatively indifferent when it comes to collaboration with other supply chain partners. To a large extent firm do not embrace partnership with their suppliers and third-party logistics providers.

Table 5.5 also demonstrates that manufacturers are neutral with respect to information sharing as resilience strategy. The overall mean recorded was 3.17. This depicts that information sharing as resilience strategy least considered as part of the efforts to reduce supply chain disruptions by manufacturers in Ghana.

Table 5.5: Constructs and measurement items mean scores

Constructs	Min	Max	Mean	SD
Agility				
We change product quality based on customer needs	1	5	3.92	0.87
We have sufficient additional capacity of materials, equipment and labour to quickly boost customer response	1	5	3.78	0.74
We quickly reallocate orders to alternate suppliers where we lack adequate capacity	1	5	3.80	0.88
Our firm has sufficient logistics system in demand response	1	5	3.48	0.99
Our firm ensures elastic labour arrangement to respond to variations in demand	1	5	3.80	0.74
Our delivery schedules are adjustable based on demand fluctuations	1	5	3.84	0.78
Our firms' supply base is able to absorb abrupt changes in demand	1	5	3.70	0.77
Average mean			3.76	0.82

Redundancy

Our firm maintains safety stock in case of supply chain disruptions	1	5	3.56	0.78
Our firm keeps extra inventory of strategic items (e.g., raw material, parts and finished goods)	1	5	3.57	0.81
Our firm holds safety stock to deal with variable demand rate or lead time	1	5	3.51	0.82
Our firm holds buffet stock to mitigate the risk of stock-outs	1	5	3.40	0.83
Our firm maintains slack capacity (additional production lines and IT backup systems) in case of supply chain disruptions	1	5	3.60	0.80
Our firm sources from multiple suppliers to minimise the likelihood of supply chain disruptions	1	5	3.67	0.81
Our firm underutilises capacity to serve as a cushion to absorb unexpected increase in demand	1	5	3.32	0.85
Average mean			3.52	0.81

Collaboration

We embrace strategic alliance with third party logistics providers	1	5	3.61	0.78
Our firm shares resources with our supply chain partners	1	5	3.41	0.83
Our firm synchronizes product development decisions with our key suppliers	1	5	3.42	0.76
We have joint accurate inventory visibility with partners	1	5	3.03	0.92
Our firm embrace partnership with our suppliers	1	5	3.67	0.90
We synchronize demand forecast with our outsourced partners	1	5	3.45	0.86
Average mean			3.43	0.84

Information sharing

Our firm shares proprietary information (e.g., production, financial, design and risk) with supply chain partners	1	5	3.00	0.96
Our firm informs supply chain partners of changing needs of customers in advance	1	5	3.21	0.97
Our supply chain partners share their proprietary information with us	1	5	3.00	0.94

Our firm and its supply chain partners keep each other informed frequently and in a timely manner about events or changes that may affect each other	1	5	3.18	0.91
Our firm and its supply partners keep each other informed frequently and used in a timely manner about events or changes that may affect each other	1	5	3.46	0.89
Our supply chain partners exchange information that help in establishment of business planning	1	5	3.15	0.92
Average mean			3.17	0.93

Source: Field Data (2021)

5.5 Model Evaluation

The Partial Least Square - Structural Equation Modelling (PLS-SEM) was employed in the analysis of the relationships amongst the research variables. The analysis of the relationships involved two steps: first, the evaluation of the measurement model and second, the structural model assessment (Hair et al., 2017).

5.5.1 Measurement Model Assessment

The measurement model was evaluated to know the reliability and validity of the study constructs' measures. The measurement model assessment includes evaluating the internal consistency, indicator reliability, convergent validity and discriminant validity of the variables.

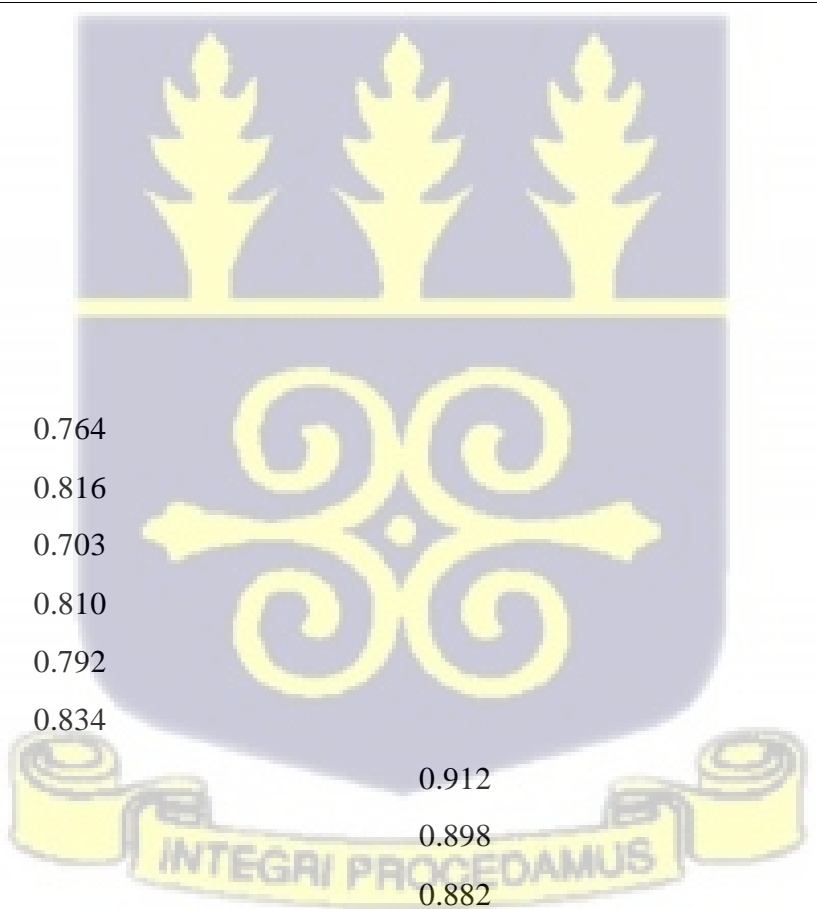
5.5.1.1 Indicator Reliability

Indicator reliability shows the extent to which a variable or set of variables is/are consistent regarding what it intends to measure. The rule of thumb says that, an indicator is reliable if the outer loadings estimated is 0.70 and above (Hair et al., 2017). As demonstrated in Table 5.6, except the factor loading with asterisk, all other indicators had loadings above the indicator reliability threshold of 0.70. Hence, indicators that do not meet the threshold were deleted from the model.

However, prior studies indicate that indicators whose loadings did not meet the threshold but had loadings between 0.40 and 0.70 should be maintained if their removal will bring about a reduction in the composite reliability and the average variance extracted of the corresponding construct (Avkiran, 2018; Hair, Hult, Ringle, & Sarstedt, 2014). Therefore, item RMC3 was maintained in the analysis. The indicator reliability values are shown in Table 5.6.

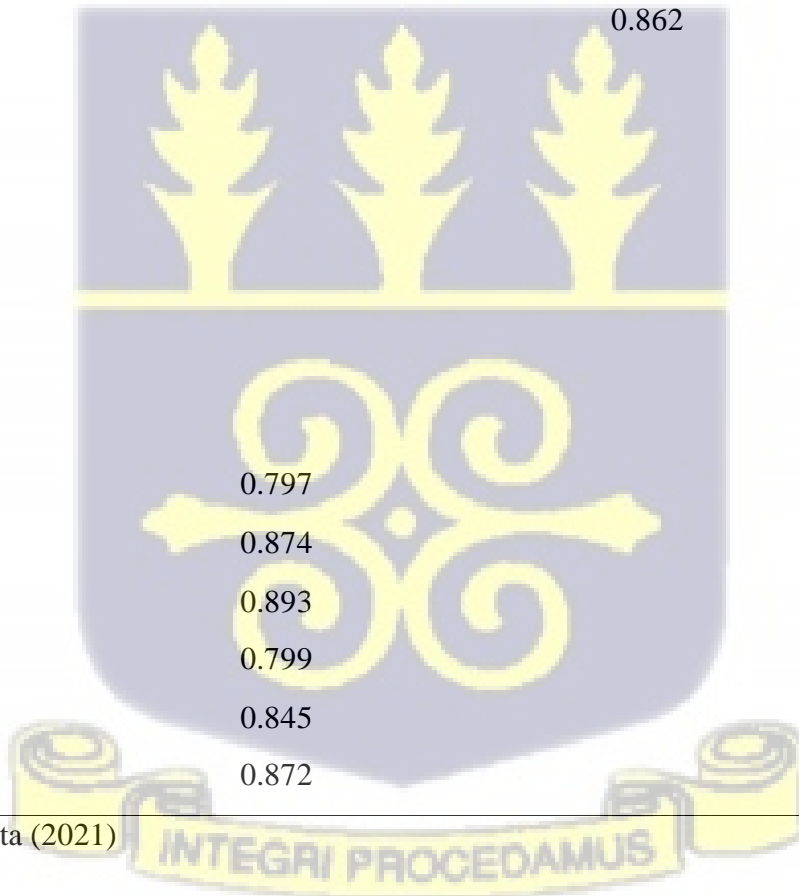
Table 5.6: Indicator Reliability

	Agility	Collaboration	Employee Wellbeing	Financial Performance	Information Sharing	Raw Material	Redundancy
Ag	0.724						
Ag2	0.795						
Ag3	0.801						
Ag4	0.809						
Ag5	0.832						
Ag6	0.849						
Ag7	0.855						
Col1		0.764					
Col2		0.816					
Col3		0.703					
Col4		0.810					
Col5		0.792					
Col6		0.834					
FP1				0.912			
FP2				0.898			
FP3				0.882			
FP4				0.896			
FP5				0.896			



RMC1		0.732
RMC2		0.726
RMC3		0.654*
RMC4		0.833
RMC5		0.828
RMC6		0.851
IS1	0.860	
IS2	0.872	
IS3	0.867	
IS4	0.84	
IS5	0.840	
IS6	0.862	
Red1		0.795
Red2		0.785
Red3		0.842
Red4		0.785
Red5		0.788
Red6		0.861
Red7		0.766
EWB1	0.797	
EWB2	0.874	
EWB3	0.893	
EWB4	0.799	
EWB5	0.845	
EWB6	0.872	

Source: Field Data (2021)



In addition to the above table, Figure 5.1 shows the indicator outer loadings that were retained for the analysis.

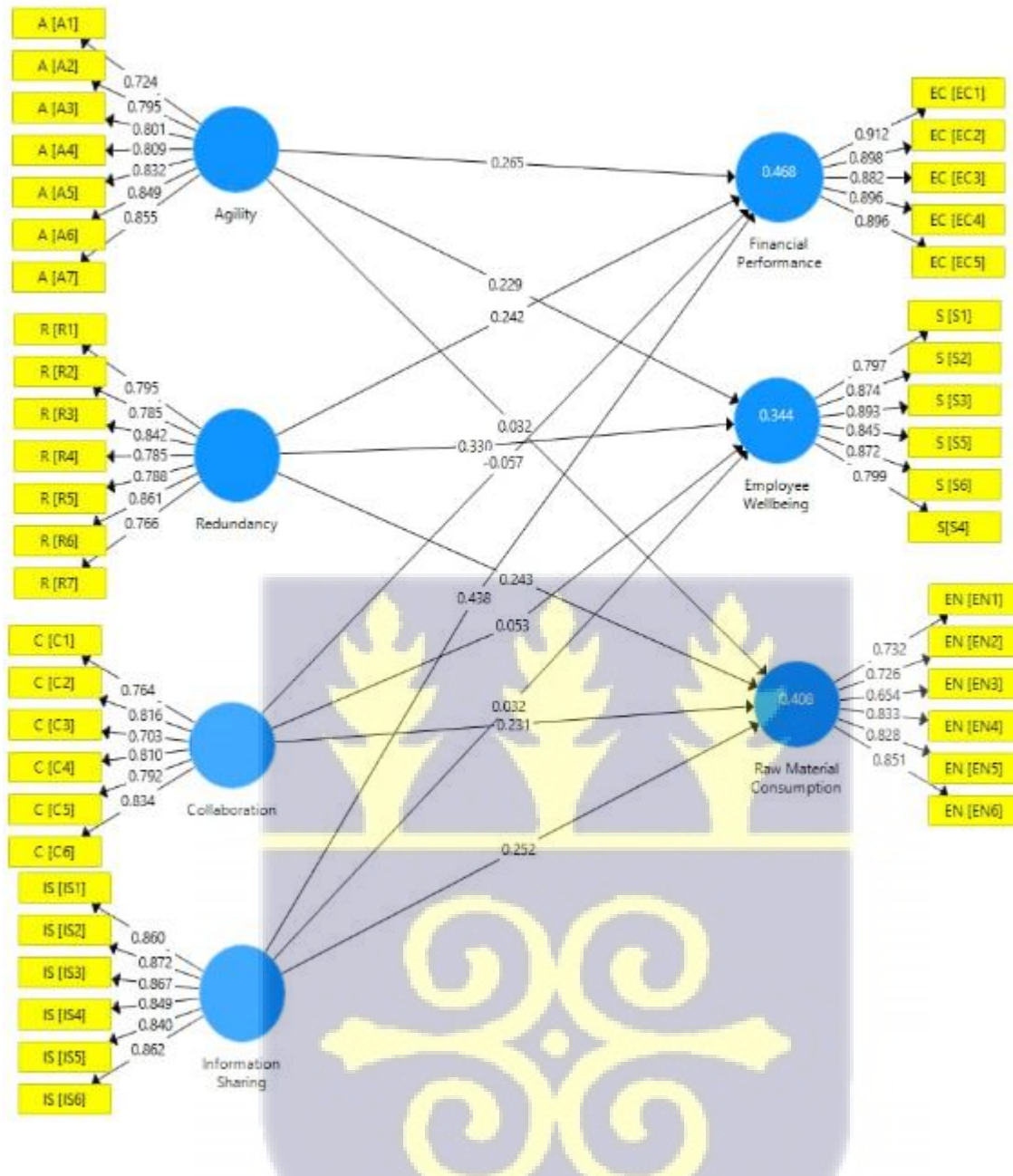


Figure 5.1: Indicator Outer loadings

5.5.1.2 Internal Consistency Reliability

The internal consistency reliability was estimated by both the Composite reliability and Cronbach alpha values. Prior studies show that Cronbach Alpha and Composite reliability with values ranging from 0.70 and above are acceptable (Aibinu & Al-Lawati, 2010; Hair, Hult, Ringle, &

Sarstedt, 2017). From Table 5.7, the Cronbach Alpha and composite reliability for all the study constructs were above 0.70. Therefore, all the study constructs have achieved acceptable levels of internal consistency, and this indicates acceptable levels of reliability.

Table 5.7: Cronbach Alpha, rho-A, Composite reliability and Average Variance Extracted.

Constructs	Cronbach's Alpha	rho -A	Composite Reliability	Average Variance Extracted (AVE)
Agility	0.912	0.913	0.930	0.657
Collaboration	0.877	0.833	0.907	0.620
Employee Wellbeing	0.921	0.925	0.939	0.718
Financial Performance	0.939	0.942	0.954	0.804
Information Sharing	0.929	0.932	0.944	0.737
Raw Mat. Consumption	0.863	0.866	0.899	0.599
Redundancy	0.908942	0.910	0.927	0.646

Source: Field Data (2021)

5.5.1.3 Convergent Validity

The convergent validity was evaluated using the Average Variance Extracted (AVE) of the constructs. The rule of thumb with respect to evaluation of convergent validity suggests that the AVE should be above 0.50 (Hair et al., 2017) to be acceptable and this is because the constructs should be capable to explain more than 50% of variations of the various indicators. Table 5.7 shows that all the study constructs met the threshold with the AVE values ranging between 0.599 and 0.804.

5.5.1.4 Discriminant validity

Discriminant validity establishment implies that a construct is unique and denotes a phenomenon not represented by other constructs (Hair et al., 2017). The discriminant validity of the constructs were assessed by employing Fornell-Larcker criterion, Indicator cross loadings and Heterotrait - monotrait ratio (HTMT).

Fornell-Larcker criterion

Fornell- Larcker criterion compares the square root of the AVE value of each construct to the construct's correlation with other constructs. The Fornell-Larcker criterion suggests that the square root of each construct's AVE should be greater than the highest correlation of the constructs with any other construct (Fornell & Larcker, 1981; Hair et al., 2016). The threshold for Fornell-Larcker criterion is the values being equal to 0.50 or greater. Table 5.8 is the summary results of the Fornell-Larcker criterion analysis and the square root of the AVE of the constructs and their correlation with other constructs which is diagonally presented. From Table 5.8 the square root of the AVEs of the constructs are higher than all of the diagonal AVEs of the other constructs and the values are all greater than 0.50. This depicts that the constructs share more variance with its related constructs than with any other construct. This result shows that the discriminant validity of the construct is established.

Indicator Cross -loadings

The cross -loadings approach suggest that an indicator's outer loadings on the related construct should be greater than any of its correlation on other constructs. The outer loadings should be 0.70 or greater (Hair et al., 2017). The cross-loadings shown in Table 5.9 confirms that the measurement items loaded effectively on their related constructs and the outer -loadings of correlation is higher

than the correlation with other constructs. This indicates that there is discriminant validity between constructs.

Table 5.8: Fornell-Lacker Criterion

	Agility	Collaboration	EWB	Fin. Perf	Info. sharing	RMC	Rd
Agility	0.810						
Collaboration	0.659	0.788					
Employee Wellbeing	0.539	0.450	0.848				
Financial Performance	0.548	0.436	0.372	0.897			
Info. sharing	0.541	0.501	0.353	0.620	0.858		
Raw Mat. Consumption	0.510	0.548	0.597	0.441	0.511	0.774	
Redundancy	0.781	0.698	0.563	0.553	0.517	0.560	0.804

Source: Field Data (2021)

Table 5.9: Indicator Cross loadings

	Ag.	Coll.	EWB	FIN.PERF	IS	RMC	Red
Ag1	0.724	0.499	0.612	0.302	0.294	0.418	0.642
Ag2	0.795	0.528	0.510	0.383	0.350	0.425	0.618
Ag3	0.801	0.515	0.390	0.395	0.454	0.340	0.579
Ag4	0.809	0.531	0.316	0.618	0.577	0.385	0.630
Ag5	0.832	0.532	0.396	0.471	0.445	0.435	0.657
Ag6	0.849	0.503	0.401	0.474	0.475	0.438	0.636
Ag7	0.855	0.619	0.421	0.453	0.472	0.440	0.652

Col1	0.619	0.764	0.331	0.255	0.315	0.366	0.594
Col2	0.562	0.816	0.364	0.286	0.383	0.380	0.514
Col3	0.459	0.703	0.302	0.257	0.343	0.458	0.497
Col4	0.467	0.810	0.309	0.542	0.580	0.451	0.516
Col5	0.510	0.792	0.419	0.345	0.334	0.450	0.570
Col6	0.523	0.834	0.400	0.324	0.377	0.472	0.613
FP1	0.588	0.439	0.357	0.912	0.594	0.422	0.565
FP2	0.463	0.376	0.331	0.898	0.560	0.353	0.462
FP3	0.551	0.395	0.343	0.882	0.521	0.349	0.497
FP4	0.435	0.394	0.330	0.896	0.571	0.447	0.493
FP5	0.400	0.341	0.302	0.896	0.531	0.403	0.450
RMC1	0.397	0.401	0.549	0.275	0.320	0.732	0.360
RMC2	0.383	0.505	0.427	0.297	0.408	0.726	0.439
RMC3	0.277	0.315	0.229	0.514	0.583	0.654	0.303
RMC4	0.455	0.431	0.539	0.286	0.352	0.833	0.521
RMC5	0.425	0.471	0.483	0.311	0.327	0.828	0.488
RMC6	0.421	0.403	0.539	0.365	0.378	0.851	0.465
IS1	0.462	0.446	0.246	0.537	0.860	0.375	0.428
IS2	0.451	0.421	0.324	0.582	0.872	0.478	0.468
IS3	0.445	0.467	0.263	0.490	0.867	0.427	0.434
IS4	0.450	0.446	0.275	0.464	0.84	0.391	0.431
IS5	0.493	0.418	0.365	0.500	0.840	0.523	0.436
IS6	0.479	0.390	0.328	0.605	0.862	0.417	0.461
Red1	0.653	0.620	0.483	0.348	0.310	0.499	0.795
Red2	0.638	0.483	0.508	0.450	0.387	0.482	0.785
Red3	0.682	0.606	0.502	0.432	0.418	0.490	0.842
Red4	0.578	0.493	0.414	0.538	0.435	0.393	0.785
Red5	0.621	0.585	0.435	0.326	0.382	0.392	0.788
Red6	0.635	0.557	0.446	0.478	0.423	0.472	0.861

Red7	0.582	0.595	0.367	0.523	0.599	0.411	0.766
EWB1	0.457	0.426	0.797	0.303	0.247	0.534	0.442
EWB2	0.493	0.340	0.874	0.279	0.219	0.491	0.455
EWB3	0.522	0.389	0.893	0.347	0.313	0.503	0.514
EWB4	0.350	0.358	0.799	0.297	0.318	0.464	0.426
EWB5	0.499	0.355	0.845	0.339	0.369	0.533	0.518
EWB6	0.454	0.423	0.872	0.322	0.326	0.509	0.495

Source: Field Data (2021)

Heterotrait – Monotrait (HTMT) Ratio

Discriminant validity was also tested using the heterotrait-monotrait (HTMT) ratio approach as proposed by Henseler, Ringle, & Sarstedt (2015). The HTMT approach is an estimation of what the exact correlation between two constructs will be if they were perfectly reliable. The threshold value for HTMT should be less than 0.85 or 0.90. Assessment values above 0.90 indicate a lack of discriminant validity. Table 5.10 shows the HTMT values did not exceed 0.90 thresholds which indicates the presence of discriminant validity. This suggests that the latent variables are distinct and different from each other.

Table 5.10: Heterotrait-Monotrait Ratio (HTMT)

	Agility	Collaboration	EWB	Fin. Perf	Info. sharing	RMC	Red
Agility							
Collaboration	0.743						
Employee Wellbeing	0.583	0.501					
Financial Performance	0.586	0.466	0.398				

Info. sharing	0.587	0.549	0.378	0.620		
Raw Mat. Consumption	0.572	0.624	0.671	0.441	0.568	
Redundancy	0.856	0.786	0.612	0.553	0.563	0.626

Source: Field Data (2021)

5.5.2 Structural Model

The evaluation of the structural model involves assessment of multicollinearity, significance of path, coefficient of determination, effect size, predictive relevance and model fitness.

5.5.2.1 Multicollinearity Assessment

In assessing the collinearity of constructs, the variance inflation factor (VIF) was employed. The threshold for the construct's measurement items should be less than or equal to 5 to avoid issues of collinearity (Hair, Ringle, & Sarstedt, 2011). From Table 5.11 below, all the VIF values are below 5. This result indicates that there are no collinearity issues.

Table 5.11: Multicollinearity Test

	Employee Wellbeing	Financial performance	Raw material Consumption
Agility	2.865	2.865	2.865
Collaboration	2.150	2.150	2.150
Employee Wellbeing			
Financial performance			
Information Sharing	1.507	1.507	1.507
Raw Mat. Consumption			
Redundancy	3.056	3.056	3.056

Source: Field Data (2021)

5.5.2.2 Assessment of path significance

The p-value approach is employed in assessing the significance levels of hypothesized relationships. The p-value is the probability of incorrectly assuming a significant path coefficient when in fact the path is not significant. Assuming the significance level and type of test (one or two tails) mostly depend on the type of study or the objective of the study. P-values (0.05) and two tailed test is considered in determining the significance level in this study and this is because most of the exiting literature on this study estimated their relationship at 5% significance level (Hair et al., 2017). Hence, a hypothesis is rejected if its p-value is greater than 0.05 and the t-value being above 1.96. Results from Table 5.12 shows the assessment of the path significance of the hypothesised relationships at the 5% significance level using the two –tailed test.

Table 5.12: Test of Direct Relationships

	Path Coefficient	T-Statistics	P-Values	Decision	
H1 _a	Ag->EWB	0.229	1.550	0.122	Not supported
H1 _b	Ag-> FP	0.265	2.078	0.038	Supported
H1 _c	Ag->RMC	0.032	0.232	0.817	Not supported
H2 _a	Col ->EWB	0.053	0.455	0.649	Not supported
H2 _b	Col ->FP	-0.057	0.518	0.604	Not supported
H2 _c	Col ->RMC	0.231	2.359	0.019	Supported
H3 _a	IS->EWB	0.032	0.393	0.694	Not supported
H3 _b	IS->FP	0.438	4.828	0.000	Supported
H3 _c	IS->RMC	0.252	1.707	0.088	Not supported
H4 _a	Red->EWB	0.330	2.704	0.007	Supported
H4 _b	Red->FP	0.242	2.031	0.043	Supported
H4 _c	Red->RMC	0.243	2.064	0.040	Supported

Significant at 5 percent level

Ag=Agility; EWB=Employee wellbeing; FP= Financial Performance; Coll. =Collaboration;
RMC=Raw Material Consumption; IS= Information Sharing; Red=Redundancy

Source: Field Data (2021)

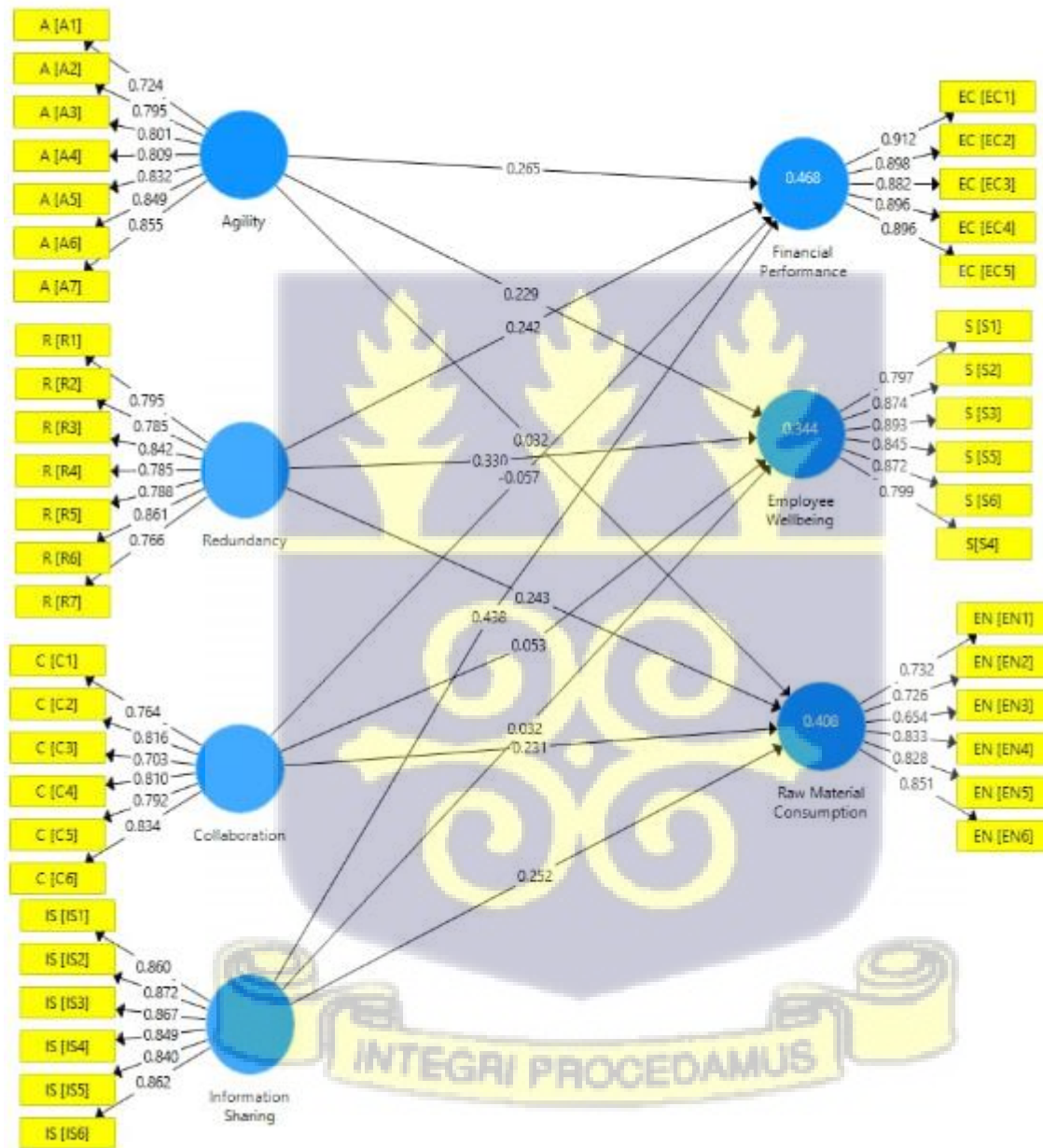


Figure 5.2: Bootstrapping output of direct relationships

Table 5.12 shows that the path relationships hypothesised for agility and the three dimensions of sustainability. With the exception of financial performance, there was no statistically significant relationship between agility and employee wellbeing and raw material consumption. This indicates that with exception of the hypothesized relationship between agility and financial performance (H1_a: *Agility in supply chains influences a firm's financial performance*), the other hypotheses H1_b: *Agility in supply chains influences a firm's employee wellbeing* and H1_c: *Agility in supply chains influences a firm's raw material consumption* were not supported.

Also, the findings show that there is a positive statistically significant relationship between collaboration and raw material consumption while there exists insignificant relationship between collaboration and both financial performance and employee wellbeing. This finding supports the hypothesis H2_c and not H2_a and H2_b. With regards to information sharing and the dimensions of sustainability, there exist an insignificant relationship between information sharing and both employee wellbeing and raw material consumption. However, a statistically significant relationship was established between information sharing and financial performance. This results support H3_b. Additionally, the path relationship hypothesised for redundancy and employee wellbeing, raw material consumption and financial performance shows a significant relationship, hence H4_a, H4_b and H4_c were supported.

5.5.2.3: Coefficient of determination R²

The coefficient of determination is used as a measure to evaluate the structural model. It was used to measure the model's predictive power. The coefficient represents the combined effects of the exogenous latent variables on the endogenous latent variables. Hair et al. (2011) argues that, as a rule of the thumb, the endogenous latent variables' R² values of 0.75, 0.50 or 0.25 can be described respectively as substantial, moderate or weak.

Table 5.13: R Square, R Square Adjusted of constructs

Constructs	R- Square	R -Square Adjusted
Employee Wellbeing	0.344	0.330
Financial performance	0.468	0.456
Raw material Consumption	0.408	0.395

Source: Field Data (2021)

From Table 5.13 the R^2 obtained by employee wellbeing is 0.334. This result shows a weak combined effect of the resilience strategies (agility, collaboration, information sharing and redundancy) on employee wellbeing. The R^2 – square Adjusted obtained by employee wellbeing (0.330) confirms the weak variation. Financial performance and raw material consumption R^2 values obtained were 0.468 and 0.408 respectively showing a weak combined effect of resilience strategies on these dimensions of sustainability.

5.5.2.4: Effect Size Assessment (F^2)

Effect size is used to evaluate whether the omitted construct has an essential impact on the endogenous constructs and thus the change in R^2 value which occurs when an exogenous construct is omitted from a model. In assessing the f^2 , the rule of thumb states that values of 0.02, 0.15 and 0.35 respectively represent small, medium and large effect and value below 0.02 indicate that there is no effect (Hair et al., 2017).

Table 5.14: Effect size of constructs

	Employee Wellbeing	Financial performance	Raw material Consumption
Agility	0.026	0.017	0.001
Collaboration	0.002	0.003	0.042

Employee Wellbeing			
Financial performance			
Information Sharing	0.001	0.239	0.071
Raw Mat. Consumption			
Redundancy	0.054	0.036	0.033

Source: Field Data (2021)

The results from Table 5.14 demonstrates that the omission of agility on financial performance and raw material consumption will not have any effect on the model. Similarly, the omission of collaboration on employee wellbeing and financial performance will have no effect on the model. Also, the removal of information sharing on employee wellbeing will have no effect on the model. However, f^2 values of agility and redundancy on employee wellbeing depict that their omission will have a small effect on the model. Additionally, the omission of collaboration, information sharing and redundancy on raw material consumption will have small effect on the model. Also, the omission of redundancy on financial performance will have small effect on the model. Furthermore, the omission of information sharing on financial performance will have medium effect on the model.

5.5.2.5: Predictive relevance (Q^2)

Stone –Geisser’s Q^2 value was utilised to measure the predictive relevance of the study constructs (Geisser, 1974; Stone, 1974). When a model shows predictive relevance, it’s able to predict endogenous latent variables. Q^2 value higher than zero for a construct indicates that the construct has a predictive relevance (Hair et al., 2017). The Q^2 values shown in Table 5.15 ($Q^2 = 0.238, 0.366$ and 0.232) indicate that the model has predictive relevance.

Table 5.15: Results of Q-square values

Constructs	Q -square
Employee Wellbeing	0.238
Financial performance	0.366
Raw material Consumption	0.232

5.5.2.6: Model fitness

The model fitness was assessed by using the Standardized Root Mean Square Residuals (SRMR). SRMR shows the average of standardized residuals between the observed and the hypothesised covariance matrices (Chen, 2007). This index is mostly preferred in studies because of its relative independence from sample size (Chen, 2007). A value less than 0.08 is mostly considered as a good fit (Henseler, Ringle and Sarstedt, 2015). The result in Table 5.16 implies that the model has a good fit.

Table 5.16: Model fit Result

	Estimated Model
SRMR	0.079

5.6 Discussion of findings

This section discusses the findings emerging from the data analysis taking into consideration the objectives of the study, the hypothesised relationships and reviewed literature.

5.6.1 Environmental Uncertainties affecting Manufacturing Supply Chains

The first objective of the study sought to find out the key environmental uncertainties that affect manufacturing supply chains. The environmental uncertainties adopted from the literature for the purposes of this study were, demand uncertainty, supply uncertainty and technological uncertainty.

The mean scores for Demand, Supply and Technological uncertainties were 3.17, 2.87 and 3.11 respectively. On a Five –point Likert scale, mean scores below 2.5 suggests that respondents disagreed, mean scores between 2.5 and 3.5 suggests that respondents are indifferent and mean scores above 3.5 suggests that respondents agreed to the assertion. From Table 5.4 above, it is evident that manufacturers were indifferent about the environmental uncertainties (demand, supply and technological) that affect manufacturing supply chains. The finding suggests that respondents were neutral about the environmental uncertainties that affect their manufacturing supply chains.

The findings on environmental uncertainties in this study contradicts that of extant studies. Ganbold and Matsui (2017) and Yu, Cadeaux, Luo, Qian, and Chen (2018) outlined demand uncertainties, supply uncertainties and technological uncertainties among others as environmental uncertainties affecting supply chains of firms. Demand uncertainty can be attributed to timing and volume mix. Likewise, supply uncertainty from quality of incoming materials and delivery dependability as well as technology uncertainty can be attributed to obsolescence of technology.

Evidently, this finding on environmental uncertainties that affect manufacturing supply chains is arguable. This finding can be attributed to the coordination, information sharing and collaborative activities among manufacturing firms' departments and functions internally (Ganbold and Matsui, 2017). For instance, the firm's manufacturing departments may have strategic collaboration with the sales department to improve sales forecast to mitigate demand uncertainty. Also, these firms might have established some supply chain management initiatives such as coordination between

the purchasing and manufacturing department internally to lessen supply uncertainty. This coordination helps to deal with the incapability of meeting quality and delivery requirement of products. Additionally, firms might have formed partnerships with other firms or partners and internal technology integration to improve and develop new technologies to minimise technological uncertainty.

More so, the resource dependence theory adds that firms create “negotiated environments” and establish relationships with other firms as a strategic response to environmental uncertainties (Ganbold and Matsui, 2017). This may also contribute to the finding on the environmental uncertainties. This study can conclude that Owners/managers, General managers, Supply chain / Procurement officers and Operations managers were indifferent about demand, supply and technological uncertainties that affect their manufacturing supply chains.

5.6.2 Supply Chain Resilience Strategies adopted by Manufacturing Firms.

The study further sought to find out the resilience strategies that manufacturing firms adopt to enhance their supply chain performance. Four strategies which were highly mentioned in literature; agility, redundancy, collaboration and information sharing were employed to constitute the resilience strategies explored in the current study. From Table 5.5 above, the result shows that manufacturing firms adopt agility and redundancy as resilience strategies to enhance their supply chain performance but not collaboration and information sharing. Agility and redundancy had overall mean scores of 3.76 and 3.52 respectively. Collaboration and information sharing on the other hand, had over all mean scores of 3.43 and 3.17 which depicts that the firms were indifferent about the use of these strategies. This finding implies that two out of the four resilience strategies are adopted by manufacturing firms in the quest of enhancing their supply chain performance.

Agility is considered as a risk management strategy that enables firms to deal with actual or potential supply chain disruption as quickly as possible (Braunscheidel & Suresh, 2009; Sodhi, 2014). Agility is seen as one of the key strategies for improving supply chain performance (Christopher & Peck, 2004; Tukamuhabwa, Stevenson, Busby, & Bell, 2015). This claim about agility may explain the reason why it is used by most manufacturers as a strategy to improve performance of supply chains. Also, redundancy is seen as one of the tools for rapid recovery from supply chain disruptions (Sheffi & Rice, 2005) and is considered as one of the most important strategies used to curb supply chain disruptions which in turn improves performance of the chain according to Shekarian, Nooraie, and Parast (2020). Therefore, the finding in the current study suggesting that firms use redundancy to enhance their supply chain performance does not come as a surprise.

More so, collaboration is a strategy that can reduce uncertainty in supply chains (Gold, Seuring, & Besk, 2010). Collaboration also assists in lessening supply chain disruptions (Jain *et al.*, 2017). However, the finding on collaboration indicates that manufacturers are indifferent concerning the use of collaboration as resilience strategy to enhance supply chain performance. This finding may be that manufacturers do not undertake product development decisions with their supply chain partners and other firms. Also, a possible explanation to this finding may be that manufacturing firms do prefer growing individually as compared to embracing alliance with their supply chain partners and other firms to plan and execute supply chain operations. Similarly, respondents were also indifferent about the usage of information sharing strategy. Information sharing is a key instrument for business continuity and also serves as a strategy to reduce risk and disruptions in supply chains (Christopher & Peck, 2004). But the finding on information sharing implies firms do not employ this strategy to enhance their supply chain performance. Evidently from the data

gathered, information sharing among supply chain partners about business processes, changing needs of customers, finance and risk is scarce in the manufacturing firms. Also, it is perceived that manufacturers are reluctant to share their business knowledge on their core activities with their partners. This might contribute to the above finding of the study.

The above results is not surprising as prior studies posited these as resilience strategies adopted by firms in minimising disruptions and uncertainties (Christopher and Peck, 2004; Hohenstein *et al.*, 2015; Agarwal, Seth and Agarwal, 2020).

5.6.3: Discussion on the Relationships between Resilience Strategies and Dimensions of Sustainability

Figure 5.2 shows the structural model of the relationships between the resilience strategies (agility, collaboration, redundancy and information sharing) and the dimensions of sustainability (financial performance, employee wellbeing and raw material consumption). The path coefficients values indicate the statistical relevance of the relationships between the independent and dependent variables.

5.6.3.1 Agility and dimensions of sustainability

The current study proposed that, *H_{1a}: Agility in supply chains influences a firm's financial performance*. The result shows that there is a statistically significant relationship between agility and firm's financial performance (path coefficient =0.265 and p-value =0.038). This finding is consistent with the previous studies which established that the relationship between agility and financial performance is significant and positive (Li et al., 2017; Musa & Nyoman Pujawan, 2018). Also, Tse et al. (2016) argues that supply chain agility can be described as firm's distinctive capability that contributes to enhancing a firm's performance. Agility is a distinctive capability of

a firm that build the capacity of the firm to accommodate variability in customer demands, leading to improved financial performance. The dynamic capability view posits that, the more a firm develop its dynamic capabilities, the more its success opportunities thus, agility is seen as a higher order dynamic capability which impacts firm performance. Agile firms introduce new products frequently and also reduce lead times thereby increasing productivity which improves firm's performance (Gligor and Holcomb, 2012; Khan and Wisner, 2019). This could be a factor for the positive and significant influence of agility on financial performance. Since firms' supply chains are faced with environmental uncertainties, most firms in turn strive to become more agile to survive. Based on the results, the hypothesis (H1a) is supported.

Next, the study hypothesised that, *Agility in supply chains influences a firm's employee wellbeing* (H1b). The result reveals that the relationship between agility and employee wellbeing (path coefficient = 0.229, p-value =0.122) is not statistically significant. This result contrast previous finding which suggests that agility practices have positive effect on the three dimensions of sustainability (economic, social and environmental) of which employee wellbeing falls under social sustainability (El-Khalil and Mezher, 2020). This insignificant relationship outcome between agility and employee wellbeing may stem from some resources or decisions that are not always beneficial to employees. For example, improper working place may result in issues such as employee inefficiency and low morale. Additionally, inadequate development for employees in terms of training and not engaging employees in decision making process are also contributing factors for the insignificant relationship between agility and employee wellbeing.

The study further hypothesised the relationship between agility and raw material consumption. *H1c: Agility in supply chains influences a firm's raw material consumption.* The result shows that the relationship between agility and raw material consumption is statistically insignificant (path

coefficient =0.032, p-value =0.817). Although, there exist a statistically insignificant relationship between the two, the relationship between agility and raw material consumption is positive. This finding contradicts previous research conducted by Altay et al., (2018) which indicated that agility practices have a higher positive impact on sustainability practices. Also, Yusuf, Menhat, Abubakar and Ogbuke (2020) study contradicts with this result. Their study revealed that in order to maximise sustainability practices, agility practices are needed to be implemented. By adopting agility strategy leads to improvement in productivity, ensuring competitiveness and longevity resulting to sustainable operations of firms. In the quest of a manufacturing firm being agile, there might be mishandling of raw materials which could cause wastage of raw materials. Also, over usage of raw materials for one-off production leads to wastage of raw material. These factors may cause an increase in raw material consumption which is a possible explanation to the insignificant relationship established between agility and raw material consumption.

5.6.3.2 Redundancy and dimensions of sustainability

This study hypothesised that: *Redundancy in supply chains influences a firm's financial performance (H_{2a})*. With a path coefficient of 0.242 and p-value of 0.043, redundancy shows a positive significant relationship with a firm's financial performance. This result corroborates that of the findings of Musa and Nyoman Pujawan (2018) which found out that, redundancy as a strategy have a significant relationship with financial performance. Additionally, a firm needs to acquire and maintain resources in order to survive according to the resource dependency theory. This assertion may have accounted for the positive significant relationship between redundancy and financial performance since redundancy as a strategy aims at keeping back up resources to deal with uncertainties and to improve performance. Redundancy is concluded by Azadeh, Atrchin, Salehi, and Shojaei (2014) as one of the most important principles of supply chain responsiveness;

this may increase the rate of customer service satisfaction which ultimately leads to higher financial performance.

The study further hypothesized that H_{2b} : *Redundancy in supply chains influences a firm's employee wellbeing*. The result reveals that there is a significant positive relationship between redundancy and employee wellbeing (path coefficient =0.333 and p-value =0.007). Redundancy according to literature is an important strategy that is used to curb supply chain disruption (Kamalahmadi, Shekarian, & Mellat Parast 2021; Shekarian, Nooraie, & Parast 2020, Meacham, & Aoyama 2008). Redundancy is seen as a tool to minimise supply chain disruptions, this in turn creates conducive working atmosphere for employees. The stability of firms' operations influences the wellbeing of its employees. Employees are provided with good working conditions, avenue for career growth and good service conditions when a firm's activities are safeguarded with resilience strategies such as redundancy to curb disruptions. Therefore, the significant relationship between redundancy and employee wellbeing.

Also, the relationship between redundancy and raw material consumption was tested in the hypothesis that; H_{2c} : *Redundancy in supply chains influences a firm's raw material consumption*. The result shows a statistically significant positive relationship between redundancy and raw material consumption with a path coefficient of 0.243 and a p- value of 0.040. This result means that redundant strategy affects raw material consumption. The use of redundancy strategy increases raw material usage. More resources or raw materials are used as more safety stocks, buffer stock, extra inventory of parts and finished goods are held in firms. Obviously, more resources are needed to pursue redundant strategy, hence the significant relationship between the two constructs.

5.6.3.3 Collaboration and dimensions of sustainability

Based on existing literature, this study hypothesised that; *Collaboration between supply chain partners influences a firm's financial performance* (H_{3a}). The result reveals a negative insignificant relationship between collaboration and financial performance (path coefficient = -0.057 and p-value = 0.604). Although statistically insignificant, this finding is not consistent with some previous studies that suggest that there is a positive and significant relationship between collaboration and financial performance (Min et al., 2005 & Pujawan, 2018). However, this finding is in line with suggestions from Blome, Paulraj, and Schuetz (2014) who found out that collaboration directly does not impact financial performance of firms. Although firms collaborate with their supply chain partners and external firms in order to benefit, it is important to adapt to internal production practices of their supply chain partners and collaborative firms so as to benefit fully from the collaboration. For instance, if a firm's collaborative partner adheres to certain sustainable practices such reduction of waste in their production process, little effect in terms of benefits will be received if the same sustainable practices are not adopted from their partners. Additionally, Schoenherr and Swink (2012) are of the view that internal practices have impact on performance. Complementing to this result, collaboration negatively influences financial performance in that firms because developing collaborative relationships with supply chain partners do not necessarily yield profit or financial gains.

The study proposed a relationship between collaboration and employee wellbeing. H_{3b} : *Collaboration between supply chain partners influences a firm's employee wellbeing*. With a path coefficient of 0.053 and a p-value of 0.649, it is observed that collaboration has an insignificant positive relationship with employee wellbeing. Firms form partnerships to capitalize on prospects for organizational learning and creation of knowledge (Cao et al., 2010). Although firms

collaborate with their supply chain partners to gain knowledge and acquire skills, the wellbeing of employees are not directly affected. It may be that few employees are given the opportunity to learn and acquire some peculiar skills from their partners or other firms. These skills are best learnt among partners because of its tacit nature but a firm stand a chance for acquiring these skills by collaborating with other firms to impact the skills unto their employees (Majchrzak, Malhotra and John, 2005; Cao *et al.*, 2010). Collaboration might provide a platform for learning but the internal practices such as provision of good working condition, information sharing from top management, involvement in decision making that has to do with them to enhance their wellbeing is not accomplished via collaboration. This could be a possible factor for the insignificant relationship between collaboration and employee wellbeing since the wellbeing of employees are mostly catered for internally.

Next, a hypothesis was proposed to test the relationship between collaboration and raw material consumption. It states: *H_{3c}: Collaboration between supply chain partners influences a firm's raw material consumption.* The result reveals a positive significant relationship between collaboration and raw material consumption (path coefficient =0.231 and p-value=0.019). This result depicts that collaboration with supply chain partners' aid in reducing raw material consumption. Firms collaborating with other partners employ aggregate competencies for sustainable operations such as practicing effective and efficient use of raw materials and avoid causing harm to the environment with respect to raw material usage. This may account for the established relationship between collaboration and raw material consumption.

5.6.3.4 Information sharing and dimensions of sustainability

Arguing from previous studies, this study hypothesised that *information sharing between supply chain partners influences a firm's financial performance (H_{4a}).* The result demonstrates a

significant positive relationship between information sharing and financial performance. This path coefficient depicts that information sharing will positively improve financial performance by 0.438. This result is in line with that of Şahin and Topal (2019); Baihaqi and Sohal (2013) and Cook, Heiser, & Sengupta (2011) studies which established that, there is a direct positive relationship between information sharing and firm's performance including financial performance. This finding can also be attributed to the fact that information sharing is vital and serves as a tool for every business continuity in today's global economy. Moreso, information sharing may increase the efficiency of a firm in terms of production which will in turn increase the performance of a firm as well as its financial performance (Min and Yu, 2008). Based on the result, (H4a) is supported.

The study further examined the relationship between information sharing and employee wellbeing. The hypothesis says; *H_{4b}: Information sharing between supply chain partners influences a firm's employees' wellbeing.* The result reveals that there is a positive but statistically insignificant relationship between information sharing and employee wellbeing. This finding is in agreement with Li and Sandino (2018) whose study indicated that information sharing system do not have significant effect on employee's performance, creativity and engagement. However, the finding is in contrast with Lotfi, Mukhtar, Sahran, and Zadeh (2013) who found out that information sharing among supply chain partners influences the performance of firms. This thereby improves employees well-being through provision of better working condition in both personal and organisational terms. This insignificant relationship between information sharing and employee wellbeing may be as a result of irregular information sharing among partners and employees. The infrequent information sharing deter employees from better understanding the requirements and

goals of firms leading to inefficiency and low performance of employees thereby affecting their wellbeing.

The study further proposed that, *Information sharing between supply chain partners influences a firm's raw material consumption (H_{4c})*. An insignificant positive relationship between information sharing and raw material consumption was exhibited with a path coefficient of 0.252 and p-value of 0.088. The hypothesis was unsupported. Information sharing is perceived to increase resource utilisation in firms (Mourtzis, 2011). This signifies that information sharing has great impact on raw material consumption. However, the finding on the relationship between information sharing and raw material consumption may be due to inaccuracy the sharing of information.

5.7 Chapter Summary

This chapter focused on analysis of data collected and the discussions of the findings. The chapter first presented the analysis of the demographic data of respondents and firms which was followed by the PLS-SEM analysis. The PLS-SEM analysis started by first assessing the measurement model and second, the structural model. In addition, analysis and discussion on key environmental uncertainties that affected manufacturing supply chains as well as the resilience strategies adopted by manufacturing firms have been presented.



CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND CONTRIBUTIONS

6.0 Introduction

This chapter presents the summary of the major findings, conclusions and contributions of the study. Also, recommendations based on the findings of the study is presented. The recommendations would be of importance to literature, Owners/managers, General managers, Supply chain / Procurement officers and Operations managers of manufacturing firms, Government policy makers, and various institutions that are responsible for improving manufacturing firms' performance and sustainability.

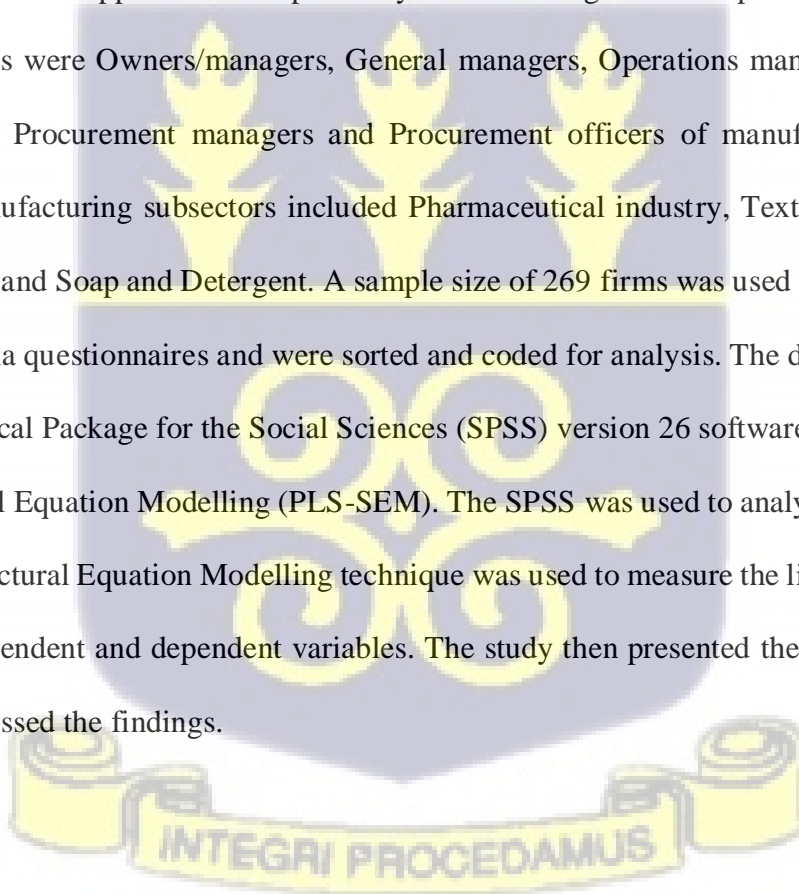
6.1 Research Summary

Globally, supply chains are faced with disruptive events including natural disasters such as earthquakes, floods, fire, among others and environmental uncertainties (Chowdhury et al., 2019). This rising global unrest has caused companies, firms and organisations to pay more attention to their supply chains as these disturbances are critical to their survival and sustainability of business operations (Min & Kim, 2012). These disruptions do not only affect the supply chains adversely but to a greater extent can lead to business closures. In order for supply chains to bounce back to their normal state or even better when faced with disruptions, supply chains need to be designed in a way that would respond to the disruptions swiftly (Ponomarov & Holcomb, 2009). The need to prepare for and quickly recover from disruptions have brought about the development of the concept of supply chain resilience and sustainability of business operations.

The Ghanaian manufacturing industry is not exempted from these supply chain disruptions; hence strategies need to be employed to manage such disruptions to improve supply chain performance

as well as sustainable operations. This research examines the concept supply chain resilience and how it influences sustainable operations of manufacturing firms. The study did that by first determining the key environmental uncertainties that affect manufacturing supply chains. The study further investigated the resilience strategies adopted by manufacturing firms to enhance their supply chain performance. Also, the study examined the relationships between supply chain resilience strategies and firms' sustainable operations. Existing literature was reviewed in relation to supply chain resilience concept, sustainable operation, overview of the manufacturing industry and also, theories and conceptual framework of the study were presented.

A quantitative research approach and explanatory research design were adopted for this study. The study populations were Owners/managers, General managers, Operations managers and Supply chain managers, Procurement managers and Procurement officers of manufacturing firms in Ghana. The manufacturing subsectors included Pharmaceutical industry, Textiles and Clothing, Food processing and Soap and Detergent. A sample size of 269 firms was used in the study. Data were collected via questionnaires and were sorted and coded for analysis. The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 26 software and Partial Least Square Structural Equation Modelling (PLS-SEM). The SPSS was used to analyse the descriptive data and the Structural Equation Modelling technique was used to measure the linear relationships among the independent and dependent variables. The study then presented the research findings and further discussed the findings.



6.2 Summary of Research Findings

In general, the results revealed that manufacturers are indifferent with regards to the environmental uncertainties that affect their supply chains. The study further reveals that manufacturing firms adopt agility and redundancy as their main resilience strategies but are indifferent with regards to collaboration and information sharing as supply chain strategies.

6.2.1 Environmental Uncertainties affecting Manufacturing Supply Chains

The findings on environmental uncertainties affecting manufacturing supply chains relates to study objective one. The study adopted demand uncertainty, supply uncertainty and technological uncertainty as the environmental uncertainties affecting the performance of manufacturing supply chains. These three categories of uncertainties were selected following a thorough review of the literature. On a 5-point Likert Scale, Owners/managers, General managers, Operation managers and Supply chain managers, Procurement managers and Procurement officers of manufacturing firms in Ghana were engaged to respond to questions pertaining to these environmental uncertainties. The three environmental uncertainties were individually analysed through a descriptive statistic using the Mean score for each category to find out whether respondents agree to it affecting their supply chains.

The Mean scores for Demand uncertainty, Supply uncertainty and Technological uncertainty were 3.17, 2.87 and 3.11 respectively. This evidence suggests that manufacturers are indifferent as to whether these environmental uncertainties affect their supply chains.

6.2.2 Supply Chain Resilience Strategies adopted by Manufacturing Firms.

The findings on supply chain resilience strategies adopted by manufacturing firms to enhance their supply chain performance relates to the objective two of the study. Existing literature (Jain, & Kumar, 2014; Christopher & Peck, 2004; Ponomarov & Holcomb, 2009; Jain & Kumar, 2014;

Hohenstein et al., 2015; Agarwal, Seth, & Agarwal , 2020) revealed different resilience strategies that are employed by firms to manage supply chain disruptions in order to enhance their supply chain performance. This researcher adopted the most dominant resilience strategies as examined within the literature for the study. This study therefore focused on four of such strategies, namely, agility, redundancy, collaboration and information sharing. The overall mean scores for agility redundancy, collaboration and information sharing were 3.76, 3.52, 3.43 and 3.17 respectively. The findings show that two out of four resilience strategies were adopted by manufacturing firms to enhance their supply chain performance. Agility and redundancy were agreed by respondents to as resilience strategies applied in manufacturing supply chains, and this was so because these strategies were considered crucially relevant for rapid recovery from supply chain disruptions as well as improving supply chain performance. On the other hand, the findings further show that, the firms were indifferent towards the use of collaboration and information sharing to enhance their manufacturing supply chains.

6.2.3 Relationship between Resilience Strategies and Dimensions of Sustainability

The findings on the relationship between resilience strategies and dimensions of sustainability relates to study objective three. The study hypothesised relationships between resilience strategies (agility, redundancy, collaboration and information sharing) and the dimensions of sustainability (financial performance, employee wellbeing and raw material consumption). The overall analysis on the hypothesised relationships established that six out of the twelve hypothesised relationships were supported. The supported relationships included H1_b, H2_c, H3_b, H4_a, H4_b, and H4_c. The rest of the hypothesised relationships which were not supported were H1_a, H1_c, H2_a, H2_b, H3_a, and H3_c.

6.2.3.1 Agility and dimensions of sustainability

The result suggested that there is a positive significant relationship between agility and firm's financial performance. This finding is so because agility is described as a distinctive capability that enhances firm performance. Again, it was revealed that there is an insignificant positive relationship between agility and employee wellbeing. Agility also had a positive insignificant influence on raw material consumption.

6.2.3.2 Redundancy and dimensions of sustainability

The research findings on the influence of redundancy on the dimensions of sustainability generally showed a positive relationship between the constructs. The study finds that redundancy shows a positive significant relationship with firm's financial performance. Additionally, the study revealed that there is a significant positive relationship between redundancy and employee wellbeing as well as with raw material consumption. The positive significant relationships between redundancy and all the three dimensions of sustainability may largely be so because redundancy appears to be one of the most important principles of supply chain responsiveness and also the strategy aims at improving performance.

6.2.3.3 Collaboration and dimensions of sustainability

The result revealed a negative insignificant relationship between collaboration and financial performance. This result was related to firms' internal practices having impact on performance than external ones and also firms having collaborative partners does not necessarily yield profit or financial gains. The finding also suggested that collaboration has an insignificant positive relationship with employee wellbeing. Again, there was a positive insignificant relationship between collaboration and a firm's raw material consumption.

6.2.3.4 Information sharing and dimensions of sustainability

The finding revealed a significant positive relationship between information sharing and financial performance. Likewise, there was a positive but statistically insignificant relationship between information sharing and employee wellbeing. An insignificant positive relationship between information sharing and raw material consumption was exhibited. The insignificant positive relationship that was exhibited between information sharing and the dimensions of sustainability was because information sharing among employees and partners were infrequent and inaccurate.

6.3 Conclusions

6.3.1 Environmental Uncertainties affecting Manufacturing Supply Chains

It is concluded that manufacturers are indifferent about the environmental uncertainties (demand, supply and technology) that affect their manufacturing supply chains.

6.3.2 Supply Chain Resilience Strategies adopted by Manufacturing Firms.

Also, the conclusion can be drawn that manufacturing firms do adopt agility and redundancy as resilience strategies but are indifferent with regards to collaboration and information sharing as resilience strategies.

6.3.3 Relationship between Resilience Strategies and Dimensions of Sustainability

The study further concludes on the relationships among the resilience strategies and the dimensions of sustainability. Agility had a positive significant influence on financial performance but insignificantly positive influence on employee wellbeing and raw material consumption. The study concludes that the manufacturing firms' capability to change product quality based on customer needs, ensure elastic labour arrangement to respond to variations in demand among other agility practices do influences the financial performance of firms and not employee wellbeing and raw material consumption of firms.

Also, redundancy had a positive significant influence on financial performance, employee wellbeing and raw material consumption. Thus, the study concludes that firms holding safety stock to deal with variable demand rate, keeping extra inventory of strategic items such as raw, part and finished materials among others do influence the financial performance, employee wellbeing and raw material consumptions of firms.

Collaboration on the other hand had negative insignificant influence on financial performance but an insignificant positive influence on employee wellbeing and significant positive influence on raw material consumption. With this result, the study concludes that collaboration do influences firms' raw material consumption and not financial performance and employee wellbeing.

Also, information sharing has been found in this study to influence financial performance significantly. However, information sharing insignificantly influenced both employee wellbeing and raw material consumption. Therefore, conclusion is drawn that the ability of supply chain partners to share information concerning business planning, production, product design among themselves do influences financial performance and not employee wellbeing and raw material consumption. The study then concludes that there exists a six out of twelve significant positive relationship between the resilience strategies and the dimensions of sustainability.

6.4 Contributions of the study

6.4.1 Contribution of the study to research

The findings obtained from this study would add value to the supply chain management literature. It extends the knowledge on how supply chain resilience strategies are used to mitigate the effects from supply chain disruptions and also, the extent to which supply chain resilience strategies influence the sustainability of manufacturing operations in Ghana. This study also shown various environmental uncertainties that affect manufacturing supply chains.

Furthermore, this study contributes to existing literature by providing preliminary evidence on the relationship between supply chain resilience strategies and all the three dimensions of sustainability. There have been considerable studies in this area, but the findings of the study adds to literature by providing insights on manufacturing firms in developing countries such as Ghana regarding the subject matter.

6.4.2 Contribution of the study to Practice

Supply chain disruptions usually have economic impact on manufacturing firms. Firms' inability to develop and implement resilience strategies can therefore have significant impact with regards to survival and continuity of businesses. Considering the already perceived impact of supply chain disruptions on firms supply chain performance and sustainability, these findings would be instrumental to managers/owners of manufacturing firms in Ghana.

Environmental uncertainties that affect manufacturing supply chains have been identified in this study. This provides insight to managers/owners as well as advisory boards about these uncertainties and the drive to manage its occurrence. Interestingly, the result from the data analysis suggests that agility and redundancy are powerful resilience strategies that can be used to manage supply chain disruptions in firms. Also, the study serves as a guide to managers in the development of resilience strategies to hedge against unforeseen supply chain disruptions. Also, the findings reveal that information sharing, agility and redundancy as resilience strategy have significant impact on the financial performance of firms. This information is pertinent to managers and practitioners as they may consider these strategies to improve their financial performance.

6.4.3 Contribution of the study to Policy

This research also provides insight to policy makers and players in the manufacturing sector such as the government, Association of Ghana Industries and other professional associations with respect to developing appropriate policies that will promote sustainable operations among manufacturers. Furthermore, these institutions can serve as a catalyst of adoption of resilience strategies and its implementation by introducing regulations that promotes the use of resilience strategies in various firms. These institutions would also see the need to focus on these resilience strategies when providing education, seminars and workshops for manufacturers considering the findings of this research.

6.5 Recommendation

Manufacturing firms need to adopt resilience strategies for them to minimise their supply chain disruptions in order to foster growth and survival of their business operations. The following recommendations are made based on this study to inform practitioners, policy and academia.

6.5.1 Practice

This study brings Owners/managers, General managers, Operation managers and Supply chain managers, Procurement managers and Procurement officers of manufacturing firms to the realisation that, there is the need to continuously develop and adopt resilience strategies to deal with supply chain disruptions which in turn improves supply chain performance as well as sustainable operations. This study provides insights on the importance of building resilience into supply chains that would reduce the impact of supply chain disruptions. Therefore, the findings of this research serve as a guide for manufacturing firms on some of the resilience strategies to use to minimise supply chain disruptions and to continue to meet the expectations of customers in terms of products and services availability. Firms were found to be neutral to environmental

uncertainties that affect their supply chains. This appears that firms may be unaware of the existence of these environmental uncertainties which can have influence on overall performance of their supply chains. Therefore, practitioners may need education to sensitise them on these uncertainties. Practitioners should equally strengthen their internal practices within their firms as one of the key steps towards dealing with environmental uncertainties. Also, managers should collaborate closely with customers, suppliers and build strong integration in order to mitigate demand, supply and technology uncertainty.

6.5.2 Policy implementation

It is recommended to policy makers and players in the manufacturing industry such as the Government, Association of Ghana Industries to provide training in the form of workshops, seminars for manufacturing firms in Ghana. This will aid in emphasizing the importance of adopting the concept of supply chain resilience and sustainability within the manufacturing industry. Next, it is recommended to the Association of Ghana Industries to develop appropriate and applicable policies that will promote sustainable operations among manufactures.

6.5 Limitations of the study and Directions for Future Studies

Although this study provides insights into the environmental uncertainties, supply chain resilience strategies and sustainable operations of manufacturing firms in Ghana, it also faced some limitations. First, since owners/ managers have busy schedules the response rate was low, and this could affect the generalisation of the study. Also, the study focused on Ghana and therefore the findings may not be generalised to other countries and other contexts that possess different features and standards. Again, the findings may not be generalised to the industry populations other than the manufacturing sector.

Although this study aimed at providing more insights into the nature of uncertainties and disruptions, resilience and sustainability, the study provides future avenues for research on supply chain resilience concept to fill research gaps. In determining supply chain resilience strategies adopted by manufacturing firms to improve their supply chain performance, this study considered agility, redundancy, collaboration and information sharing. Therefore, the researcher suggests that future research should explore the relevance and significance of other resilience strategies that firms may adopt to improve their supply chains.

Another direction for future studies is to identify different constructs to examine sustainability since this research used financial performance, employee wellbeing and raw material consumption as study constructs for economic, social and environmental sustainability respectively. Also, other subsectors of manufacturing firms should be considered in studies related to supply chain resilience as this study focused on food processing, textiles and clothing, pharmaceuticals and soap and detergents subsectors of manufacturing firms.

6.6 Chapter Summary

This chapter concludes the study. The summary of the findings has also been presented. Conclusions have been drawn on the research objectives. Additionally, contributions of the study to research, practice and policy have been presented. Recommendations have been proposed for practice and policy. The limitations of the study and directions for future research have also been presented.



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APPENDIX

JULIET OHENEWAA SIAW

UNIVERSITY OF GHANA BUSINESS SCHOOL

DEPARTMENT OF OPERATIONS AND MANAGEMENT INFORMATION SYSTEMS

SURVEY QUESTIONNAIRE

Dear Sir/Madam,

This study is being conducted by a MPhil Operations Management student of University of Ghana Business School on the topic “**Supply Chain Resilience: Strategies and Impact on Sustainable Operations among Ghanaian Manufacturers**”. Your participation is critical to the success of the study. All responses will be kept confidential and will not be traceable to your firm personally. Please your participation is entirely voluntary and information collected will be used for academic purpose only.

Kindly spare a few minutes off your busy schedule to complete the questionnaire as your participation is of value to the study. Thank you for your cooperation and in case of any concerns, please contact the researcher.

Researcher’s contact details: (+233245662418/jsohenewaa80@gmail.com)

PART A: DEMOGRAPHIC PROFILE

The following questions are about the demographic profile of you and your firm.

Please tick [v] the appropriate box and write in your answers where appropriate.

1. What is your gender?
 Male Female
2. How old are you?
 18 -24 25-34
 35-44 45-54
 55-64 65-above

3. What is your highest completed level of education?
 Secondary HND/ Degree Postgraduate
Others [Please specify]:

4. What position do you hold in your firm?
 Owner/Manager General Manager
 Operations Manager Supply chain /Procurement Manager
 Procurement/ logistics Officer

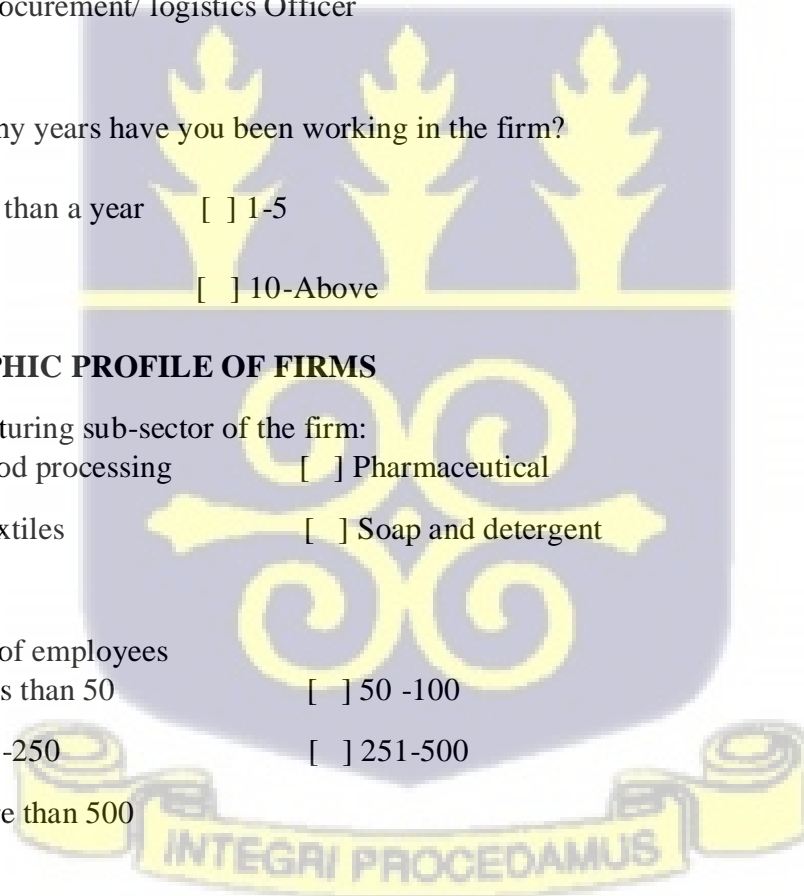
5. How many years have you been working in the firm?
 Less than a year 1-5
 6-10 10-Above

DEMOGRAPHIC PROFILE OF FIRMS

6. Manufacturing sub-sector of the firm:
 Food processing Pharmaceutical
 Textiles Soap and detergent

7. Number of employees
 Less than 50 50 -100
 101-250 251-500
 More than 500

8. Annual sales of this firm:
 Less than 1 million 1-5 million
 6-10 million 11-50 million



51 -100 million More than 100 million

9. Years of operating experience of this firm:

Less than 1 year 1-5 years

6-10 years 11-15

16-20 More than 20 years

SECTION A: SUPPLY CHAIN RESILIENCE STRATEGIES

Please indicate your level of agreement or disagreement with the following statements on supply chain strategies using a scale of 1-5 where; 1=Strongly Disagree, 2= Disagree, 3=Neutral, 4= Agree to 5=Strongly Agree.

CODE	AGILITY	1	2	3	4	5
SCRA1	We change product quality based on customer needs					
SCRA2	We have significant additional capacity of materials, equipment and labour to quickly boost customer response					
SCRA3	We quickly reallocate orders to alternate suppliers where we lack adequate capacity					
SCRA4	Our firm has sufficient logistics system in demand response					
SCRA5	Our firm ensures elastic labour arrangement to respond to variations in demand					
SCRA6	Our delivery schedules are adjustable based on demand fluctuations					
SCRA7	Our firms' supply base is able to absorb abrupt changes in demand					
	REDUNDANCY	1	2	3	4	5

SCRR1	Our firm maintains safety stock in case of supply chain disruptions					
SCRR2	Our firm keeps extra inventory of strategic items (e.g. raw material, parts and finished goods)					
SCRR3	Our firm holds safety stock to deal with variable demand rate or lead time					
SCRR4	Our firm holds buffet stock to mitigate the risk of stock-outs					
SCRR5	Our firm maintains slack capacity (e.g. additional production lines and IT backup systems) in case of supply chain disruptions					
SCRR6	Our firm sources from multiple suppliers to minimise the likelihood of supply chain disruptions					
SCRR7	Our firm underutilises capacity to serve as a cushion to absorb unexpected increase in demand					
	COLLABORATION	1	2	3	4	5
SCRC1	We embrace strategic alliance with third party logistics providers					
SCRC2	Our firm shares resources with our supply chain partners					
SCRC3	Our firm synchronizes product development decisions with our key suppliers					
SCRC4	We have joint accurate inventory visibility with our partners					
SCRC5	Our firm embrace partnership with our suppliers					
SCRC6	We synchronize demand forecast with our outsourced partners					

	INFORMATION SHARING	1	2	3	4	5
SCRI1	Our firm shares proprietary information (e.g. production, financial, design and risk) with supply chain partners					
SCRI2	Our firm informs supply chain partners of changing needs of customers in advance					
SCRI3	Our supply chain partners share their proprietary information with us					
SCRI4	Our supply chain partners share their business knowledge of core business processes with us					
SCRI5	Our firm and its supply chain partners keep each other informed frequently and in a timely manner about events or changes that may affect each other					
SCRI6	Our supply chain partners exchange information that help in establishment of business planning					

SECTION B: SUSTAINABLE OPERATIONS

Please indicate your level of agreement or disagreement with the following statements on the dimensions of operations sustainability using a scale of 1-5 where; 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4= Agree to 5=Strongly Agree.

Code	ECONOMIC (FINANCIAL PERFORMANCE)	1	2	3	4	5
SFP1	We have a high market share growth					
SFP2	We have high sales growth rate					
SFP3	Our products command a significant share of the market					

SFP4	We have a high -profit margin on sales					
SFP5	We have a high return on sales					
	SOCIAL (EMPLOYEE WELL-BEING)	1	2	3	4	5
SEW1	Our firm offers employees opportunity for career growth through training and development					
SEW2	Our firm provides a very conducive workplace for employees					
SEW3	Our firm cares a lot about its employees					
SEW4	Our firm involves employees in decision making					
SEW5	There is improved information flow between top management and employees within the firm					
SEW6	Our firm provides its staff with good conditions of service					
	ENVIRONMENTAL (RAW MATERIAL CONSUMPTION)	1	2	3	4	5
SRMC1	Our firm has a culture that aims at reducing waste of raw materials					
SRMC2	We are able to recycle raw materials used					
SRMC3	We have a raw material usage policy					
SRMC4	We buy our raw materials from sustainable sources					
SRMC5	We use raw materials from renewable sources					
SRMC6	Our use of raw materials does not harm the environment					

SECTION C: ENVIRONMENTAL UNCERTAINTIES

Please indicate your level of agreement or disagreement with the following statements on environmental uncertainties facing your firm using a scale of 1-5 where; 1=Strongly Disagree, 2= Disagree, 3=Neutral, 4= Agree to 5=Strongly Agree.

Code	SUPPLY UNCERTAINTY	1	2	3	4	5
SU1	Our suppliers are not consistent in meeting our requirement					
SU2	Our suppliers provide us with raw materials of inconsistent quality					
SU3	The price of our raw materials and component parts changes frequently					
SU4	We have capacity issues with suppliers of raw materials for our major products					
SU5	We do extensive inspection of materials from our suppliers before accepting them for use					
SU6	We face frequent delays from our key suppliers					
	DEMAND UNCERTAINTY	1	2	3	4	5
DU1	Our demand fluctuates drastically from week to week					
DU2	Customer requirement for our products changes drastically from time to time					
DU3	Our master production schedule has a high percentage of variation in demand over time					
DU4	Our requirement for raw material supply vary drastically from week to week					
DU5	The volume and/or composition of our customers' demand is difficult to predict					
DU6	We can hardly keep to our demand forecast due to frequent demand changes					

	TECHNOLOGY UNCERTAINTY	1	2	3	4	5
TU1	Our production technology changes frequently					
TU2	Our industry is characterised by rapidly changing technology					
TU3	The rate of technology obsolescence in our industry is high					
TU4	If our firm do not keep up with changes in technology, it will be difficult to remain competitive					
TU5	The cost of investing into new technologies in our industry is high					

Any comment (s)

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END OF QUESTIONNAIRE

THANK YOU FOR YOUR PARTICIPATION

