LEAGILE STRATEGIES AND SUPPLY CHAIN ROBUSTNESS IN MANUFACTURING FIRMS IN KENYA

BY

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DECLARATION

I declare that this research project is my original work and has not been presented for an award in any other university or an institution of higher learning.

Sign: __  _____ Date: _____12/5 /2022____

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D61/34846/2019

This research project has been submitted for examination with my approval as the appointed university supervisor.

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DEDICATION

I give special dedication specifically to my family; my beloved husband Stephen Okiya for his love, support and sacrifice, and to my exceptionally wonderful, loving daughter Maria.

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I give all glory and honour to our Lord for the miracle of guiding me through the whole journey of academic heights. It is my great pleasure to thank my supervisor Mrs.Nancy Marika and my moderator Dr. Magutu who remained consistently strong in pursuit of academic professionalism. I also acknowledge the School of Business family for the strong leadership in providing an academic environment for both career and professional growth together with efficient management for completion of my studies.

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ABBREVIATIONS AND ACRONYMS

COVID-19	Corona Virus Disease 2019
GDP	Gross Domestic Product
KAM	Kenya Association of Manufacturers
LSCT	Lean Supply Chain Theory
SC	Supply Chain
SEM	Structural Equation Modelling
TOC	Theory of Constraints
SRC	Supply Chain Robustness
LS	Lean Supply Chain Strategies
AS	Agile Supply Chain Strategies

ABSTRACT

The supply chain concept is a critical anchor in the overall performance of any organization as shown through various studies. More so, several examples exist that show operational performance by organizations result from well-coordinated supply chain operations and this necessitated the need for this research work. The current study aimed to examine the effect of leagile strategies on SC robustness of manufacturing companies in Kenya. The key objectives were to; establish the leagile supply chain strategies adopted by manufacturing companies in Kenya and to establish the association between leagile strategies and SC robustness in manufacturing organizations in Kenya. This study was anchored on theory of lean supply chain (LSCT) by Lamming and supported by Goldratt's theory of constraints (TOC). A descriptive cross-sectional research design, with a sample of 132 firms was used. The main tool of data collection was a 5-point Likert scale questionnaire. Descriptive and inferential statistics with Regression analysis using mathematical models were applied to produce outputs. Results from the study indicated that all the lean strategies and agile strategies had a positive influence on the robustness of supply chain. The study concluded that the two strategies combined forming the leagile strategies had a significant influence on robustness of SC in manufacturing companies in Kenya. This study thus recommended that firms should establish what lean strategies practices could work best for each firm. Additionally, the study recommended that there was need for manufacturers to actively practice agile strategies that would guide in achieving robust supply chain. Finally, the study recommended that manufacturers should benchmark their leagile strategies to test their supply chain robustness. The empirical data generated from the study is meant to be of benefit in improving supply chain practitioners as well as leagile strategies applications in manufacturing firms in Kenya. Further studies could be carried out to involve other sectors of the Kenyan economy away from manufacturing as well as within manufacturing but for the small firms.

CHAPTER ONE: INTRODUCTION

This chapter introduces; the background of the study, main variables, the statement of the problem, the study objectives and the values.

1.1 Background of the Study

In the twenty-first century, supply networks are becoming increasingly fragile, thus enhancing robustness of supply chain (SC) is a critical management problem that has an impact on organization's success. Despite increased scholarly and industry attention, the frequency and impact of disruption remain crucial. According to Udofia, Adejare,& Olaore, (2021), disruption may take various forms, including withdrawal or loss of financial capital, delivery failure by suppliers, employee union strikes, natural disasters, protests and riots, plant-related issues, and disruptions caused by pandemics such as the Corona Virus Disease 2019 (COVID-19). Precisely, COVID-19 has necessitated businesses to rethink their SC strategy in order to become more collaborative, resilient and networked with suppliers, customers, and other stakeholders (Singh, Kumar, & Tiwari, 2021).

Agile and lean are the popular strategies that any organization can choose for their manufacturing or non-manufacturing operations to enhance the robustness of the supply chain (Mohammaddust, Rezapour, & Farahani, 2017). The benefits of both lean and agile strategies can be obtained by implementing a "leagile strategy"(Ahmed & Huma, 2018). They argue that implementing both strategies concurrently allow organizations to improve quality, reduce, costs, and be more responsive and flexible to customer demand while upholding sustainability.

The lean supply chain theory (LSCT) and theory of constraints (TOC) will anchor the study. The theory of LSCT by Lamming (1996) has concepts that were adapted from lean manufacturing. The key tenet of the theory is that by increasing efficiency and reducing waste, a lean SC assists the organization in realizing substantial financial and nonfinancial gains. Goldratt's (1986) theory of constraints (TOC) points out the obstacles that may

hinder an organization from reaching its goals and objectives by working strategically to convert the constraints and obstacles into a positive element and coming up with a solution. The study will focus on the Kenyan manufacturing firms which is largely dominated by subsidiaries of multinational businesses. Kenya Association of Manufacturers (KAM) observes that the gross domestic product (GDP) in manufacturing industry has contributed to an average of 10% from 1964 to 1973, increased considerably to 13.6% from 1990 to 2007, and has recently been below 10% on average (KAM, 2018). These are large firms in various manufacturing sectors including pharmaceuticals, beverages, food, tobacco, batteries, chemicals and carbon dioxide and equipment manufacturing. Ochieng (2019) poses that most of large manufacturing companies in Kenya face SC disruptions due to their insufficient capacity to adopt dynamic and flexible strategies coupled with the environmental uncertainties and poor physical and technological infrastructure in Kenya.

1.1.1 Lean Supply Chain strategy

In this period of heightened environmental instability and unforeseen changes, lean strategy seek to create dynamic manufacturing and supply networks to acquire a speedy reaction with the least cost in this competitive environment (Assen, 2021). The objective is to increase consumer value by minimizing waste and defects, and decreasing the cost of products (Tortorella, Giglio, & Limon-Romero, 2018). This kind of supply chain prioritizes predictability and consistency above adaptation and flexibility (Piotrowicz, Ryciuk, & Szymczak, 2022). Rather than adjusting to changes in the market or customer demand, production scheduled in days, weeks or even months beforehand. This planning helps in establishing the least possible cost for large quantities of products. For products with low fluctuation in the market, the lean strategy is appropriate. However, it's not suited for products that require high customization or those with fluctuating market demand.

Lean strategy, according to Kimaro, Kisawike, and Ruoja (2021), focuses on reducing defects, errors and waste in the production and supply chain, while at the same time improving information flow along the value chain. Regardless of the shifting trends or economy, demand for certain items remains stable and thus making the lean strategy perfectly suited to their production. These are usually utilitarian and essential items like

beverages, toiletries and food. The lean strategy focusses on lowering costs and hence is suited in industries where competition on costs is paramount (Mohammaddust et al., 2017). A lean supply chain approach focuses on minimizing the seven main wastes that are often experienced in mass production systems as categorized by Taiichi Ohno as "the seven wastes" (McBride, 2003). These include wastes in inventory, transportation, waiting, motion, overprocessing, overproduction, and defects. Waste in inventory relates to accumulating too many undelivered products or parts or having too much equipment that could one day be needed (Gourley, 2020). Waste in transportation refer to the loss that occurs in the movement of materials and components form one location to another while motion waste relates to unnecessary equipment or staff movement (McBride, 2003). There is also waste in waiting for the delivery of the items and in overproduction when the firm makes too many products. Moreover, overprocessing can lead to waste when a job is given a lot of time or when incorporating features that are not useful. The last kind of waste is defects which relate to defective or broken parts that require reworking (Gourley, 2020).

1.1.2 Agile Supply Chain Strategy

A SC that is agile emphasizes on responsiveness ,flexibility and how fast responds to changes in industry, demand or client preferences (Gurahoo & Salisbury, 2018). By delaying production and waiting to determine the needs of the market before moving forward, it is intended to cope with volatility in the market. An agile SC performs research to ascertain demand before creating the final product, responding right away to demand rather than anticipating demand and producing first (Ahmed & Huma, 2018). However, some market forecasting is still necessary since parts of a product are developed in advance to speed up and streamline the finalization process. As a result, agility emphasizes fusing information about present product demand with projections for the immediate future. Most often, agile strategy are appropriate for products with customizability and short life cycles (Minagawa, 2018).

For an agile strategy to be implemented effectively, strong vendor interactions and partnerships are critical (Matawale, Datta, & Mahapatra, 2016). This is because products will not be produced speedily and effectively as required by a SC that is agile if suppliers

do not cooperate with the market and with one another (Piotrowicz et al., 2022). A SC that flexible also has lesser storage costs as the manufacturing entity does not have to keep large inventories on hand to keep up with demand (Mohammaddust et al., 2017). Instead, demand arises, and supply is generated to fulfill it. There are various measures of supply chain agility that have been fronted by various scholars and practitioners. These include responsiveness, flexibility, and extent of cooperation and information sharing (Ahmed & Huma, 2018). Other metrics include time to deliver, quality of the products, and customer satisfaction.

1.1.3 Supply Chain Robustness

Robustness of the supply chain is indicated by its capacity to remain strong and effectively attain its objectives in the face of internal and external disturbances (Huma & Siddiqui, 2019). Besides, Piotrowicz et al. (2022) observe that a robust SC has the capacity to maintain operations while resisting the effects of interruptions. Further, Hohenstein et al. (2015) observe that a robust supply chain adapts to changes in the operating and market environment without taking drastic measures, while Durach et al. (2015) note that over a particular planning horizon, a resilient supply chain hedges the firm's performance against the worst scenarios in terms of unpredictable elements. Various antecedents have been fronted as key to supply chain robustness including reduced network complexity, risk management orientation, and visibility (Durach et al., 2015).

There has been much scholarly work seeking to synthesize and evaluate the emerging concept of supply network robustness, which is characterized by resilience of the SC (Ariadi, Surachman, Sumiati, & Rohman, 2021). In this pursuit, Piotrowicz et al. (2022) provided a framework that encapsulates the antecedents, dimensions, measures and indicators of supply chain robustness. They indicated that resistance and avoidance are the key measures, resistance indicates the SC’s capacity to withstand variation while avoidance is the capacity of the SC not to be influenced by variation. Moreover, Durach et al. (2015) had previously provided measures such as intelligence, connectedness and dependability. Connectedness is the capacity of the processes of partners in the SC to effectively connect and coordinate with others in the system. Intelligence is the capacity of the network

systems, processes and players to acquire data from the environment and respond autonomously. While responsiveness is the capacity to appropriately react towards external and internal changes.

1.1.4 Manufacturing Firms in Kenya

Kenya holds a sizable manufacturing industry that caters for domestic needs and exports to regional and international markets. The manufacturing industry in Kenya is largely dominated by subsidiaries of multinational businesses. Kenya association of manufacturers (KAM) indicate that Kenya's industrial industry has had serious difficulties and as a result, its contribution to GDP has decreased dramatically (KAM, 2018). KAM further observes that the manufacturing industry's contribution to GDP has increased considerably to 13.6% from 1990 to 2007, and has recently been below 10% on average (KAM, 2018). The reduction in GDP could be due to the economy's overall downturn, rising poverty levels, stifled demand for locally manufactured products, and competition from comparatively cheaper imported manufactured goods. Furthermore, high input costs as a consequence of insufficient infrastructure have resulted in high pricing for locally made goods, restricting their competitiveness in regional markets and decreasing the sector's capacity utilization. The major products manufactured in Kenya include beverages, food, furniture, plastic products, textiles, batteries, clothing, cigarettes, soap and oils, fuels, flour, cement and steel. The largest manufacturing sub-sector is the food-processing sector which has over 1,200 companies producing beverages and food.

This study will focus on large manufacturing companies in Kenya. According to Ochieng (2019) significant number of manufacturing firms in Kenya face SC challenges because of their insufficient capacity for inventory forecasting, periodic analysis of procurement, and continuous pre-screening of the capacity of suppliers, all of which have a negative impact on their performance. Environmental uncertainties and poor physical and technological infrastructure in Kenya had also added to the diffficulties faced by the SC of the manufacturing companies (Muriithi, Sammy, & Shalle, 2021).

1.2 Statement of the Problem

A manufacturing entity that adopts and implements agile and lean strategies are more efficient and responsive to market changes (Piotrowicz et al., 2022). A lean strategy seeks to reduce expenses by manufacturing large quantities of standardized products. Conversely, an agile strategy focusses on flexibility and responsiveness to the environmental changes and market demand. Combining these two strategies makes the supply chain more cost-effective, flexible and adaptive for increased SC robustness and performance (Tortorella et al., 2018). However, the empirical evidence regarding the efficacy of agile and lean strategies towards building a resilient and strong supply chain is mixed (Ahmed & Huma, 2018; Assen, 2021; Gurahoo & Salisbury, 2018; Tortorella et al., 2018). Despite these, Piotrowicz et al. (2022), indicate that SC robustness suffers due to SC network risk that can be lowered by adopting lean and agile strategies.

Kenya's manufacturing industry is beset by performance issues and an unorganized supply chain strategy. Demand fluctuations, supply disruptions, high production costs, technological changes, unavailability of raw materials, competition from imports, financial risk, and employee strikes are all factors contributing to the manufacturing sector's slow growth (Ochieng, 2019). The COVID-19 pandemic also generated a health crisis that intensified into an economic crisis with damaging effects on the global supply and demand chains. This had notable negative effects on supply chains of Kenya’s manufacturing sector which adds to the pre-existing challenges in the local manufacturing sector (Muriithi et al., 2021). A question of how the manufacturing companies have adopted agile and lean strategies to enhance the robustness of their supply chains then suffices.

There have been several studies that have been conducted evaluating the effect of agile and lean strategies on several organizational outcomes such as organizational performance, supply chain performance, supply chain robustness and competitive advantage. In Pakistan, Huma and Siddiqui (2019) assessed the influence of agile and lean strategies on SC robustness and found that agile and lean strategies have a positive influence on robustness of a SC. The study however, left some contextual gaps as it was conducted in Pakistan whose manufacturing environment may be different from Kenya. In India, Singh

and Modgil (2020) determined that lean strategy enhances SC performance. This study however, was not on supply chain robustness. In Saudi Arabia, Ahmed and Rashdi (2020) established that lean strategy has no influence on a supply chain robustness under uncertain market conditions. This study focused on steel manufacturers and not manufacturers from different sectors .Another study in Indonesia by Ariadi et al. (2021) determined that agile and lean SC strategies significantly affect profitability of companies in the bottled water sector. This study also leaves some contextual gaps as it only focused on bottled water firms while the current study will focus on firms from different manufacturing sectors.

A study in Libya by Huxel and Gelashvili (2014) established that agile and lean practices positively influence response and preparedness of humanitarian organizations. This study was on humanitarian organizations and not manufacturing companies. A study in Nigeria by Ateke and Nwiepe (2017) determined that agile supply strategies enhances performance of SMEs. This study has left some methodological gaps as it did not have SC robustness as the dependent variable. Another study in Angola by Oliveira-Dias et al. (2022) determined that leagile SC strategies are positively related with operational performance. This study has contextual gaps as it was conducted in Angola not in Kenya. A study in Ethiopia by Getachew (2017) found that agile and lean strategy did not affect responsiveness. This research was undertaken in the garment sector while the current research will focus on manufacturing companies in different sectors. A study in Tanzania by Kimaro et al. (2021) explored the effect of lean strategy on profitability of organizations in the dairy sector. This study left some conceptual and methodological gaps as it did not consider agile strategy and used performance as the dependent variable instead of SC robustness.

Locally, Kimari and Muli (2022) investigated the effect of lean strategies on the profitability of Unilever Kenya. This study left some contextual gaps as it was a case of Unilever Kenya and did not focus on Kenyan manufacturing organizations, the motivation of the current study. Another study in Kenya by Muricho and Muli (2021) explored whether agile strategy influenced the performance of manufacturing companies in the food and beverage sector. This study only focused on food and beverage manufacturers. Another

study by Nyile et al. (2021) determine that the leagile strategy enhanced SC responsiveness of humanitarian aid organizations.

A similar study by Kuria (2014) found that supply chain leagility significantly influenced performance of charitable institutions in Kenya. These studies were not on manufacturing companies. Another study by Memia (2018) determined that lean strategy influenced performance but agile strategy did not. This study was on all manufacturing companies and did not examine the joint influence of the two strategies. The present study sought to fill these gaps by responding to the query: what is the influence of lean and agile strategies on SC robustness in manufacturing companies in Kenya?

1.3 Objectives of the Study

The study's main intention was to ascertain the influence of leagile strategies on supply chain robustness of manufacturing companies in Kenya. This study's specific objectives were;

i) To establish the leagile supply chain strategies adopted by manufacturing firms in Kenya.

ii) To establish the association between leagile strategies and supply chain robustness in manufacturing firms in Kenya.

1.4 Value of the Study

In today's world full of disruptions that costs much to companies and can dent their competitiveness, reputation and bottom-line, a robust supply chain is vital as it could reduce the negative effects of disruption. This research sought to examine the influence of agile and lean strategies on SC robustness in manufacturing companies in Kenya. It therefore provided vital findings that could be used by various stakeholders. These include policy makers, regulators, management of manufacturing companies, supply chain practitioners, scholars and researchers.

The study findings might be used by policymakers such as the Ministry of Industrialization and Enterprise Development, Ministry of Transport and Infrastructure and Kenya

Association of Manufacturers to develop or advocate for design of policies that enable manufacturing companies to develop agile and lean strategies for robustness of their supply chains. The policymakers could be aware of the effect of agile and lean strategies on SC robustness and hence would be in a better position to determine the regulation or policies that will enable manufacturing companies to improve their SC performance.

Managers and SC practitioners in the manufacturing companies would have an in-depth knowledge of how lean and agile strategies influence SC robustness in their manufacturing companies. This could enable them to apply the findings in their firms to improve on their supply chain robustness by adjusting their lean and agile strategies and also develop solutions to address the critical SC robustness issues that will be identified in this research.

The study findings could also be beneficial to theory, research and academics. To theory, the research could add to the available empirical literature and theoretical regarding the effect of agile and lean approaches on SC robustness in manufacturing companies. This will increase the depth of the reference materials available for scholars and academicians when furthering their knowledge on lean strategies, agile strategies, and supply chain robustness. Besides, the study will provide recommendations for further research which researchers can explored in the future as they further knowledge regarding the study subject.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This part discusses both empirical and theoretical literature appertaining to leagile strategies and SC robustness is provided in this chapter. An outline of the two theories (theory of lean supply chain and theory of constraints) that serve as the basis for this research is given in the theoretical review. This section concludes by summarizing the empirical studies and the knowledge gaps. Finally, conceptual framework is given that guides the study.

2.2 Theoretical Review

The research employed theory of lean supply chain and theory of constraints. The authors who developed these theories, the key tenets of the theories and the applicability of the theories to the study is discussed.

2.2.1 Theory of Lean Supply Chain

The theory of lean supply chain (LSCT) by Lamming (1996) has concepts that were adapted from lean manufacturing. The key tenet of the theory is that by increasing efficiency and reducing waste, a lean strategy assists the organization in realizing substantial financial and nonfinancial gains. The focus of lean strategy is on locating and removing waste in the SC, taking into account the non-value added activities. The theory further indicated that a firm's supply chain inventory could be significantly reduced due to the implementation of the lean principles, which can also lead to product quality and increased productivity, and also presents information as quickly as possible for more economical and effective market reactions (Matawale et al., 2016). The theory also indicates that waste is a consequence of tasks, delays, needless errors and expenses and when these are reduced, an organization can experience significant financial and nonfinancial gains.

The LSCT was applied in this study as it advocates for developing dynamic production and supply networks to gain a quick response with the least amount of expense in this competitive climate, which is characterized by high degrees of environmental instability

and unanticipated changes (Ketchen & Hult, 2006). By reducing waste and faults and the cost of goods, the goal is to improve customer value and enhance the supply chain robustness to market reactions. The goal of the lean SC approach is to improve information flow across the value chain while simultaneously decreasing waste, mistakes, and defects in the manufacturing and SC (Ho, Zheng, Yildiz, & Talluri, 2015). As a consequence, a business may gain a competitive advantage, enhance the reaction time of its supply chain, improve SC robustness, and enhance performance by effectively implementing a lean strategy.

2.2.2 Theory of Constraints

Goldratt's (1986) the constraints theory (TOC) indicates that an organization should determine the biggest obstacle or restriction impeding the achievement of a goal, and then gradually eliminate it until it no longer poses a problem. The TOC advocates for the adoption of a methodical strategy for development of limit factors to enhance processes, systems and activities in the organization. It assumes that each complex system, including industrial processes, consists of a collection of related processes, each of which puts restrictions on others. The constraints in a supply chain can be inventory management rules, supply chain structure, customer demand, information exchange, forecasting techniques, lead times, and review period duration (Huma & Siddiqui, 2019). The TOC can hence be applied to manage these limiting factors to influence the robustness and performance of the SC.

The TOC was applied in this study to link management of the various limiting factors through adoption of agile strategies, and the robustness of the supply chain. The agile strategy places a strong emphasis on dealing with various constraints by enabling responsiveness and flexibility, to empower the SC to quickly adapt to changes in market demand, customer preferences, and industry changes (Kimaro et al., 2021). An agile strategy deals with constraints by undertaking research to ascertain demand before creating the final product, responding right away to demand rather than anticipating demand and producing first (Ahmed & Huma, 2018). Supply chain agility emphasizes fusing information about present product demand with projections for the immediate future to

effectively deal with constraints and enhance robustness of the SC. Effective execution of an agile strategy through strong vendor relationships and alliances enables the firm to deal with the limiting factors and thus enhancing SC robustness.

2.3 Lean Supply Chain Strategies

A lean supply chain strategy focuses on reducing seven key types of waste as noted by Taiichi Ohno which are wastes in inventory, transportation, waiting, motion, overprocessing, overproduction, and defects (McBride, 2003). Waste in transportation arises when resources (materials) are shifted without adding value to the final product. Inefficient materials transportation might cost the firm resources and compromise product quality. While using transportation, the company may often be required to pay extra for equipment, space and time while using transportation (McBride, 2003). According to Huma and Siddiqui (2019), transportation of resources from one place to another, is wasteful since it does not improve the product in any way.

Waste in inventory entails holding "just in case" stocks by an organization which often results in excessive inventory thus increasing carrying and holding costs (Huxel & Gelashvili, 2014). When a manufacturing company overstocks to prepare for unforeseen demand, this can lead to obsolescence, damages, pilferage and other costs. Moreover, this excess inventory often fails to satisfy client demands and offer little value. Gourley (2020) observes that inventory relates works-in-progress, raw materials, or completed products which has to be packaged, requires room for storage, and must be moved about. It stands a risk of becoming damaged in transit and losing its usefulness.

Motion is one of waste that affect labor-intensive and unnecessary movements of equipment and personnel (McBride, 2003). They could result in longer lead times, accidents, and other challenges. A firm should set up procedures so that employees are required to do their duties with the least amount of effort and motion. Further, Oliveira-Dias, Moyano-Fuentes, and Maqueira-Marín (2022) indicate that a waste emanating from motion is excessive movement, whether it comes from machinery or workers. Unnecessary

motions are actions taken by a machine or a worker that are not as quick or simple to complete as they are required.

Waiting is another type of waste which is probably the simplest waste to identify (Gourley, 2020). Waiting waste is any time when tasks or items are not progressing, or idle time. Because wasted time is the most evident item that a manufacturing company can see, it is simple to identify. These include broken equipment awaiting repair, items awaiting delivery, or an order awaiting approval. The manufacturing company wastes time waiting, which results in downtime(McBride, 2003). The waste of waiting interferes with flow, which is one of the fundamental principles of mean manufacturing.

Overproduction is a waste since producing more products entails exceeding client demand, which results in further expenses (Gourley, 2020). According to McBride (2003) most of the wastes are brought about by overproduction. The cause is that too many tasks or products need extra transportation, too much movement, and waiting times which cause defects. Additionally, if a fault sometimes occurs as a result of overproduction, the production team have to rework additional units. The overproduction waste is the most serious of the seven wastes. This often occurs as a result of dealing with lengthy lead times, large volumes, and strained relationships with suppliers among other factors (Ahmed & Rashdi, 2020).

Overprocessing is a kind of waste often results from doing work that either adds no value at all or adds more value than is necessary (Gourley, 2020). These might include providing additional features to a product that the customer does not need but which raises the company's expenses. Doing more than the consumer requests is wasteful overprocessing, and it costs the organization time and resources. Besides, when the organization employs oversized equipment, improper procedures, carry out operations that the client does not demand, this is also overprocessing. According to McBride (2003), one of the most prominent instances of over-processing in most manufacturing companies is the "mega machine," which performs an operation quicker than any other but must be used for every process flow, resulting in delays, and scheduling issues among others. An organization

should use small, suitable machines where they are required in the flow rather than interrupting it to pass through an outrageously costly machine.

The seventh type of waste is defects which may result in rework or, worse yet, discarding of some products (Gourley, 2020). Defective work often has to be redone, which takes important time. A second reworking area may be necessary in certain circumstances, which necessitates using more equipment and workers. Although defects are not always the simplest to identify before they reach the clients, it is the most evident of the seven wastes. The organization always pay significantly more than it anticipated for quality mistakes that result in defects. Every faulty product consumes materials and resources, necessitates repair or replacement, may result in lost business and generates more paperwork. Wherever feasible, defects should be avoided since it is preferable to prevent them than to attempt to discover them (McBride, 2003).

2.4 Agile Supply Chain Strategies

Agility of a SC, according to Nyile et al. (2021), is depicted by the supply chain's flexibility and responsiveness and how it quickly adapts to changes in the industry environment, customer preferences, and market demand. Besides, Muricho and Muli (2021) indicates that in an agile supply chain , research is undertaken to ascertain demand before creating the final product. However, some market forecasting is still necessary since parts of a product are developed in advance to speed up and streamline the finalization process. As a result, agility emphasizes fusing information about present product demand with projections for the immediate future. Effective implementation of an agile supply chain depends on strong vendor relationships and alliances. The degree of collaboration between SC partners is therefore vital. This is because if suppliers do not work together and with the market, items will not be produced as quickly and efficiently as an agile chain demand.

There are various indicators or measures used to indicate the agility of a supply chain. These include responsiveness, adaptability, information exchange and the degree of collaboration between supply chain partners (Durach et al., 2015). Other measures,

according to Ketchen and Hult (2007), include product quality, and time to delivery. Regarding adaptability, this entails the tactics required to create a SC that is dynamic and able to adjust as demands and the environment change over time (Kuria, 2014). Alignment enables the numerous and sometimes disparate interests and objectives of SC partners to be included to achieve joint advantages and success.

Information exchange among the supply chain partners is also vital for success of an agile strategy. The supply chain management's goal is to oversee the intricate business operations carried out by various interconnected SC players as a cohesive whole (Huma & Siddiqui, 2019). Information systems are essential because they provide the instruments to routinely acquire, transport, analyse, and exchange information throughout the SC, therefore managing the resultant frequent, complex, and inter-organizational flows of information (Verdouw et al., 2011). Platform for shared communication should be present before attempting to incorporate control operations into supply chain. In terms of applications, information definitions, data sharing, and technological infrastructure, this necessitates a successful coordination of the information systems of the various SC participants.

Customization is another important feature in agile. Agile strategy focussed on concentrating on the ability to comprehend and respond speedily to changes in the market based on quality or customer needs (Oliveira-Dias et al., 2022). The agile strategy is also focussed on applying order to make provisions, postponed fulfilment, a fast restocking, and not pledging to items until demand is understood. This empowers the SC partners to produce with the demands and quality standards in mind. By raising quality levels and cutting lead times, agile strategy emphasizes the capacity to satisfy market needs and calls for setting aside some capacity to address variable quality demand.

Time to delivery or lead time is another aspect that an agile strategy seeks to reduce (Oliveira-Dias et al., 2022). Reduction of lead time is done by increasing the production and SC system efficiency. Besides, the organization could boost the production and SC system's capacity during peak times. When the lead time is increasing, this indicates that

the SC system is being overloaded with demands that exceed its capabilities. To be able to reduce lead times, the agile strategy must incorporate enhanced communication amongst the supply chain partners, increased information flow and close collaborations amongst the SC partners.

2.5 Supply Chain Robustness

It's a performance indicator of which is depicted by the capability of the SC to hold up well and accomplish its goals in the face of external and internal disruptions (Assen, 2021). Moreover, according to Kouvelis et al. (2019), a robust supply chain is resilient and it is able to enable the firm to attain its performance objectives against complex and dynamic environmental variables. Additionally, Yang, Xie, Yu, and Liu (2021) indicate that a robust SC network is the one that is responsive changes in the industry or market environment without taking drastic measures. Responsiveness is also the Supply chain's capability to be timely, the degree to which it takes into account the shifting demands of consumers and responds to other changes in the dynamic business environment.

Several other factors have been put up as essential to supply chain robustness including a focus on intelligence, optimization, and consistency (Ariadi et al., 2021). The ability of network systems, processes, and participants to gather information from their surroundings and act independently is referred to as intelligence. By enabling organizations to comprehend the SC of their products and effectively interact with their consumers, supply chain intelligence, or the application of predictive analytics and data analytics to a company's SC, may assist minimize supply chain shocks and risks. Businesses should have the capacity to analyze, organize, and retain historical organizational data as well as make product, marketing, and strategies based on the business intelligence skills do. Supply chain intelligence has improved a number of crucial areas, including warehouse management, SC performance and supplier cooperation.

The other indicators of supply chain robustness is dynamism (Piotrowicz et al., 2022). To enhance performance and effectiveness in a supply network, SC dynamism makes the best use of resources and technology artificial intelligence, and internet of things. The supply

chain of an enterprise is a fundamental business operation that is essential for a positive customer experience. Customers may obtain what they want, where and when they want it with the assistance of a responsive and efficient SC model that is lucrative for the organization and promotes SC sustainability. To enhance dynamism of a supply chain, there should be efficient design, planning and execution.

Resilience is a very vital aspect of supply chain robustness (Ariadi et al., 2021). The resilience of the supply chain of an organization is one of the most difficult issues it faces when it outsources some processes and operations from third parties. An organization must take into account more factors when a product is produced by partners than when it produces the product entirely in-house. Resilience is measured by the reliability of the SC to deliver the rights products, in the required quality and quantity and at the required time. Working with capable supply chain partners who are familiar with the complexities of production, logistics, and operational environments helps guarantee that businesses get the most reliable supply chains.

2.6 Empirical Review

Numerous studies have shown a connection between agile and lean strategies and a range of organizational outcomes, including organizational performance, operational performance, supply chain performance, customer satisfaction, and supply chain robustness. In Pakistan, Huma and Siddiqui (2019) assessed the influence of agile and lean strategies on SC robustness. They used a descriptive design with a population of 140 supply chain experts from the Pakistani manufacturing sector. The study applied structural equation modeling to analyze the gathered data. According to the study's results, agile and lean strategies have positive influence on robustness of a supply chain.

In Saudi Arabia, Ahmed and Rashdi (2020) undertook a study with the purpose of determining the effect of a lean strategy on supply chain robustness and risk management capabilities of the firm. A questionnaire was applied to gather sample data from 257 SC professionals working in manufacturing companies in the country. The study applied structural equation modeling (SEM) as the statistical method to test analyze the gathered

data. The study determined that lean strategy does not make a supply chain robust under uncertain market conditions.

Another study in Angola by Oliveira-Dias et al. (2022) assessed the influence of agile and lean strategies on firm competitiveness. The study used an explanatory design and collected data using questionnaires from top supply chain professional in the pharmaceutical companies in the country. Descriptive statistics and multiple regression analysis were utilized to evaluate the gathered data. The study demonstrated a beneficial relationship between use of technology, performance, competitiveness and the two strategies. The study also determined that lean and agile strategies are positively associated with operational performance.

In Tanzania, a study undertaken by Kimaro et al. (2021) explored the influence of lean strategy on profitability of businesses in the dairy industry. The study population was workers in the firms and a descriptive research was applied. The sample of the study comprised of sixty factory workers who provided information through a structured questionnaire. The relationship amongst study variables was assessed using regression analysis. The study determined that the profitability of the dairy industry in was strongly impacted by lean strategy.

In Kenya, Kimari and Muli (2022) investigated the influence of lean strategy on the profitability of Unilever Kenya. The study adopted a descriptive approach where 400 employees from five divisions that make up Unilever Kenya Limited's internal supply chain were the target population. A representative sample was obtained using a stratified random sampling approach. Eighty respondents, or 20% of the target group, were encompassed in the research. A semi-structured questionnaire was utilized in gathering data. Regression, as well as, descriptive analysis were applied to analyze the gathered data. According to the findings of the regression analysis, six sigma, lean principles and total quality management had a positive influence, whereas just in time procurement did not have a significant influence on profitability.

Muricho and Muli (2021) focused on analyzing how resilience of a supply chain affected the profitability of Kenyan food and beverage manufacturing companies. The research used mixed methods approach in a cross-sectional survey methodology. The study's sample size was 50 firms selected from a population of 102 food and beverage manufacturing companies in Nairobi, Kenya. The research utilized a questionnaire gather data. Linear regression, descriptive statistics, as well as correlation analysis were adopted in analyzing the data. The research results determined that agile strategy significantly affected the profitability of the companies.

2.7 Knowledge Gaps

The extant empirical studies reviewed left some contextual, conceptual and methodological gaps which the current study pursues to fill. For instance, the study in Pakistan, by Huma and Siddiqui (2019) assessed the influence of agile and lean strategies on supply chain robustness. The study applied structural equation modeling (SEM) to analyze the gathered data. The study however, left some contextual gaps as it was conducted in Pakistan whose manufacturing environment may be different from Kenya. Besides, the study left some methodological gaps as it used SEM in analyzing the data while the current study will use multiple linear regression. Another study in Saudi Arabia by Ahmed and Rashdi (2020) sought to ascertain the consequence of a lean strategy on SC robustness and risk management capabilities of the firm. This study focused on steel manufacturers and not manufacturers from different sectors as will be the case in the current study.

In Angola by Oliveira-Dias et al. (2022) studied the influence of lean and agile strategy on firm competitiveness. This study has contextual gaps as it was conducted in Angola, and not in Kenya. Another study in Tanzania by Kimaro et al. (2021) explored the effect of lean strategy on profitability of businesses in the dairy industry. This study left some conceptual and methodological gaps as it did not consider agile strategies and used profitability as the dependent variable instead of SC robustness which will be used in the current study. In Kenya, Kimari and Muli (2022) investigated the impact of lean strategy on Unilever Kenya's the performance. This research left some contextual gaps as it was a case of Unilever Kenya, while the current study focusses on manufacturing firms.

2.8 Conceptual Framework

Figure 2.1 provides the conceptual framework for the study, where the independent variables are lean strategies and agile strategies. The dependent variable was supply chain robustness.

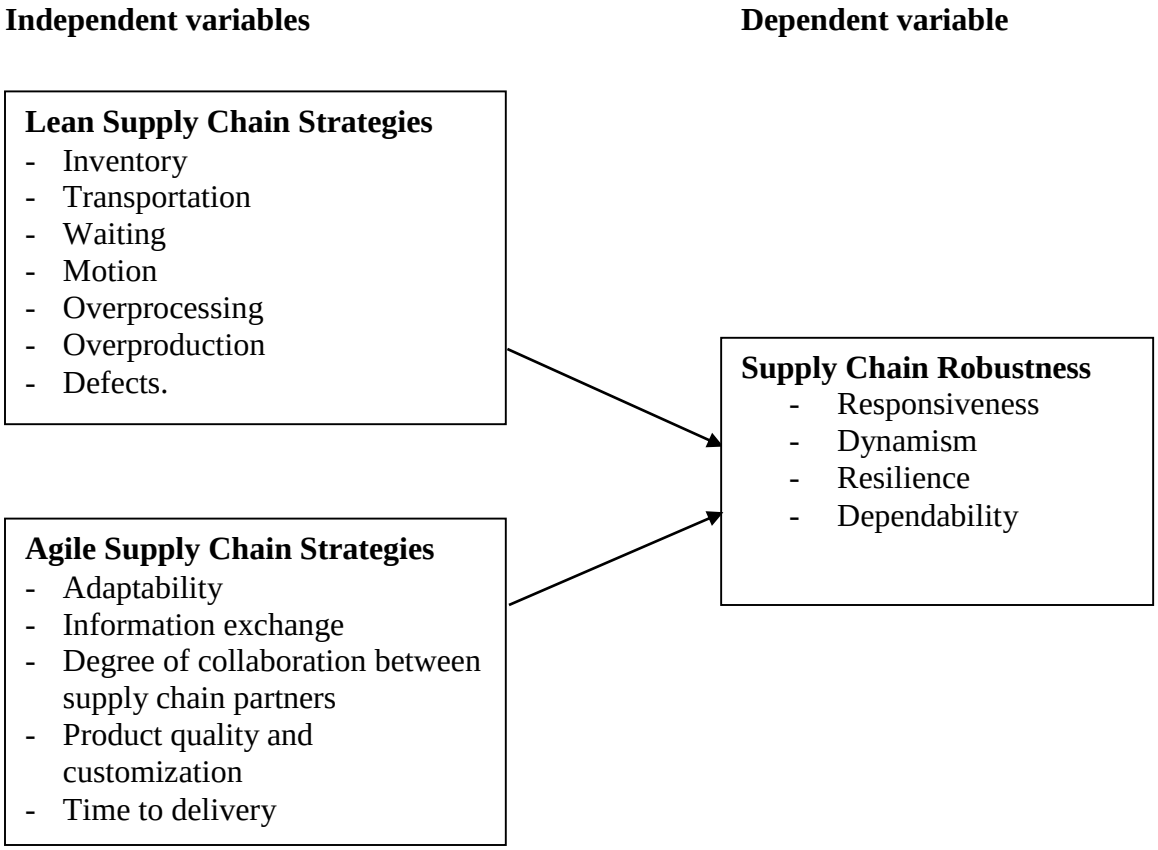

Figure 2.1: Conceptual Framework

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This part discusses the methodological approach that was used in this study. This part offers a detailed discussion of research design, data gathering tools, procedures and techniques that were applied. In addition, it outlines the study population, sampling strategy, and sample size. Lastly, the chapter describes the techniques that was used for data processing and analysis.

3.2 Research Design

The research adopted a descriptive cross-sectional research design. This design provides data for illustrating the status of phenomena or relationships among phenomena at a fixed point in time (Saunders et al., 2019). This design allowed the study to determine the prevalence of leagile strategies and SC robustness in manufacturing companies in Kenya. The design also enabled the study to examine the influence leagile strategies on supply chain robustness in manufacturing companies in Kenya. Morgan (2021) observes that a descriptive cross sectional research design is an arrangement of techniques for acquiring information on characteristics, processes, concepts and ideas by asking study participants to fill out a questionnaire with pre-written questions. A descriptive survey is a research method used to acquire data using a highly organized instrument, according to Huntington-Klein (2021). This method was applicable for this research since it sought information from manufacturing companies in Kenya.

3.3 Population of the Study

This study targeted 494 large manufacturing corporations who were members of the KAM (KAM, 2018). The heads of operations or production departments will make up the units of observation. These large manufacturing firms are from various sectors including mining, chemicals, building, fast moving consumer goods, agro-processing, construction, automotive, energy, electronics and electrical, paper, and leather and footwear. Other sectors include food and beverages, plastics and rubber, and textile and apparels sector. A survey of these firms was thus representative of all manufacturing firms in Kenya.

3.4 Sample Design

Convenience sampling was used to select the sample that participated in the study because of convenient location of Nairobi City County which contained majority of the manufacturers. The study hence selected a sample of 132 large manufacturing organizations participated in this enquiry. The sample was distributed to the population as indicated in Table 3.1.

Table 3.1: Sample Size and Sampling Design

Sector	Population	Percent	Sample
Agro-processing	55	11.1	15
Automotive	37	7.5	10
Building, Mining and Construction	69	14.0	19
Energy, Electrical and Electronics	46	9.3	13
Chemical & Allied	16	3.2	5
Food and Beverages	79	16.0	22
Leather and Footwear	37	7.5	10
Pharmaceutical and Medical Equipment	19	3.8	5
Plastics and Rubber	34	6.9	10
Textile and Apparels Sector	39	7.9	11
Metal and Allied	41	8.3	12
Paper	22	4.5	6
Total	**494**	**100**	**132**

3.5 Data Collection

This research utilized primary data which was acquired by use of structure questionnaires directed to the operations managers of the 132 manufacturing firms. One questionnaire was administered to each organization. The questionnaire was self-administered and was developed following literature review of leagile strategies and the robustness of supply chain. The questionnaire was composed of four sections. The organization basic information was obtained in the first part (A). The information on lean strategies implemented by the manufacturing companies was gathered in the second section (B) while information on agile strategies was requested in the third part (C). The information on the robustness of the supply chains of the manufacturing companies was sourced in the last

section (D). A five-point Likert scale was utilized in arranging queries in the sections B, C and D.

The validity and reliability of the research questionnaire was assessed beforehand. Five large manufacturing firms in the food and beverage sector were used for the pilot testing. Eight participants, who were 10% of the sample for the main study as recommended by Huntington-Klein (2021), was chosen to take part in the pilot study. Validity refers to the fact that the questionnaire will be gathering data it is supposed to (Collis & Hussey, 2018). To test the questionnaire's face validity, the researcher used SC specialists from the University of Nairobi. Another form of validity that was tested was content validity which evaluated whether a research tool measured what it was projected to measure. The comments and outcomes of the pretest were used to evaluate the questionnaire's content validity. Items that did not pass the validity test could be removed or changed as necessary. The questionnaire was also tested for reliability. According to Saunders et al. (2019), an instrument is considered as dependable if it is precise and consistently yields findings that are comparable when used again. The Cronbach's alpha reliability test was applied to assess the reliability of the questionnaire. To be regarded as reliable, the questionnaire must have a reliability coefficient of 0.7 and above. It is only after being declared reliable and valid that the questionnaire was administered to the target employees at their places of work. The filled questionnaires were later collected as agreed with every study participant.

3.6 Data Analysis

The collected questionnaires were first arranged such that the ones that were selected for analysis were those that were properly and adequately filled. Following classification, the raw data was then entered into SPSS computer software program, to provide the necessary statistics. Descriptive statistics and regression analysis were used to analyze the gathered data. To help in determining the extent, scope, and ways that manufacturing firms employ leagile strategies, as well as SC robustness indicators, descriptive statistics were used to analyze closed questions. Frequency distributions, mean scores, and percentages were some of the descriptive statistics employed. The effect of agile and lean strategies on the

robustness of the supply chain of the manufacturing firms was determined using regression analysis. Regression models applied was;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

The variable Y denotes supply chain robustness. Whereas β_0 denotes the constant in the regression models. Besides, β_1, β_2, represents regression coefficients. X_1 represents lean strategies, X_2 represents agile strategies while ε was the error term. The study's findings were presented using charts and figures.

Table 3.2: Analytical Model of Data

Objectives	**Analytical model**	**Explanation**
To assess the leagile strategies adopted by manufacturing companies in Kenya	Descriptive statistics (means and standard deviations)	Means will indicate the prevalence of leagile strategies
To assess the effect of leagile strategy on supply chain robustness in manufacturing companies in Kenya	Multiple linear regression $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$ Y = Supply chain robustness. β_0 = Constant X_1 = Lean strategy X_2 = Agile strategies while ε is the error term.	Rejection of null hypothesis when the p value of the coefficient is below 0.05.

CHAPTER FOUR: DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

The study's main intent was to examine the influence of leagile strategies on SC robustness of manufacturing companies in Kenya. Both descriptive and inferential statistics were done for the each study objectives .The first part of the chapter covers organization basic information of the respondents and field instrument testing through pilot study. The second part presents description on data analysis and the results based on each objectives of this research. The third section discusses results of inferential statistics performed through regression analysis.

4.2 Response Rate

This enquiry targeted 132 respondents from large manufacturing companies in Kenya specifically from the convenient location of Nairobi City County which contained majority of the manufacturers. Since the study was voluntary for all participants, only completed questionnaires were considered in analysis. Questionnaires that were mutilated or deformed as well as incomplete in answering were not considered. From the results in Figure 4.1, there were 95 respondents out of the total sample of 132 giving a response proportion of 72 % and a non-response rate of 28 %. The response proportion when compared to previous studies was sufficient as a social study as evidenced from other scholars including Singh and Modgil (2020) who attained a field response rate of 68 percent and Ochieng' (2019) who achieved a response rate of 70 percent. The study response proportion was also fit for further statistical analysis with the threshold of 60 percent according to Kothari (2014) considered sufficient for social studies.

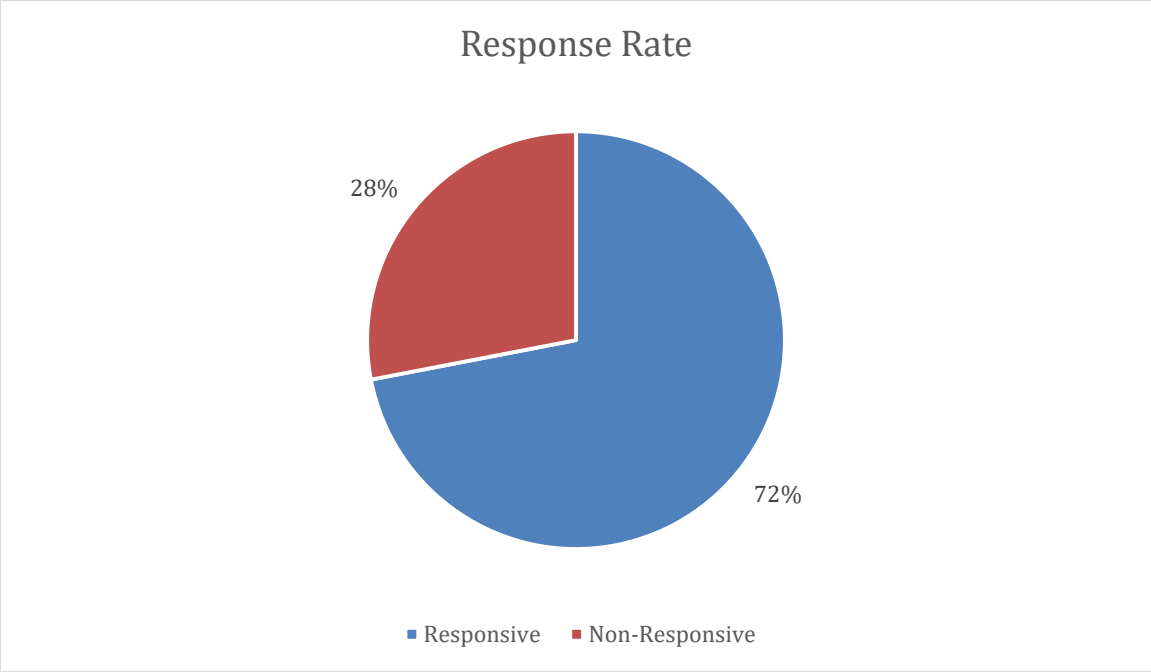

Figure 4.1: Field Response Rate

4.3 Pilot Test Results

To test the validity and reliability of the field instrument which was a structured questionnaire pilot study was conducted. Participants in the pilot study were specifically selected from large manufacturing firms which later did not participate in the main study. The next sub-section presented results of the pilot study for both reliability and validity.

4.3.1 Reliability tests

The reliability of the study instrument was tested by use of Cronbach Alpha coefficient with values ranging from 0 to 1 and a threshold for the coefficient acceptance of 0.7 was applied. Results indicated in Table 4.1 show that all the coefficients were above the threshold with values ranging from alpha coefficient of 0.87 to 0.91 and hence indicating good reliability. The instrument was thus reliable and utilized in the main field.

Table 4.1: Instrument Reliability

Variable	Alpha Co-	Decision
General Information	0.87	Reliable
Lean Strategies	0.89	Reliable
Agile Strategies	0.91	Reliable
Supply Chain Robustness	0.86	Reliable
Average	0.88	Reliable

4.3.2 Validity tests

To test the instrument validity, content validity was used by consulting with the study supervisor. Average Variance Extracted (AVE) test was used seeking to obtain a measurement of at least 0.5.In Table 4.2, the AVE results were over 0.5. This was an indication that the measurement scales revealed a satisfactory measurement of content validity hence the instrument was fit and valid enough for the main field data collection exercise.

Table 4.2: Validity of the Study Constructs

Constructs	**Average Variance Extracted (AVE)**
General Information	0.613
Lean Strategies	0.712
Agile Strategies	0.651
Supply Chain Robustness	0.619

4.4 Demographic Analysis

The questionnaire comprised of demographic section where five main characteristics of the respondents were considered including years of existence, years in lean supply strategy, years in agile supply strategy, working experience and category of manufacturing. The discussion of results for these five characteristics follows in the next subsections.

4.4.1 Years of Existence for Company

Results in Figure 4.2 indicate that 26 percent out of a total of 95 respondents of the firms were under 5 years, 34 percent were in existence for 5 to 10 years and the majority, 40

percent were found in the over 10-years category implying that most of the large manufacturing firms were in operation for a long period.

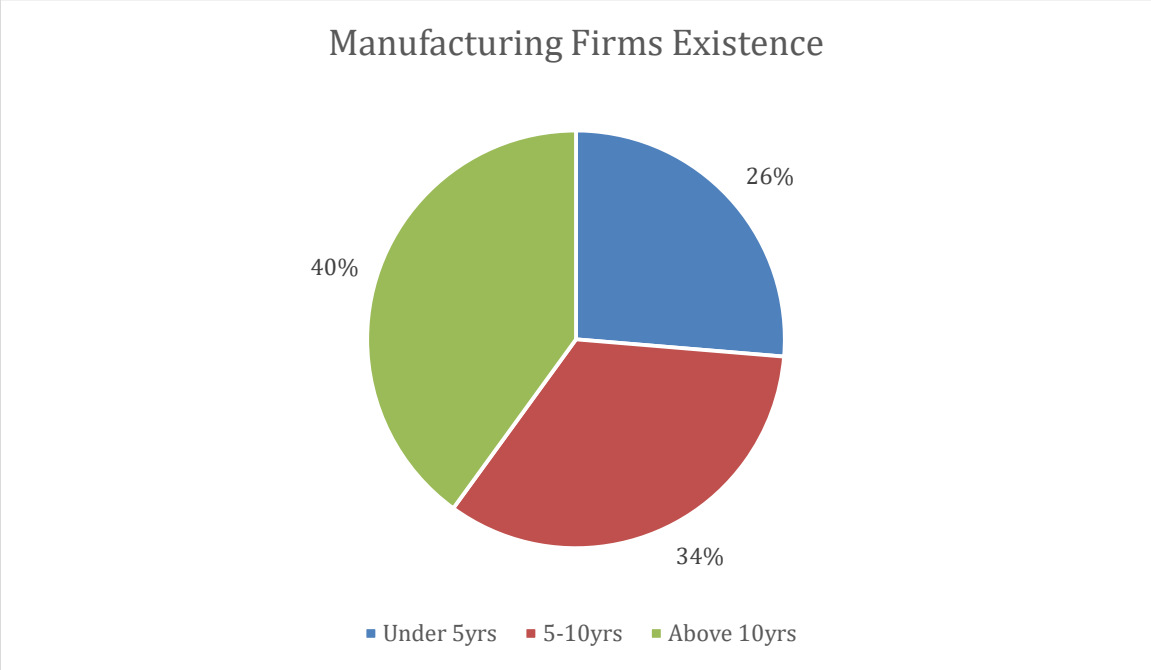

Figure 4.2: Company Existence in Manufacturing

4.4.2 Years in Lean Supply Strategies

In terms of how many years the companies had practiced lean supply strategies, there were four categories. The results are presented in Table 4.3 indicating that 19 percent of the companies had never practiced lean supply strategies while another 26 percent had been practicing lean supply strategies for under 5 years. Additionally, 23 percent had practiced lean supply strategies for 5 to 10 years while a large number, 32 percent had practiced lean supply strategies for over 10 years in Kenyan manufacturing industry.

Table 4.3: Lean Supply Strategies Period

Years Category	Frequency	Percent
It has never	18	19
Under 5 years	25	26
5-10 Years	22	23
Above 10 Years	30	32
Total	95	100

4.4.3 Years in Agile Supply Strategies

The study also captured the respondents' company practice of agile supply strategies since their inception. Table 4.4 presents results from the analysis indicating that 16 percent of the companies had never practiced agile supply strategies, 27 percent had practiced for just below 5 years and 21 percent had practiced agile supply strategies for 5-10 years. The larger majority of the manufacturing companies at 36 percent had practiced agile supply strategies for above 10 years.

Table 4.4: Years of Agile Strategy Practice

Number of Years		Frequency	Percent
Valid	It has never	15	16
	Under 5 years	26	27
	5-10 Years	20	21
	Above 10 Years	34	36
	Total	95	100

4.4.4 Working Experience in Manufacturing Firm

Additionally, the study also captured the respondents' working experience at the manufacturing firms. Findings based on the analysis were presented in Table 4.5 showing 26 percent out of 95 respondents had operated below 5 years and 29 percent had operated

at the firms for 5-10 years.44 percent which is the majority participants had operated at the manufacturing firms for over 10 years.

Table 4.5: Working Experience in Manufacturing

Years Category	Frequency	Percent
Under 5 years	25	26
5-10 Years	28	29
Over 10 Years	42	44
Total	95	100

4.4.5 Category of Manufacturing Firm

The category of their manufacturing firms were also indicated by the respondents as in Table 4.6 with the largest respondents at 18 percent coming from food and beverages manufacturers, followed by agro processing at 14 percent and building, mining and construction at 13 percent of the total 95 respondents. The sector with least respondents were textiles and apparels as well as chemical and allied, both at 3 percent.

Table 4.6: Category of Manufacturing Firms

Sectors	Frequency	Percentage
Food and Beverages	17	18%
Agro-processing	13	14%
Building, Mining and Construction	12	13%
Plastics and Rubber	9	10%
Metal and Allied	8	8%
Automotive	8	8%
Leather and Footwear	7	7%
Energy, Electrical and Electronics	6	6%
Paper	5	5%
Pharmaceutical and Medical Equipment	4	4%
Textile and Apparels Sector	3	3%
Chemical & Allied	3	3%
Total	**95**	**100%**

4.5 Descriptive Analysis of Study Variables

The next subsections of the analysis focus on the study variables including Lean Supply Strategies, Agile Supply Strategies and Supply Chain Robustness which was the dependent variable. The descriptive analysis presented involves frequencies of the various options selected by respondents. The following response options were used for Likert scale:- 1 = Very low degree, 2 = Low degree, 3 = Moderate degree, 4 = Great degree and 5 = Very great degree.

4.5.1 Lean Supply Chain Strategies Adopted by Manufacturing Firms in Kenya

From outcomes in Table 4.5, 75% of respondents reported that the extent to which the company had reduced the transportation of goods was low, while only 3% reported it to be very great. 56% of respondents reported that holding inventory was to a moderate extent whereas 5% answered that it was to a very great degree. 40% of the participants reported that to a great degree, the firm engaged in unnecessary movement of equipment while only 8% agreed that the extent was very low. In general, the participants agreed that to a moderate degree, the firm engaged in unnecessary movement of workers with 37% of respondents collaborating to this while 33% said to a great degree. Only 7% of participants settled that unnecessary movement of workers was to a very low extent. 44% of respondents agreed that the extent to which waiting time had been reduced to a minimum possible was a moderate extent, while 22% agreed that the extent was great. However, 9% responded that it was a very low extent. 34% and 33% of respondents felt that the company engaged in needless processes at great and moderate extent respectively. 54% of respondents held the view that to a moderate extent, the firm experienced defects.

Table 4.5: Descriptive Statistics for Lean Supply Chain

Lean Supply Chain strategies	**1**	**2**	**3**	**4**	**5**	Mean	Std. Deviation
Considering this firm, to what extent does it engage in unnecessary movement of equipment	8%	8%	21%	40%	22%	3.59	1.171
To what extent does this firm engage in unnecessary movement of workers	7%	7%	37%	33%	16%	3.42	1.078
To what extent does this company engage in needless processes	11%	8%	33%	34%	15%	3.34	1.154
To what extent has waiting time been reduced to the minimum possible in this firm	9%	11%	44%	22%	14%	3.20	1.107
To what extent does this firm overproduce products	12%	13%	27%	44%	4%	3.17	1.088
To what extent does this firm experience defects	9%	11%	54%	21%	5%	3.02	0.956
To what extent does this firm engage in business process reengineering to optimize processes	11%	33%	27%	20%	9%	2.85	1.148
To what extent does this firm hold inventory	12%	20%	56%	7%	5%	2.75	0.945
To what extent has this company reduced transportation of products	13%	75%	4%	5%	3%	2.12	0.810
Average Total Mean						**3.05**	

4.5.2 Agile Strategies Adopted by Manufacturing Firms in Kenya

The questionnaire's second section explicate agile strategies adopted by the manufacturing firms. In trying to understand how the agile supply chain strategies are implemented, the

participants were requested to provide to what degree they thought the firm responded to changes in the supply network. 46% of respondents reported that to a moderate extent, the firm responded quickly to changes in the supply network. 47% of the participants also disclosed that to a great degree, the supply network responded with the least cost. A majority of the respondents also reported that the extent to which the firm took the shortest time to respond to customer orders was great, at 44%. The firm seemingly adapts quickly to changes in market demands as 52% of the respondents reported that the firm adapts to market demands quickly. However, the firm appeared to rarely conduct research to determine the demand before producing the final product, as 41% of the respondents reported the extent to be low, and 13% reported it as very low. The firm did however modify their products to meet specific demands as the extent to which they did this was great. Similarly, the firm to a great extent also adhered to specific customer quality demands as reported by 45% of the respondents while 12% reported that this was done to a very great extent. Collaboration between the suppliers and the firm was reported to be existent, as only 11% agreed that this was done to a low extent while 24%, 28% and 5% reported that collaboration was done to a moderate, great and very great extent respectively.

Table 4.6: Descriptive Statistics for Agile Strategies

Agile Supply Chain Strategies	**1**	**2**	**3**	**4**	**5**	Mean	Std. Deviation
The supply network responds with least cost	6%	9%	18%	47%	19%	3.63	1.092
This firm takes shortest time possible to meet customer orders	7%	9%	21%	44%	18%	3.56	1.118
This firm adapt quickly to changes in market demand	8%	8%	17%	52%	15%	3.56	1.108
This firm exchanges information quickly	7%	6%	31%	40%	16%	3.51	1.071
This firm adheres to specific customer quality demands	6%	9%	27%	45%	12%	3.46	1.029
This firm responds quickly to customer preference changes	7%	7%	37%	34%	15%	3.41	1.067
The firm modifies products to meet specific demands	8%	16%	21%	45%	9%	3.32	1.113
The supply network responds quickly to changes	12%	15%	46%	19%	8%	2.98	1.072
The firm and its suppliers collaborate well together	11%	32%	24%	28%	5%	2.86	1.107
This firm conducts research to determine demand producing final product	13%	41%	29%	8%	8%	2.59	1.087
Average Total Mean						3.25	

4.5.3 Descriptive for Supply Chain Robustness

The last part of the questionnaire focused on the aspect of SC robustness. The participants indicated the extent that the firm had attained the various indictors of supply chain robustness. 36% of the respondents reported that the degree to which the SC in the firm

responded well to disruptions was low whereas 33% said it was moderate extent. Only 7% reported that the firm to a great extent responded well to supply chain disruptions. 40% of respondents reported that to a moderate extent, the supply chain is resilient enabling the firm to attain its objectives. Only 7% reported that the supply chain was to a very minimal degree resilient enough to attain its objectives. To a mild extent, 44% of the respondents reported that the firm had efficient design, planning and execution in the supply chain to enhance dynamism. 13% of the respondent reported that this extent was low. Learning in the firm was reported as continuous by the respondents with 27% of the respondents confirming that it was done to a great extent. The firm was reported not to be affected by market demand changes to a great extent by 43% of respondents. 53% of the participants reported that to a modest degree, there is increased product quality while 55% reported that the firm has the best time to market in the industry to the same extent. 42% of the respondents reported that the supply chain in the firm was moderately reliable. In general, while the existence of both agile and lean strategies was noticeable, the firm adopted them mostly to a moderate extent.

Table 4.7: Descriptive Statistics for Supply Chain Robustness

Supply Chain robustness aspect	**1**	**2**	**3**	**4**	**5**	Mean	Std. Deviation
This firm is not affected by market demand changes	4%	18%	20%	43%	15%	3.46	1.080
The supply chain is resilient enabling the firm to attain its objectives	7%	15%	40%	32%	6%	3.15	1.000
There is increased product quality	8%	14%	53%	18%	7%	3.02	0.978
There is continuous learning in the firm	13%	20%	35%	27%	5%	2.93	1.094
The firm has the best time to market in the industry	7%	18%	55%	16%	4%	2.92	0.895
There is efficient design, planning and execution in the supply chain to enhance dynamism	13%	19%	44%	19%	5%	2.85	1.041
The supply chain in this firm is very reliable	9%	29%	42%	8%	11%	2.81	1.075
The supply chain in this firm responds well to disruptions	9%	36%	33%	15%	7%	2.75	1.062
Average Total Mean						3.0	

4.6 Inferential Analysis

The study further tested the relationships between the dependent and independent variables through inferential statistics applied on the data using regression analysis. Regression analysis's aim was to ascertain whether there exists a statistically significant linear affiliation between the dependent variable, SCR as well as independent variables, LS and AS. This was based on a linear regression equation $\mathbf{Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon}$ where Y is SCR, X_1 is LS, X_2 is AS, β_0 is the constant, β_1 is the coefficient of lean strategies, β_1 is the coefficient of agile strategies and ε is the error designation.

SCR = Supply chain Robustness

X_1 = Lean Supply chain strategies

X_2 =Agile Supply chain strategies

4.6.1 Regression Model Summary

The model summary results revealed in table 4.8. Shows the correlation between the observed and predicted values of dependent variable deduced from the value R=.723 . The proportion of variance in the dependent variable (SCR) which can be explicated by independent variables (LS and AS) is determined by the value of R Square = 0.523. The output indicates that the effect of leagile strategies was statistically significant at 5% level since Sig. F <.05.

Table 4.8: Model Summary of leagile strategies on Supply Chain Robustness

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.723[a]	.523	.258	.21680

a. Predictors: (Constant), LS, AS
b. Dependent Variable: Supply Chain Robustness

4.6.2. Regression ANOVA Results

Table 4.11 shows the ANOVA output which provides a summary of the source of variance. The independent variables (Regression) 3.606 explain the variance in dependent variable while the variance which cannot be explained by independent variables (residual) is 32.292. The Mean Square Regression and Mean Square Residual are 1.202 and 0.351 respectively.

Table 4.9: Regression ANOVA of Leagile Strategies and Robustness

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	3.606	3	1.202	3.425	.000[b]
	Residual	32.292	92	0.351		
	Total	35.898	95			

a. Dependent Variable: SC Robustness

b. Predictors: (Constant), LS, AS

4.6.3. Regression Coefficient for Leagile Strategies on SC Robustness

Table 4.10 confirmations the outcomes of the regression coefficient of the two independent variables. The regression coefficients associated with LS and AS are 0.158 and 0.115 respectively. Both coefficients imply a positive association between the dependent variable (SCR) and independent variables (LS and AS) due to their positive magnitude. The outcomes disclosed that all the independent variables had a significant stimulus on the robustness of supply chain in manufacturing firms since the p-values associated with each independent variable is less than 0.05.

Table 4.10: Coefficients of Leagile Strategies and SC Robustness

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.690	.381		1.811	.031
Lean Strategies (LS)	.158	.077	.133	2.052	.042
Agile Strategies (AS)	.115	.059	.120	1.949	.041

a. Dependent Variable: SC Robustness

b. Predictors: (Constant), LS, AS

From coefficients of regression in the model $SCR = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$,

This is fitted as follows SCR= 0.690 + .158LS +.115AS+.381

In summary, leagile strategies statistically influenced the supply chain robustness of manufacturing firms of Kenya. Specifically, a unit rise in SCR results to a unit rise in LS of 0.158 units and. Similarly, a unit rise in SCR results to a unit rise in AS of 0.115 units .

CHAPTER FIVE: DISCUSSION OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This part discusses the study results founded in the literature reviewed followed by conclusion and recommendations of the study. Each sub-section anchors on research objectives discussed with respect to the study variables.

5.2 Discussion of the Findings of the Research Study

To examine the effect of leagile strategies on robustness of SC in large manufacturing corporations in Kenya. This study sought to accomplish through descriptive and inferential statistical analysis. Results of the first objective focusing on leagile strategies implemented by manufacturing firms in Kenya clearly indicated that there was an effect of the leagile strategies on the robustness of the supply chain. Similar results have been established elsewhere with studies by Oliveira-Dias et al (2022) and Gourley, 2020) showing that there was declining performance firms that did not practice agility in their supply chain operations. Both sets of scholars indicated that the decreased performance is manifested through increased breakages as well as high cost of transportation. Elsewhere, Nyile et al. (2021) have also pointed out that there was increased slowdown in performance of firms when agile strategies were not fully adopted resulting into overload and could lead to break down in the supply chain operations of the firm.

In relation to robustness, the study found out that this was affected by the adoption of both lean and agile strategies. The results mimic previous results from studies by Huma and Siddiqui (2019) as well as Oliveira-Dias et al., (2022) who both concluded that agile and lean strategies played a key role in achieving an efficient and robust supply chain in any organization. Raj et al. (2018) concluded that Leagile was the best supply chain strategies firms could implement. Adoption of leagile system improves supply chain performance.

Other scholars including Kouvelis et al. (2019), Ariadi et al., (2021) and Piotrowicz et al., (2022) have identified lack of full indulgence in the lean as well as agile strategies as the main problem facing supply chain robustness. However, majority of previous research studies including those by Huma and Siddiqui (2019), Ahmed and Rashdi (2020) as well as Kimaro et al. (2021) recommended gradual adoption of leagile strategies as the main booster for a well-functional robust supply chain in firms.

5.3 Conclusion of the Research Study

This is concluded from this research results and interpretation based on each study variable. First, there is indeed an element of agile strategy application in the manufacturing firms in

Kenya, but most practices were not followed to the letter. For instance, most of the firms participated in practices that did not improve their overall strategies such as reducing transportation of products and engaging in unnecessary movement of equipment. Similarly, most firms engaged in overproduction of goods and needless processes without conducting research to determine changes in market demand. This led to most manufacturing firms experiencing defects. The study also established that leagile manufacturing methods are significantly correlated to performance of the SC. The study also found that some manufacturing firms more fully adopted leagile manufacturing methods, such as postponement procedures, waste control, continuous improvement, and supply chain information exchange which led them to perform better than others.

Second, the study concluded that lean strategies were practiced at most manufacturing firms only that the levels of application varied a lot. Most companies' top management, to a large extent, had in-depth knowledge of lean manufacturing techniques and fought against obstacles to improve the manufacturing process. The company also had leaders and managers that could translate customer's needs in the quest of a strategic advantage. These arguments support the idea that organizational structure in the macro environment, business culture, and leadership style are the environment enablers considered to accomplish lean strategies. To a moderate extent the manufacturing firms adopted the required uniformity of mission and vision as was evidenced by the firm's ability to solve challenges consistently through a team approach and specialized responsibility. In the firms, the practice of total productive maintenance was used to great effect. This was accomplished by maintaining the businesses and their equipment at their highest level of productivity through organization-wide coordination.

Finally, the study concluded that indeed the robustness of the supply chain was heavily affected by leagile strategies adopted by the manufacturing firms. Leagile system would positively affect the performance of the manufacturing firms. It is therefore fit to conclude that overall, there was a relationship between leagile strategies and supply chain robustness in the manufacturing firms of Kenya.

5.4 Recommendations of the Research Study

Results founded from this study , it is fair to make the following recommendations that first, there is need to have a thorough review of lean practices to establish what lean strategies practices could work best for each firm. The lean manufacturing principles must be aligned with firms' overall strategy of the business. In order to foster employee buy-in and convey results, the implementation should be in line with the organization's mission, visions, values and strategies for communication and evaluation. As a result, performance will be tracked against goals, expenditures, development strategies, present operations for lean projects, and resources required for new initiatives to compare actual performance to expectations. The study recommends that manufacturing firms must concentrate on instigating all the major areas of lean manufacturing principles from a general perspective in order to fully benefit from lean and meaningfully improve their operational performance, more specifically, lead time efficiency,

Second, there is need for manufacturers to actively practice agile strategies that would guide in achieving robust supply chain. Virtual enterprises are another key component of agile supply chains. The study recommends manufacturing companies to intermittently partner up with other companies as a strategic response, occasionally embrace collaboration with other companies to seize market opportunities and use information technology to connect with other networks of partners because these virtual enterprise practices are deliberate strategies rather than a reaction to an emerging opportunity. The firms will be able to develop agility due to these virtual enterprise methods. The businesses might increase their adaptability and delivery times while also offering products suited for the low-cost market sector. In large part, production lead times should be as short as possible, and businesses should be more receptive to consumer tastes and preferences. They should also give supporting services like after-sales assistance and offer the items that the target market finds most appealing.

On a regular basis, manufacturers should benchmark their leagile strategies to test their supply chain robustness. To be more adaptable and quicker to change, the firms require processes, tools, and business relations with their trading partners. As a result, they also need to compare themselves to top-tier organizations that employ leagile techniques.

5.5 Limitation of the study

As with most studies, this study also had limitations. First, only a few manufacturing firms were sampled in Kenya but while the sample size was sufficient, and valid conclusions were drawn, the study acknowledges the significance of large sample sizes which would greatly improve the results. The study also had to deal with the constraint of just getting a single response from each firm, which made it difficult to extrapolate the findings. However, in order to ensure the accuracy of the results, the study tried to concentrate on administering questionnaires to the key people in the operations departments. The study faced lack of cooperation from some respondents due to suspicion and fear of victimization. This issue was addressed by explaining to the participants why the information that was being gathered was imperative and reassuring them that their responses were confidential.

5.6 Recommendation for Further Research

There is need to improve further on the current study which was only limited to large manufacturing firms in Kenya. This means that a similar study should focus on small-scale manufacturing firms. The study recommends a study linking SC practices and the performance of specific manufacturing sector rather than the whole manufacturing industry in Kenya. For broader generalization, a confirmatory study and cross-sector validation utilizing a larger sample acquired from the manufacturing firms is required. This study could also be replicated, with more time allocated to it, and a combination of more than one data-collection tool used, such as focus groups, which will help to cross-check the data collected.

More variables can also be included in such as geographical locations to clearly bring out the connection between leagile strategies and performance of companies. This is to determine whether there are spatial differences in the implementation of leagile strategies with the possibility of variation of results.

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Appendix I: Questionnaire to Operation Managers in Manufacturing Firms

SECTION A: GENERAL INFORMATION

1. How many years have this company been in existence?
   Less than 5 years [ ] 5 - 10 years [ ] Above 10 years [ ]

2. How many years have this company practiced lean supply strategy?
   It has never [ ] Less than 5 years [ ] 5 - 10 years [ ]
   Above 10 years [ ]

3. How many years have this company practiced agile supply strategy?
   It has never [ ] Less than 5 years [ ] 5 - 10 years [ ]
   Above 10 years [ ]

4. How many years have you worked in this organization?
   Less than 5 years [ ] 5 - 10 years [ ] Above 10 years [ ]

5. Which category does this manufacturing company belong to?

Agro-processing	[ ]	Automotive	[ ]
Building, Mining and Construction	[ ]	Energy, Electrical and Electronics	[ ]
Chemical & Allied	[ ]	Food and Beverages	[ ]
Leather and Footwear	[ ]	Pharmaceuticals and Medical	[ ]
Plastics and Rubber	[ ]	Textile and Apparels Sector	[ ]
Metal and Allied	[ ]	Paper	[ ]

SECTION B: LEAN STRATEGIES

1. Considering the supply chain strategies employed by this firm, indicate the extent that this firm has adopted the strategies listed in the table below. Apply the rating scale as; 1 = Very low extent; 2 = Low extent; 3 = Moderate extent; 4 = Great extent; 5= Very great extent.

Lean Supply Chain strategies	**1**	**2**	**3**	**4**	**5**
To what extent has this company reduced transportation of products					
To what extent does this firm hold inventory					
Considering this firm, to what extent does it engage in unnecessary movement of equipment					

To what extent does this firm engage in unnecessary movement of workers					
To what extent has waiting time been reduced to the minimum possible in this firm					
To what extent does this firm overproduce products					
To what extent does this company engage in needless processes					
To what extent does this firm engage in business process reengineering to optimize processes					
To what extent does this firm experience defects					

SECTION C: AGILE STRATEGIES

1. Considering the supply agility of the supply chain strategies employed by this firm, indicate the extent that this firm has adopted the strategies listed in the table below. Apply the rating scale as; 1 = Very low extent; 2 = Low extent; 3 = Moderate extent; 4 = Great extent; 1 = Very great extent.

Agile Supply Chain Strategies	**1**	**2**	**3**	**4**	**5**
The supply network responds quickly to changes					
The supply network responds with least cost					
This firm exchanges information quickly					
This firm takes shortest time possible to meet customer orders					
This firm responds quickly to customer preference changes					
This firm adapt quickly to changes in market demand					
This firm conducts research to determine demand producing final product					
The firm modifies products to meet specific demands					
This firm adheres to specific customer quality demands					
The firm and its suppliers collaborate well together					

SECTION D: SUPPLY CHAIN ROBUSTNESS

1. Considering the results of the supply chain strategies employed by this firm, indicate the extent that this firm has attained the outcomes listed in the table below. Apply the rating scale as; 1 = Very low extent; 2 = Low extent; 3 = Moderate extent; 4 = Great extent; 1 = Very great extent.

Supply Chain robustness aspect	**1**	**2**	**3**	**4**	**5**
The supply chain in this firm responds well to disruptions					
The supply chain is resilient enabling the firm to attain its objectives					
There is efficient design, planning and execution in the supply chain to enhance dynamism					
There is continuous learning in the firm					
This firm is not affected by market demand changes					
There is increased product quality					
The firm has the best time to market in the industry					
The supply chain in this firm is very reliable					