ASSESSMENT OF SUPPLY CHAIN RESILIENCE OF ETHIOCHICKEN POULTRY FEED BUSINESS

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DECLARATION

I, Meskerem Ayele hereby declare that this study entitled; Assessment of Supply Chain Resilience of Ethiochicken's Poultry Feed Business is my work. All information in this document has been obtained and presented in accordance with academic rules and ethical conduct. This study has not been submitted for the award of any degree or diploma program in this or any other institution and, I have fully cited, acknowledged, and referenced all material and results that are not original to this work.

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Abstract

The 21st-century business environment is characterized by a higher level of interdependence between players within a supply chain, and if anything happens at any point in this relationship, it ignites a chain reaction across the supply chain. Supply chain disruptions have the potential to unfavorably affect both cost and revenue by leading to lost sales as well as a decline in market share and, that is why that these potential impacts of disruptions on a firm and its supply chain make clear the importance of building supply chain resilience. Accordingly, the main objective of the study was to assess the supply chain resilience of EthioChicken's poultry feed business. The study additionally had specific objectives to identify EthioChicken's poultry feed business's major supply chain capabilities, vulnerabilities and to examine whether a comparison of EthioChicken's poultry feed business supply chain vulnerabilities and capabilities indicate resilience or not. To meet the study objectives, the researcher used a quantitative research method and, a descriptive, cross-sectional, survey type research design. The study sample consisted of 63 respondents selected using non-probability purposive sampling. A structured questionnaire adapted from similar studies was used to collect data. SPSS 23.0 and supply chain resilience framework used to analyze data. The findings revealed the existence of vulnerabilities of Connectivity, External pressure & Sensitivity, and higher capabilities of market position, efficiency, organization, and anticipation are inherent in the EthioChickens poultry feed business supply chain. Findings further revealed that with a resilience score of 83%, Ethiochicken's feed business supply chain is highly resilient. It is therefore recommended that the management of EthioChicken's feed business It is recommended that supply chain vulnerability of external be mitigated through the capability of visibility through further strengthening effective business intelligence programs.

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List of Abbreviations and Acronyms

SC	Supply Chain
SCRES	Supply Chain Resilience
IT	Information Technology
JIT	Just in Time
SCRAM	Supply Chain Resilience
VMI	Vendor managed inventory
GDP	Gross Domestic Product
SPSS	Statistical Package for Social Science

CHAPTER 1- INTRODUCTION

1.1 Introduction

This chapter will introduce what is known and what has been done in the area of supply chain resilience.

1.1.1. Background of the Study

Twenty-first-century business competition has stopped to be a competition between individual businesses but, a competition among supply chains. Business relationships are no longer focused on traditional short-term transactions but, are following a collaborative relationship to operate as a chain. Suppliers of the core business firm in a supply chain have their suppliers, also, these suppliers have their chain of suppliers too, this shows that there is a higher level of interdependence between the actors in a supply chain. If anything happens at any point in the supply chain, it ignites a chain reaction across the supply chain.

It is stated that the current business environment is characterized as unstable, and chaotic due to such factors as 'unplanned information and technology (IT) or telecom networks outages, adverse weather, cyber-attack and data breach, loss of talent/skills, transport network disruption, new laws or regulations, outsourcer failure, health & safety incident, currency exchange rate volatility, fire, and human illness' (Gianluca and Lucila, 2018, p. 21). These factors as declared in this supply chain resilience report are either internal or external factors, and these factors, that are increasing in intensity and frequency result in magnified disruption to supply chains and disruption at any place within the supply chain can alter businesses' capability to responding to client demands (Favor et al., 2013, Coelho, 2017). Also, disruptions caused by these events have resulted in monetary, logistical, and reputational impacts on businesses as affirmed by (Abdoun, Ghazali, and Razali, 2018). Supply chain disruptions have the potential to adversely affect cost and revenue by resulting in lost sales furthermore as a decline in market share and, that's why that these potential impacts of disruptions on a firm and its supply chain build a strong case for the importance of building supply chain resilience (Skamokawa et al., 2015).

Ponies and Koronis(2012, p. 925-926) defined SCRES as 'the ability to proactively plan and design the supply chain network for anticipating unexpected disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post-event robust state of operations, if possible, more favorable than the one before the event, thus gaining a competitive advantage'.

It has also been stated that:

> SCRES is not simply the ability to withstand these disruptions but, is a proactive, structured, and integrated exploration of capabilities inside the SC to address unforeseen events. These capabilities are qualities that enable an enterprise to predict and conquer disruptions by preventing actual disruption from happening, lessening the effects of a disruption, or enabling adaptation following the disruption (Savard et al., 2015, p.305).

Pettit, Fiksel, and Croxton(2010, p.6) bringing the idea of vulnerabilities defined optimal resilience as 'the balance between vulnerabilities (fundamental factors that make an enterprise susceptible to disruptions), and capabilities (attributes that enable an enterprise to anticipate and overcome disruptions)'. Also as per the authors, 'optimal resilience occurs when capabilities are managed to best fit the inherent vulnerabilities of a supply chain' (Pettit, Fiksel and Croxton, 2010,6-7).

Negash(2018) stated in his study that livestock production contributes up to 80 percent of farmers' income in Ethiopia and about 20 percent of agricultural GDP. Ethiopia has the largest livestock population of any country in Africa. The demand for animal feeds is derived from the demand for animal products as human food, and the general pattern is that this demand rises in response to increases in income, urbanization, and population, and from this, it can be concluded that there is a high market demand for animal feed.

EthioChicken is one of the leading poultry feed producers in Ethiopia with a current production capacity of 240,000 tons of poultry feed per year. The poultry feed business is a complementary business to the day-old chicken production and sales wing of the business. The company gets the raw materials required to produce poultry feed from its

supply chain located both locally and internationally. Ethiopia has seen major major disruption in 2018 and 2019 due to the countrywide unrest, road blockage, internet blockage, devaluation of the country's currency, the depletion of forex reserves, a draught that resulted from el nano effect, and a record number of internally displaced people. These incidents have caused supply chain disruptions in the supply chain of many manufacturing companies in Ethiopia including EthioChicken and this study will try to assess the supply chain resilience of EthioChicken poultry feed business.

1.1.2. Problem Statement

There is a problem in the increasing level of disruptions within supply chains that results in negative financial and market share impact on core businesses. Many authors have investigated and identified the causes of disruptions (Vulnerabilities) in supply chains, developed a list of these vulnerabilities that expose supply chains to disruptions. The disruptions identified include globalization, increased level of outsourcing, just in time delivery, sudden telecom outages, human illnesses, fire, changing regulations and laws and currency exchange rate changes (Shih, 2020; Savitz, 2020; Gianluca and Lucila, 2018; Pettit, Croxton, and Fiksel, 2013).

Considering the severity of the impacts of disruptions in supply chains, building supply chain resilience, and assessing the state of the resilience of the supply chain is of utmost importance. The agreement by researchers on achieving supply chain resilience is through supply chain capabilities which are attributes that can enable supply chains to predict and overcome disruptions due to vulnerabilities inherent within the supply chain (Abdoun, Ghazali and Razali, 2018). Additionally, Based on an extensive literature review (Mohamad, Mobbing and Bottini, 2016, favor et al., 2013, Pettit, Crofton and Aigbogun, 2013, Ghazali and Razali, 2018), the agreement is that resilience of supply chains can be measured through the measuring dimensions of vulnerabilities and capabilities.

Developing countries, which constitute a significant part of global supply chains and the world's population, have experienced the devastating effects of supply chain failures. According to Tukamuhabwa et al. (2015) and Tukamuhabwa (2015), SCRES research

until today has focused almost entirely on the developed world context leaving developing countries extremely underrepresented. Ethiopia which is one of the developing countries in Africa also has seen major supply chain disruptions recently. Nationwide unrests, and the road blockages that occurred in most parts of Oromia as well as towns surrounding Addis Ababa (Dahir 2019; Tiksa 2019), restriction on the movement of heavy trucks in Addis Ababa(Girma 2019) and the depletion of forex reserve with the National Bank of Ethiopia(AF, 2019) are recent examples of factors that have disrupted many supply chains including the poultry feed manufacturing sector.

With the lack of researches in the area of SCRES in the Ethiopian context, and especially in the poultry feed production sector, this study is one of the few empirical types of research on the concept of SCRES and will fill the current literature gap on the subject matter by assessing the supply chain resilience of EthioChicken's poultry feed business using the two supply chain resilience measurement dimensions of vulnerability and capability.

1.1.3. Research Objectives

1.1.3.1.General Objective

The general objective of the study is to assess the supply chain resilience of EthioChicken's poultry feed business.

1.1.3.2.Specific Objectives

The study will have the following specific objectives

a) To identify EthioChicken's poultry feed business's major supply chain capabilities.

b) To identify the major supply chain vulnerabilities of EthioChicken's poultry feed business.

c) To examine whether a comparison of EthioChicken's poultry feed business supply chain vulnerabilities and capabilities indicate resilience or not.

1.1.4. Research Questions

1.1.4.1. Research Questions

The study will try to answer the following research questions:

a) What are the supply chain capabilities of EthioChicken's poultry feed business?

b) What are the supply chain vulnerabilities of EthioChicken's poultry feed business?

c) What do the identified vulnerabilities and capabilities indicate about the supply chain resilience of EthioChicken's poultry feed business?

1.1.5. Significance of the Study

The Study will enable EthioChicken to identify major vulnerabilities within its poultry feed business supply chain. Additionally, it will enable EthiChicken to identify supply chain capabilities that can mitigate against existing vulnerabilities.

The study will further provide a view of the supply chain resilience of the poultry feed industry in Ethiopia as Ethiochicken is one of the biggest poultry feed producers occupying of 30.7 % of the poultry feed market share (Ethiochicken, 2019). It will also serve as a groundwork for future research on the concept of supply chain resilience in the Ethiopian context specifically in the poultry feed industry.

1.1.6. Scope of the Study

Conceptually, the study will mainly focus on identifying Ethiochicken's poultry feed business supply chain vulnerabilities and capabilities and measuring the resilience of the supply chain. It will not investigate the causal relationships between the identified capabilities and vulnerabilities.

Geographically, the study was limited to Addis Ababa City and the two production locations of EthioChicken's poultry feed namely Gelan and Burayu.

1.1.7. Limitation of the Study

The study has the below limitations

- Sample size limitations as the study only considered supply chain members that are located in Ethiopia and specifically in the Addis Ababa, Burayu, and Gelan areas which impacted the size of the sample population. International suppliers and local supply chain members that are located outside the geographical scope of the study where not included. As a result, caution should be taken with the generalizability of the study.
- Limitations with the availability of literature in the area of supply-chain resilience especially in the context of Ethiopia.

1.1.8. Organization of the Study

The study paper was organized into five chapters. Chapter one is composed of the background of the study statement of the problem, research questions, objectives of the study, significance of the study, the scope of the study, and the organization of the study. The second chapter dealt with a review of related literature. Chapter three discusses the research methodology details. The results and discussion part are presented in the fourth chapter. Lastly, chapter five presents the summary, conclusion, recommendation, and suggestions for future research.

1.1.9. Definition of Terms

Supply Chain: Supply chain is a sequenced network of business partners involved in production processes that convert raw materials into finished goods or services to satisfy the consumers' demand (Mensah & Merkuryev, 2012).

Supply Chain Resilience: is stated to be:

> the adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations, which is preferably better than before the disruption, to maintain or increase customer service, market share and financial performance (Wagenberg et al., 2018, p. 2).

Supply Chain Disruptions: Supply chain can be defined as any occurrence which has negative consequences for regular SC operations and hence, causes some degree of "confusion/disorder" within the SC.

Supply Chain Vulnerabilities: Are "Fundamental factors that make an organization prone to disruptions" (Pettit, 2008)

Supply Chain Capabilities: Is defined as: "attributes that enable an enterprise to anticipate and overcome disruptions." (Pettit, Fiksel and Croxton, 2013). (Vakharia & Yenipazarli,2009)

CHAPTER 2- LITERATURE REVIEW

2.1.Introduction

This section of the study discusses theoretical and empirical literature and conceptual framework regarding the concept of SCRES, concepts such as supply chain, supply chain risks, and disruptions. Literature regarding the historical background, definition, components, and measurement of SCRES are discussed in detail in this chapter.

2.1.1 Theoretical literature review

2.1.1.1 Supply Chain and Supply Chain Disruptions

2.1.1.1.1 Supply Chain

Before reflecting on the "supply chain resilience" it is necessary to grasp a better understanding of the supply chain itself. According to Mensah & Merkuryev(2014, P. 311) 'supply chain is a sequenced network of business partners involved in production processes that convert raw materials into finished goods or services to satisfy the consumers' demand'. A simple supply chain includes raw materials suppliers' suppliers, raw material suppliers, manufacturers, distributors, retailers, and customers. Other than materials, there is also the flow of finance and information within the supply chain

2.1.1.1.2 Supply Chain Risks and Disruptions

It has been stated that 'Managing the supply chain is quite a challenging task as supply chains are more complex today. Although the operational efficiency of a well-structured supply chain is high, the risk involved is still a concern and should not be neglected.' (Christopher and Peck, 2004, p. 2).

In seeking cost reduction and competitiveness, firms have resorted to globalization and outsourcing, which have led to increased connectivity and interdependency. As a result, risk exposure has increased because of shorter product life cycles, higher dependency on suppliers and other external players in their supply chain.

Pettit (2008, p.5) added to the notion of supply chains being more prone to risk by stating that, 'Supply chains are complex networks of enterprises that experience continual turbulence, creating a potential for unpredictable disruptions. This interconnectedness and

complexity have increased the vulnerability of firms to disruptive events at any point in their supply chains'. (Simon. et al., 2017) claims that Supply chain risks contain disruptions that interfere with the steady movement of materials, information, and finances support Pettit's notion above. As supply chains depend on their supply base to purchase goods and services, suppliers located in complex global supply chains may be disrupted with relatively no warning (Benjamin,2015; Namdar et al, 2017; Blackhurst et al. cited on Pettit, Croxton and Fiksel, 2013).

In addition to the above-stated causes for supply chain risks that cause disruptions, various initiatives applied by managers to enhance supply chain efficiency, e.g. reducing supply base, just-in-time (JIT) inventory, vendor-managed inventory, outsourced manufacturing, etc., increase the chance of supply chain vulnerability (Pettit, Croxton, & Fiksel, 2013).

Supply chain networks are vulnerable to disruptions (Agnieszka, Tomasz, & Sylwia, 2017), and each failure at any point in the supply chain may cause the entire network to fail. As Rice and Caniato (2003) put it, for many companies, the only thing standing between them and a disastrous supply chain disruption is luck. But, as any bettor knows, your luck eventually drains out. When luck runs out and the inevitable(disruption) happens, the occurrence of disruptions, while relatively infrequent, brings devastating long-term economic or social consequences and the recovery process can be slow. (Namdar et al., 2017). That is why in today's business environment, a supply network that has comprehensive security processes and procedures in place and is resilient enough to bounce back from any disruptions that do happen is needed.

2.1.1.2 Supply Chain Resilience

2.1.1.2.1 Historical Background and SCRES Definitions

According to (Pettit, 2008; Namdar et al., 2017; Mensah & Merkuryev, 2014), many tools and methods have been used to prevent disruptions before the emergence of SCRES studies starting from the era of industrialization till the 1990s. The methods and tools included adding safety stock on cycle stock to cover for time and risks associated with lead time and demand uncertainty, quick response method applying just in time (JIT) delivery, vendor managed inventory system and continuous replenishment to increase customer service, a lean manufacturing method that focused on identifying and eliminating non-value-adding activities and six sigma management tool that focused on process improvement via reducing defect rate to less than 3.4 defects per million

items. Quick response systems increase the exposure of supply chains by forcing connectivity requirements and reducing inventory buffers. Lean manufacturing practices will leave the supply chain with less inventory at each processing step which results in less buff capacity for disruptions. Also, with the six-sigma management tool, forcing a system into an exceptionally small variation can create a challenge to change with little flexibility. As Fiksel (2003) concluded, toughness can be achieved through resilience, not with resistance.

The concept of resilience has been traditionally studied in different disciplines, such as ecology, engineering, psychology, and economics, but in the business context, the SC resilience concept is new. According to (Pettit, Fiksel, and Croxton, 2010; 2019), the concept of supply chain resilience gained attention in the early 2000s according to. one of the first published studies on SCRES – Building a resilient and secure supply chain by Rice and Caniato (2003) focused on providing a basic definition for SCRES and ways to build a secure and resilient supply chain by focusing on improving the security of supply chains through physical security, information security, and freight security and improving the resilience of their supply chains mainly through redundancy and flexibility. The first studies focused on some initiatives that focused squarely on security, others are directed toward resilience.

As per (Merriam-Webster 2007) resilience is defined as 'the tendency of a material to come to its original form once the removal of stress that has created elastic strain.' Taking this definition (Pettit, Croxton, & Fiksel, 2013) added that it may not be helpful for a supply chain to not come to its original shape following an interruption, however, rather learn from the disturbance and adapt into a new model.

Although different authors defined SCRES in many ways and the definitions lack consensus the following are some of the definitions:

Ponomarov (cited on Tukamuhabwa et al., 2015, Sec. 2) defined the concept of SCRES as 'The adaptive capability of a firm's supply chain to prepare for unexpected events, respond to disruptions, and recover from them promptly by maintaining continuity of operations at the desired level of connectedness and control over structure and function'

Additionally, SCRES is that the ability to survive, adapt and grow within the face of turbulent change (Pettit, Fiksel, and Croxton, 2010) to support this, Ponis and Koronis (2012, P. 925) outlined it as 'the ability to proactively plan and design the supply chain network for anticipating sudden turbulent (negative events), respond adaptively to disruptions whereas maintaining control over structure and performance and transcending to a post sturdy state of operations, if attainable a lot favorable one than that before the event, therefore gaining a competitive advantage'. These definitions specially Ponis and Koronis (2012) show that SCRES is not only the ability to prepare for unexpected disruptions and surviving through it but, it is a unique capacity to thrive and grow into a better state than the firm was at before the disruption.

The most comprehensive definition of SCRES is:

> The adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to excel the disturbance and return the supply chain to a robust state of operations, which is rather better than before the disruption, to preserve or increase customer service, market share and financial performance Wagenberg et al. (2018, p. 3).

Building on the definition of resilience from an ecological science perspective provided by Folke et al., (cited on Pettit,2013), Fiksel (2003) stated that a supply chain may be seen as a network of "living" systems. And based on the concept of this system, Fiksel (2003), proposed four major characteristics of resilient systems that are diversity, efficiency, adaptability, and cohesion.

On the other hand, Christopher & Peck (2004) provided an insight into five principles that guide resilience, these being, having a good understanding of the supply chain network, applying reengineering practices, applying a collaborative supplier base strategy based on information sharing, creating and maintaining agile supply chain

networks capable of responding rapidly to changing conditions and introducing a supply chain risk management culture.

(Ponis and Koronis, 2014; Ponomarov,2012) that provided the most comprehensive definitions of SCRES and incorporated in their definitions the most characteristics of SCRES including adaptative capability and capacity, preparation, response, connectedness, and control yet as timely recovery to the initial or, preferably, an improved state. Yet, like all definitions, these Also ignore the side of cost-effectiveness. nonetheless, it is indicated that cost value and resilience exist together exist without a significant negative impact and, ideally, ought to be complementary (World Economic Forum, 2013; Tukamuhabwa et al., 2015).

Most earlier studies (Simba et al., 2017; Tukamuhabwa et al., 2015; Pettit, Croxton, & Fiksel, 2013; Christopher and Peck 2004) focused on detailing strategies towards a resilient supply chain and these strategies have been broadly organized into two categories – proactive and reactive strategies. Most cited SCRES strategies consist of increasing flexibility, creating redundancy, forming collaborative supply chain relationships, and improving supply chain agility. Below are SCRES strategies mentioned in most SCRES literature.

a) Flexibility

'The capability of an enterprise to adapt to the ever-changing needs of its surroundings and stakeholders with minimum time and effort' (Tukamuhabwa et al., 2015, p. 13). The study revealed various flexibility practices to improve SCRES, for instance, postponement, a flexible supply base, flexible transportation, flexible labor arrangements, and order fulfilment flexibility.

b) Creating Redundancy

Redundancy involves the strategic and selective use of redundant capability and inventory that may be summoned throughout a crisis to deal with supply shortages or demand s increases (Christopher and Peck, 2004).

c) Supply Chain Collaboration

According to Pettit, Croxton, and Fiksel (2013), supply chain collaboration refers to the power to work effectively with different actors for shared benefit in areas like forecasting, postponement, and risk-sharing. Collaboration additionally involves data exchange (Christopher and Peck 2004), which may cut back uncertainty, increase transparency, and facilitate the creation and sharing of information, such as regarding supply chain risks and uncertainties. Collaboration also can enable supply chain partners to share the costs of building security and resilience.

d) Supply Chain Agility

Christopher and Peck (2004, p.18) defined provide chain agility as "the ability to reply quickly to unpredictable changes in demand or supply; this might maybe be achieved through a speedy change to business processes and systems.".

Vargas and González(2016) stated that resilience capacity can be assessed based on three categories of indicators; having a labor resilience (via assessing labor capabilities to overcome vulnerable living conditions), achieving organizational resilience (through assessing the results of responsiveness, flexibility, and effectiveness), and through attaining business resilience (days of inventory, days of receivables and days of payables)'.

Additionally, some studies like (Karl et al., 2018) have focused on identifying SCRES KPI's which are, capacity employment, stock level, quality of delivered goods, order lead time, delivery lead, on-time delivery of goods, Supplier delivery efficiency, Supplier reject rate, Consumer Satisfaction, and damage return rate.

As Rice and Caniato (2003) stated, other than enabling a company to maintain operations following a disruption, resilience can be a competitive advantage if one can respond more favorably to disruption than the competition. 'This might mean being ready to capitalize on opportunities to serve your competitors' customers if your competitors cannot. Even in cases where the disruption affects the competitors equally, companies can compete on their resilience capabilities' (Rice and Caniato, 2003).

2.1.2 Empirical literature review

2.1.2.1 Measurement Dimensions of SCRES

Resilience may be a mandatory characteristic of a supply chain to survive within the short term, however, conjointly provides the potential to adapt to change and flourish within the long run. scholars are beginning to claim supply chain resilience can prove to be a competitive advantage in an era of turbulence. The question that is still relevant currently is how to measure supply chain resilience. Even if there are continuous efforts focused on quantitative analysis and measurement most of the designed systems are literature reviews or conceptual/theoretical work, and modeling work (Lenort & Wicher, 2013; Scavarda et al., 2015; Ponis and Koronis, 2012; Tukamuhabwa et al., 2015).

Most analyses on supply chain resilience lack conclusions regarding causalities between supply chain practices and supply chain resilience, however, they solely answer explorative queries without giving any statistical proof of the findings. It is, however, valuable to mention that this issue has lately been considered by modern researchers on supply chain resilience (Pettit,2008; Croxton, and Fiksel, 2013,2019; Mohamad, Mohammadsadegh and Eleonora, 2016; Aigbogun, Ghazali and Razali, 2018; Pettit et al., 2013; Fakoor et al., 2013; Chowdhury & Quaddus; 2016). According to (Aigbogun, Ghazali, and Razali, 2018) most studies focused their attention on the measurement dimensions, as well as the ancestors of supply chain resilience. Based on an extensive literature review done (Aigbogun, Ghazali and Razali, 2018; Mohamad, Mohammadsadegh and Eleonora, 2016; Pettit, 2008, Pettit, Croxton and Fiksel, 2013; Wagenberg et al., 2018; Fakoor et al., 2013) the agreement is that supply chain resilience can be valued via the measurement dimensions of vulnerabilities and capabilities.

The supply chain resilience assessment and management tool (SCRAM$^{TM)}$ developed by Pettit (2008) for measurements of supply chain resilience takes advantage of the comparison of supply chain vulnerabilities and supply chain capabilities. This tool defines 7 vulnerability and 14 capability factors. Each factor is further divided into an exactly defined number of sub-factors. The intensity of the sub-factors is determined expertly using a five-point scale. The intensity of vulnerability and capability factors is calculated as an arithmetic average of the relevant subfactors.

2.1.2.1.1 Supply Chain Vulnerability

Supply chain vulnerabilities are defined as “essential factors that make an enterprise prone to disruptions” (Pettit, 2008; Elleuch et al., 2016).

(Pettit, 2008; Pettit, Fiksel and Croxton,2013; Angappa, Nachiappan & Shams,2015) identified the sources of change in seven categories of vulnerabilities listed below with their definitions and subfactors.

Turbulence: An environment known for frequent changes in external factors past one's control and contains sub-factors such as natural disasters, geopolitical disruptions, the volatility of demand, instabilities in currencies and prices, technology failure and pandemic.

Deliberate Threats: Are intentional attacks aimed at disrupting operations or causing human or financial harm with subfactors as theft, terrorism, labor disagreements, espionage, special interest groups, product liability.

External Pressures: These are effects, not specifically targeting the firm, that produces business barriers such as aggressive innovation, social/cultural change, political/regulatory change, price pressures, corporate responsibility as well as environmental change.

Resource Limits: This is defined as constraints on output based on the disposal of the factors of production that includes supplier, production and distribution capacity, raw material and utility availability, and human resources.

Sensitivity: It is the importance of controlled conditions for product and process integrity which includes subfactors as complexity, product purity, restricted materials, fragility, reliability of equipment, safety hazards, visibility to stakeholders, a symbolic profile of the brand, and concentration of capacity.

Connectivity: Is the level of interdependency and dependence on outside entities which includes a scale of the network, dependence upon information, degree of outsourcing, import and export channels, and reliance upon specialty sources.

Supplier/Customer Disruptions: Is the susceptibility of suppliers and customers for external forces that include subfactors such as supplier reliability and customer disruptions.

2.1.2.1.2 Supply Chain Capabilities

(Angappa, Nachiappan & Shams, 2015; Pettit, 2008; Pettit, Fiksel and Croxton, 2013) defined supply chain capabilities as, "qualities that empower an enterprise to predict and overcome disruptions.". To counter vulnerabilities, research has shown that a supply chain can build capabilities that assure long-term survival. Notions such as flexibility, agility, adaptability, and visibility are just a few commonly talked about managerial capabilities. These capabilities could prevent an actual disruption, mitigate the effects of disruption, or enable adaptation following a disruption (Pettit,2008). Supply chain capability factors suggested are flexibility in procurement, flexibility in order fulfillment, capacity, efficiency, visibility, adaptability, anticipation, recovery, dispersion, collaboration, organization, market position, security and financial strength (Angappa, Nachiappan & Shams 2015; Lenort & Wicher, 2013; Pettit, 2008; Pettit, Fiksel and Croxton, 2013) which are discussed below with a list of their subfactors as defined by these authors.

Flexibility in-sourcing: The capability to quickly change inputs or the mode of receiving inputs which include subfactors such as part commonality, modular design, multiple uses, supplier contract flexibility, and multiple suppliers.

Flexibility in order fulfillment: The ability to swiftly change outputs or the mode of delivering outputs. Subfactors include alternate distribution channels, risk pooling/sharing, multi-sourcing, delayed commitment, production postponement, inventory management and re-routing of requirements,

Capacity: The availability of assets to facilitate sustained production levels with subfactors including reserve capacity, redundancy, backup energy sources, and communications.

Efficiency: Which is the ability to produce outputs with minimum resource requirements including subfactors such as waste elimination, labor productivity, asset utilization, product variability reduction, and failure prevention.

Visibility: The knowledge of the position of operating assets and the environment. Sub factors include business intelligence gathering, information technology, products, assets and people's visibility, and information exchange.

Adaptability: Is about the ability to alter operations in response to challenges or opportunities, fast re-routing of requirements, Lead time reduction, Strategic gaming, and simulation, seizing advantage from disruptions, Alternative technology development, Learning from experience

Anticipation: That is the ability to identify potential future events or situations. including subfactors such as monitoring early warning signals, forecasting, deviation, and near-miss analysis, contingency planning, preparedness, risk management, business continuity planning as well as recognition of opportunities.

Recovery: Is the ability to get back to normal operational state immediately including subfactors such as crisis management, resource mobilization, communications strategy, and consequence mitigation.

Dispersion: Is the decentralization of assets encompassing subfactors such as distributed decision-making, distributed capacity and assets, decentralization of key resources, location-specific empowerment, and dispersion of markets.

Collaboration: Is the capability to work effectively with other entities for mutual benefit that includes subfactors as collaborative forecasting, customer management, communications, postponement of orders, product life cycle management, and risk-sharing with partners.

Organization: Includes human resource structures, policies, skills, and culture. It includes subfactors as learning, accountability, and empowerment, teamwork, creative problem solving, cross-training, substitute leadership, and culture of caring.

Market position: Has to do with the position of a company or its products in specific markets which includes product differentiation, customer loyalty/retention market share, brand equity, customer relationships, and customer communications.

Security: A defense against deliberate attack encompassing subfactors such as layered defenses, access restrictions, employee involvement, collaboration with governments, cyber-security, and personnel security.

Financial Strength: The capacity to absorb fluctuations in cash flow including sub-factors of insurance, portfolio diversification, financial reserves and liquidity, and price margin.

2.1.3 CONCEPTUAL FRAMEWORK

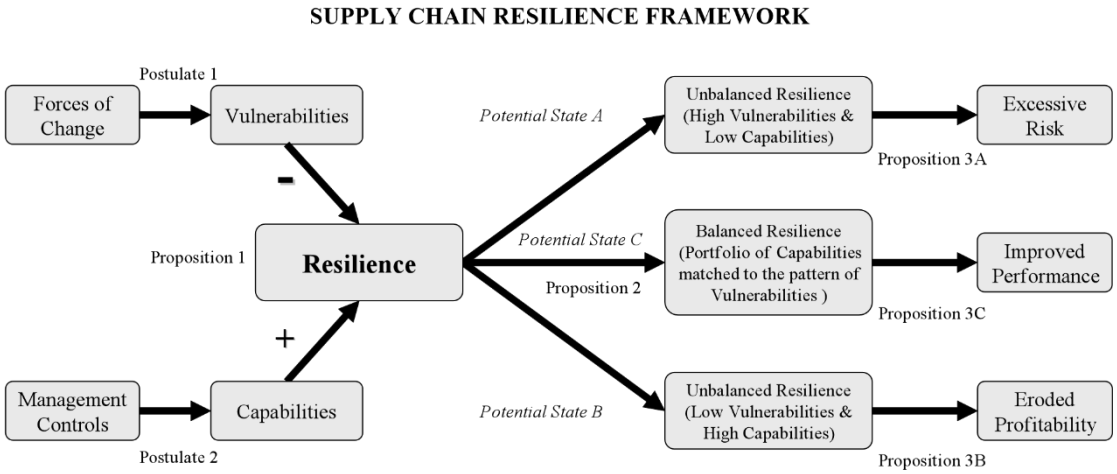

Figure 2.1 supply chain resilience framework adopted from Pettit(2008)

As per Pettit, Fiksel, and Croxton, (2013) a resilient supply chain is a balance between vulnerabilities and capabilities. A supply chain that does not develop enough capabilities to offset high levels of vulnerabilities will be overly exposed to risks. Pettit (2008) has validated through his empirical study that supply chain resilience increases as capabilities increase and vulnerabilities decrease.

On the contrary, a supply chain can over-invest in capabilities compared to their vulnerabilities and therefore erode profits, which is an undesirable state of resilience.

And finally, developing capabilities that are best linked to overcoming the supply chain's vulnerabilities create a state of balance between investment and risk and this state is

called a state of balanced resilience (Pettit,2008). This is the most desirable resilience state for a supply chain.

This study accordingly will assess the resilience of the supply chain of EthioChicken's feed business using the two measurement dimensions of capabilities and vulnerabilities.

CHAPTER 3- RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a background of the research organization, the research approach, methods, and design being used by the study while highlighting the population and issues related to sampling technique, sample size determination, and data collection instrument. Besides, the chapter outlines the approach to data collection and analysis.

3.1.1 Background of the Study organization

EthioChicken is an umbrella name for three affiliated sister companies including Mekelle Farms PLC, AGP Poultry PLC, and Andassa Poultry PLC. The company launched its feed manufacturing operation in 2010 with a mission of providing healthy and affordable poultry meat and eggs to every Ethiopian family (EthioChicken mission, n.d). To support this mission, Ethiochicken manufactures poultry feed that is sold to its customers across Ethiopia in its Gelan and Burayu production sites.

The company using its two feed mills currently produces and sells over 5000 tons/month of a variety of poultry feed to its internal (The company's poultry breeding farms) and external customer (Distributors and individuals that make direct purchases). The company currently occupies 30.7 percent of the poultry feed market share and the poultry feed business has a 20 % gross profit contribution (Ethiochicken,2019).

EthioChicken uses a variety of raw materials and inputs to produce poultry feed based on the nutritional requirements to rear chickens. Some of the raw materials include maize, soya bean cake, wheat bran, limestone, groundnut cake, and vitamin premixes. The company receives its raw materials and inputs from its supply chain within the local and international market and works with third-party transport service providers to deliver the manufactured poultry feed to its customers.

3.2 Research Approach, and Methodology

3.2.1 Research Approach

The study followed a quantitative approach. The quantitative approach involves the generation of data in a quantitative form which can be subjected to rigorous quantitative analysis formally and rigidly. This usually means survey research where a sample of the population is studied (questioned or observed) to determine its characteristics, and it is then inferred that the population has the same characteristics (Kothari, 2004, p5).

3.2.2 Research Design

A descriptive cross-sectional survey design was employed in this study. as described by Kothari (2004) Descriptive survey is a scientific method that involves observing and describing the behavior of a subject without influencing it in any way. A survey research design is suitable for this study because it is an efficient way of collecting information from a selected number of respondents being targeted from a given population. Cross-sectional studies involve data collection from a population, or a selected subset, at one specific point in time. Cross-sectional surveys have been used in previous studies dealing with supply chain resilience including (Mohamad, Mohammadsadegh, & Eleonora, 2016; Fakoor et al., 2013; Pettit, 2008).

3.2.3 Research population

The research population contained 224 people that are involved in the upstream, downstream, and core business supply chain activities of EthioChicken's poultry feed business. The population includes EthioChicken's poultry feed business employees, third party feed transport suppliers, raw materials suppliers, and customers/poultry feed dealers that are directly linked to the day to day supply chain activities located in Burayu, Gelan and Addis Ababa areas. Details of the population size include a total of 150 EthioChicken's feed business employees obtained from the payroll of the company, from the upstream supply chain actors, 13 first tire local raw material suppliers, and third-party feed transport service providers where identified from EthioChicken's supplier's list. Additionally, from downstream supply chain actors, 58 customers/feed dealers have been identified from EthioChicken's customers' master list.

3.2.4 Sample Design

The non-probability sampling design was followed using purposive sampling to determine the respondents for the survey type data collection. Respondents from the core business, upstream and downstream supply chain activities have been selected purposefully based on their involvement in the company's day to day supply chain activities, and years of experience within the supply chain.

Respondents that have experience of two years and above within the supply chain and have been part of Ethiochicken's poultry feed business supply chain activities have been selected purposefully.

3.2.5 Sample Size

From EthioChicken's poultry feed business employees sampling frame which is the company's payroll, all Managers, and professional staff that are involved in the supply chain activities and have experience within the supply chain for two years and above have been selected. As a result total of 35 samples have been selected.

All upstream and downstream supply chain actors including third-party feed logistics service providers, customers/feed dealers, and first-tier raw materials suppliers that operate within the geographical scope of the study and have been part of EthioChicken's supply chain for 2 years, and above have been purposively selected. A total of 28 samples have been selected containing 3,15 &10 third party feed logistics service providers, customers/feed dealers, and first-tier raw materials suppliers, respectively.

3.2.6 Data Collection

Primary data was collected through a survey method using a structured questionnaire based on a five-point Likert scale using the SCRAM^{TM} tool developed by Pettit (2008). Structured questionnaires are simple to administer and relatively inexpensive to analyses. The provision of alternative replies, at times, helps to understand the meaning of the question clearly (Khotari,2004, P102). Data were collected from employees of EthioChicken's feed business, local first-tier raw materials suppliers, third-party logistics service providers, and customers/dealers that make up EthioChicken's supply chain.

3.2.7 Data Analysis

In the study, descriptive statistics (frequency, percentage, mean and count) and a supply chain resilience formula developed by Pettit (2008) was used to analyze the data collected.

3.2.7.1 Descriptive Statistics

Descriptive statistics (frequency, percentage, mean and count) was used to characterize employees of EthioChicken's feed business that are directly linked to the day to day supply chain activities, third party feed logistics providers, local first-tier raw material suppliers, customers/Feed dealers that are distributors involved in the storage and sales of poultry feed.

Data from the primary source was verified, coded, and analyzed using Statistical Package for Social Sciences (SPSS 23.0 for windows) computer software. As a result, frequency, percentage, and the average mean score were employed to present analysis and discuss the result of the paper.

3.2.7.2 Supply Chain Resilience Framework

Respondent responses collected from the survey using a structured questionnaire were transcribed and coded using SPSS 23.0 for windows, and using the supply chain resilience framework developed by Pettit (2008), supply chain resilience of Ethiochicken's poultry feed business was computed using the two-dimensions of vulnerabilities and capabilities. As per the formula provided by SCRES framework for the calculation of resilience score, R, is based on a firm's average vulnerability score, V, and the average capability score, C, as given by:

$$R = \frac{C - V + 1}{2}$$

when utilizing the Likert Scale of 1 to 5 employed by the SCRAM^{TM} tool. Construct scores can be computed by averaging the factor scores, assuming equal weights for each factor, in the manner of:

$$V = \sum_{i=1}^{n_V} V_i, n_V = 7 \text{ , and } C = \sum_{j=1}^{n_C} C_j, n_C = 14.$$

Factor scores come directly from the assessment tool by similarly averaging the associated sub-factors, again assuming equally weighted items, as:

$$V_i = \frac{\sum_{k=1} V_{i,k}}{n_{V_i}}, \quad i = 1 \rightarrow n_V ,$$

where n_{Vi} changes with the number of items in the i^{th} vulnerability factor and

$$C_j = \frac{\sum_{k=1} C_{j,k}}{n_{C_j}}, \quad j = 1 \rightarrow n_C ,$$

where n_{Cj} changes according to the number of items in the j^{th} capability factor. where nCj varies according to the number of items in the jth capability factor.

Finally, the resilience score that could range from 0% to 100 % is depicted on the resilience fitness space developed by Pettit(2008) that shows the resilience level of Ethiochicken's poultry feed business

3.3 **Reliability and Validity**

3.3.1 Reliability

According to Kothari (2004), a measuring instrument is reliable if it provides consistent results. Cronbach's alpha is a coefficient of reliability. It is commonly used as a measure of the internal consistency or reliability of a psychometric test score for a sample of examinees. Cronbach's alpha score of 0.8 and 0.95 is considered to have very good quality, scales with coefficient alpha between 0.7 and 0.8 are considered to have good reliability, and coefficient alpha between 0.6 and 0.7 indicates fair reliability. Accordingly, the reliability test for each of the factors under the constructs of Vulnerability and Capability falls within a good reliability range.

Vulnerability factors	Turbulence	Deliberate Threats	External Pressures	Resource Limits	Sensitivity	Connectivity	Supplier/Customer Disruptions
Items	6	6	6	6	9	5	2
Chronbach's alpha	0.716	0.772	0.827	0.813	0.695	0.863	0.804

Table 3.1 Cronbach's Alpha for vulnerability factors

Cabability factors	Flexibility in Sourcing	Flexibility in Order Fulfillment	Capacity	Efficiency	Visibility	Adaptability	Anticipation
Items	5	6	3	5	4	6	6
Chronbach's alpha	0.825	0.704	0.853	0.884	0.789	0.701	0.737

Table 3.2 Cronbach's alpha for capability factors

Capability factors	Recovery	Dispersion	Collaboration	Organization	Market Position	Security	Financial Strength
Number of items	4	5	5	6	6	6	4
Chronbach's alpha	0.802	0.765	0.827	0.704	0.823	0.816	0.853

Table 3.3 Cronbach's alpha for capability factors

3.3.2 Validity

The data collection instrument has been adopted without any modifications in any of the measurement items. As all the measurement items have been adopted from the formerly established measurement scale, the SCRAM tool by Pettit (2008), therefore, the validity of these items have been previously rigorously evaluated

3.3.3 Ethical Considerations

During data collection, survey respondents were given the freedom to participate in the study, by filling the questionnaire, and the results of the research were presented as aggregate. And the same was reported.

Finally, in addition to giving due respect to confidentiality and anonymity of research participants, great care was taken to avoid asking sensitive and leading questions and not to offend the research participants. In General, the overall process of the study was conducted within the frame of acceptable professional ethics.

CHAPTER 4- RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents an analysis of data collected and discusses the findings on the assessment of supply chain resilience of Ethiochicken's feed business. This chapter deals with the presentation, interpretation, and analysis of data gathered from primary sources.

4.1.1 Respondent demographics and Response rate

4.1.1.1 Response rate

To achieve the objectives of the study and to answer the related research questions, a total of 63 questionnaires were distributed, 8 were not returned properly filled and returned. 55 questionnaires were therefore effectively used for data analysis and it makes the response rate 87 % which was sufficient to continue the study.

4.1.1.2 Respondents' Profile

As seen in the table below, 56 % of the respondents where core business(EthioChicken poultry feed business employees) involved in the production, procurement, inventory management, and sales functions of the supply chain. 23 % of the respondents where upstream supply chain actors which are, local raw materials suppliers and third-party transport service providers. The remaining 20 % of the respondents where downstream actors that are the company's customers/feed dealers.

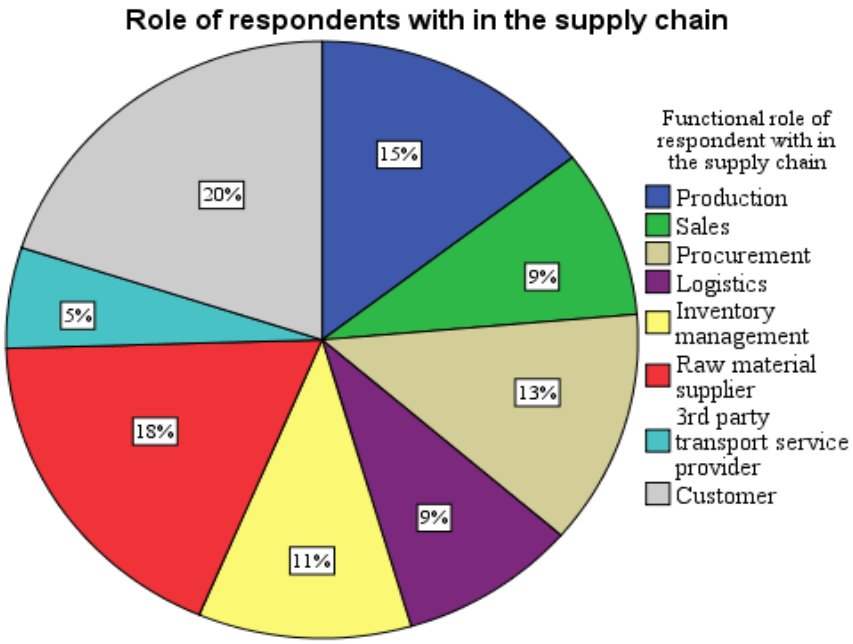

Figure 4.1 Respondents role within EthioChicken's feed business supply chain

As the below figure 91% of the respondents have been involved in the supply chain between two to five years. Only 9.1 % of the respondents have five to ten years of experience.

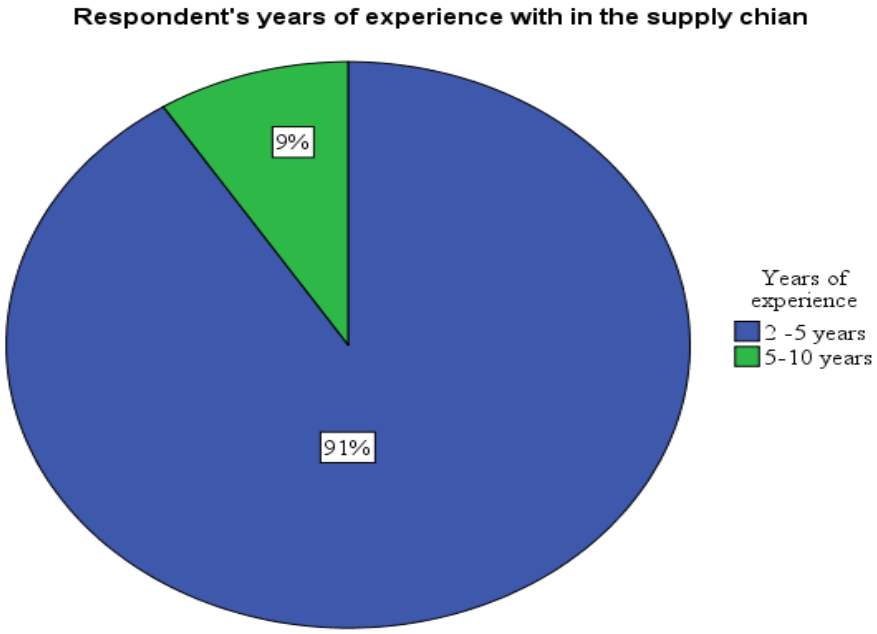

Figure 4.2- **Role of the respondent within the supply chain**

Geographical dispersion of the respondents as can be seen in the below table is mainly concentrated around Addis Ababa (58.2%) due to the scope of the study limitation, which is delimited to Addis Ababa, Burayu and Gelan area. Most First-tier suppliers, although their factories are located at other locations, they are based at their offices in Addis Ababa.

Respondents location	Frequency	%
Addis Ababa	32	58.2
Burayu	12	21.8
Gelan	11	20.0
Total	55	100.0

Table 4.3 -Location of respondent

4.2 **Descriptive analysis**

Respondents level of agreement on the supply chain resilience of EthioChicken's poultry feed business that was measured on a five scale Likert type scale. (1= Strongly Disagree and 5 Strongly Agree is presented below.

As a firm's supply chain resilience can be measured using the two supply chain resilience constructs of vulnerabilities and Capabilities (Pettit et al., 2013; Pettit,2008, Aigbogun, Ghazali and Razali, 2018; Mohamad, Mohammadsadegh and Eleonora, 2016), an average score of above 3.0 rating was deemed good as this indicated the level of the respondents' agreement to those statements representing subfactors of both constructs tested.

4.2.1 EthioChicken's poultry feed business Supply chain vulnerabilities

This study sought to identify vulnerabilities that exist within the supply chain of Ethiochicken's feed business by using average/mean score values of vulnerability subfactors. The weighted average score of each vulnerability factor derived from the score of subfactor under each vulnerability factor will further be used to rank inherent vulnerability factors within the study organization's supply chain.

Turbulence: Average mean scores of subfactors indicates that turbulence in EthioChicken's poultry feed business supply chain is prevalent in the form of two of its subfactors. Price and currency fluctuations associated with the export and supply market as well as the risk of health pandemics affecting employees. Both subfactors with mean scores higher than 3.0 are turbulence related vulnerabilities inherent within the supply chain that can result in disruptions. Respondents have not recognized the existence of the remaining subfactors as the mean score for these subfactors are below 3.0.

V1	Turbulence: Frequent changes in external factors beyond company control	
#	Sub factors	Mean
1	Supplies and export market with currency/price fluctuation	4.07
2	Health pandemic affecting our employees	3.02
3	Products unpredictable demand shift	2.69
4	Unforeseen technology failures	2.20
5	A severe natural disaster affecting markets and facilities	1.91
6	Geopolitical turmoil affecting imports or exports	1.42

Table 4.4 Turbulence subfactors rating

Deliberate threat: A deliberate threat in the form of potential liability claims has been proven by respondents to be a vulnerability area with a mean score of 3.80. The remaining sub-factors have a mean score below 3.0 indicating no or a less significant presence of these vulnerabilities

V2	Deliberate threat: Intentional attacks aimed at disrupting operations or causing human or financial harm	
#	Sub factors	Mean
1	Liability claims	3.80
2	Terrorism or sabotage	2.83
3	Unionized labor	2.81
4	Special Interest Groups impeding operations	2.37
5	Products regularly are stolen/vandalized.	2.28
6	Industrial espionage	1.63

Table 4.5 Deliberate threat sub factors rating

External pressure: Respondents indicated the presence of external pressure is very high with all the subfactors of this vulnerability factor have higher than 3.0 mean score values. The potential of public opinion to exert significant pressure on the company's operations, the influence of environmental concerns on product design and operations as well as the impact of social and cultural changes on the company's ability to serve its customers have been rated to be the highest vulnerability areas with mean values of 3.74, 3.51 &3.45 respectively. Additionally, frequent competitive innovation and changing government regulations affecting the company with equal mean values of 3.41 have been acknowledged to be vulnerability areas. Competitive innovation with a relatively lower mean value(3.17) compared to the other sub-factors is also a vulnerability area.

	External Pressures “Influences, not specifically targeting the firm, that creates business constraints	
V3		
#	Sub factors	Mean
1	Public opinion	3.74
2	Environmental concerns influence product design& operation	3.51
3	Social or cultural changes impact on customers	3.45
4	Strong price competition	3.41
5	Changing gov't regulations	3.41
6	Competitive innovation	3.17

Table 4.6 External pressure subfactor scores

Resource limits

Results in Table 4.8 below show the extent of the existence of resource limits within the company’s supply chain. As can be observed there are no vulnerabilities of resource limits with all the subfactor mean values falling below 3.0.

v4	Resource Limits “Constraints on output based on the availability of the factors of production”	
#	Sub factors	Mean
1	Recruiting and retaining skilled workers	2.93
2	limited supplier capacity	2.93
3	Poor utility infrastructure	2.89
4	Raw materials scarcity	2.83
5	limited production capacity	2.54
6	Limited access to distribution capacity	2.11

Table 4.7 Resource limit subfactor mean scores

Sensitivity: Results in table 4.7 strongly indicate the presence of sensitivity related vulnerabilities in the supply chain manifested in the sub-factors of the sensitivity of the poultry feed produced to input quality (mean 4.50), the importance of protecting the product brand names (mean 4.41) as well as visibility of errors in the production process to stakeholders with a mean value of 4.26. Products requiring strict storage and handling control, regulated/restricted materials used in the operation, and

equipment prone to failure are also sensitivity subfactors that could expose the supply chain to disruption.

V5	Sensitivity “Importance of carefully controlled conditions for product and process integrity”	
#	Sub factors	Mean
1	Product quality sensitivity to input	4.50
2	Strong brand name	4.41
3	Visibility of errors in production to stakeholders	4.26
4	Strict storage/ handling controls on products	3.94
5	Use of regulated or restricted materials.	3.81
6	Equipment s delicate or failure-prone.	3.31
7	Complex production operation	2.74
8	Extreme or hazardous working conditions.	2.52
9	suppliers/production facilities geographic concentration/codependency	2.33

Table 4.8 Sensitivity subfactors mean score

Connectivity: The importance of information flow within the supply chain, the existence of a large number of supply chain members are areas of connectivity-related vulnerabilities with mean scores of 4.20 and 3.43 respectively. The level of outsourcing of operations although not strongly rated, is also a vulnerability area with a mean value of 3.04.

V6	Connectivity “Degree of interdependence and reliance on outside entities”	
#	Sub factors	Mean
1	Importance of information flow	4.20
2	a large number of supply chain members.	3.43
3	Level of outsourcing	3.04
4	Globally distributed supply chain.	2.72
5	Use of specialty components	2.63

Table 4.9 Connectivity subfactors mean score

Suppliers/Customer disruptions: Respondents confirmed that there are no significant vulnerabilities within the supply chain resulting from suppliers' or customers' disruptions. Both supplier and customer disruptions scores show a mean value of 2.17 and 1.89 significantly lower than the acceptable mean of above 3.0.

V7	**Supplier/Customer Disruptions "Susceptibility of suppliers and customers to disruptions"**	
#	Sub factors	Mean
1	Supplier disruptions	2.17
2	Customer disruptions	1.89

Table 4.10 suppliers/customer disruption subfactor mean scores

Vulnerability factors rank

The below table shows vulnerability factors ranked according to the weighted average score value of each of their respective subfactors. Accordingly, the rank confirms that external pressure and connectivity related vulnerabilities within the supply chain are the highest with a mean value of 3.71 each, flowed by sensitivity related vulnerabilities with a mean value of 3.62. Respondents wherein consensus on the insignificance or lower presence of supplier/customer disruptions, deliberate threats, and turbulence within the supply chain as the mean value of these factors are below the midpoint of 3.0.

Factors rank	Vulnerability factors	Mean
1	Supplier/Customer disruptions	1.87
2	Deliberate threats	2.48
3	Turbulence	2.74
4	Resource limits	2.84
5	Sensitivity	3.62
6	External pressure	3.71
7	Connectivity	3.71

Table 4.11 Vulnerability factors score rank

(1- Lowest vulnerability to 7 highest vulnerability)

4.2.2 EthioChicken's poultry feed business Supply chain capabilities

Respondents in the survey were asked to rate 71 capability subfactors to identify existing capability factors existing in EthioChicken's poultry feed business supply chain. The results below show a list of capability subfactors categorized under their respective capability factors. The average mean of these sub-constructs is used to rank each capability factor to identify the level of presence within the company's supply chain.

Flexibility in sourcing: Results in table 4.12 indicates the presence of sourcing flexibility capabilities within the company's supply chain. Similar inputs used in the production of poultry feed, the flexibility of supply contracts modular design of products, and the flexibility to manufacture products with a variety of machines and workers provide a source of the capability to the supply chain. Additionally, a low mean value (2.89) for alternative sources for key inputs indicates consensus among respondents for lack of this capability subfactor.

C1	**Flexibility in Sourcing "Ability to quickly change inputs or the mode of receiving inputs"**	
#	Sub factors	Mean
1	Part commonality	4.22
2	The flexibility of supply contracts	4.09
3	Modular design	3.89
4	Our products can be made with a variety of machines and workers.	3.36
5	We have many alternative sources for key inputs	2.89

Table 4.12 Flexibility in sourcing subfactor scores

Flexibility in order fulfillment: The results regarding the existence of flexibility in order fulfillment as can be seen in Table 4.12 indicate that there is a higher level of existence of the capability factor as all of its subfactor scores are above the midpoint of 3.0.

c2	**Flexibility in Order Fulfillment "Ability to quickly change outputs or the mode of delivery outputs"**	
#	Sub factors	Mean
1	Centralized inventory pooling	3.65
2	Ease of changing routing and mode of transportation for outbound	3.57
3	Time postponement of production	3.46
4	Sophisticated inventory system	3.28
5	Ease of increasing storage and distribution capacity	3.26
6	Ease of reallocation of orders and jobs	3.09

Table 4.13 Flexibility in order fulfillment subfactors mean score

Capacity: Ethiochicken's feed business supply chain possesses the capability capacity in the form of having access to duplicate equipment and facilities as well as possessing reliable backup utilities with mean score values of 3.61 and 3.48 respectively. The results also indicate that when it comes to having a significant excess capacity of equipment, materials, and labor to boost output quickly, the capability is not there as this subfactor received the lowest score with a mean value of 2.70.

c3	**Capacity "Availability of assets to enable sustained production levels"**	
#	Sub factors	Mean
1	Access to duplicate equipment & facilities	3.61
2	Reliable backup utilities	3.48
3	Significant excess capacity	2.70

Table 4.14 Capacity sub factors mean score

Efficiency: When it comes to possessing efficiency as a capability, the survey result shows that a higher level of efficiency exists within the company's supply chain with all four of the associated subfactor score mean values above 4.0. The scores indicate that there is high labor productivity, asset utilization, reliable equipment, and effective preventive maintenance programs. Additionally producing products with little variability is also an additional efficiency subfactor with a mean value of 3.61.

C4	**Efficiency "Capability to produce outputs with minimum resource requirements"**	
#	Sub factors	Mean
1	Effective preventive maintenance	4.17
2	Uniformly utilized assets	4.11
3	High labor productivity	4.09
4	Reliable equipment	4.00
5	Variance of quality	3.61

Table 4.15 Efficiency subfactor scores

Visibility: Regular interchange of information across the supply chain and with stakeholders is a strong visibility capability with a mean value of 3.93 followed by the possession of real-time data on location and status of resources (Mean 3.56) and information system that accurately track operations of the business with a mean value of 3.46. Effective business intelligence-gathering programs exist within the supply chain is not significant as the mean value is not above the midpoint.

C5	**Visibility "Knowledge of the status of operating assets and the environment"**	
#	Sub factors	Mean
1	Effective business intelligence-gathering programs	3.00
2	Regular interchange of information among supply chain members and stakeholders	3.93
3	Real-time data on location and status of resources	3.56
4	Information systems that accurately track operations	3.46

Table 4.16 Visibility subconstruct factor scores

Adaptability: the results in table 4.17 indicate a consensus among respondents on the existence of capabilities relating to adaptability. The existence of continuous improvement programs focuses on lead time reduction of products and the ability to seize advantages resulting from changes in the market with respective mean values of 3.94,3.93, and 3.69 is a strong indication that adaptability exists in the supply chain.

C6	**Adaptability** **"Ability to modify operations in response to challenges or opportunities"**	
#	Sub factors	Mean
1	We use strategic gaming and simulations to design more adaptable processes.	2.10
2	Continuous improvement programs	3.94
3	Focus on product lead time reduction	3.93
4	Advantage seizing on market changes	3.69
5	Innovative technologies	3.65
6	Ease of relocating orders b/n suppliers and facilities	3.43

Table 4.17 Adaptability subfactor scores

Anticipation: The results in table 4.18 below indicates that the company can anticipate a potential disruption in the supply chain. All anticipation subfactors have a mean value significantly above the midpoint indicating the existence of a higher level of anticipation in the supply chain.

C7	**Anticipation** **"Ability to discern potential future events or situations"**	
#	Sub factors	Mean
1	Risk identification and prioritization	4.48
2	Demand forecasting	3.94
3	Performance deviation monitoring	3.93
4	Contingency plan and preparedness exercise	3.91
5	Monitoring of early warning signals	3.89
6	Capitalization of business opportunities	3.72

Table 4.18 Anticipation subfactor scores

Recovery: The ability to recover and return to normal operations manifested in the form of taking immediate actions against disruptions, effective crisis management, effective communication strategy, and ease of organizing response teams during disruptions. All subfactor scores of recovery have a mean value above 3.0.

C8	Recovery “Ability to return to normal operational state rapidly”	
#	Sub factors	Mean
1	Immediate action against disruptions	4.04
2	effective crisis management	3.83
3	Effective communication strategy	3.81
4	Ease of organizing response teams	3.59

Table 4.19 Recovery subfactors score

Dispersion: The results in table 4.29 indicate that Ethiochicekns poultry feed business assets are decentralized, and key decisions can be made with employees offsite. Ethiochicken’s suppliers and customers as well are located at a decentralized location. The dispersion of the senior leadership team with a mean score of 2.61 indicates that the company’s leadership is located in one area.

C9	**Dispersion** **“Broad distribution or decentralization of assets”**	
#	Sub factors	Mean
1	Decentralized customers	4.51
2	Decentralized production facilities	3.89
3	Key decision making offsite	3.69
4	Decentralized suppliers	3.59
5	Dispersion of senior leadership	2.61

Table 4.20 Dispersion subfactor scores

Collaboration: The company's ability to work effectively with supply chain actors for mutual benefit is higher with all of its’ subfactor scores mean falling above the midpoint. Ethiochicken’s customers although are not able to delay orders when production capacity is hampered with respondents rating the subfactor below mean value of 2.61.

C10	Collaboration “Ability to work effectively with other entities for mutual benefit”	
#	Sub factors	Mean
1	Collaborative demand forecasting	3.87
2	Proactive product lifecycle to reduce costs	3.72
3	Risk sharing	3.70
4	Transparent data flow in the supply chain	3.54
5	Time postponement of production	2.77

Table 4.21 Collaboration subfactor scores

Organization: The company as can be deduced from the results in table 4.22, has the organizational capability. It’s the capability to fill leadership gaps quickly (4.48), a strong culture of caring for employees (4.02) is the highest-rated organizational capability subfactors.

C11	**Organization** **“Human resource structures, policies, skills, and culture”**	
#	Sub factors	Mean
1	Capability to fill the leadership gap	4.48
2	Caring for employees	4.02
3	Accountability for performance	3.94
4	Creative problem solving	3.89
5	Makes use of benchmarking and feedback	3.85
6	Employees training	3.26

Table 4.22 Organization subfactor scores

Market position: There is a strong indicator considering the results of the survey that the company has a strong market position capability with in the market as there is strong brand recognition for its products, effectively communicates to its customers, customers are loyal to producers, there are a strong customer relationship and strong market share. All subfactor mean values are above 4.0 indicating a strong presence of market position.

C12	Market Position “Status of a company or its products in specific markets”	
#	Sub factors	Mean
1	strong brand recognition	4.43
2	Effective customer communications	4.37
3	Customer loyalty	4.31
4	Strong customer r/p	4.28
5	strong market share	4.24
6	Differentiate products	4.06

Table 4.23 Market position subfactor scores

Security: All of the subfactor scores have a mean value above 3.0 indicating a presence of capability of security for defense against a deliberate threat.

C13	**Security** **“Defense against deliberate intrusion or attack”**	
#	Sub factors	Mean
1	Layered security	4.06
2	Collaborate with the government on security.	3.98
3	Strong Information systems security.	3.57
4	Personnel security programs (as awareness briefings, travel restrictions & threat assessments)	3.52
5	Active security awareness programs	3.39
6	Restrictions for access to facilities & equipment	3.21

Table 4.24 Security subfactor mean scores

Financial strength: The survey respondents were asked to rate their level of agreement on the financial strength of the company using it’s sub-constructs. The results show that the capability exists in the form of insurance coverage for facilities, equipment, goods, and personnel with a mean score value of 3.52 and a higher profit margin on sales with a mean value of 3.09. How every company doesn’t enough financial reserve and diverse financial portfolio with respective mean scores of 2.78 and 2.74.

C14	**Financial Strength "Capacity to absorb fluctuations in cash flow"**	
#	Sub factors	Mean
1	Insurance coverage for facilities, equipment, goods, and personnel.	3.52
2	The high margin on sales.	3.09
3	Financial reserve	2.78
4	Diverse financial portfolio	2.74

Table 4.25 Financial strength subfactor scores

Capability factor rank

The below table shows Capability factors ranked according to the weighted average score value of each of their respective subfactors. The results in table 4.26 show that all of the capability factors have a mean value above 3.0 indicating the presence of all 14 capability factors that exist within the supply chain. Further, the ranks indicate that Market position, efficiency, and organization have higher mean scores of 4.30, 4.02, and 4.01 respectively.

Capability factors rank

Factors rank	Capability factors	Mean
1	Financial strength	3.02
2	Flexibility in order fulfillment	3.11
3	Capacity	3.25
4	Dispersion	3.47
5	Visibility	3.50
6	Collaboration	3.54
7	Security	3.54
8	Adaptability	3.69
9	Recovery	3.85
10	Flexibility in sourcing	3.92
11	Anticipation	3.97
12	Organization	4.01
13	Efficiency	4.02
14	Market position	4.30

Table 4.26 Capability factors rank

4.3 Supply Chain Resilience Framework

4.3.1 Ethiochicken's poultry feed business supply chain resilience level

As discussed in Chapter 3 data analysis section, the supply chain resilience framework was used to further analyze the data collected from respondents and arrive at the resiliency level of the company's supply chain.

As per the supply chain resilience framework, construct scores can be computed by averaging the factor scores, assuming equal weights for each factor.

Factor scores come directly from the assessment tool by similarly averaging the associated sub-factors.

$$V = \sum_{i=1}^{n_V} V_i, n_V = 7 \text{ , and } C = \sum_{C}^{j=1} C_j, n_C = 14.$$

Average construct scores according to the framework, have been arrived at by taking the weighted average scores for the two constructs calculated using SPSS 23.0 be seen in the below table

Constructs	Mean
V	3.00
C	3.66

Table 4.27- Constructs average scores

Finally, to arrive at the resilience level of the study organization supply chain, resilience score (R), ranging from 0% to 100%, was calculated using the formula provided by Pettit (2008) based on the vulnerability(V) and capability (C)scores in table 4.27.

$$R = \frac{3.66-3+1}{2} = 0.83\ \%$$

The computed resiliency score (R) of EthioChicken's poultry feed business supply chain which is 83 % is depicted in the resilience space below to identify the level of resilience of the firm. The result indicates that EthioChickens supply chain resilience falls in a higher resilience range where there is a higher level of capabilities and lower Levels of vulnerabilities within the supply chain.

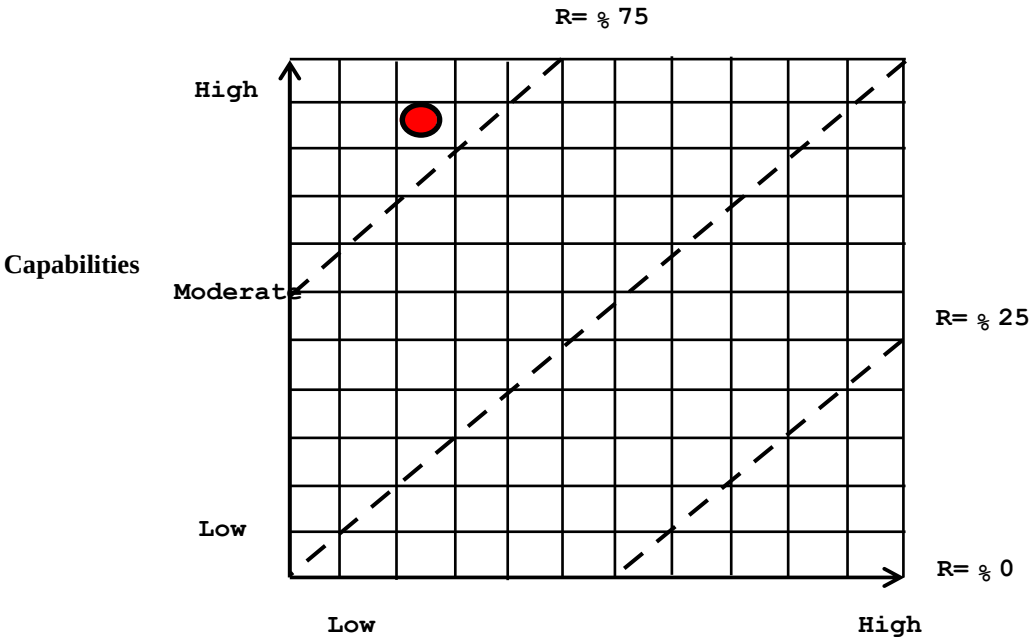

Figure 4.28 Resilience space

According to (Pettit, 2008, Petit, Fiksel, and Cronox, 2010) a resilience score of 50% (Balanced resilience) and above (Higher capabilities compared to vulnerabilities) is favorable for supply chains.

CHAPTER 5- SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

This final chapter presents a summary of the basic findings of the study based on the objectives and research questions detailed in Chapter 1 of this research study. Additionally, conclusions as per the summary of findings, recommendations & suggestions for further area of research are discussed.

5.2 Summary

The objective of this study was to assess the supply chain resilience of EthioChicken's poultry feed business by answering the below three main questions and a summary of the study concerning each research question is discussed below.

a) What are the supply chain capabilities of EthioChicken's poultry feed business?

The study sought to identify Ethichicken's poultry feed business supply chain vulnerabilities and the below vulnerabilities where identified in the supply chain.

- Connectivity, External pressure & Sensitivity were the highest-ranked vulnerability factors with a mean value of 3.71, 3.71, and 3.62 respectively. The remaining 4 vulnerability factors were all below the midpoint of 3.0 indicating that these vulnerability factors (resource limit, turbulence, Deliberate threat, and Supplier/Customer disruption) do not impact EthioChicken's feed business supply chain significantly

b) What are the supply chain capabilities of EthioChicken's poultry feed business?

- From the study undertaken, it has been identified that all 14 capabilities (Market position, Efficiency, Organization, Anticipation, Flexibility in sourcing, Recovery, Adaptability, Security, Collaboration, Visibility, Dispersion, Capacity, Flexibility In order fulfillment, Financial strength) exist in EthioChicken's feed business supply chain with a mean value above the midpoint score of 3.0. Capability factors of Market position, Efficiency, Organization have a relatively significantly higher mean (4 and above) indicating the significant presence of the capability factors within EthioChicken's feed business supply chain

c) What do the identified vulnerabilities and capabilities indicate about the supply chain resilience of EthioChicken's poultry feed business?

As defined by Pettit, Croxton, and Fiksel, (2013), supply chain resilience can be estimated via the measurement dimensions of vulnerabilities and capabilities using the supply chain resilience score formula provided in this study. Using average vulnerability and capability factor rating supply chain resilience score was calculated and resulted in a score of 0.83 (83%). The result indicates that EthioChicken' feed business is highly resilient with a higher level of capabilities within the supply chain.

5.3 **Conclusion**

In this study, the vulnerabilities, and capabilities of EthioChicken's poultry feed business supply chain were identified and the level of resilience of the supply chain was measured. The results obtained from this research could give managers within EthioChicken's supply chain invaluable information regarding the present resilience of their organization so they would be able to make effective plans to improve organizational resilience by identifying the most important vulnerabilities and linking these to relevant capabilities applicable in the same area. As a survey study, EthioChicken's poultry feed business supply chain resilience was measured. To do this, at first, the values of the company's supply chain capabilities (C) and vulnerabilities (V) were calculated by the average subfactor scores of each construct, average factor scores of C=3.66 and V=3.00 were obtained. Therefore, EthioChicken's poultry feed business resilience was estimated to be at 83% which indicates the situation that is highly desirable for the company.

Therefore, we can conclude that there is a prevalence of higher capability within the supply chain.

Connectivity, External pressure & Sensitivity were determined as the most important vulnerabilities of the EthioChicken's poultry feed business. The findings of the study also suggested that EthioChicken's poultry feed business possesses a higher number of capabilities with the highest being the Market position, Efficiency, Organization, and Anticipation.

5.4 **Recommendation**

The following recommendations are suggested by the researcher

- It is recommended that supply chain vulnerability of external pressure specifically associated with public opinion exerting significant pressure on operations through the capability of visibility through building effective business intelligence programs which is a capability that can be further strengthened.
- It is further recommended that vulnerabilities associated with sensitivity such as the use of regulated or restricted materials be mitigated by further building on capabilities of sourcing flexibility specifically by increasing alternative sources of key inputs. It can further be mitigated by building on the capacity to take immediate action to mitigate the effect of disruptions created by such vulnerabilities.
- The researcher's final recommendation is for creating a balance between inherent vulnerabilities within the company's supply chain, as keeping capabilities that do not mitigate against inherent vulnerabilities will erode the company's profit.

5.4.1 Suggestions for future study

The researcher suggests the below points for further study in supply chain resilience.

- Although this study met its objectives using the appropriate sample size as per the scope of the study, more extensive research by including all supply chain members in all geographic locations of the feed business is recommended to identify further vulnerabilities within the supply chain.
- Further additional research on the relationship between existing capabilities and inherent vulnerabilities is recommended as excessive capabilities without any related inherent vulnerabilities carry excessive cost and erodes the company's profit.
- Delphi method has been used to gather qualitative data from experts at an industry level to accurately identify inherent capabilities and vulnerabilities of companies within the supply chain. As there are environmental and contextual differences in different countries, the researcher recommends the use of the Delphi method to collect qualitative data on inherent capabilities

and vulnerabilities within the industry of the study organizations and refine the data instrument based on qualitative data gathered.

- Other models to average construct factor scores such as fuzzy logic, grey system approach are recommended to calculate vulnerability and capability factor scores.

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Appendix

Questionnaire

1. Introduction

a. Overview: You are invited to participate in a unique questionnaire designed to assess the resilience of Ethiochicken's feed business supply chain resilience.

b. Confidentiality: Your responses to this assessment was kept strictly confidential by the researcher. Your honest and accurate assessment is important for gaining meaningful insights into supply chain resilience.

c. Thank you for participating in this project. Completion of the assessment should require approximately 30 minutes.

2. Your functional role within the Supply Chain

Select one from the list below:

- ☐ EthioChicken's poultry feed business store supervisors
- ☐ EthioChicken's poultry feed business managers
- ☐ EthioChicken's breeding farm/Production Managers
- ☐ Ethiochicken's poultry feed business raw material purchasers
- ☐ Poultry feed transport service providers
- ☐ Raw materials suppliers
- ☐ Customer/Feed dealers
- ☐ EthioChicken's feed logistics employee

Other _____

How long have you worked in Ethiochicken? _____

3. Research Overview

a. The Problem: The business environment is becoming more and more turbulent. Supply chain disruptions, whether an accident, natural disaster, security breach, competitive threat, or shift in demand, can be costly in the short term and may have lasting adverse impacts. It is essential for companies with complex supply chains to develop a clear understanding of their supply chain vulnerabilities and to proactively strengthen their capabilities to anticipate, respond, and adapt.

b. The Solution: Based on research in management, economics, ecology, and sociology, the concept of resilience has emerged as a critical characteristic of complex, dynamic systems such as business enterprises. In the business context, Resilience is defined as the capacity for an enterprise to survive, adapt, and grow in the face of turbulent change.

Change not only presents threats to business continuity but can also create opportunities for business value creation. When disruptions change the competitive landscape, a resilient company can often take advantage of introducing business innovations, increasing market share, and enhancing its reputation.

c. Definitions: While completing the assessment, consider only the operations internal to EthioChicken's poultry feed business. Therefore, while completing the assessment, consider EthioChicken's products to be the poultry feed business's breeder and commercial feed types. Consider customers to be EthioChickens poultry breeding farms and feed dealers that directly purchase commercial feed from EthioChicken's poultry feed business. Finally, consider suppliers to be firms supplying raw materials and poultry feed transport service to Ethiochicken's poultry feed business.

4. Assessment

First, you will be asked to assess the vulnerabilities that currently challenge the supply chain of EthioChicken's poultry feed business. For each statement, indicate the extent of your agreement or disagreement based on your knowledge of EthioChicken's poultry feed business products, and operations. If you do not have personal knowledge of the subject, select "Don't Know". 1- means "Strongly disagree", - 2 - means " Disagree", - 3 - means "Neither agree or disagree", - 4 - means " Agree",- 5 - means "Strongly agree", - 0 - means "Don't know"

Part 1: Vulnerabilities

Turbulence "Environment characterized by frequent changes in external factors beyond your control"	1	2	3	4	5	0

V1.1- Our products face unpredictable demand shifts.						
V1.2 - We depend on supplies and/or export markets that experience severe currency or price fluctuations.						
V1.3 – Our imports or exports face recurring disruptions due to geopolitical turmoil.						
V1.4 – Our facilities or markets are frequently exposed to severe natural disasters.						
V1.5 – We regularly face unforeseen technology failures in our operations.						
V1.6 – Our operations are susceptible to a potential health pandemic affecting our employees.						

Deliberate Threats “Intentional attacks aimed at disrupting operations or causing human or financial harm”	1	2	3	4	5	0
V2.1 – Our facilities or personnel may be targets of terrorism or sabotage.						
V2.2 – Our products are regularly stolen or vandalized.						
V2.3 – We depend on unionized labor which can be hostile to the firm.						
V2.4 – Our operations are frequently impeded by Special Interest Groups.						
V2.5 – Our products or technologies may be compromised by industrial espionage.						

V2.6 – Our operations or products may face liability claims.						

External Pressures "Influences, not specifically targeting the firm, that creates business constraints or barriers"	1	2	3	4	5	0
V3.1 – Our products are threatened by frequent competitive innovations.						
V3.2 – Our operations and/or products are subject to stringent and/or changing government regulations.						
V3.3 – Our products face strong price competition.						
V3.4 – Public opinion can exert significant pressure on our operations.						
V3.5 – Social or cultural changes have had a significant impact on our ability to serve our markets.						
V3.6 – Environmental concerns influence how we design our products and/or conduct our operations.						

Resource Limits "Constraints on output based on the availability of the factors of production"	1	2	3	4	5	0

V4.1 – Our suppliers have limited capacity.						
V4.2 – Our production capacity is limited.						
V4.3 – We have limited access to the capacity for distributing products.						
V4.4 – Raw materials for our products are scarce or in high demand.						
V4.5 – Utilities are over-extended, and our utility infrastructure is poor.						
V4.6 – We have difficulty recruiting and retaining highly skilled workers.						

Sensitivity "Importance of carefully controlled conditions for product and process integrity"	1	2	3	4	5	0
V5.1 – We depend on the use of regulated or restricted materials.						
V5.2 – The quality of our products is highly dependent on the quality of our inputs/supplies.						
V5.3 – Our products require strict storage or handling controls to maintain their purity and/or integrity.						
V5.4 – Our production operations are very complex.						
V5.5 – Some equipment in our operations is delicate or failure-prone.						

V5.6 – Our workers sometimes operate in extreme or hazardous conditions.						
V5.7 – Errors or deficiencies in our operations are highly visible to stakeholders.						
V5.8 – Our products carry brand names that are important to protect.						
V5.9 – Our suppliers or production Facilities are geographically concentrated and/or codependent.						

Connectivity "Degree of interdependence and reliance on outside entities"	1	2	3	4	5	0
V6.1 – Our supply chain has many members.						
V6.2 – We are part of a globally distributed supply chain.						
V6.3 – Many of our products require specialty components.						
V6.4 – Continuous information flow is critical to regular operations.						
V6.5 – We outsource our operations to many different suppliers.						

Supplier/Customer Disruptions "Susceptibility of suppliers and customers to disruptions"	1	2	3	4	5	0
V7.1 – Our suppliers frequently face significant disruptions.						
V7.2 – Our customers frequently face significant disruptions.						

Part 2: Capabilities

You will then assess the capabilities currently employed by your company to offset these vulnerabilities. Responses are in the same format as Part 1.

Flexibility in Sourcing "Ability to quickly change inputs or the mode of receiving inputs"	1	2	3	4	5	0
C1.1 – Our supplies are used in multiple finished goods.						
C1.2 – Our finished goods use modular designs.						
C1.3 – Our products can be made by a variety of machines and workers.						
C1.4 – Our supply contracts can be easily modified to change specifications, quantities, and terms.						
C1.5 – We have many alternative sources for key inputs.						

Flexibility in Order Fulfillment "Ability to quickly change outputs or the mode of delivery outputs"	1	2	3	4	5	0
C2.1 – We can quickly increase the capacity of storage and distribution services.						
C2.2 – We currently delay the final production of finished goods until close to the time that customers place orders.						
C2.3 – We pool inventory for a wide variety of customers at centralized locations.						

C2.4 – We have a sophisticated inventory management system that regularly computes both safety stock and cycle stock at all storage and retail locations.						
C2.5 – We can quickly change the routing and mode of transportation for outbound shipments.						
C2.6 - We can quickly reallocate orders to alternate suppliers and reallocate jobs between different production units.						

Capacity "Availability of assets to enable sustained production levels"	1	2	3	4	5	0
C3.1 – We have reliable back-up utilities(electricity,water,communications)						
C3.2 – We maintain access to duplicate or redundant facilities and equipment.						
C3.3 – We have significant excess capacity of materials, equipment, and labor to quickly boost output if needed.						

Efficiency "Capability to produce outputs with minimum resource requirements"	1	2	3	4	5	0
C4.1 – Our labor productivity is very high.						
C4.2 – Our assets are uniformly utilized with no limiting bottlenecks.						

C4.3 – We produce products with little variability in quality.						
C4.4 – We have effective preventative maintenance programs.						
C4.5 – Our equipment is very reliable.						

Visibility "Knowledge of the status of operating assets and the environment"	1	2	3	4	5	0
C5.1 – We have information systems that accurately track all operations.						
C5.2 – We have real-time data on the location and status of supplies, finished goods, equipment, and employees.						
C5.3 – We have a regular interchange of information among suppliers, customers, and other external sources.						
C5.4 – We have effective Business Intelligence gathering programs.						

Adaptability "Ability to modify operations in response to challenges or opportunities"	1	2	3	4	5	0
C6.1 – We can quickly reallocate orders to alternate suppliers and reallocate jobs between different production facilities.						

C6.2 – We use strategic gaming and simulations to design more adaptable processes.						
C6.3 – We excel at seizing advantages from changes in the market.						
C6.4 – We develop innovative technologies to improve operations.						
C6.5 – We continually strive to further reduce lead-times for our products.						
C6.6 – We effectively employ continuous improvement programs.						

Anticipation "Ability to discern potential future events or situations"	1	2	3	4	5	0
C7.1 – We effectively employ demand forecasting methods.						
C7.2 – We have formal risk identification and prioritization process.						
C7.3 – We monitor deviations to normal operations, including near misses.						
C7.4 – We monitor and recognize early warning signals of possible disruptions.						
C7.5 – We have detailed contingency plans and regularly conduct preparedness exercises and readiness inspections.						
C7.6 – We recognize new business opportunities and take immediate steps to capitalize on them.						

Recovery "Ability to return to normal operational state rapidly"	1	2	3	4	5	0
C8.1 – We can quickly organize a formal response team of key personnel, both on-site and at the corporate level.						
C8.2 – We have an effective strategy for communications in a variety of extraordinary situations.						
C8.3 – We are very successful at dealing with crises, including addressing public relations issues.						
C8.4 – We take immediate action to mitigate the effects of disruptions, despite the short-term costs.						

Dispersion "Broad distribution or decentralization of assets"	1	2	3	4	5	0
C9.1 – Our key inputs are sourced from a decentralized network of suppliers.						
C9.2 – Our production facilities are distributed at various locations.						
C9.3 – Our senior leaders are based on a variety of different locations.						
C9.4 – Our organization empowers on-site experts to make key decisions, regardless of the level of authority.						
C9.5 – Our products are sold to customers in a variety of geographic locations.						

Collaboration	1	2	3	4	5	0

"Ability to work effectively with other entities for mutual benefit"						
C10.1 – We effectively employ collaborative demand forecasting techniques using shared data.						
C10.2 – Our data flows transparently between supply chain members, with full access by all firms to facilitate collaborative decision making.						
C10.3 – Our customers are willing to delay orders when our production capacity is hampered.						
C10.4 – We have proactive product life-cycle management programs that strive to reduce both costs and risks.						
C10.5 – Our firm invests directly in our suppliers' or customers' operations, as well as other actions to share risks.						

Organization "Human resource structures, policies, skills, and culture"	1	2	3	4	5	0
C11.1 – We strongly encourage creative problem-solving.						
C11.2 – We strictly enforce individual accountability for performance.						
C11.3 – We train employees in a wide variety of skills.						
C11.4 – We are capable of filling leadership voids very quickly.						
C11.5 – We are a learning organization, regularly using feedback and benchmarking tools.						

C11.6 – We have a strong culture of caring for employees.						

Market Position "Status of a company or its products in specific markets"	1	2	3	4	5	0
C12.1 – Our brands have excellent customer recognition and a strong reputation for quality.						
C12.2 – Our customers are very loyal to our products.						
C12.3 – Our products command a significant share of the market.						
C12.4 – Our customers can differentiate our products from competitors' products.						
C12.5 – Our firm has strong, long term relationships directly with each of our customers.						
C12.6 – Representatives of our firm communicate effectively with our customers.						

Security "Defense against deliberate intrusion or attack"	1	2	3	4	5	0
C13.1 – We employ layered defenses and do not depend on a single type of security measure.						
C13.2 – We use stringent restrictions for access to facilities and equipment.						

C13.3 – We have active security awareness programs that involve all personnel.						
C13.4 – We effectively collaborate with government agencies to improve security.						
C13.5 – We have a high level of information systems security.						
C13.6 – We use a variety of personnel security programs such as awareness briefings, travel restrictions, and threat assessments.						

Financial Strength "Capacity to absorb fluctuations in cash flow"	1	2	3	4	5	0
C14.1 – We have significant financial reserves to cover all potential needs.						
C14.2 – Our financial portfolio is very diverse.						
C14.3 – We have significant insurance coverage for facilities, equipment, goods, and personnel.						
C14.4 – We sell our products at a relatively high margin.						