RESILIENT AND SUSTAINABLE SUPPLY CHAIN NETWORKS: A CASE STUDY OF THE PERISHABLE FOOD INDUSTRY IN THE US

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Resilient and Sustainable Supply Chain Networks: A Case Study of the Perishable Food Industry in the US

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Abstract

Contemporary supply chain management (SCM) issues are multiplex and continually evolving catalysed by complexities and dynamism. The perishable food industry exemplifies this phenomenon, driven by globalisation, technological advancements and a highly competitive business environment. Inescapably, food supply chains are increasingly operating as supply chain networks (SCN). SCNs are typified by a higher level of interdependence and connectivity amongst firms, consequently evolving from dyad and triad relationships, which have dominated SCM research. These changes generate divergent risks and vulnerabilities that perturb perishable food supply chains in unconventional ways. Thus, the purpose of this empirical study is to investigate how firms within a perishable food supply chain network can build resilience and sustainability. The research focuses on advancing the management of fast-moving consumer goods (FMCG).

Methodologically, an empirical qualitative study is undertaken within a food manufacturer (focal firm) and 18 independent firms operating across all tiers of its SCN. Applying a pragmatic philosophical positioning, the study draws concepts from key supply chain theories to investigate the phenomena. The investigation uses Nicolini's Zooming in and Zooming out as an analytical lens. The zooming in and out is established by shifting analytical lenses and re-positioning actors' praxis, to ensure certain facets of their actions are fore-grounded while others are put in a background position and contrariwise moving the background to the foreground. The purpose of this technique is to draw meaning from everyday practices and trace the actions of actors across the entire SCN.

The results uncover four distinct but intertwined main categories; whose subtle and often ignored interplay is crucial in attaining SCN resilience and sustainability. These main categories are Collaboration, Power Dynamics, SCN Culture and Information Systems. Current supply chain literature argues that collaboration is an essential enabler of resilience and sustainability. Building on this, the findings make a significant contribution by teasing out the intangible and predominately unacknowledged antecedents and salient sustaining factors of effective SCN collaboration. Furthermore, the study develops a resilience and sustainability (RS) matrix, which renders different impacts and outcomes of varying levels of SCN collaboration between firms operating in a perishable food SCN. Therefore, this thesis contributes knowledge towards constructing resilient and sustainable perishable food SCNs by proffering pragmatic propositions. These aim to address challenges facing industry stakeholders and ignite pertinent future research avenues for scholars.

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To quote a famous proverb, *"a journey of a thousand miles begins with a single step"*. This PhD process has been a long and intellectually challenging journey that I could not have completed on my own. Accordingly, some acknowledgements are in order. First, I would like to thank my Doctoral Advisors who guided and encouraged me, especially during the more difficult times of the PhD journey. I want to acknowledge and give a massive thank you to, Professor Jyoti Mishra, Dr Zahid Hussain, Professor Kevin Barber (Retired) and the Late Dr Brian Drabble. All their words of wisdom and encouragement have helped me to achieve this most significant milestone in my academic career thus far.

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Dedication

I dedicate this thesis to all my family and true friends.

I want to give special thanks to my Father and Mother. I am grateful to my Mother for all her love and encouragement; I could not have completed this journey without her support. A big thank you to all my siblings, a big shout out to Tawanda for your constant calls of support, Kuda for your encouragement and my sisters Michelle and Bethel. Many thanks to Uncle Godwin and Aunt Julia for hosting and looking after me when I visited the USA for my data collection.

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Conference Presentations

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Working Papers

Chiwenga, K., Mishra, J. & Hussain, Z., 2019. Re-examining the role of information systems for effective safety management: An agri-food supply chain case study

Chiwenga, K., Mishra, J. & Hussain, Z., 2019. Untangling Power Dynamics in Complex and Dynamic Supply Chain Networks

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LIST OF ABBREVIATIONS

FF: Focal Firm

IS: Information Systems

SCM: Supply Chain Management

SCR: Supply Chain Risk

SCRM: Supply Chain Risk Management

SCC: Supply Chain Collaboration

SCRES: Supply Chain Resilience

SSCM: Sustainable Supply Chain Management

SCN: Supply Chain Network

FMCG: Fast-Moving-Consumer-Goods

FSCN: Food Supply Chain Network

FSC: Food Supply Chain

SFSC: Short Food Supply Chain

PFSCN: Perishable Food Supply Chain Network

NT: Network Theory

SCNT: Supply Chain Network Theory

DC: Dynamic Capabilities

RBV: Resource Based View

CAS: Complex Adaptive Systems

TBL/3BL: Triple Bottom Line

GLOSSARY

The Table below provides vital definitions of words or phrases used in this thesis.

CONSTRUCT	DEFINITION
Actor	An individual/person with the ability to take actions or make decisions that affect or effect the operations of the perishable food supply chain network under investigation
Actor-Firm	A food firm/company operating in the perishable food supply chain network (SCN) under investigation
Perishable Food	Perishable food refers to fresh fruit and vegetables that have a short shelf life and will decay quickly after processing. These foods typically require refrigeration or specialised packaging to extend shelf-life
Supply Chain Management (SCM)	Supply chain management is the network of organisations or individuals to coordinate and collaborate in the delivery of product or service to the end-customer through planning and management of all activities both physical and non-physical
Supply Chain Risk	Supply chain risks are events or disruptions that cause negative consequences to the actor-firms operating the perishable food (SCN). These may be frequent or may be abrupt with a small probability of occurrence (Tang & Musa, 2011; Tang, 2006)
Supply Chain Vulnerability	Supply chain vulnerability refers to a point of weakness and/or possible threat to the supply chain network. These inherent points of weakness may be known or unknown to actors (CIPS, 2013)
Supply Chain Resilience	The ability to proactively plan and design the supply chain network to anticipate 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 favourable than the one prior to the event, thus gaining competitive advantage (Ponis & Koronis, 2012)
Supply Chain Sustainability	The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, into account, which are derived from customer and stakeholder requirements (Seuring & Muller, 2008)
The Network theory	Competitive advantage can only be achieved through an efficiently and effectively orchestrated network of supply chains. Therefore, the focus of the network theory is to develop a long-term, trust-based relationship between supply chain firms in a supply network (Ketchen & Hult, 2007)

Supply chain collaboration	A long-term partnership process where supply chain partners with common goals work closely together to achieve mutual advantages that are greater than the firms would achieve individually (Cao & Zhang, 2011)
Information sharing	The extent to which a firm shares a variety of relevant, accurate, complete and confidential ideas, plans, and procedures with its supply chain partners in a timely manner (Cao & Zhang, 2011)
Goal congruence	The extent to which supply chain partners perceive their own objectives are satisfied by accomplishing the supply chain objectives
Incentive alignment	The process of sharing costs, risks, and benefits among supply chain partner (Cao & Zhang, 2011)
Resource sharing	The process of leveraging capabilities and assets and investing in capabilities and assets with a supply chain partner (Cao & Zhang, 2011)
Joint knowledge creation	The extent to which supply chain partners develop a better understanding of and response to the market and competitive environment by working together (Cao & Zhang, 2011)

CHAPTER 1: Thesis Introduction

1.0. Chapter Introduction

The purpose of this introduction is to explain the motivation for pursuing this study, its background, and future implications within the field of supply chain management (SCM). This chapter aims to demonstrate why the chosen area of focus is crucial for academics, industry practitioners and any other concerned stakeholders in SCM. Chapter 1 will present the research journey undertaken, which provides structural clarity for the logical approach and investigation strategies adopted in this thesis. Structurally, this study presents the research problem and questions, the scope of the study, the chosen methodology, and the research outcomes. The chapter provides a rational overview of the steps undertaken to address the identified research gaps. Essentially, every chapter in this study will begin with an introductory overview of the structure and critical areas of focus, leading to its overall contribution to the thesis.

1.1. Research Background and Motivations

The motivation to undertake this thesis emanates from an extensive background researching and working in the agricultural and food manufacturing (Agri-food) industry. My experiences allowed me to witness first-hand the various evolving risks and vulnerabilities perturbing 21st century food supply chains and consequently, the urgent need for resilient and sustainable solutions. For instance, I was a production manager in a major global meat firm when the horsemeat scandal occurred in 2013; this was one of the more significant motivations, which inspired me to undertake this thesis. The horsemeat crisis exposed how susceptible the global food industry had become to food fraud.

Consequently, the horsemeat scandal highlighted the transformation of food supply chains across Europe and naturally the globe to a higher degree of complexity, which created perplexing food safety and quality issues for actors. As global food supply chains evolve, there are subsequent increases to the levels of unknown risks and vulnerabilities that warrant further examination (Mangla, et al., 2018). This is evident from the considerable increase in research focusing on risk measurement and management in supply chains (Abdel-Basset, et al., 2019; Zsidisin & Henke, 2019; Diabat, et al., 2012; Ghadge, et al., 2012). Hence, my research motivations emanate from a deep passion for addressing supply chain challenges through building resilience and sustainability as a pragmatic solution.

Contemporary research points to several factors driving the importance of building resilience and sustainability into supply chains as an effective way of managing risk and vulnerabilities (Ansari & Kant, 2017; Brusset & Teller, 2017; Aitken, et al., 2016; Giannakis & Papadopoulos, 2016). Some of these factors identified by scholars include globalisation of markets (Wallace, et al., 2018), short product life cycles, increasing pressure for lean production (Prajogo, et al., 2016), strategic offshoring and outsourcing (Kim, et al., 2018) and advancement in technologies, e.g. information systems (IS) (Daneshvar Kakhki & Gargeya, 2019) and artificial intelligence (AI) (Baryannis, et al., 2019).

Furthermore, the increasing prevalence of natural disasters, accidents, terrorist attacks, and financial markets volatilities over the last decade have caused unprecedented disruptions and, in some cases, resulted in a prodigious amount of loss (Namdar, et al., 2018; Sodhi & Tang, 2012). Hence, supply chain resilience (SCRES) is emerging as an area of critical focus within the field of supply chain management (SCM) to address the mounting operational challenges (Machado, et al., 2018; Hohenstein, et al., 2015; Wieland & Wallenburg, 2013). Similarly, sustainable supply chain management (SSCM) which focuses on the economic, environmental and social aspects known as the triple bottom line (3BL/TBL) is proffered as a practical approach.

This approach manages supply chain vulnerability (SCV) and maintaining high levels of supply chain performance (SCP) over long-term periods (Konstantas, et al., 2019; Rohm & Aschemann-Witzel, 2019; Koberg & Longoni, 2018; Touboulic & Walker, 2015). This thesis aims to advance research in these crucial areas by investigating supply chain resilience and sustainability. The study is undertaken in the context of a perishable food supply chain network (SCN) to advance SCM theory and practice.

The chosen research topic is timely and relevant due to the increasing prevalence of supply chain disruptions, e.g. food fraud, natural disasters, accidents, food product recalls and financial markets volatilities, which over the last decade have caused substantial loses for businesses (Schmitt, et al., 2017; Tang, et al., 2012). For instance, KFC closed down three-quarters of its United Kingdom (UK) outlets in 2018 due to a massive supply chain disruption (Priday, 2018). The disruption was traced to its new logistics partner DHL that was hampered by a major accident blocking their single functional warehouse in the Midlands. More detrimental to the crisis, KFC and DHL, which contracted information systems (IS) firm Quick Service Logistics (QSL), did not have a viable contingency plan as a resilient measure (Priday, 2018). Contingency planning is considered an essential step in achieving SCRES (Lam & Bai, 2016).

Apart from the loss of revenue, KFC had to discard a huge amount of raw chicken due to its perishability thereby creating huge food waste, which is detrimental to the environment and is socially unacceptable (Priday, 2018). The incident reflects risks on the TBL principles with, economic loss, environmental damage due to food waste and social degradation by discarding a vast amount of food in a world plagued by many hungry and undernourished people. This highlights the importance of SCRES in today's perishable food supply chains. To mitigate supply chain risk (SCR) effectively, various scholars have put resilience in all its facets forward as a viable solution (Pettit, et al., 2019; Leat & Revoredo-Giha, 2013; Wieland & Wallenburg, 2013).

21st century supply chains are fraught with many operational difficulties arising from the ever-changing business landscape (Giannakis & Papadopoulos, 2016; Wieland, et al., 2016). However, food supply chains struggle with unique challenges that require special attention due to their differing characteristics from other supply chains (Aggarwal & Srivastava, 2016). These different characteristics include short shelf-life (perishable) products, stringent requirements of food product safety and quality standards and high susceptibility to environmental conditions (Siddh, et al., 2017; Siddh, et al., 2015). Moreover, food supply chains (FSC) are susceptible to various disruptions caused by sudden shocks, e.g. flash-flooding, crop or animal disease and food safety risks, e.g. bacterial or viral contamination (Nerín, et al., 2016; Tendall, et al., 2015). Thus, the food-manufacturing sector is unique due to the high number of perishable products that constitute its supply chain operations. These are often referred to as fast-moving consumer goods (FMCG), which create an unparalleled level of dynamism and complexity along the supply chain (Siddh, et al., 2015).

These complexities make perishable food SCNs prone to cascading effects, which propagate risks throughout the supply chain due to the interconnectedness and at times, intertwinement of firms operating in the food industry (Wu & Huang, 2018; Ojha, et al., 2018). Thus, the primary motivation of this thesis is to contribute towards building resilient and sustainable perishable food supply chains with the highest levels of food safety and quality. This goal will be achieved by proffering propositions to build resilience and sustainability into food supply chain networks (FSCN). It is critical to highlight that as global supply chains continually metamorphose, they create new degrees of complexity for the food industry (Govindan, 2018). Hence, this thesis will apply network theory to explore how actor-firms can build resilience and sustainability in an SCN. The study investigates how actors can effectively build resilient and sustainable supply chain practices to address prevailing risks and vulnerabilities in perishable food SCNs. Accordingly, an examination of two critical areas of supply chain management (SCM) namely (i) resilience and (ii) sustainability is undertaken. Figure 1 illustrates the two distinct but complementary areas of critical examination in this study.

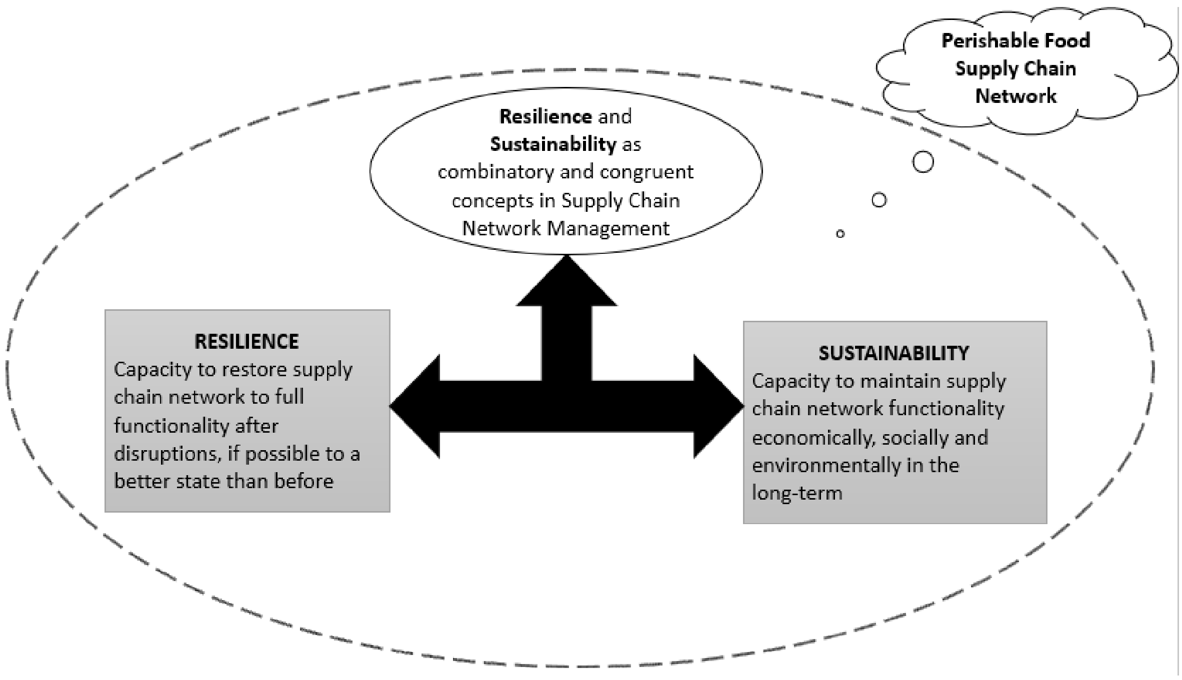


Figure 1: The key areas of research focus

Figure 1 illustrates two distinct but critical key areas of this study, whose combinatory application is vital in attaining effective perishable food SCN management. While these critical areas have been extensively investigated separately, very little research examines the combinatory impact of these concepts on SCM. Despite a myriad of research into these concepts, their interplay has been seldom explored (Ivanov, 2018).

Moreover, the trade-offs required to implement these strategies remain underplayed (Xiao, et al., 2019). Additionally, there is limited empirical research that explores resilience and sustainability from a supply chain network theory perspective (SCNT). Research in this area is primarily dominated by studies that focus on dyadic, triadic and linear supply chains while negating supply chain networks (SCN) (Blackhurst, et al., 2018). To address these issues, the fulcrum of this study is to make a significant contribution towards building practical resilience and sustainability knowledge in SCM.

1.2. Study Context – Perishable Food SCN (USA)

The context of this investigation is a perishable food SCN based in the United States of America (USA), which will be referred to as the US. While the identified research gaps were drawn from various industry supply chains, it is worth noting that supply chains are highly contextualised (Brusset & Teller, 2017; Lam & Bai, 2016). Therefore, analysis of a specific industry allows for an in-depth exploration of the phenomenon in its real-life setting (Yin, 2014). Food manufacturing is one of the largest global enterprises, contributing immensely to the gross domestic product (GDP) of many countries (Mattevi & Jones, 2016). In the US, the agriculture and food industry generated sales and revenue worth approximately US$ 5.75 trillion in 2017, thus, contributing $1.053 trillion to US gross domestic product (GDP), a sizable 5.4-per cent share (USDA, 2019). The US food supply chain as of 2017 employed approximately 21.7 million full and part-time employees; thus, accounting for over 10% of the total labour market (USDA, 2019).

This thesis focuses on the Agri-food SCN because it is idiosyncratic and differs from other supply networks due to several factors. The purpose is to address the risks of effectively managing FMCG operations, which are unique and have different challenges in comparison to other supply chains. The following identified factors typify the uniqueness of food supply chains and justify its selection as the study context (Diabat, et al., 2019; Ghadge, et al., 2019; Ali, et al., 2017; Iakovou, et al., 2016; Diabat, et al., 2012; Van der Vorst, et al., 2007):

1. Food supply chains are highly susceptible to climate change risks which cascade throughout the SCN
2. Globalisation generates long food SCNs that increase the complexity and dynamism of business operations.
3. Perishable foods are characterised by short product life cycles (7 – 10 days)
4. Food supply chains have high product differentiation.
5. Products are seasonal, meaning production and operations change frequently
6. High variability between suppliers supplying the same product due to differences in geographic location or farming practices.

7. Different products require different processes regarding, transportation, storage, processing, quality, and safety, e.g. tomatoes and pineapples require different processing and storage operations.
8. High requirements for product traceability and visibility along the supply chain.
9. Food production and processing is highly labour – intensive and relies heavily on expensive technical equipment.
10. Stringent laws and regulations at both national and international levels regarding, food exports/imports, public health, food quality and safety.
11. External pressures from stakeholders for instance, public consumers or activists demanding farmers or food firms change their operational behaviour, waste processing, genetically modified foods (GMOs), farming practices etc.
12. Presence of significant capacity constraints, e.g. land availability, water etc.

The twelve distinctive characteristics listed elucidate how unique and different FSC are in comparison to other sector supply chains. This justifies the study context and accentuates the need for more research in this critical area. For instance, in the European Union (EU), food is the largest manufacturing sector. Evidence drawn from member-states data shows the importance of this research area; for instance, in the UK; food manufacturing is the largest industry (FDF, 2017). The UK food and drink-manufacturing sector employs approximately 400 thousand people directly while indirectly employing over 4 million people throughout the EU. The food industry generates over £100 billion annually towards the UK economy (FDF, 2017).

These statistics mean the food industry is larger than the automotive and aerospace sectors combined. It contributes 19% of the total manufacturing output in the UK. Due to the dynamic nature of food manufacturing; food suppliers, manufacturers, and retailers are continuously under pressure to improve the quality, safety and timely delivery of products in the right quantity (Mattevi & Jones, 2016; Li, et al., 2014). The complex and dynamic nature of food networks require further research (Gadde & Amani, 2016) hence; this study aims to fulfil this gap.

Van der Vorst *et al.* (2007, p. 15) concluded that supply chains are part of complex networks, implying that analysis of these phenomena "*should ideally take place [...] within the context of a food supply chain network"* thus, this study will employ a cross-sectional embedded case study. The US agriculture and food industry is one of the largest and most advanced food SCNs in the world. Figure 2 depicts the contribution of the food industry to the US economy accounting for 5.4% of GDP. Drawing on data from the United States Department of Agriculture (USDA), Figure 2 illustrates the growth of the different US food sectors that make up the food industry. When viewing the diagram below, attention should be paid to the farms (green in colour), food manufacturing (yellow) and retail sector (blue). This is critical as the perishable food SCN under investigation draws data from actor-firms in these tiers.

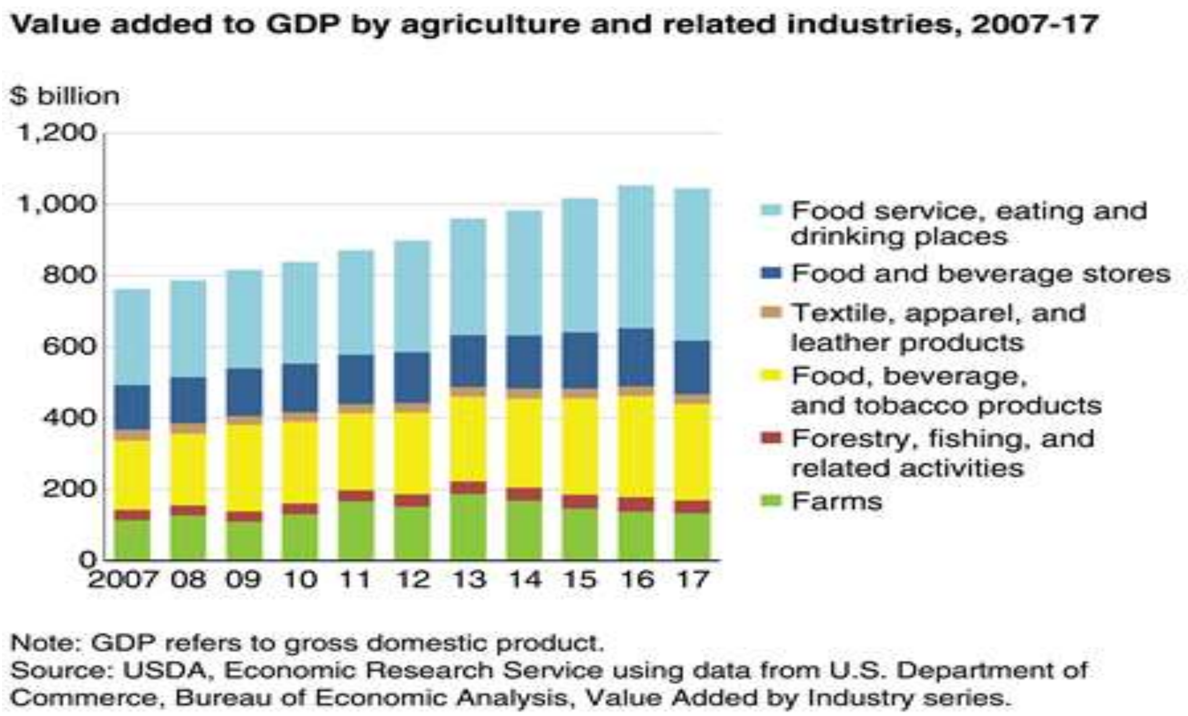


Figure 2: Contribution of Food Industry to US GDP from 2007 – 2017

Figure 2 illustrates the growth and contribution of the food industry to the US economy. The US has one of the most advanced and globally connected food industries in the world, which make it ideal for drawing data to fulfil the purpose of this study.

1.3. Research Problem, Objectives and Questions

Despite a significant rise in research focusing on SCRES and SSCM in the last two decades, it still lacks integration and the combinatory effect of these two concepts on SCNs is still underexplored (Ivanov, 2018; Papadopoulos, et al., 2017; Fahimnia & Jabbarzadeh., 2016). While several studies have investigated other related combinatory concepts, e.g. risk and resilience (Brusset & Teller, 2017; Leat & Revoredo-Giha, 2013), SCRES and SSCM are still viewed as separate concepts (Ivanov, 2018). There is still ambiguity on the connection and interplay of these two key areas in addressing supply chain challenges (Jabbarzadeh, et al., 2018).

Moreover, there is inadequate empirical research focusing on SCRES and SSCM from a network perspective (Wang, et al., 2018; Iakovou, et al., 2016). Most research focuses on dyad and triad supply chain relationships (Stone & Rahimifard, 2018; Chicksand, et al., 2012). Therefore, solutions drawn from linear supply chain analysis may be inadequate to address SCN risks and vulnerabilities. Data released from the Chartered Institute of Procurement & Supply (CIPS) shows that global supply chain risk is at the highest level in 24 years (Buist, 2017). The measure used by CIPS derives from an index score that calculates risks based on, socio-economic, physical trade and business continuity factors. These are weighted against a region's contribution to global exports (CIPS, 2017).

The measure scored global supply chain risk at 82.64 out of a score of 100. This dire view of the current state of affairs is further supported by the Business Continuity Institute (BCI), which released its report in November 2016, focusing on global supply chain resilience. The report's evidence is based on a survey of firms based in 64 countries on all continents; the majority of respondents were from Europe and North America, which made up 70% of study participants (BCI, 2016). The results of the survey show the impact of disruption to businesses.

Table 1 presents some of the notable disruptions and their impact on resilience capabilities.

Table 1: Survey of global firms' Supply Chain resilience

Global Resilience Issues	*2015*	*2016*
Loss of productivity	58%	68%
Increased cost of working	39%	53%
Damage to brand or reputation	27%	38%
Disruptions emanating from immediate supplier	50%	41%
Single supply chain incidents costing firms over £1 million	9%	9%
Management engagement in Resilience	33%	27%

Source: BCI (2016)

As Table 1 shows, the loss of productivity emanating from supply chains, lacking adequate resilience to risks and vulnerabilities has increased year on year from 58% in 2015 to 68% in 2016 (BCI, 2016). This ultimately affects the cost of working as staff work overtime to rectify the arising issues; hence, the increase from 39% to 53%. While the level of supply chain resilience has decreased and risk has increased, it is important to note that the source of these disruptions from immediate suppliers is decreasing. Therefore, the researcher postulates that firms are increasingly operating from a network perspective; hence, the decrease in the source of disruption emanating from an immediate supplier. This justifies the importance of this thesis to research from a network perspective to examine these phenomena. Concerning sustainability, the Carbon Disclosure Project (CDP) released its global supply chain report focusing on sustainability. It derived information from 89 of its members including companies such as, Bank of America, Wal-Mart Stores, Inc., PepsiCo, Inc., The Coca-Cola Company, who have a combined annual procurement spend on approximately US$2.7 trillion (CDP, 2017). These 89 members leveraged their suppliers totalling 8,200 firms, thus obtaining information for the report. One significant finding of the report was its suggestion that supply chain sustainability could improve through collaboration (CDP, 2017).

However, the report shows that only 22% of surveyed companies were effectively collaborating with their suppliers on sustainable issues. So, why are so few companies collaborating? What are the drivers and barriers? These are some of the issues arising, and this thesis aims to make a knowledge increment in the research area of SSCM in supply chain networks. Accordingly, the primary purpose of this thesis is to explore the implications for academia and practitioners on how firms within a perishable food supply chain network (PFSCN) can attain resilience and sustainability.

The following objectives will be addressed to fulfil the research purpose:

1) Examine the current state of supply chain resilience (SCRES) practices within perishable food SCNs
2) Investigate the current state of sustainable practices in perishable food SCNs
3) Proffer practical propositions on how to effectively build and/or enhance resilience and sustainability in perishable food SCNs
4) Create pertinent avenues for future research on SCRES and SSCM within SCNs

This study investigates and answers two complementary and relevant research questions and their accompanying sub-questions.

1. **How can perishable food supply chain networks build and sustain resilience?**

a. What resilience practices do actors operating in a perishable food supply chain network adopt to mitigate risks and manage vulnerabilities?

b. How can these practices be enhanced to build and sustain resilience?

2. **How can actor-firms in a perishable food supply chain network build sustainability**?

a. What are the current issues perturbing actor-firms' capability to build sustainability in perishable food supply chain networks?

b. How can actors effectively build and continually enhance supply chain network sustainability?

Perishable food supply chains are complex and dynamic, and the issues perturbing these networks are highly contextualised (Rohm & Aschemann-Witzel, 2019; Siddh, et al., 2017; Bowman, 2015). Therefore, building resilience and sustainability requires an analysis of how food firms can prepare, resist and rebound from disruptions in a complex and dynamic business environment (Ali, et al., 2018). Furthermore, food SCNs must be able to maintain TBL functionality over the most prolonged period possible. This study aims to address the lack of research exploring the interplay between resilience and sustainability. The study draws on the tenets of supply chain network theory (SCNT) to investigate how firms operating in an SCN can build and sustain resilience and sustainability.

1.4. Research Methodology

This study applies a cross-sectional qualitative study of a perishable food SCN based in the US. A cross-sectional study is critical in enabling the investigation of all the supply chain issues identified in the study questions. Furthermore, this approach is effective at studying multiple outcomes and exposures (Bryman, 2016). This will allow a rich description of the prevailing circumstances and facilitate the robust generation of propositions that can easily be converted to hypothesis for further studying. The researcher adopts a subjective positioning, which views knowledge and reality as culturally situated and highly correlated to a context, time, place and people/individuals (Cunliffe, 2011). Therefore, this study accepts that perishable food SCNs are highly-contextualised (Brusset & Teller, 2017) and differ from other SCNs in relation to, culture, context, time, place and people/individuals (Cunliffe & Locke, 2016).

Subjectivism postulates that both researcher and object co-create knowledge (Ratner, 2002). This means subjectivism is *“double hermeneutic”* implying the researcher embedded in the world, is both shaped by and shapes experiences and accounts of actors during the study (Cunliffe, 2011). This affords the researcher a genuine ability to mediate the meanings of actors. Philosophically, a pragmatist approach is adopted due to its characteristics as both a lived and living philosophy (Elkjaer & Simpson, 2011).

Pragmatism does not commit to any one system of philosophy or reality; instead, it focuses on the 'what' and 'how' of research questions (Goldkuhl', 2012). Pragmatism is an appropriate philosophy as this research attempts to answer the 'what' and 'how' of resilience and sustainable issues in perishable food SCNs. As a pragmatist, I accept that there is a reality somewhere out there; however, it is ever changing, due to the actions taken by actors in the supply chain. Data for this empirical study were collected using various methods whose evidences were triangulated during analysis. The following data collection methods were undertaken:

- Forty semi-structured interviews from participants representing all selected actor-firms operating in the perishable food SCN under investigation.
- Direct observations of supply chain operations, e.g. fruit and vegetable processing, receiving and dispatching of food products, food safety and quality inspections etc.
- Photographs (only when actors granted permission) as per University of Bradford ethics guidelines.
- Non-confidential company documents, e.g. annual reports, standard operations procedures (SOP), food provenance documentation, food safety and quality inspection paperwork etc.

This multi-method data collection approach allows for methodological triangulation, which enriches the research outputs and minimises bias (Saunders, et al., 2016; Kennedy, 2009). The first level of data analysis is conducted in Chapter 4, followed by the second level in Chapter 5. Chapter 6 compiles the findings to generate four practical propositions for both academia and actors operating in perishable food SCNs. Chapter 7 concludes the thesis, providing insightful remarks and outlining the limitations of the study and future research avenues.

1.5. Contributions of Thesis

This study makes crucial contributions to both theory and practice within the field of SCM.

i. First, this study provides pertinent insights into current supply chain resilience and sustainable practices employed by actor-firms operating in the perishable food industry.
ii. Second, this study provides insights into the current risks and vulnerabilities perturbing perishable food supply chain networks
iii. Third, the research draws out four distinct but intertwined main categories; whose subtle and often unacknowledged interplay is crucial in attaining SCN resilience and sustainability. These main categories are Collaboration, Power Dynamics, SCN Culture and Information Systems (IS).
iv. Fourth, a Resilience and Sustainable (RS Matrix) for Supply Chain Network Management is developed. The RS Matrix is a significant contribution to both theory and practice.
v. Fifth, this study advances the use of a combination of theoretical concepts and contributes towards critical factors that are necessary to build a resilient and sustainable SCN.
vi. The study provides pragmatic propositions for food industry practitioners regarding building and sustaining resilience and sustainability
vii. Finally, the research points out future research avenues for academics in relation to SCRES and SSCM in SCNs.

The findings are critical in uncovering intangible and often unacknowledged antecedents and salient sustaining factors of effective SCN collaboration essential in the building of SCN resilience and sustainability. Accordingly, this thesis' contributions are sufficient to inspire further research and provide valuable and sincere insights to academics and industry practitioners.

1.6. Thesis structure

This section provides a brief overview of the thesis structure, which outlines a synopsis of all the chapters.

Chapter 1 presents the thesis introduction, comprising of the research journey undertaken in the study. This aims to provide structural clarity, justifying the logical approach and research direction used in this thesis. This includes the presentation of the research problem and questions, the context of the study, chosen methodology, and the research outcomes obtained. Hence, it provides an overview of the logical steps undertaken in the thesis to address the stated research questions.

Chapter 2 conducts an extensive and rigorous critical review of the published literature. The main aim of Chapter 2 is to examine critical areas of resilience and sustainability within the field of SCM and to identify crucial issues that need urgent attention. The study undertakes a thematic literature review. Thematic reviews of the literature are organised and focused around the topic or theme under investigation as opposed to chronological order. Hence, this approach is selected as the most appropriate to identify pertinent research gaps for this study.

Chapter 3 elucidates the philosophical positioning of the researcher and justifies the methodological approach undertaken in this thesis to answer the research questions. Chapter 3 provides justification for the adoption of a qualitative cross-sectional study, undertaken from a pragmatic philosophical positioning. This chapter maps out the processes and procedures applied to ensure high quality and trustworthiness of the study in fulfilling the primary research purpose.

Chapter 4 conducts the first of a three-phase data analysis process to answer the research questions. This first stage will include the coding processes and the application of Nicolini's ZIZO approach to analyse actors' response.

Structurally, a content analysis process is followed. Chapter 4 will thus configure the perishable food SCN under investigation to facilitate a coherent second stage analytical process. This chapter will apply within-and across-case analytic techniques to answer sub-questions from research questions 1 & 2.

Chapter 5 draws on the main findings from Chapter 4 and further examines them in a second data analysis phase. Using across-case analysis, this chapter also discusses the four main categories identified in Chapter 4. In Chapter 5, a breakdown of how the determined four main categories can enhance resilience and sustainability in perishable food SCN is undertaken. This process draws on the existing literature to position the study and draw out contributions to the field of SCM.

Chapter 6 compiles the findings and analysis undertaken to develop sincere, credible and meaningfully coherent propositions that are rich in rigour and qualitative resonance. Thus, the study makes significant contributions to the body of SCM research by advancing knowledge in building resilient and sustainable SCNs. Chapter 6 generates propositions underpinned by in-depth discussions, which draw on the tenets of supply chain network theory, pragmatism and current SCM discourse.

Chapter 7 provides the thesis concluding remarks, research limitations and pertinent avenues for future research generated from this study.

CHAPTER 2: Literature Review

2.0. Chapter Introduction

Chapter 2 critically evaluates key published literature with a primary focus on resilience and sustainability. The main aim is to situate this thesis' research focus in the context of the wider SCM field. Structurally, the critical review will be undertaken thematically. Thus, it will follow a thematic inverted pyramid approach beginning with a broad overview of the provenance and current state-of-the-art literature in SCM. Chapter 2 undertakes a critical review of the following key themes (i) SCM with a focus on supply chain risk and vulnerability, (ii) supply chain resilience and (iii) supply chain sustainability (see Figure 3). Thus, the focus will be twofold, first, to provide a structured background on key developments in SCM and second, to conduct a critical review that identifies the most relevant areas of SCRES and SSCM. The identified key issues will be examined in separate sections and collated using an inverted pyramid system cumulating to the justification of the research focus. Figure 3 depicts the inverted pyramid approach undertaken in this thematic critical review to identify the research gaps.

Figure 3: Overview of Literature Review Chapter

Rudestam and Newton (1992, p.49) eloquently explain the main aim of a literature review. They state it is to *"build an argument, not a library".*

2.1. Supply Chain Management (SCM) Topography

The supply chain topography continues to evolve, driven by various ever-changing factors (Min, et al., 2019; Wieland, et al., 2016). The diverse drivers fuelling SCM evolution include but are not limited to, new complexities, market trends, technological advances, and globalisation of business operations (Hugos, 2018). Furthermore, changes to organisations' sizes, shapes and supply chain configurations ultimately affect supply chain operations, relationships, management strategies and practices (Cousins, et al., 2019; MacCarthy, et al., 2016). SCM scholars encounter a plethora of confusing research questions; the majority of these are dependent and overlap in scope (Wieland, et al., 2016).

This section aims to evaluate the field of SCM and justify the selection of SCRES and SSCM as crucial research topics requiring further examination. Scholars often view SCM as an expanding field; hence, it is somewhat awash with an overindulgence of predictions and forecasts about various issues including technological advancements and management changes (Wieland, et al., 2016; Economist Intelligence Unit, 2013; Melnyk, et al., 2009). SCM's provenance dates to the early 1980s (Carter, et al., 2015), It was put forward as a concept by Booz Allen consultants (Oliver & Webber, 1982).

Further research and developments of SCM following its conceptualisation enabled the evolution of a more unified field (Ellram & Cooper, 1990; Jones & Riley, 1987). Early researchers in the field began to connect all the elements of SCM namely, procurement, operations and distribution to create a consolidated and coherent mapping of the field (Ellram & Cooper, 1990; Jones & Riley, 1987). As SCM research matured, theories were developed; however, the majority were adaptations from other fields (Ketchen & Hult, 2007). Therefore, a gap remains in the development of supply chain specific theories (Gligor, et al., 2019). However, there remains ambiguity with some scholars arguing SCM cannot be classified as a field (Chicksand, et al., 2012). Thus, Chicksand et al., (2012) draw on Fabia's explanations of what constitutes a 'discipline' and conclude that SCM is not yet a discipline. They reach this conclusion based on the following factors,

- *"Lack of coherence: The field has not yet developed a rich and robust theoretical grounding.*
- *Breadth and depth are lacking, as evidenced by the low level of inductive research.*
- *Quality is lacking as evidenced by the lack of "clear research norms",* (Chicksand et al., 2012, p. 468).

Thus, drawing on these conclusions reached by Chicksand et al., (2012), this thesis aims to contribute towards the advancement of SCM in the areas of supply chain resilience and sustainability. As SCM continues to evolve (Avittathur & Jayaram, 2016), researchers need to contribute towards coherence of the field and development of a paradigm (Chicksand, et al., 2012). To summarise the background review, SCM is a contemporary field that is evolving (Wieland & Wallenburg, 2013; Chicksand, et al., 2012). Therefore, further research is crucial to its advancement.

2.1.1. Constructing a Supply Chain Definition

Research into SCM thus far has yielded different definitions to contextualise the field (Min, et al., 2019; CSCMP, 2019; LeMay, et al., 2017; Croom, et al., 2000). This has led to many researchers approaching the field from various angles to define and map it (Fan & Stevenson, 2018; LeMay, et al., 2017; CIPS, 2013). Due to the variegated approaches employed by academics and practitioners alike, a critical analysis of the topology indicates conflict on what constitutes the field with various researches producing an abundance of terminologies focusing on different aspects which often have protruding meanings (Fan & Stevenson, 2018; LeMay, et al., 2017).

Furthermore, Carter, et al., (2015) in an attempt to move the field towards a theory, provide vital characteristics of supply chains. First, they argue the supply chain is broadly a network and therefore, scholars should move away from the dyadic and triadic research approach. Instead, they claim the supply chain is a network, consisting of nodes and links. This study agrees with this analogy; hence, the thesis aims to investigate perishable food supply chains from a network perspective. Carter et al., (2015) also point out the supply chain as a network operates as a complex adaptive system (CAS) which means it is self-organising and actors have control over their sphere of influence, e.g. resources. However, power and emergence are difficult due to high degrees of complexity and dynamism.

Furthermore, the supply chain is relative to a particular product and agent; this is akin to Brusset & Teller, (2017) analysis that states that supply chains are highly contextualised. Hence, this study identifies the uniqueness of perishable food supply chains and the importance of yielding new insights into the field of SCM. Carter et al., (2015) focus on the components of the supply chain by arguing it consists of both a physical and a support supply chain. Thus, they include other often-neglected areas like information systems (IS) as critical, non-physical components of the supply chain. A crucial point is also the limitation of supply chain actors to see beyond their horizon (Carter, et al., 2015). This horizon can constitute physical distance, cultural distance, and closeness centrality. Table 2 shows some of the key definitions which were used in the construction of a supply chain definition for this thesis.

For this thesis, an all-encompassing definition, which provides a holistic perspective of the supply chain be, constructed drawing on various studies (LeMay, et al., 2017; Carter, et al., 2015; Christopher, 1998; Lambert, 1992; Lee & Billington, 1992; Ellram, 1991). Therefore, this thesis defines a supply chain as follows:

Supply chain management is the network of organisations or individuals to coordinate and collaborate in the delivery of product or service to the end-customer through planning and management of all activities, both physical and non-physical.

Table 2: Key Supply Chain Definitions

AUTHORS	**DEFINITIONS**
LeMay *et al* (2017)	"Supply chain management is the design and coordination of a network through which organizations and individuals get, use, deliver, and dispose of material goods; acquire and distribute services; and make their offerings available to markets, customers, and clients".
Canadian Supply Chain Sector Council (2017)	"Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. Supply chain management integrates supply and demand management within and across companies".
Stadtler (2015)	"A supply chain is the network of all the individuals, organizations, resources, activities, and technology involved in the creation and sale of a product, from the delivery of source materials from the supplier to the manufacturer, through to its eventual delivery to the end user. Supply chain management (SCM) is the oversight of materials, information, and finances as they move in a process from supplier to manufacturer to wholesaler to retailer to consumer".
CIPS Australasia (2013)	"The supply chain conceptually covers the entire physical process from obtaining the raw materials through all process steps until the finished product reaches the end consumer. Most supply chains consist of many separate companies, each linked by virtue of their part in satisfying the specific need of the end consumer".
Tan *et al* (1998)	"Supply chain management encompasses materials/supply management from the supply of basic raw materials to the final product (and possible recycling and reuse). Supply chain management focuses on how firms utilise their suppliers' processes, technology, and capability to enhance competitive advantage. It is a management philosophy that extends traditional intra-enterprise activities by bringing trading partners together with the common goal of optimisation and efficiency".
Berry *et al* (1994)	"Supply chain management aims at building trust, exchanging information on market needs, developing new products, and reducing the supplier base to a particular OEM (original equipment manufacturer) so as to release management resources for developing meaningful, long term relationship".
Jones & Riley (1985)	"An integrative approach to dealing with the planning and control of the materials flow from suppliers to end-users".
Ellram (1991)	"A network of firms interacting to deliver product or service to the end customer, linking flows from raw material supply to final delivery"
Christopher (1992, 1998)	"The network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer"
Lee and Billington (1992)	"Networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products, and distribute the finished products to customers".
Kopczak (1997)	"The set of entities, including suppliers, logistics services providers, manufacturers, distributors, and resellers, through which materials, products, and information flow".
Lee and Ng (1997)	"A network of entities that starts with the suppliers' supplier and ends with the customers' custom the production and delivery of goods and services".

There are still vital areas within the SCM discipline that remain underdeveloped (Kurniawan, et al., 2017). Christopher & Holweg (2011) argue current supply chain models have attempted to address challenges from a stable, undisturbed perspective and therefore, are not fully equipped to deal with periods of turbulence. To better mitigate the risks and vulnerabilities associated with complex supply chains, it is vital that research progress from both an endogenous (internal – firm perspective) and exogenous (external environment) (Christopher & Holweg, 2011). The exploration of sustainability (Giannakis & Papadopoulos, 2016; Touboulic & Walker, 2015; Seuring & Müller, 2008) and resilience (Kochan & Nowicki, 2018; Melnyk, et al., 2016; Pettit, et al., 2013) are gaining increasing recognition as an effective way to address better the challenges emanating from a continually evolving global supply chain. Supply chain practitioners acknowledge that most activities bare an inherent risk that an unexpected disruption can occur (Fahimnia, et al., 2018; Ponis & Koronis, 2012; Ponomarov & Holcomb, 2009).

A myriad of reasons makes organisations more cognizant of the operational and fiscal impact of unmitigated risks (Swanson, et al., 2018). Some research advocates for the reduction of risk by designing supply chains/networks to integrate capabilities that allow readiness to ensure an efficient and effective response to any negative impacts thereby allowing recovery that restores the original state or an even better state (Ponomarov & Holcomb, 2009). According to scholars, this is the essence of supply chain resilience (Ponomarov & Holcomb, 2009; Ambulkar, et al., 2015; Brusset & Teller, 2017).

Wieland et al., (2016) use Meyer & Booker (1991)'s model of soliciting researchers to conduct a study. This model is effective in providing current insights as well as identifying expert opinion on future directions. The study analysed current literature, which was done in three phases, and interviewed 141 leading academics who published in *Journal of Business Logistics*, *Journal of Operations Management*, *Journal of Supply Chain Management*, and *Production and Operations Management* (Wieland, et al., 2016). The study found potentially under and over-researched themes in SCM.

Table 3 shows the areas of focus in this thesis is justified by the positive score attributed to concepts within SCRES and SSCM, e.g. resilience, co-operation, complexity, volatility/turbulence, sustainability, disruption, networks, etc. Table 3 shows the results obtained from Wieland, et al., (2016) justify the relevance of SCRES and SSCM as pertinent research topics.

Table 3: Scholars' perceptions of key SCM research areas

RANK	RESEARCH THEME	DIFFERENCE
1	People dimension of SCM	0.65
2	Ethical issues	0.63
3	Integration (internally between departments)	0.44
4	Transparency/visibility	0.39
5	Human capital/talent management	0.30
6	Coopetition	0.30
7	Humanitarian issues	0.29
8	Reverse logistics	0.27
9	Behavioural issues	0.25
10	City logistics	0.24
11	Complexity	0.23
12	Volatility/turbulence	0.22
13	Sustainability (ecological, economic, ethical, social)	0.22
14	Disaster relief/emergency management	0.20
15	Innovation	0.18
16	Resilience	0.18
17	Environmental/green issues	0.17
18	Disruption	0.17
19	Coordination	0.12
20	Integration (externally between firms)	0.10
21	International/global issues	0.10
22	Multitier management	0.09
23	Health care	0.09
24	Real-time information	0.08
25	Networks	0.06
26	Back-sourcing/in-sourcing	0.05
27	Servitization/services	0.03
28	Finance	0.03
29	Risk management	0.03
30	Emerging markets	0.02
31	Information security	-0.03
32	Reshoring/back-shoring	-0.04
33	IT/digitalization	-0.08
34	Analytics	-0.34
35	Big data	-0.69

Source: (Wieland, et al., 2016)

The findings highlight the themes academics believe will be critical areas of research in the near future. The results with a positive score are those areas scholars believe should become important and felt research in these areas was potentially underestimated. The themes with negative scores are the areas scholars believe have been likely overestimated. Drawing from Table 3, this thesis will focus on two key themes resilience and sustainability. However, it is essential to note that effectively researching SCRES and SSCM requires a grounded understanding of the prevailing risks and vulnerabilities of the supply chain under observation. Consequently, this literature review will critically analyse the concepts of '*risk' and 'vulnerability'* (Kremer, et al., 2016; Zepeda, et al., 2016; CIPS, 2017), *'resilience'* (Ambulkar, et al., 2015; Liu, et al., 2016) and '*sustainability'* (Carter & Easton, 2011; Touboulic & Walker, 2015; Ansari & Kant, 2017) to effectively achieve the study purpose.

2.2. Supply Chain Risk and Vulnerability

Over the last couple of decades, many businesses have suffered severe disruptions, which have borne operational chaos and production losses (Ho, et al., 2015). In this context, disruptions will be defined as major breakdowns in the production or distribution nodes that comprise a supply chain/network (Handfield, et al., 2011). These may include events such as fire, machine breakdowns, an unexpected surge in demand that creates bottlenecks, quality problems, natural disasters, customs delays, or any other number of different problems (Scheibe & Blackhurst, 2018; Chopra & Sodhi, 2014). These disruptions, at times referred to in the literature as ruptures and interruptions (de Oliveira, et al., 2017) arise from a variety of factors. These factors can either be endogenous or exogenous. Equally, there could be expected risks and vulnerabilities (known) or emerging (unknown/unexpected); both require further attention from scholars and practitioners (Tate, et al., 2019).

2.2.1. Defining Supply Chain Vulnerability (SCV)

First, it is important to define 'vulnerability'. Table 4 lists some of the more prominent definitions used to describe vulnerability within SCM over the last three decades. There are several definitions of supply chain vulnerability (SCV), most of them have similar themes, which have a multidisciplinary approach and are influenced by certain characteristics, e.g. supply chain design variables (Nowakowski, et al., 2015). Table 4 lists a variety of definitions widely used in SCV literature. However, for this thesis, the definition proposed by the Chartered Institute of Procurement and Supply (CIPS) on vulnerability, as stated in Table 4 will be applied. Thus, this thesis will define SCV as *"a point of weakness and/or possible threat to the supply chain network".* As supply chains have become more complex and have evolved into networks (Carter, et al., 2015; Christopher, 1998) so have the number of potential weaknesses throughout the entire network (CIPS, 2013). CIPS argue that vulnerability precedes risk (CIPS, 2013), to this endeavour they provide a practical example of when a 'point of weakness' (vulnerability) becomes a serious risk.

Table 4: Definitions of Supply Chain Vulnerability

AUTHOR (S)	DEFINITIONS
Albino & Garavelli (1995)	*"aimed to estimate the system sensitivity to changes, in terms of damages to performance due to the intrinsic system incapacity of reaction to unexpected events"*
Christopher & Peck (2004)	*"an exposure to serious disturbance, arising from risks within the supply chain as well as risks external to the supply chain"*
Juttner *et al* (2003)	*"the propensity of risk sources and risk drivers to outweigh risk mitigating strategies, thus causing adverse supply chain consequences"*
Svensson (2002)	*"Condition that is caused by time and relationship dependencies in a company's business activities in supply chains. The degree of vulnerability may be interpreted as proportional to the degree of time and relationship dependencies and the negative consequence of these dependencies, in a company's business activities towards suppliers and customers"*
Wagner & Neshat (2012)	*"is a function of certain supply chain characteristics and that the loss a firm incurs as a result of its supply chain vulnerability to a given supply chain disruption"*
CIPS (2013)	*"is a point of weakness and/or possible threat to the supply chain network"*

The example states: one can imagine a vehicle with low-grip tyres travelling on the motorway at 70 miles per hour. In this instance, the low-grip tyres are a point of weakness. However, the tyres become a serious risk if it suddenly begins to rain and the vehicle must apply emergency braking to avoid traffic congestion. In this case, the car will be incapable of stopping in time, and consequently, a collision would occur with possibly fatal consequences (CIPS, 2013). Thus, the low grip tyres represent a vulnerability in terms of car driving safety; however, the introduction of rain into the process converts the vulnerability into a risk. It is important to note that the above example is an oversimplified attempt of explaining vulnerability. It ignores many factors, e.g. if they are other cars in the vicinity, and it does not account for the fact that just because something is possible, does not make it probable. However, it is crucial to provide an example to allow a visual explanation, simple as it may be, to explain a rather complex phenomenon. Research in SCV has been gaining ground amongst both practitioners and scholars (Wagner & Neshat, 2012; Asbjornslett, 2009; Wagner & Bode, 2006).

Hence, at the turn of the century, in recognition of research deficits in understanding vulnerability within supply chains, four United Kingdom (UK) government departments commissioned a study from Cranfield University's School of Management (Cranfield University, 2002).

The Cranfield study produced four key findings:

1) *Supply chain vulnerability is a critical business issue.*
2) *There is little research thus far into supply chain vulnerabilities.*
3) *Awareness of the subject is sparse.*
4) *There is a need for a methodology for managing supply chain vulnerability.*

(Cranfield University, 2002)

Almost two decades after the Cranfield study, SCV is still a critical evolving research area especially from an SCN perspective (Blackhurst, et al., 2018; Kurniawan, et al., 2017) and the food supply chain context (Van Ruth, et al., 2018). Hence, Peck (2007) corroborates Cranfield's findings by concluding that SCV was an under-explored area within the field of management research. This conclusion builds on Svensson (2000) paper at the turn of the millennium, which pointed to the obscurity of research pertaining to vulnerability. Despite a significant increase in attention to SCV, more research is needed to understand its dynamics fully (Sodhi, 2016; Paloviita, et al., 2016; CIPS, 2013; Neureuther & Kenyon, 2009; Peck, 2007). Peck (2005) study into the drivers of vulnerability highlighted the extent to which the scope and dynamic nature of the issue are widely misunderstood. The study suggests further research is required at all levels of the supply chain.

Therefore, exploration of vulnerability should be holistic and at the four levels of analysis: value stream/product or process; asset and infrastructure dependencies; organisations and inter-organisational networks; and social and natural environment (Peck, 2005). However, Chowdhury & Quaddus (2016) argue that despite an escalation of studies focusing on supply chain vulnerability, risk, and resilience, there is still a lack of theoretically enforced and empirically ratified research on justifying the precursors and measurement dimensions. 21st century supply chains have become complex networks that intertwine and therefore create dependencies between organisations, industries and economies (Ali & Shukran, 2016). Most supply chains operate within a network (CIPS, 2013); however, it is important to note that there are specific chains that provide commodities directly to consumers, especially within the food industry. These supply chains will strictly operate in dyadic or triadic relationships. As stated earlier, this thesis will apply the term Supply Chain Network (SCN) due to the current complexities and setups of today's chains (Brusset & Teller, 2017).

Depending on the product or service, that has been manufactured, produced or provided, the SCN can constitute a short, direct supply chain or it could be a wide variety of firms in multiple locations throughout the globe (Thekdi & Santos, 2016). This complexity can present a wide range of vulnerabilities; the CIPS (2013) classifies them in two categories.

1. ***Weaknesses and potential risks*** – The inability of organisations to satisfy their customers due to an imbalance in demand and supply dynamics. This creates a negative impact on several supply chain outcomes, e.g. total cost, time and performance.

2. ***Fragility –*** This refers to the ***external*** events/threats that can affect SCNs. Fragility, therefore, refers to both current and future events/threats. This also encompasses all types of movements within the chain, not just physical but also information (CIPS, 2013).

As previously stated, it is vital to continuously research and aim to understand vulnerability in SCN as the impact on business operations can be serious. However, concrete analysis of supply chain vulnerability requires the research area to undergo investigation in context. To this effect, the following section will further analyse the drivers/barriers of vulnerability in supply chains. It is therefore important to understand what drives vulnerability as it leads to disruptions that can cause serious problems for business (Thekdi & Santos, 2016).

2.2.2. Defining Supply Chain Risk (SCR)

Supply chain risk management (SCRM) literature contains a wide range of definitions (de Oliveira, et al., 2017; Tang & Musa, 2011). Some research within SCRM does not clearly distinguish the difference between risk and uncertainty (Tang & Musa, 2011). Waters (2011) attempts to provide clarification of this issue by stating that 'uncertainty' means something might happen in the future without any means or ways of measuring or estimating its likelihood. In contrast, 'risk' also means something negative might happen in the future, but unlike uncertainty, there is a mechanism of measuring or estimating the probability of this occurrence (Waters, 2011). It is also important to note that in terms of supply chain literature, the risk is mostly associated with negative consequences (Baryannis, et al., 2019; Buist, 2017; Christopher & Holweg, 2011) unlike in other disciplines, e.g. finance, and were it can be viewed as positive when investing. Practitioners and academics have struggled to set up defined parameters of what a suitable definition of risk within SCM should contain (Tang & Musa, 2011).

To address this Tang & Musa (2011) came up with characteristics a suitable risk definition should have:

I. events with small probability but may occur abruptly,

ii. These events bring substantial negative consequences to the system.

However, Nassim Nicholas Taleb takes a different approach and classifies risk as either a grey swan or black swan (Nassim, 2007). While swans were all thought to be white signifying the knowledge we are certain of, black swans do appear though rarely. Taleb argues that the appearance of a black swan has a huge impact on human psychology; and how we rationalise the event after the occurrence. According to Taleb (xvii–xviii), a Black Swan is an event distinguished by three key properties:

P1. *"It is an outlier, as it lies outside of the realm of regular expectations, because nothing in the past can convincingly point to its possibility";*

P2. *"it carries an extreme impact"; and*

P3. *"in spite of its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable."*

It is important to observe that according to Taleb, a Black Swan is an event rather than a hypothesis, an object, or a state of affairs (Nassim, 2007). Critics of Taleb's view argue that he assumes to assume a realist philosophical positioning which means that whether or not any particular event occurs is independent of the observer; hence, they have no influence (Runde, 2009). Taleb also defines a 'grey swan'. For example, in supply chain management, we can have a robust model yet we fail to predict accurately, because even small observational errors can lead to huge discrepancies in the outcome *(fractals exhibit bifurcations, when the result suddenly splits at a point for no apparent reason);* the precision we need grows too fast (Nassim, 2007). If we work with a fractal world, we *know* that we *do not know,* so we will have not-so-white "swans" even in the absence of *unknown* unknowns (the real black swans). Swans that are neither white (because we cannot see them ahead of time) nor black (because their nature is well known) are regular in a fractal world (Nassim, 2007).

In addition, most definitions include the following characteristics: risk identification and modelling, risk analysis, assessment and impact measurement, risk management, risk monitoring and evaluation, organisational and personal learning including knowledge transfer (Fan & Stevenson, 2018; Wu & Blackhurst, 2009). This thesis will adopt the SCRM definition from Tang (2006), which states SCRM is *"the management of supply chain risk through coordination or collaboration among the supply chain partners to ensure profitability and continuity".* This aligns with the research context of perishable food SCNs.

2.2.3. Impact of SCV and SCRM on SCRES and SSCM

The last couple of decades have seen massive disruptions due to unmitigated risks; these have resulted in negative impacts for various business operations (Ho, et al., 2015). A quintessential example is the case of Swedish-owned Ericsson, which was one of the big international players in the mobile phone industry, together with the Finnish company Nokia (Chopra & Sodhi, 2004) at the end of the 20th century. On March 17, 2000, a small fire hit a microchip plant owned by Philips, the Dutch company (Husdal, 2008). The plant supplied chips to both Ericsson and Nokia, and the smoke and water damage from the small and easily contained fire contaminated millions of chips damaging almost all of the plant's entire stock (Norrman & Jansson, 2004). Nokia acted swiftly and moved to purchase spare capacity at other Philips plants and every other supplier they could find (Husdal, 2008). They even re-engineered some of their phones, so they could take chips from other Japanese and American suppliers (Norrman & Jansson, 2004). Ericsson, miscalculated by accepting new assurances that the fire was unlikely to cause a big problem, and settled on 'waits it out' strategy (Chopra & Sodhi, 2004). When they realized their mistake, it was too late: Since Ericsson a few years earlier had decided to buy critical components from a sole source to simplify its supply chain (Husdal, 2008). Single sourcing turned out to be a major weakness in Ericsson's supply chain strategy. This resulted in an unmitigated business disaster with severe operational and financial cost (Husdal, 2008).

Ericsson struggled to bounce back as Nokia had purchased huge amounts of available microchip stocks. Ericsson lost many months of production, and consequently sales in a booming market, which resulted in Nokia, establishing dominance. Eventually, Ericsson merged with Sony to survive (Husdal, 2008). This example highlights uncertainty as a reality all managers and decision-makers must contend with to achieve SCRES (Heckmann, et al., 2015). Thus, risk management is vital in building SCRES. As previously mentioned, SCV refers to the susceptibility of the network to disruptions and events (Chowdhury & Quaddus, 2016).

According to Wagner & Bode (2008), vulnerabilities occur because of the functioning of the characteristics of the supply chain. The argument put forward is that the aspects of the supply chain are a precursor for its vulnerability (Wagner & Bode, 2006). To understand SCV further, Nowakowski & Werbińska-Wojciechowska (2014) developed a framework for supply chains vulnerability indicators as depicted in Figure 4. The framework represents theoretically based constructs of supply chain vulnerability indicators and their impact on SCRES and SSCM (Nowakowski & Werbińska-Wojciechowska, 2014). The characteristics of the supply chain structure have a significant bearing on the vulnerability drivers (Wagner & Bode, 2008).

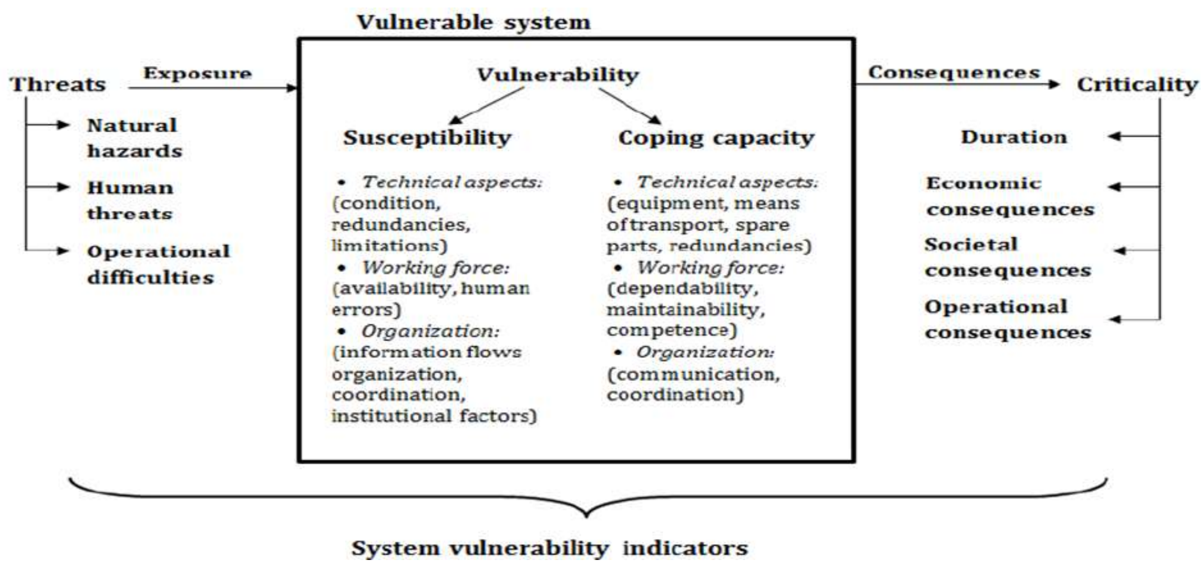


Figure 4: Supply Chain Vulnerability indicators

Following Figure 4, some factors have been carefully selected to highlight key risk and vulnerability drivers that could affect food supply chains. In addition, examples have been provided to indicate potential vulnerability origins within supply chain structures.

2.2.3.1. Complexity

A former Vice President of Coca Cola North America referred to complexity within supply chains as a '*cancer*' today is managers must contend with frequently (Gilmore, 2008). Both scholars and practitioners agree at the urgency to address this issue. Complexity is understood to be an impediment to sustaining functional supply chains (Bode & Wagner, 2015; Bozarth, et al., 2009; Choi & Krause, 2006). Due to the elevated levels of interconnectedness in supply chain networks, which are characterised by constant flows of finances, information, and materials; complexities can cause inefficiencies and thus, be an antecedent to disruptions (Bode & Wagner, 2015; Chopra & Sodhi, 2004). These complexities are apparent in the food supply chain, which is under pressure to produce products that are safe for human consumption at adequate levels and quality (Bowman, 2015). To this endeavour (Ge, et al., 2016) investigated how changes in the Canadian wheat supply chain policy by the government introduced unforeseen vulnerabilities. The study posits that the series of policy changes, which were implemented, could potentially produce a negative impact on both the quality and integrity of the Canadian wheat handling system (Ge, et al., 2016).

Thus, the new measures could create new wheat quality risks, which could threaten the export position of this industry. Therefore, in complex networks, any changes pose a potential vulnerability as most only become apparent when they become a risk due to exposure of stress on the network (Bode & Wagner, 2015). For instance, disasters are becoming more prevalent as the climate continues to change, and this is affecting business supply chain networks negatively (Leichenko, et al., 2010). The economic effect of disasters has been staggering, rising from US$ 16.1 billion per year between 1992 – 2001 to US$ 40 billion per year from 2002 to 2011 (Apte, et al., 2016).

Hence, Apte, et al., (2016), argue that the increasing complexity of supply chain networks makes them less responsive to sudden shocks and disruptions. To remedy this inadequacy, they propose the concept of a self-sustaining response supply chain (SSRSC). Figure 5, further illustrates how complexity potentially generates many vulnerable points within an SCN. Figure 6 depicts how many actors in a manufacturing company SCN can potentially create a complex web with many uncertainties. Risks and vulnerabilities may only become apparent after the supply chain is exposed to pressure or stress (Aitken, et al., 2016).

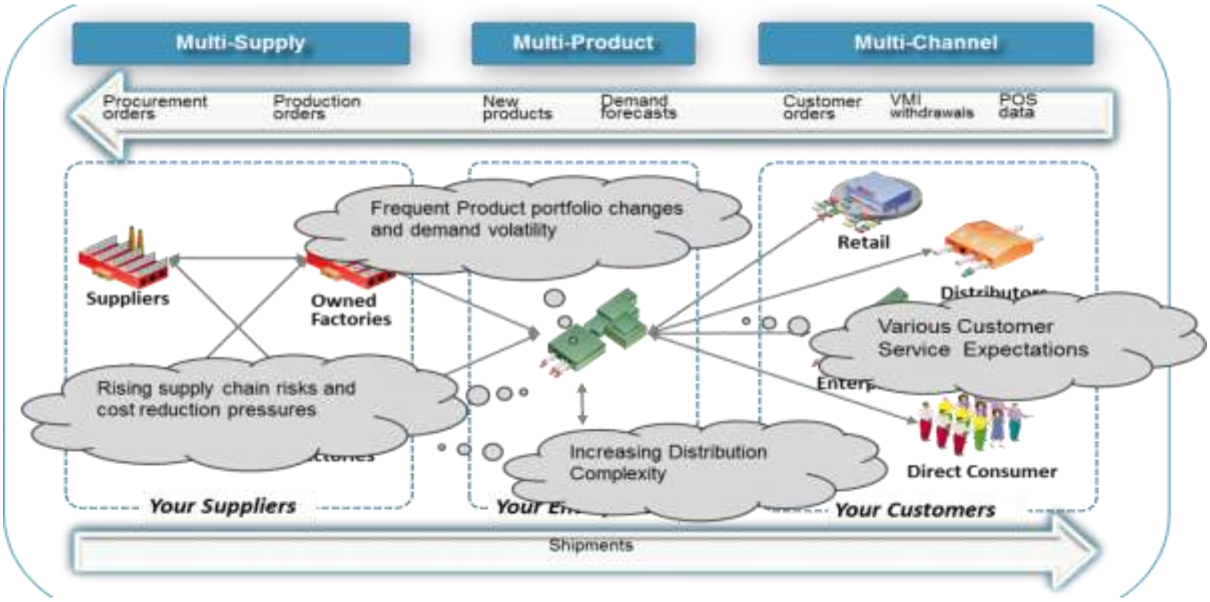


Figure 5: Depiction of Supply Chain Complexity

Source: Procurement Professionals (2015)

Complexity increases risk and vulnerability within the SCN by increasing the number of potential weak points (CIPS, 2013). This is due to the high-volume movement of materials, information, and finances within SCNs (Apte, et al., 2016). This creates many opportunities for the network weaknesses to come under either internal or external pressure or maybe both. To this effect, Aitken, et al., (2016) questioned how best scholars and practitioners should respond to complexity. As this has become an inherent issue in this era of globalisation, they query whether research should focus on eliminating complexity or absorbing it (Aitken, et al., 2016). In their case study of a packaged foods manufacturing company, Aitken, et al., (2016) concluded that firstly, organisations need to distinguish between strategic and dysfunctional drivers prior to choosing an organizational response.

Once a distinction establishment occurs, and appropriate measures are undertaken; these efforts to address supply chain complexity can unearth previously unknown weaknesses in the system that would have stayed dormant until an introduction of stress.

2.2.3.2. Sourcing

There are diverse types of sourcing applied by businesses, from multiple to single sourcing, offshoring and outsourcing etc. (Kim, et al., 2018; Blome & Henke, 2009) Organisations strategically select the most appropriate sourcing strategy for their operations (Kim, et al., 2018; Ahmed, 2016). However, the last decade has seen an increase in sustainable purchasing focused research (Akhavan & Beckmann, 2017). Stakeholders are increasingly pressuring and holding buying firms responsible for social and ecological issues along their supply chains (Veit, et al., 2018). In FSC, there is a demand for visibility and traceability of products to ensure the sourcing process is safe (Sun, et al., 2017).

Therefore, organisations are attempting a holistic view of the supply chain to increase performance and implementing outsourcing and offshoring strategies (Kim, et al., 2018). Apart from outsourcing production, many businesses have extended this to their transportation and are increasingly relying on 3PLs (third-party logistics providers) (Kannan, et al., 2017). Literature identifies key components of sustainable sourcing as having the ability to undertake (Ball, et al., 2018; Akhavan & Beckmann, 2017; Abdulkader, et al., 2015; Gray, et al., 2011):

- Demand planning, forecasting and business analytics
- Sourcing and procurement from vetted and credible suppliers
- Manufacturing, warehousing, and storage
- Fulfilment with order management, transport planning and management, customs handling
- Customer service and reverse logistics.

However, Ahmed (2016) argues single sourcing is still a viable and advantageous arrangement for both manufacturer and supplier as they could benefit from, administrative efficiency, lower inventory cost, continuous quality improvement of product and access to innovative technology. Hence, sourcing decisions by organisations can have significant strategic, operational implications. Companies like Beazer Homes USA named Kwikset in 2004 as the sole supplier of hardware and entry devices for their construction projects (Martin, 2004). Toshiba Electronics opted to use a single-sourcing arrangement with Asyst Technologies Inc. (Toshiba, 2004). This was for fab production in its new 300mm fab in Oita, Japan. Toshiba undertook this measure as a way of streamlining training and reducing downtime and inefficiencies caused by interoperability factors (Toshiba, 2004). However, single sourcing possesses inherent weaknesses, which under stress could quickly turn into risks, thereby creating disruption in the supply chain (Blome & Henke, 2009). For instance, in 1998, supply problems at Ford resulted in the temporary, three-day shutdown of the Fiesta and Puma manufacturing facilities in Cologne and Dagenham, Germany (Blome & Henke, 2009). The source of the supply problem was a computer glitch at Ford's provider of door and trunk latches. Those three days cost Ford approximately £70 million in labour costs and the production of about 7000 vehicles. While not a recent situation, a discussion of the reliance Peugeot has on its parts supplier, Bertrand Faure-ECIA is relevant when considering the risks of single sourcing (Lewis, 2001). Bertrand Faure-ECIA produces approximately 11% of Peugeot's parts in France (ibid).

Additionally, the manufacturing of seats is entirely dependent on the supplier (Lewis, 2001). In the event of a shutdown, the company would suffer a shortage of seats for its vehicles. Peugeot, however, considered risk in its selection of a single supplier. While a situation has not occurred yet, other options are under assessment and a different sourcing plan may undergo implementation (Martin, 2004). As the examples above illustrate, there is an inherent vulnerability with the single supplier concept and organisations will need to create resistance within their supply chains to avoid disruption (CIPS, 2013). Re-evaluation of these strategies, as was the case with Peugeot, is also necessary along the way.

2.2.3.3. Just- in -Time (JIT) Philosophy

Many manufacturing companies have applied the ‘just-in-time’ (JIT) system throughout their supply chains since the early 1980s (Othman, et al., 2016). Hence, JIT is widely regarded as an efficient manufacturing and supply chain system throughout many organisations (Levy, et al., 1995). There are many documented benefits of this system in literature, which include but are not limited to, inventory reduction, quick delivery, and cost reduction (Meybodi, 2015; Cook & Rogowski, 1996). Advocates of JIT manufacturing argue that it can help reduce throughput time, inventory cost, delivery time, labour cost, and the cost of quality (Swanson, et al., 1998). For instance, literature focusing on JIT manufacturing by Japanese firms, or lean production explains most of the cost differential between Japanese and US automobile producers (Othman, et al., 2016).

Thus, a hypothesis positing JIT manufacturing to be a function of logistical complexity is proposed by (Sakun Boon-itt & Paul, 2006). These include revised layouts, reduced set-up times, simple production systems, and just-in-time purchasing (Funk, 1995). However, there are vulnerabilities within this supply chain approach, which only rears its head when the system suffers from stress. These vulnerabilities include risk of running out of stock, lack of control over the timeframe and the requirement of extensive planning (Meybodi, 2015).

For instance, Mitsubishi Heavy Industries builds the 787's wing; no other organisation can do this (Ray & Black, 2011). This creates vulnerabilities, which means that in the event of disruption, the entire production comes to a halt. In the next section, an analysis of risk in supply chain networks will be undertaken. This is because there are unique as the issues that perturb them are different from other manufacturing industries (Paloviita, et al., 2016).

2.3. Supply Chain Resilience (SCRES)

Organisations operate in an increasingly dynamic and uncertain environment. Consequently, every business within the supply chain is vulnerable to supply chain disruptions (Ambulkar, et al., 2015). This realisation has driven both academics and practitioners to seek effective ways of managing supply chain disruptions (Blackhurst, et al., 2011; Melnyk, et al., 2016). Both academics and practitioners are promoting resilience as one of the most effective approaches of dealing with risks and vulnerabilities within the supply chain (Ambulkar, et al., 2015; Melnyk, et al., 2016; Brusset & Teller, 2017). Designing resilient supply chains is vital due to vast negative consequences unmanaged vulnerabilities and unmitigated risks e.g. economic loss, poor operational performance etc. (Hendricks & Singhal, 2003) (Hendricks & Singhal, 2005; Wagner & Bode, 2008; Narasimhan & Talluri, 2009). A recent study by the World Economic Forum on global risks concluded that 80% of firms interviewed considered resilience to supply chain disruptions a matter of urgency that required prompt redress (World Economic Forum, 2017). Due to this, organisations are now focussing on building resilience to mitigate risks (Melnyk, et al., 2010; Wieland & Wallenburg, 2013; Wieland, et al., 2016). Current research indicates that resilience is an important aspect of SCM; this cannot be understated.

Resilient supply chains allow firms to be effective in managing any disruptions that can occur thereby allowing them to continue delivering their products and services to their customers (Melnyk, et al., 2010; Wieland & Wallenburg, 2013). Hence, it is vital firms build resilience in their supply chains to counter the effect unforeseen and unquantifiable risks (Sheffi & Rice, 2005). While many academics and practitioners agree on the vital role of supply chain resilience, there is conflicting information on, what it is, and how it operates (Melnyk, et al., 2016). In addition, contradictions are rife among practitioners on where and how to invest resources along their supply chains to mitigate risks and recover from any disruptions (Chopra & Sodhi, 2014; Melnyk, et al., 2016). Before undertaking a critical review of the literature surrounding resilience, this thesis will define it.

There is a myriad of definitions on resilience, and in the following section, some of the most widely used will be analysed. Following this analysis, a suitable definition selection will occur. Recent research has allowed a deeper understanding of phenomena such as natural disasters, the breakdown of technological systems, epidemic propagation, and spreading social unrest in terms of their complex network structure (Tang, et al., 2016). To counter these risk and vulnerabilities that cause disruption to supply chains and networks scholars and practitioners are advocating for the building of resilience into SCN (Pettit, et al., 2013; Wieland & Wallenburg, 2013; Ambulkar, et al., 2015). Resilience as a concept has its foundations in the work of ecologist C.S. Holing as cited by (Melnyk, et al., 2016) through his work investigating the resilient trails of ecological systems.

Following its inception, the concept of resilience has been utilised in various fields such as psychology, disaster management, healthcare, and more recently SCM (Jüttner & Maklan, 2011; Yildiz, et al., 2016). Literature indicates that firms have approached resilience differently; some view it proactively through preplanning and building tolerances (Ponis & Koronis, 2012). In contrast, some firms view it as a reactive capability that is utilised when a disruption or shock occurs (Melnyk, et al., 2016).

2.3.1. Supply Chain Resilience (SCRES) Definition

Currently, there are fewer consensuses on a unifying resilience definition and scholars attribute this to the ambiguity of supply chain resilience (Ponomarov & Holcomb, 2009; Wieland & Wallenburg, 2013; Melnyk, et al., 2016). Table 5 lists some of the widely used definitions of SCRES. Most definitions show that resilience happens by design and involves the bouncing back of supply chain/network back to its original state or an even better condition (Rice & Caniato, 2003; Peck, 2006; Klibi, et al., 2010; Hohenstein, et al., 2015).

However, for this thesis, Ponis & Koronis (2012)'s definition will be adopted. This is because the definition is in line with the definition selected for SCM. Unlike the other definitions, it focuses on being proactive rather than reactive in the planning and designing stage of the supply chain (Ponis & Koronis, 2012). Furthermore, it focuses on the supply chain network and this research is mainly concerned with the implications of the focal firm throughout the supply chain. This definition also stresses the importance of business to maintain control of their structures and functions throughout a disruption and afterwards with the aim of achieving an even better state (Ponis & Koronis, 2012).

Table 5: Examples of Supply Chain Resilience (SCRES) definitions

AUTHOR	DEFINITION
Rice & Caniato (2003, p. 25)	In today's business environment, resilience is widely used to characterize an organization's ability to react to an unexpected disruption, such as one caused by a terrorist attack or a natural disaster, and restore normal operations
Christopher & Peck (2004, p. 2)	The ability of a system to return to its original state or move to a new, more desirable state after being disturbed
Sheffi & Rice (2005, p. 41)	The ability to bounce back from a disruption
Fiksel (2006, p. 16)	The capacity for an enterprise to survive, adapt and grow in the face of turbulent change
Peck (2006, p. 132)	The ability of the system to return to its original or desired state after being disturbed, i.e. its ability to absorb or mitigate the impact of the disturbance
Williams *et al* (2009, p. 253)	The ability to react to unexpected disruption and restore normal supply network operations
Klibi et al. (2010, p. 287 and p. 291)	Resilience is the capability of a SCN to avoid disruptions or quickly recover from failures. The capacity of a system to survive, adapt and grow in the face of unforeseen changes, even catastrophic incidents
(Kumar *et al* (2010, p. 3721)	Resilient supply chain networks need to be built having the ability to maintain, resume and restore operations after any disruption
Melnyk *et al* (2010, p. 34)	Resilience ensures that the supply chain can recover quickly and cost-effectively from disruptions caused by natural disasters (such as earthquakes), social factors (employee strikes), medical emergencies (epidemics such as H1N1 flu), economic setbacks (the bankruptcy of a critical link in the chain) or technological failures (a software crisis)
Pettit *et al* (2010, p. 1)	The capacity for an enterprise to survive, adapt and grow in the face of turbulent change
Zsidisin & Wagner (2010, p. 3)	Supply chain resiliency consists of the ability to return to normal performance levels following a supply chain disruption
Blackhurst *et al* (2011, p. 374)	Companies, for example, can build resilience in their supply networks, which enhances a firm's ability to absorb disruptions or enables the supply network to return to stable conditions faster and thus has a positive impact on firm performance. We specifically define supply chain resilience as a firm's ability to recover from disruptive events
Jüttner & Maklan (2011, p. 247)	Supply chain resilience addresses the supply chain's ability to cope with the consequences of unavoidable risk events in order to return to its original operations or move to a new, more desirable state after being disturbed
Ponis & Koronis (2012, p. 925)	The ability to proactively plan and design the SC 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 favourable than the one prior to the event, thus gaining competitive advantage

Wieland & Wallenburg (2013, p. 301)	A supply chain can be resilient if its original stable situation is sustained or if a new stable situation is achieved. In this research, resilience is understood as the ability of a supply chain to cope with change
Wu *et al* (2013, p. 676)	Resilience is "the ability to respond and recover from a stock-out disruption"
Hohenstein *et al* (2015)	Supply chain resilience is the supply chain's ability to be prepared for unexpected risk events, responding and recovering quickly to potential disruptions to return to its original situation or grow by moving to a new, more desirable state in order to increase customer service, market share, and financial performance.

Applying the definition by Ponis & Koronis (2012), SCRES involves both proactive and reactive characteristics. This has led Melnyk, et al., (2016) to posit SCRES is composed of two critical but complementary characteristics: which are the ability to resist and the ability to recover.

- **Resistance Capacity –** Is the capability of a system to completely avoid adverse or negative events or the ability to contain the disruption thereby minimising the recovery time (see figure 8)
- **Recovery Capacity –** This is the ability of a SCN to return promptly to its full operational and functional performance levels (see figure 8) (Melnyk, et al., 2016).

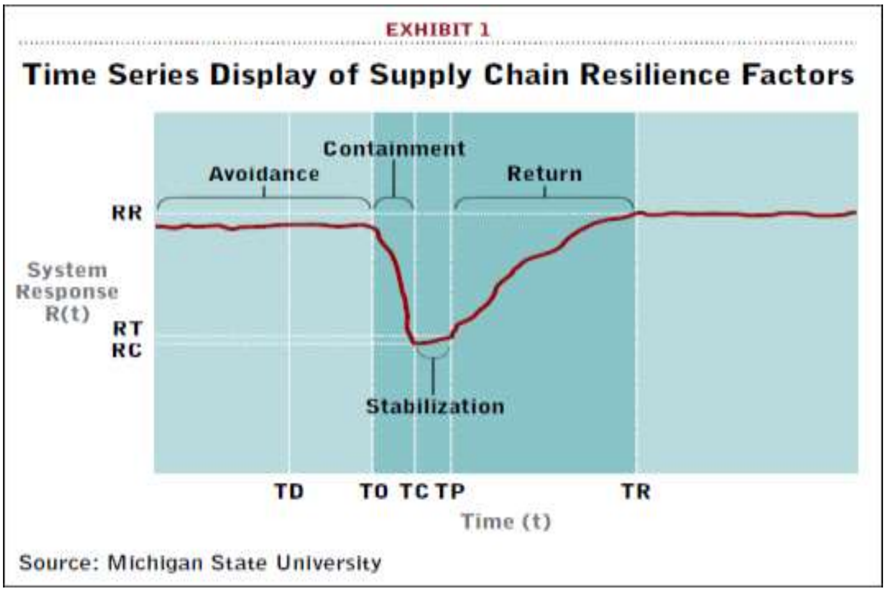


Figure 6: Impact of Disruption overtime/SCRES Factors

Source: (Michigan State University, 2015)

Figure 6 represents the effect of disruptions in SCNs over time. This begins at the time of disruption (TD), which can occur anywhere in the system until the network returns, to normalcy (TR) (Michigan State University, 2015). There are two significant variables within figure 7, which are T and R. T represents the time while R represents the impact of the disruption, depending on the business, this could be a monetary loss, inventory, systems or infrastructure failure etc.

Figure 7 provides descriptions for the variables used in figure 6. Figure 7 provides a vivid description of all the infliction points alluded to in figure 6. Both illustrations can allow firms to reflect on their resilience after a shock or disruption to assess their capabilities.

EXHIBIT 2

Description of Time Series Inflection Points

Event	Type	Full Name	Operational Definition
TD	T-Time	Time of Disturbance	Specific time period in which the triggering event is initiated.
T0	T	Time of Onset	The time period in which the system being studied feels the impact of the triggering event.
TC	T	Time of Climax	Time period in which the system reaches its climax.
RC	R-Response	Response at Climax	The system response at the climax.
TP	T	Turning Point	The time period in which the system begins to recover from the disturbance.
RT	R	Response at Turning Point	The system response at the turning point; the response at which the system transitions from being impacted by the disturbance to recovering from the disturbance.
TR	T	Time of Recovery	The time period in which the system returns to steady-state.
RR	R	Response at Recovery	The system response level at the recovery period (may differ from the pre-disturbance response level).

Figure 7: Disruption of Time Series Infliction Points

Source: (Melnyk, et al., 2016)

Melnyk, et al., (2016) state that upon completion of recovery organisations can reflect and this complete the SCRES cycle. The cycle as illustrated in figure 8 comprises of Avoidance – Containment – Stabilisation – Return – Review – Avoidance.

2.3.2. Resistance and Recovery

The three factors of 'anticipation', 'resistance' and 'recovery' underpin most SCRES models and frameworks (Ambulkar, et al., 2015; Kamalahmadi & Parast, 2016; Melnyk, et al., 2016). However, Kamalahmadi & Parast (2016) designed a three-phase model that introduces the concept of anticipation (see Figure 8). Anticipation ties in with the chosen definition for this thesis, which advocates for a proactive approach (Ponis & Koronis, 2012). This phase advocates for supply chain managers to use all resources available at their disposal to anticipate disruptions and act accordingly (Kamalahmadi & Parast, 2016). Thus, managers should be able to understand the impact of any disturbances and must have the capability of calculating the probability of the risk and apply appropriate contingency measures (see figure 8).

Three Phases of Supply Chain Resilience

Figure 8: Three phases of Supply Chain Resilience

Source: (Kamalahmadi & Parast, 2016)

As illustrated in Figure 8, resistance refers to the ability of a firm to constrain effectively a disruption or shock to its SCN (Kamalahmadi & Parast, 2016). For example, the 2011 Japan earthquake that led to the tsunami affected the suppliers of both Nissan and Toyota (Melnyk, et al., 2016) as they lacked adequate resistance capabilities to maintain control over their structures and function.

However, Nissan showed high recovery capabilities as it quickly regained control of the situation by finding alternative suppliers. In contrast, Toyota which relied on a 'just in time' (JIT) system, struggled and lost market share as well as cancelled orders despite having similar SCN as Nissan. Though this vulnerability was exposed in 2011, which resulted in both Nissan and Toyota's suppliers making changes to make their firms more resilient earthquake in 2016 caused similar disruptions as those experienced in 2011 though it was at a lower level (Fortune, 2016). This led Nissan and Toyota to begin collaborating to reduce risks and vulnerabilities in their supply chain. The failure of Toyota and Nissan's suppliers to learn effectively from the 2011 tsunami could be due to a lack of mechanisms that adequately measure risk (Fortune, 2016). To assist firms' better make decisions, Michigan State University developed a matrix depicted in Figure 9.

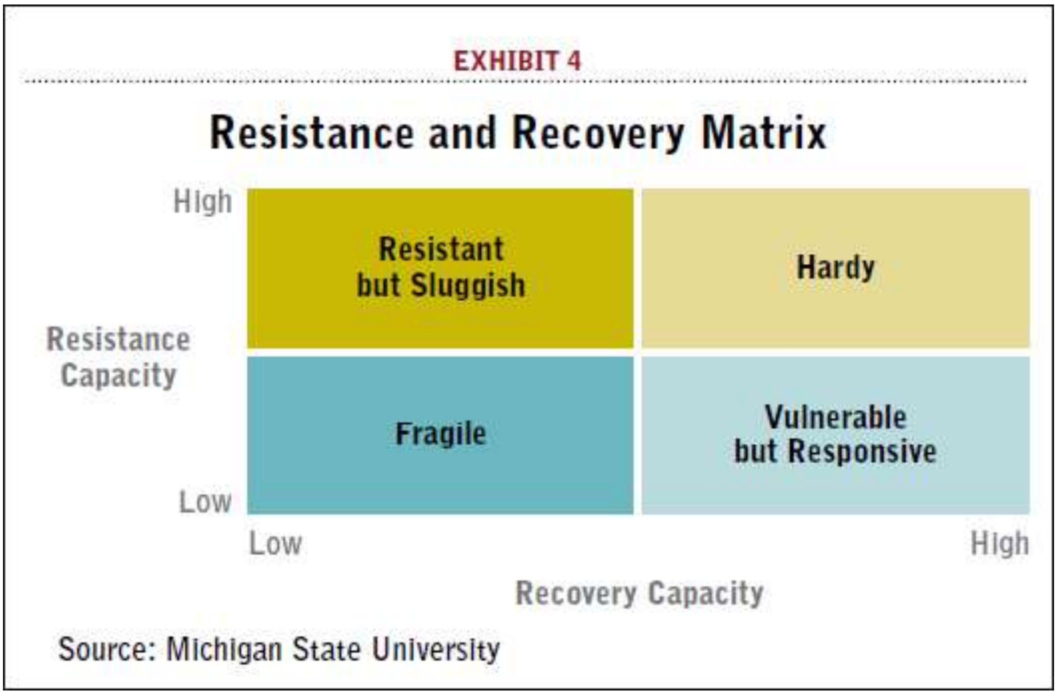


Figure 9: Resistance and Recovery Matrix

Source: (Michigan State University, 2015)

When critically evaluating SCV, the issue of fragility is critical and if not adequately addressed, can generate a very disadvantageous position for any business (see Figure 9). 'Fragile' represents both low resistance and recovery capabilities. Supply chains that are 'hardy' have high resistance and recovery capabilities.

To mitigate and respond to supply chain risks appropriately, research advocates for risk identification, assessment, mitigation, and responses (Fan, et al., 2016; Ghadge, et al., 2012). While supply chain risk (SCR) information plays a crucial role in the implementation and decisions of many of these activities, the importance of a firm's information processing capability to its supply chain risk management effort has received very little attention in the literature (Fan, et al., 2016). Although the extant literature recognizes that SCR information plays a fundamental and critical role in supply chain risk management (SCRM), little is known about how firms process SCR information for SCRM (Fan, et al., 2017).

2.3.3. SCRES key concepts

Drawing from the current body of literature, Kamalahmadi & Parast (2016) conducted a comprehensive study into the gaps and probable future research for SCRES. The study concluded that there is a lack of an overreaching framework for SCRES. To advance knowledge, they created framework illustrating the major components of SCRES (Kamalahmadi & Parast, 2016). This framework illustrates the key research areas that need further attention within SCRES (see Figure 10). Due to the nature of today's supply chain networks, organisations are expanding globally and adopting lean strategies, which, exposes them to vulnerabilities and risks, arising from disruptions and other undesirable events in the supply chain (Blackhurst, et al., 2011).

Hence, SCRES has gained prominence as a vital capability in supply chain management (Carvalho, et al., 2012). Recent studies have identified a number of associated skills, namely, agility (Swafford, et al., 2006), flexibility (More & Subash Babu, 2009), responsiveness (Gunasekaran, et al., 2008), and re-designing (Kurniawan, et al., 2017). These identified capabilities alongside supply chain collaborations are the antecedents for attaining supply chain resilience (Christopher & Peck, 2004; Sheffi & Rice, 2005; Mandal, 2014).

According to Mandal (2014), collaboration relates to the ability of two or more independent firms to work constructively in organising and accomplishing supply chain operations to achieve common aims and objectives. While there have been some studies focussing on collaboration within the context of supply chain risk, it is still in its infancy in relation to resilience (Mandal, 2014). Research clearly identifies the benefits firms can achieve from collaborating in supply chain operations, which, include the sharing of useful information in real-time, the ability of a partner to jointly plan common goals thus, developing synergies (goal congruence) (Whipple & Russell, 2007; Cao & Zhang, 2011).

These benefits allow collaborating firms to recover efficiently from supply chain disruptions before they drastically affect a considerable part of the network (Mandal, 2014). It is for these reasons that many scholars cite information sharing as well as sharing the risks and rewards as the core foundation of collaboration (Barratt, 2004; Fan, et al., 2017). Although the benefits of collaboration are well documented, there is still a significant level of ambiguity on how best firms can effectively undertake it and how best they can handle the required trade-offs (Mandal, 2014). This is evident from the conflicting recommendations emanating from literature.

On one side, you have scholars who assert that the rise in single sourcing by organisations has increased their vulnerability and the magnitude to which disruptions affect their supply chains (Christopher & Peck, 2004; Juttner, 2005; Pettit, et al., 2010). Opposing this assertion, are scholars advocating for increased collaboration and information sharing, which is much more attainable in single sourcing dependencies (Skjoett-Larsen, et al., 2007), this is because these relationships allow organisations to respond and communicate promptly concerning risk (Ergun, et al., 2010). Besides, research argues that decision synchronisation and incentive alignment to help organisations effectively respond to disruptions and shocks in their supply chains (Jüttner & Maklan, 2011). Communication between supply chain partners has a positive effect on the enhancement of resilience (Wieland & Wallenburg, 2013).

Thus, studies show the beneficial effects of supply chain collaboration in enhancing organisational capabilities to respond effectively to disruptions (Ambulkar, et al., 2015; Scholten & Schilder, 2015). However, there is still a gap in knowledge of how the latent activities of collaboration influence resilience (Cao & Zhang, 2011; Jüttner & Maklan, 2011). Figure 10 depicts the key principles of SCRES (Kamalahmadi & Parast, 2016).

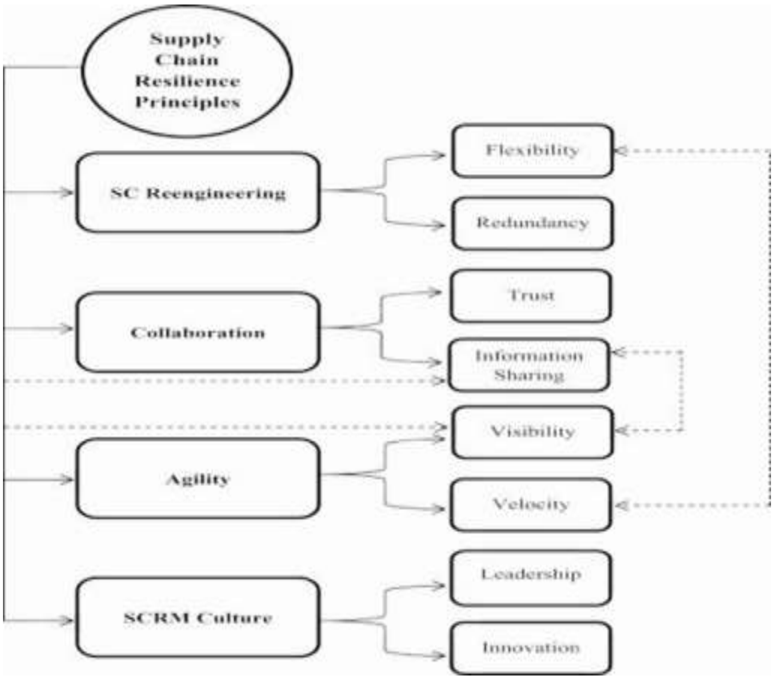


Figure 10: SCRES principles

Source: Kamalahmadi & Parast (2016)

Due to increasing complexity resultant from globalisation, SCN have an increased risk of suffering from disruptions (Kamalahmadi & Parast, 2016). Hence, as previously discussed, SCV is a network-phenomenon that requires urgent attention (Nowakowski, et al., 2015). Therefore, some scholars strongly argue that the investigation of risk should be from a network perspective (Christopher & Peck, 2004). The reasoning behind this assertion stems from the point that, SCRM and SCV in a network with high dependency is challenging to examine unless there are equally elevated levels of collaboration, cooperation, and partnership between the actors (Kamalahmadi & Parast, 2016). Collaboration can be defined as the ability of actors within a supply network to work together effectively.

The management of supply chain risks has emerged as a critical area of research in the field of SCM (Ali & Shukran, 2016). Due to the increasing level of risk which the CIPS 2016 report indicates is at the highest level in two and half decades, the need to address this issue is of utmost importance (Buist, 2017). To find solutions a variety of frameworks have been proposed in the literature to mitigate risk better. One key SCRES strategy emerging as a mitigating factor to supply chain risk is collaboration and more specifically, the information-sharing aspect of it (Wakolbinger & Cruz, 2012). For example, Wakolbinger & Cruz (2012) developed a framework that aims to mitigate risk within SCN through strategic information sharing and risk-sharing contracts. Figure 8 below illustrates the different origins of risks and current mechanisms firms use to deal with them (Tang & Musa, 2011).

Chen, et al., (2013) presented a collaborative approach for mitigating supply chain operational risks and focused on supply risks, demand risks and process risks. Tse and Tan (2011) proposed a framework for product quality risk and visibility assessment. The study argues that better visibility of risk in supply tiers could minimise quality risks. However, these studies do not consider risk factors (or root causes) and risk interconnections when risks are calculated. Supply chain risk modelling is an important topic that needs more investigation because having quantitative measures for the risks enables companies to assess and prioritise the risks and develops proper mitigation plans (Ojha, et al., 2018; Ghadge, et al., 2012).

Supply chain collaboration enables the development of synergies among partners, facilitates joint planning and encourages real-time information exchange (Whipple and Russell, 2007) required to prepare for, respond to and recover from supply chain disruptions while reducing their impact. Many authors cite mutuality of benefit, rewards and risk sharing together with the exchange of information as the foundation of collaboration (Barratt, 2004). For instance, Daugherty et al. (2006) state that collaboration is about information-sharing, jointly developing strategic plans and synchronizing operations;

Nyaga et al. (2010) refer to information-sharing, joint relationship effort and dedicated investments, whereas the architecture of Simatupang and Sridharan (2008) of supply chain collaborations contains the collaborative activities information-sharing, decision synchronization and incentive alignment. This study will emulate the recent research by Cao et al. (2010) who offer the most elaborated conceptualization of supply chain collaboration to date. This thesis defines collaboration via the collaborative activities of information-sharing, joint knowledge creation, decision synchronisation, incentive alignment, resource sharing, goal congruence and collaborative communication among supply chain partners. Reducing the impact of any disruptions in the supply chain presents a clear business need and convergence of interests. Nevertheless, how to collaborate and what collaborative activities are important remains unclear.

Some literature suggests that single sourcing increases vulnerability and the possible impact of a disruption (Christopher & Peck, 2004; Juttner, 2005; Pettit, et al., 2013). However, other scholars state that increased collaboration and information-sharing - which is present to a higher degree in single sourcing relations (Skjoett-Larsen et al., 2007) - are mitigating, as they help to make risk response processes faster (Ergun et al., 2010). Furthermore, research states that decision synchronization and incentive alignment are essential for effective system-level disruption responses (Jüttner & Maklan, 2011) and communication for supply chain resilience (Wieland & Wallenburg, 2013).

Hence, previous studies show that collaboration is important to improve responsiveness and mitigate effects of disruption, yet there is limited knowledge on how the underlying activities of supply chain collaboration influences supply chain resilience (Ambulkar, et al., 2015; Brusset & Teller, 2017). Collaboration can be defined as the ability of actors within a supply network to effectively work together to attain mutual benefits (Pettit, et al., 2010). Furthermore, some scholars argue that collaboration is the very glue that binds organizations in times of crisis (Faisal, et al., 2006). Due to the reconfiguration of supply chains, emphasizing collaboration will result in better SCRM (Sheffi, 2001).

A case study conducted by Leat & Revoredo-Giha (2013) into the ASDA pork meat supply chain in Scotland reviewed the importance of collaboration between actors in the network to have better mitigate risks. Empirical research conducted by Wieland & Wallenburg (2013) focusing on the influences of relational competencies (communication, cooperation, and integration) on supply chain resilience showed that communicative and cooperative relationships have a positive effect on resilience, while integration does not have a significant impact. Studies focusing on financial investments also found a positive correlation between cooperation by partners and improved supply chain security and resilience (Bakshi & Kleindorfer, 2009). Furthermore, a survey conducted by (Soni, et al., 2014) concluded that amongst fourteen enablers of SCRES that were measured, collaboration was the second most crucial enabler.

Also, Scholten & Schilder (2015)'s study found specific collaborative activities like information sharing increase supply chain resilience through their impact on visibility, velocity, and flexibility. Despite a growing amount of research showing the importance of collaboration in building resilience, studies have shown that many organisations still overlook this area especially in relation to investment (Christopher & Holweg, 2011; Wilding, 2013; Kamalahmadi & Parast, 2016). Two key factors are established as a prerequisite for effective collaboration:

I. Inter-firm trust, and

II. Information sharing

Faisal, et al., (2006) argue for the importance of trust, they believe it cultivates cooperation and collaboration within firms and across actors in the supply chain network. Hence, a lack of trust amongst actors within a network can lead to increases in supply chain risks (Sinha, et al., 2004). A study conducted by (Ponomarov, 2009) on mutual trust behaviours of buyer-supplier resilience and found that more mutual trusting behaviours can cause greater relational resilience in buyer-supplier relationships.

Thus, the findings allude that long-term relationship orientation cultivates strong mutual relationships allowing trusting behaviours to grow. Furthermore, a survey conducted by (Soni, et al., 2014) concluded that amongst fourteen enablers of SCRES under measurement, trust was seventh in the rank. Hence, trust is encouraged especially within the context of networks; this is due to research suggesting its benefits in enhancing resilience (Wicher & Lenort, 2012).

Some academics argue that information sharing is so pertinent that research must consider it a separate driver of resilience (Soni, et al., 2014; Kamalahmadi & Parast, 2016). Research conducted by Datta, et al., (2007) considered information sharing (IS) as an independent driver alongside with flexibility, monitoring, and decentralized structure. These four were selected as independent key drivers of SCRES in the study (Datta, et al., 2007). Information sharing is currently under-researched; however, it is vital in understanding the drivers of risk (Blackhurst, et al., 2011; Soni, et al., 2014; Kamalahmadi & Parast, 2016). The following section will critically evaluate the key area of sustainability.

2.4. Sustainable Supply Chain Management (SSCM)

Organisations in the 21st century face unprecedented pressure from various stakeholders to undertake their business operations in a sustainable manner (Wolf, 2014). For instance, various businesses have encountered scrutiny from stakeholders analysing some unethical business practices like Nestle (anti-deforestation), Nike (child labour), Apple (sweatshop labour) and Mattel (toxic materials) (Wolf, 2014). Furthermore, scholars have argued that the benefits of organisations undertaking sustainable business practices yield benefits, which exceed issues from stakeholders through possible reduction of long-term risks associated with pollution and waste management (Gualandris, et al., 2015). Hence, scholars have argued strongly against viewing sustainability as corporate social responsibility (CSR) or corporate philanthropy as this is limiting.

Instead, it involves a triple bottom approach, which involves economic, social and environmental concerns (Savitz & Weber, 2014; Touboulic & Walker, 2015). This triple bottom approach allows organisations to serve better both their shareholders and stakeholders (Carter & Rogers, 2008). In recognising the importance of SSCM, the research area has grown rapidly over the last decade due to acceptance of its strategic importance in most of the firm's operations by enabling sustainable practices (Burgess, et al., 2006; Hall & Matos, 2010).

Evidence pertaining to the maturing of SSCM as a field is conspicuous from the variety of literature reviews, which have sought to map the field, and the conclusions show the field continues to expand and evolve (Seuring & Müller, 2008; Carter & Easton, 2011; Touboulic & Walker, 2015). While there has been a significant rise in research focusing on SSCM, some academics have expressed concern over the 'theoretical dearth' surrounding most research (Carter & Rogers, 2008; Carter & Easton, 2011). Due to this, academics and practitioners advocate for the continuous development of the field from both a theoretical and practical perspective (Touboulic & Walker, 2015; Touboulic & Walker, 2016). However, to explore the current state of research adequately, this thesis will begin by defining SSCM.

The following sections will evaluate the development of SSCM definitions and select an appropriate definition for this research aspect of the thesis.

2.4.1. Defining Sustainability

There have been various definitions provided for SSCM (Touboulic & Walker, 2015). Table 6 presents some of the key definitions applied to this area. While definitions of SSCM date back to as early as 1996, there have been omitted from the table because they do not explicitly, define SSCM, instead they provide certain aspects e.g. environment or environmental aspects. However, as noted by Touboulic & Walker (2015) in their comprehensive literature review, most definitions that began to state explicitly SSCM came at the turn of the millennium.

Various authors concentrate on various aspects of SSCM, some on the procurement/purchasing angle and others opt to analyse the chain as a whole (Touboulic & Walker, 2015). However, recent definitions, especially over the last decade, have begun to focus on the triple bottom line (3BL/TBL) (Seuring & Müller, 2008; Pagell & Shevchenko, 2014). This is a deviation from the pioneering definitions, whose focus was on issues within sustainability e.g. 'green' or 'social' (Touboulic & Walker, 2015). The triple bottom line (TBL) framework of sustainability focuses on a firm's social, environmental, and economic performance. (Nichols, et al., 2019)

Hence, some scholars are noting that SSCM is integrating more by incorporating a wider variety of issues (Carter & Rogers, 2008; Spence & Bourlakis, 2009). Interestingly, this broad range of issues now includes the concept of 'pressure' from stakeholders (Meixell & Luoma, 2015) thereby increasing the expectations of organisations from simply focusing on economic performance to widening their scope (Touboulic & Walker, 2015). When looking at SSCM from an exogenous and endogenous operational perspective, the role of collaboration between supply chain partners becomes very crucial (Beske & Seuring, 2014). Despite, the increase of integrating various issues, there is still an absence of consensus on the definition of SSCM (Krause, et al., 2009).

This lack of consensus is due to the complexity of SSCM application in different industries with different priorities; it, therefore, becomes difficult to construct a cross-industry framework (Pullman, et al., 2009). The snapshot of definitions provided in Table 6 illustrates the variety of approaches taken by different authors. While they are much more conceptual diversity, the definitions selected are those that had better represent the 3BL approach.

Table 6: SSCM definitions from the literature

AUTHOUR/S	DEFINITION
Wolters (2003, p.8)	*Sustainable chain management [...] involves issues of sustainable development insofar as companies can be held responsible for the social and environmental impacts arising along the supply chain. It demands that companies integrate ecological and social aspects into their decisions and actions, not only internally but also along those supply chains that determine the economic value of their business*
Carter and Rogers (2008, p.368)	*The strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains*
Seuring and Müller (2008, p.1700)	*The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, into account, which are derived from customer and stakeholder requirements*
Spence & Bourlakis (2009, p.291)	*The chain-wide consideration of issues beyond the narrow economic, technical and legal requirements of the supply chain to accomplish social (and environmental) benefits along with the traditional economic gains which every member in that supply chain seeks*
Tate *et al* (2010, p.19)	*Firms are increasingly under pressure from stakeholders to incorporate the triple-bottom line of social, environmental and economic responsibility considerations into operations and supply chain management strategies*

Table 6 shows some of the definitions widely applied in SSCM research. However, for the purposes of this thesis, Seuring & Muller (2008) definition is the most pragmatic given the nature of focus on supply chain networks. It defines SSCM as *"the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, into account, which are derived from customer and stakeholder requirements"* (Seuring & Muller, 2008, p.1700).

This definition clearly adopts the triple bottom line (3BL/TBL) concept, which has become a major backbone of SSCM literature (Seuring & Muller, 2008). Thus, the drive to sustainability is through a triple-pronged approach of incorporating environmental, socio-cultural, and economic drivers (Lang & Barling, 2012; Lang & Ingram, 2014; Meixell & Luoma, 2015).

The 21st century has seen the rise of SSCM into prominence within SCM (Seuring & Muller, 2008; Pagell & Wu, 2009; Carter & Easton, 2011; Ahi & Searcy, 2013; Pagell & Shevchenko, 2014; Marshall, et al., 2015; Dubey, et al., 2017). The issue of building sustainability in supply chain networks is required urgent attention (Dubey, et al., 2017). For instance, Walmart auditing records indicate that 90% of all total emissions generated from its vast operations originate from its supply chain (Birchall, 2010). Furthermore, a report by the Carbon Disclosure Project (CDP) indicates that the largest 2,500 global companies are responsible for generating 20% of global greenhouse gasses (GHG) (CDP, 2017). This data shows the growing environmental concerns that are a key dimension of the 3BL approach to sustainability. However, to explore critically SSCM, an analysis of the three dimensions that constitute 3BL will take place in the following sections.

2.4.2. The Economic Dimension

Despite a plethora of theory touting the benefits of adopting a triple bottom line (TBL) approach, Milton Friedman argued that it is actually a dereliction of duty for a company not to put its shareholders first (Friedman, 1983) . The Shareholder Theory, is a normative theory of business ethics which holds that a firm's main responsibility is to its shareholders (Friedman, 1983). This approach views shareholders as the economic engine of the organization and the only group to which the firm is socially responsible. Therefore, before an organisation can spend money on social or environmental issues to satisfy other stakeholders, it must first maximise the profit of its shareholders. Therefore, according to Friedman the goal of the firm is to maximize returns to shareholders Friedman (2007). In essence, Friedman is arguing that shareholders can then decide for themselves what social initiatives to take part in, rather than have appointed managers make autonomous decisions (Friedman, 2007). This dimension has been the traditional focus of profit-making organisations; therefore, this area has attracted a lot of research (Touboulic & Walker, 2015) seeking to address the various issues associated with economic sustainability e.g. supply chain cost, service levels (Pullman, et al., 2009).

Friedman's approach differs with the consensus amongst a group of academics that economic sustainability is concerned with balancing the trade-offs required for a business to achieve its financial targets while protecting the environment and safeguarding society (Yusuf, et al., 2013). Hence, a number of researchers have conducted studies that have shown positive dependencies between economic performance and environmental incentives as well as addressing socio-cultural concerns. For instance, Carter & Rogers (2008) found that cost savings are feasible through the reduction of package waste as well as engaging in activities like recycling and re-designing to reuse. In addition, research into the economic dimension of the TBL concluded that firms could gain economic performance enhancements from undertaking environmental purchasing and sustainable packaging (Varsei, 2016).

Other improvements also include the reduction of health and safety (H&S) costs through introducing safer, sustainable warehousing, transportation and manufacturing (Varsei, 2016). A study by Hanson et al., (2004) reviewed the benefits of improving product quality and lead times gained from implementing environmental management standards, e.g. ISO 14000.

Rao & Holt (2005) argued that firms that engage in sustainability initiatives would improve marketing performance due to the positive association customers will make to their products thereby creating a good reputation, which fosters trust with partners in the supply chain. Despite these studies advocating for the positive benefits firms can draw from engaging in sustainability initiatives; other scholars differ with this assertion and claim research is still its infancy to draw solid conclusions (Pullman, et al., 2009; Varsei, 2016). Pullman, et al., (2009) argue that current research is inadequate in clearly indicating the financial benefits organisations can gain from engaging in social and environmentally sustainable. They advocate for researchers to investigate and clarify the trade-offs organisations should make between the three dimensions (Pullman, et al., 2009). Furthermore, Linton, et al., (2005) cautioned that firms adding sustainability onto their agenda are increasing the level of complexity they must contend with, both on a strategic and operational level.

Recent studies have also highlighted the financial cost firms will incur particularly in the initial stage of initiating sustainability issues (Wu & Pagell, 2011). This further strengthens Pullman, et al., (2009) argument for further investigations into trade-offs of engaging in sustainability initiatives.

2.4.3. The Environmental Dimension

The environmental dimension of SSCM research is often referred to as 'green supply chain management' and is mainly concerned with embedding environmental issues into supply chain processes and functions e.g. purchasing, product design, transportation etc. (Srivastava, 2007). Research within the environment dimension has concentrated on pressing issues perturbing supply chains like GHG (Paksoy, et al., 2011), resource depletion (Yusuf, et al., 2013), waste management (Tsai & Hung, 2009) and energy consumption as well as water consumption (Cholette & Venkat, 2009; Varsei, 2016). Most literature within SSCM has given prominence to the issue of GHG emissions, particularly CO2, due to its dire effects on both human health and the ecosystem (Varsei, 2016).

Srivastava (2007) identifies two main streams applied to environmental dimensions of SSCM research these are 'green operations' and 'green design'. Green operations focus on operational areas like remanufacturing, designing the supply chain to address issues such as waste including incorporating reverse logistics. (Srivastava, 2007). Green design mainly involves proactive integration of environmental concerns into the product/service 's design, processes and delivery (Ilgin & Gupta, 2010). Therefore, the main purpose of green design is to ensure the production of materials is through an environmentally friendly way and can continue to exhibit these qualities throughout the product's life cycle (Srivastava, 2007). Despite this, arguments have been put forward that separation of these two is not necessary, as they are closely dependant on each other (Jayaraman, et al., 1999; Varsei, 2016).

Apart from economic issues Touboulic & Walker (2015) in their comprehensive literature review mapping the field of SSCM, they argue that the environmental/green dimension to sustainability has gained the most research focus amongst academics. Touboulic & Walker (2015) conduct a descriptive statistical analysis of over 300 peer-refereed articles and conclude that most articles are concerned with environmental/green issues rather than the social dimension. Other scholars have noted neglect in focus on social issues within the current literature (Matos & Hall, 2007). Furthermore, Touboulic & Walker (2015) also note that the most recent articles from 2010 – 2013 have taken a more mixed approach, thus, they combine two or more dimensions e.g. environmental/green issues and social concerns. Their study shows that these mixed articles accounted for 39.9% of all published literature within the field. However, environmental/green issues continue to be the most dominant focus of research with SSCM.

2.4.4. The Social Dimension

Social sustainability requires firms to incorporate a set of social considerations into their business operations (Varsei, 2016). The social responsibility-related standards, codes of conduct, and reporting frameworks consider to some extent similar social criteria (GRI, 2017; SAI, 2017) and assimilation of these into supply chain management can occur. The social dimension in the Global Reporting Initiative includes four aspects: labour practices and decent work conditions, human rights, society, and product responsibility (GRI, 2017). These categories are also congruent with the guidelines of Social Accountability 8000 standard (SAI, 2017) and the International Labour Organisation (ILO, 2017).

Arguments put forward state that the social dimension incorporation into organisations is still in its infancy in relation to supply chain performance measures (Cetinkaya, 2011). One reason lies in the fact that implementing social initiatives across global supply chains is a complicated undertaking that there are many supply chain members for many multinational companies (Mamic, 2005).

The empirical study by Mamic (2005) highlighted this problem across sports footwear, apparel, and retail sectors in which there are often thousands of suppliers. The study suggested that focal companies should prioritise their suppliers according to their importance and the nature of the relationship with them. In addition, the research found that the influence of a focal company is the major determinant of adopting social initiatives at the supplier level (Mamic, 2005). Ansett (2007) acknowledges only a few organisations have grasped the strategic advantage of being socially sustainable at the supply chain level. This is despite the well-documented rewards of enhanced credibility and reputation, license to operate, risk mitigation and strategic innovation advantages. The implementation of social sustainability (or corporate social responsibility) practices at the supply chain level would face two interlinked challenges: firstly, how focal companies and their executives can make a long-term commitment to social sustainability (Andersen & Skjoett-Larsen, 2009).

Secondly, how committed focal companies can develop decision-making processes and business models underlying social issues to design and manage sustainable supply chains (Wu & Pagell, 2011). Notwithstanding these challenges, focal companies in today's business environment are increasingly under pressure to minimise the number of incidents regarding the social dimension at the supply chain level, which could harm their reputation (Greenhouse, 2013; Varsei, 2016). It is believed that reputation is *"a valuable corporate asset, hard to build, yet easy to diminish"* (Roberts, 2003, p.168). Some scholars have examined the linkage between social sustainability initiatives and financial performance outcomes, which could encourage focal firms to make a long-term commitment to social initiatives (Pullman, et al., 2009).

While these efforts have addressed the first challenge (as noted earlier) and may encourage organisations to create 'a business case for sustainability' (Schaltegger, et al., 2011), few studies in recent years have taken one step further and examined how social concepts can be applied to supply chains in order to provide insights for practitioners (Varsei, et al., 2014).

The study by Carter (2000) is among the first to analyse practically social issues in the global (i.e. international) supplier management. He advocated that setting up a mechanism for formally communicating codes of conduct and reporting violations of codes would dissuade supply chain members from engaging in unethical behaviours. His findings show that engaging in socially sustainable practices could create a win-win situation in supply chains, providing a secure business opportunity for all partners involved.

A few research gaps have been identified in the extensive literature review of SSCM conducted. The social, environmental, and economic dimensions should be analysed through integrated approaches, otherwise, it tends to be difficult for decision-makers to examine the linkages between the three sustainability dimensions and balance strategic priorities. This identifies a major gap in the literature (Brandenburg, et al., 2014). For instance, Blome, et al., (2014) highlights the following gap in their research; "*there is only limited knowledge about the performance benefits of the alignment of sustainability-related upstream and downstream collaboration*". This highlights two major gaps in SSCM literature: (1) supply chain collaboration and sustainability (Blome, et al., 2014) (2) how they can consider multiple aspects and follow a broad integrated approach to design and manage sustainable supply chains despite its inevitable limitations. Following an earlier analysis of risk and resilience, collaboration between supply chain partners will be explored in this thesis through a sustainability perspective. The following section will now contextualise the key research areas and design research questions.

2.4.5. Sustainability in Food Supply Chain Networks

Food in the 21st century is a global industry that is mainly under the hegemony of multinational companies (Little, 2002). Food is a basic human need it is only natural, that people are passionate about what they eat. This influences how consumers view corporate social responsibility of major food companies there-by elevating its importance (Hartmann, 2011).

The increased pressure for sustainable practices complicates the requirements food companies face from all stakeholders e.g. inputs/raw materials (animal welfare), the environment (energy, water, waste) and social (labour conditions) (Maloni & Brown, 2006). The production, processing, and distribution make up the bulk of operations within the industry and are extremely vital to its sustainability. Despite many advances in technologies and improved processes many people around the world still suffer from food starvation, shortages and inadequate quality (FAO, 2016). This is mainly due to a decline in basic resources e.g. water and land, hence, the issue of sustainability throughout the food supply chain has become critical and requires urgent redress (FAO, 2016). Tang & Musa (2011) provide an illustration of risks drivers and consequences in the context of the TBL in Figure 11.

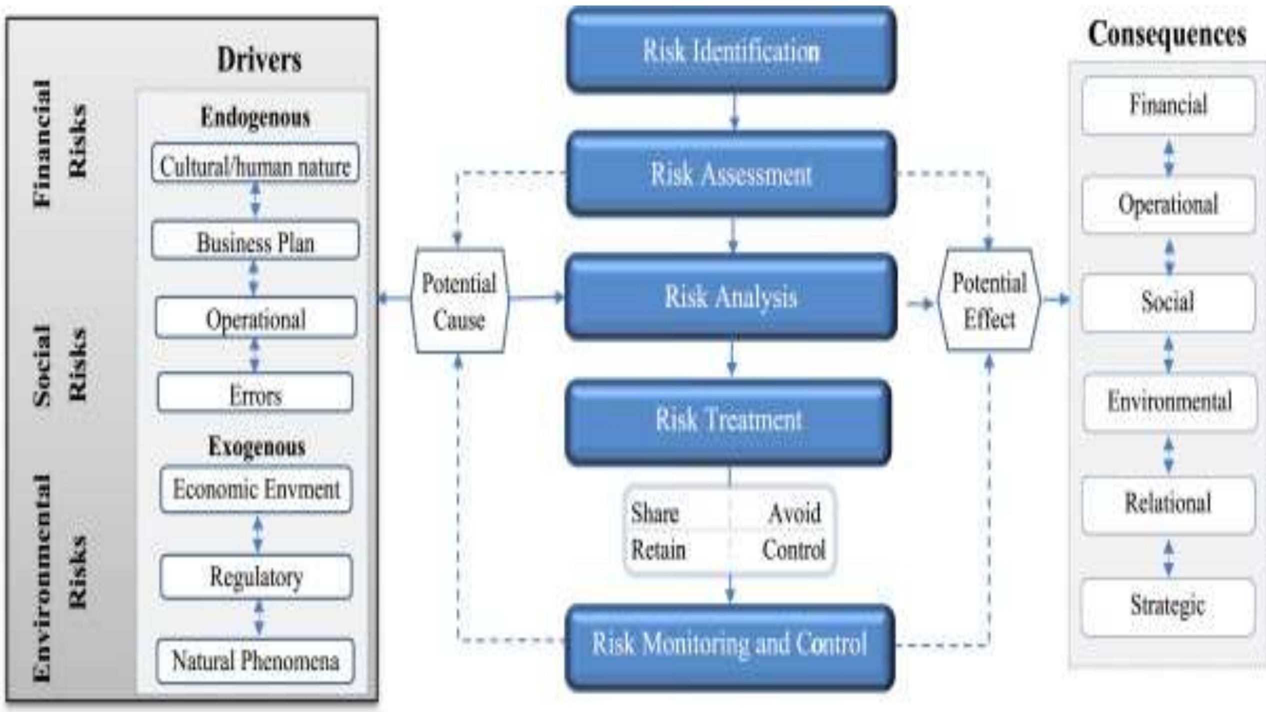


Figure 11: TBL risk factors

Source: (Tang & Musa, 2011)

Furthermore, the food industry is a high impact sector that strongly relies on natural, human, and physical resources (Hartmann, 2011).

This increases the pressure on both academics and practitioners to tackle the issue of creating sustainable resilient SCNs. To address the vulnerabilities and risks in current food SCNs, there is a need to fully adopt and implement sustainable development principles. (Sundkvist, Milestad, & Jansson, 2005). Academics and practitioners advocate for sustainability as an important consideration for supply chain management (Carter & Easton, 2011; Gualandris, et al., 2015). Furthermore, Sundkvist *et al* (2005), point out that the food production system has evolved over the past decades from a locally/regionally based operation to a global industry. While this has massively improved economic performance, it has also created many negative social and environmental consequences (Prima Dania, et al., 2016).

Studies linking supply chain sustainability to collaboration are still in infancy (Aggarwal & Srivastava, 2016). However, as previously mentioned studies have shown positive relationships between collaboration and firm performance (Simatupang & Sridharan, 2002; Simatupang & Sridharan, 2004; Squire, et al., 2009). Prima Dania, et al., (2016) identify two types of collaboration they argue we should view in singularity, which are vertical collaboration, and horizontal collaboration. Vertical collaboration is the relationship among stakeholders from upstream to downstream along the supply chain (Prima Dania, et al., 2016).

Horizontal collaboration is the relationship among stakeholders that play in the same level including competitors as well as external parties such as government, NGOs etc. (Barratt, 2004). The turn of the millennium has seen a rise in concerns regarding the role of collaboration in aiding attainment of supply chain sustainability especially within the food industry (Aggarwal & Srivastava, 2016). However, there is a consensus that collaboration is difficult to implement due to the complex nature of food supply networks (Aggarwal & Srivastava, 2016; Prima Dania, et al., 2016). Furthermore, the number of actors/partners within a network is a crucial factor in enhancing complexity, simply, the more they are, the level of difficulty in collaborating increases.

In addition, current research points to Bezuidenhout, et al., (2012) identified trust, commitment, and willingness to share risks as key factors in determining the ability of films within a network to collaborate effectively. While myriads of studies have been conducted focusing on collaboration either from a vertical or horizontal perspective concerning the food industry; there is scarcity of research undertaking a holistic approach that views these issues from a network perspective (Bezuidenhout, et al., 2012; Aggarwal & Srivastava, 2016). This thesis aims to address this gap.

2.5. Study Context – Food Supply Chains

The issues and challenges within global food networks have seen SSCM gaining wide attention from both academics and practitioners alike, due to its potential strategic long-term benefits (Carter & Easton, 2011; Touboulic & Walker, 2015). Food supply chains are the backbone of human survival on our planet. Whether these supply chains are local, regional or international, it is of no consequence, what is important is that food is available in the right quantity and quality (Dani, 2015). The food supply chain is not a single homogenous chain; on the contrary, it consists of a complex web of interwoven, interconnected, and at times integrated systems that ensure food moves from farm to fork (Dani, 2015).

Within the food supply chain, there are four main types of chains, namely, local, conserved, manufactured and commodity (Smith, 2008). Scholars like (Galli & Brunori, 2013; Nestle, 2002) argue for local or short food supply chains (SFSC) as an alternative to globalised food networks. SFSCs differ in nature, however, they are characterised by both physical and social distance (Galli & Brunori, 2013). They differ in size and characteristics throughout the world and can be either commercial or non-commercial. Galli & Brunori (2013) further argue that SFSCs can positively influence the following policy areas, local and regional development, integrated food strategies, business and development entrepreneurs as well as promote food democracy.

This, they point out will be through a variety of schemes, which include but are not limited to, box schemes, farmers' market, on-farm sales, direct internet sales and community gardening. The second supply chain is that of conserved food, this is important for food that must be in transport over long distances or that, which must be stored for consumption over prolonged periods of time (Hulse, 2004). Attainment of healthy nutritious food products through drying, salting, fermentation and smoking is now more efficiently accomplished, these can then be traded globally, and this has been one of the most enduring and effective food supply chains over the past millennium.

Technological advancements in the last couple of decades have seen variety increase within the conserved food chain through preserving food by canning, pasteurisation and freezing (Hulse, 2004), this has seen frozen meals become some of the most traded and consumed products in the 21st century. This is because this study will adopt a network theory approach and centrality in a network is a crucial assumption. Manufactured foods are products that have undergone a transformation from their natural state through processing. These can be food or drink and their supply chains can range from very simple to a complex web of producers, buyers, and multiple suppliers (Smith, 2008). Food manufacturing processes are under heavy regulation especially in developed countries where there are strict food safety laws and regulations to prevent fraud and malpractice (Fortin, 2017).

Unlike manufactured food that require massive amounts of traceability, the "commodity" supply chains tend to deal with the bulk wholesale of agricultural foods (Hochman, et al., 2014). These tend to include grains like wheat, corn, or soya beans and because these foods can be naturally stored over lengthy periods, some parts of the world will tend to have surplus while other parts may have an inadequate amount (Smith, 2008).

2.5.1. Food Systems as Supply Chain Networks (SCN)

The food supply chain is composed of a wide variety of actors producing diverse types of products to satisfy a diverse but demanding market. The actors within the supply chain fall into one or all categories dependant on the level of integration. The first category is the agricultural sector, which makes up the primary production of food, then the processing industry that is responsible for manufacturing and lastly the distribution and retail industry. According to Eakin (2010, pp. 81) *"vulnerability is a central concept in food system research, policy and management, since the negative outcome of food system vulnerability is food insecurity".*

In this context, food system refers to the path that food travels from farm to fork. It includes the growing, harvesting, processing, and packaging, transporting, marketing, consuming, and disposing of food. Food system also encompasses the inputs needed and outputs generated at each step. In this thesis, the 'food system' refers to the food supply chain network (FSCN). Therefore, the supply chain is a significant component of the food system. Despite, general acceptance on the importance of researching vulnerability of perishable food SCNs, studies continue to be nebulous as a myriad of definitions and terms that seem to overlap are awash in the literature (Hinkel, 2011).

Also, research produced by Khazai et al, (2014), concluded that the knowledge base which exists in other fields and is primarily used to assess and understand data, methods and research initiatives does not exist within food supply chain research. Therefore, this creates a gap in current knowledge and understanding. However, scholars are beginning to attempt to plug this gap as Paloviita et al., (2016) noted, research is beginning to grasp the complex issues surrounding vulnerabilities of food SCNs.

2.5.2. Vulnerability of Food SCNs

Ericksen *et al* (2010) point out that this endeavour to understand vulnerability is twofold, firstly, it focuses on global environmental issues and secondly, a societal change which draws on multiple factors to influence the direction of research. Therefore, the identification of vulnerabilities within the SCNs is paramount in terms of rectifying the issues perturbing the food industry. Research conducted by Paloviita et al, (2016), identifies two main gaps in food-related vulnerability studies:

1. *There is a lack of structured representation of food SCNs vulnerabilities*
2. *The current concept of resilience within food SCNs is not operational*

Furthermore, the CIPS (2013) argue that all supply chains bare inherent weaknesses within their networks. However, supply chain actors can build intrinsic tolerance into supply chains through contingency design measures (CIPS, 2013). Issues will only arise when a disturbance or disruption occurs that is outside the natural tolerance or ability of the supply chain to withstand it; this point becomes the area of vulnerability (ibid). Hence, Paloviita *et al* (2016), argue that currently within food SCNs, there is a lack of structured representation of vulnerabilities.

CIPS (2016) argues that due to the increased complexity of SCNs, many potential points of weaknesses now exist which complicates the building of resilience. Furthermore, previous research has focused on significant disruptions/events. However, the CIPS (2013) argues that an accruement of minor issues throughout the supply chain can be equally devastating to business performance. Cutter *et al* (2003) argue vulnerability is a highly contextualised and location-based concept. Therefore, food businesses need to consider the idea of building strategic resilience that draws on innovative mechanisms to increase business performance (Manning & Soon, 2016). Therefore, when building SCRES, businesses must consider many contextual issues, e.g. exposure, sensitivity and adaptive capacity (Cutter, et al., 2003).

Exposure in the case of food SCNs refers to the impact of climate change on the supply chain. However, propositions from the literature (Paloviita, et al., 2016) based on deductions suggest that the impact of climate change will vary amongst different countries and regions as some suffer worse from the effects in comparison to others. Due to the uniqueness of food SCNs (Leichenko, et al., 2010) there are not only exposed to climate or environmental vulnerabilities but are prone to several social factors. These two-pronged vulnerabilities are what Leichenko *et al* (2010) refers to as the concept of 'double exposure'. However, one significant drawback in vulnerability identification is its fluid nature, as Hinkel (2011) points out; it is a theoretical concept and not a stable observable occurrence that can come under easy measurement. Hence, criticism of vulnerability research in food is its substantial skewness towards agriculture while ignoring the wider SCN (Eakin, 2010).

To address this imbalance (Paloviita, et al., 2016) developed a framework for vulnerability indicator as well as explored the difficulties associated with its measurements. This point is further emphasised by Lang & Barling (2012) who points out that even at a governmental level, most states in the 20th century had a Ministry of Agriculture, not food. Hence, most policies and consequently, the main research focus has been on the agriculture level at the expense of the entire food SCN (Lang & Barling, 2012) Furthermore, food supply chains have a natural cycle of 'inside-out' impacts (Paloviita, et al., 2016). Inside-out refers to the impact food supply chains have on the environment and society. On the contrary, there are also 'outside-in' factors, which are external issues that affect the operations of food supply chains (Paloviita, et al., 2016). Khazai *et al* (2014) classify vulnerability into two categories:

1. Exogenous – Natural drivers
2. Endogenous – Social drivers

2.5.3. SCRES and SSCM in Food SCNs

Consequently, exogenous drivers (Khazai, et al., 2014) are what the CIPS refers to as 'fragility'. Hence, there are concerned with natural and external vulnerabilities to the supply chain (Khazai, et al., 2014; CIPS, 2013). Examples of vulnerability include severe weather events, climate change, and global environmental change (Paloviita, et al., 2016). These exogenous drivers are continuing to increase the complexity of managing FSCNs, as there are incalculable. FSCN complexity is driven by is about their timing, magnitude, locality, and effect on the vulnerability of the network (Linnenluecke, et al., 2012; Beermann, 2011). The negative impacts of climate change on global food systems through the rapid increase of carbon dioxide levels into the atmosphere are well-researched (Rosenzweig & Parry, 1994; Myers, et al., 2017).

Contemporary research has portrayed a bleak future for global crop yields and animal production due to climate change creating a socio-economic crisis (Parry, et al., 2004). Many multinational food companies responding to current research and growing concerns of the bleak ecological impacts damaging environmental practices cause are adopting initiatives to green their supply chains (Rueda, et al., 2017). The food industry is heavily dependent on favourable environmental conditions (Maloni & Brown, 2006) as primary production (agriculture) requires the natural environment. Therefore, a disruption in the environment has adverse effects on the involved actors of that chain. For instance, in February 2017, the United Kingdom (UK) suffered a vegetable shortage (BBC News, 2017).

The vegetable shortage was a result of poor growing conditions in Southern Europe, mainly Italy and Spain that experienced a combination of flooding, extremely low temperatures, and reduced light levels due to a lack of consistent sunshine (Flynn & Devlin, 2017). UK supermarkets rationed vegetables like courgettes, spinach, tomatoes, peppers, lettuce, and cabbage resulting in supply falling by approximately 25% - 30% (BBC News, 2017).

These disruptions exemplify the vulnerability of the food supply chain. These disruptions are made worse by the ripple effect created when one actor's fragility (CIPS, 2013) fails to withstand the external pressures and the inherent tolerances built into the system collapse. Depending on the severity, it can affect many actors throughout the SCN, instigating chaos, which could ultimately result in weaknesses and potential risks (Bowman, 2015; CIPS, 2013). On the other spectrum are 'endogenous drivers' which are mainly concerned with socio-economic drivers as well as anthropogenic impacts.

Thus, the social drivers of vulnerability (Khazai, et al., 2014) primarily influence it. Asbjornslett (2009) designed the theoretical framework to illustrate the internal and external factors influencing susceptibility within the supply chain. The internal factors identified include staff factors, maintenance factors and system attributes. The external factors mainly comprise of, financial considerations, market factors, legal issues and environmental factors (Asbjornslett, 2009). Furthermore, data released from CIPS shows that global supply chain risk is at the highest level in 24 years (Buist, 2017). The measure derives from an index score that measures risks based on, socio-economic, physical trade and business continuity factors and weighted according to region's contribution to global export (CIPS, 2017).

The measure scored global supply chain risk at 82.64 out of a score of 100. This dire view of the current is further, supported by the Business Continuity Institute (BCI), which released its report in November 2016, focusing on global supply chain resilience. The report's evidence emanates from a survey of firms based in 64 countries on all continents; most respondents were from Europe and North America, which made up 70% of all respondents (BCI, 2016). The loss of productivity emanating from supply chains lacking adequate resilience to risks and vulnerabilities has increased year on year from 58% in 2015 to 68% in 2016 (BCI, 2016). This ultimately affects the cost of working as staff work overtime to rectify the arising issues; hence, the increase from 39% to 53%.

While the level of supply chain resilience has decreased, and risk has increased, it is essential to notice that the source of these disruptions from immediate suppliers is falling. Therefore, the researcher postulates that firms are increasingly operating from a network perspective; hence, the decrease in the source of disruption emanating from an immediate supplier. Therefore, this thesis will research from a network perspective with the main aim of considering this phenomenon. Concerning sustainability, the Carbon Disclosure Project (CDP) released its global supply chain report focusing on sustainability. It derived information from 89 of its members including companies like, Bank of America, Wal-Mart Stores, Inc., PepsiCo, Inc., The Coca-Cola Company, who have a combined annual procurement spend on approximately US$2.7 trillion (CDP, 2017). These 89 members leveraged their suppliers totalling 8,200 firms, thus obtaining information for the report. A significant finding of the report centred on the improvement of supply chain sustainability could occur through collaboration (CDP, 2017).

Surprisingly, the report findings show that only 22% of the companies were effectively collaborating with their suppliers on sustainable issues. So, why are so few companies collaborating? What are the drivers and barriers? These are some of the problems arising, and this thesis aims to make a knowledge increment in this research area. Furthermore, a study conducted by Leat & Revoredo-Giha (2013) into risk and resilience in the agri-food supply chain concluded that collaboration with partners in the network could vastly reduce risk and improve resilience. Despite the study interviewing supply chain managers a gap in knowledge remains regarding how best to operationalise collaboration in the SCN to combat challenging issues. An analysis of the research problem has reviewed that current studies do acknowledge the benefits of collaboration; however, there is a lack of knowledge on how firms could implement this in a network perspective and the impact on building resilience and sustainability.

2.6. Thesis Theoretical Approach

As established in section 2.1 in the constructed definition of SCM research, which contests the rather simplistic portrayal of supply chains as linear systems, operating within dyadic relationships (Carter, et al., 2015). Recent studies have shown that this linear characterisation, while effective at explaining supply chains in a straightforward manner, oversimplifies the operational reality of 21st-century chains (Hearnshaw & Wilson, 2013). Other scholars have viewed this as more of a progression, Cousins, et al., (2008), identified three main stages of development namely, dyadic linkages, a chain of suppliers and supply networks.

Globalisation and various changes to supply chain structures have rendered dyadic relationships obsolete in their representation of the current landscape, instead 'triads' are now viewed as the starting point of supply chain, hence the move to view them as networks (Mena, et al., 2013). Supply chains and supply networks both describe the flow and movement of materials and information, by linking organisations together to serve the end-customer. However, 'Network' describes a more complex structure, where organisations can be cross-linked and there are two-way exchanges between them: 'chain' describes a simpler, sequential set of links (Harland, et al., 2001).

A supply chain network shows the links between organisations and the information and materials flows between these links. The more detailed the supply chain network the more complex and web like the network becomes. Trienekens *et al* (2012) explain in detail how the complexity of 21st-century dynamic food supply chains (FSC) require much more in-depth research to improve information systems, quality and safety standards (Trienekens, et al., 2012). There are two types of flows crucial in linking organisations within a SCN.

Material Flow: This is the most visible part of the network and is concerned with the movement of raw primary goods (apples) to the finished products (apple juice) to the end consumer.

Information Flow: Is the demand from the end-customer to preceding organisations in the network (Mentzer, et al., 2001).

Financial Flow: Is the economic aspect of the supply chain that is concerned with flow of funds from buyers to sellers. This involves investment, costing, and capital expenditure. It is critical to the profitability and optimisation of the supply chain.

Supply chains have become complex with different layers, moving away from the perspective of buyer and supplier dyadic relationships (Hearnshaw & Wilson, 2013). The chain itself is no longer liner and the focal firm may at times be both a buyer and supplier thus, increasing the level of complexity (Cox, et al., 2006). Despite the vast amount of research within SCM, the contrast between supply chains and supply networks is still in its infancy and further investigations are required within this area (Braziotis, et al., 2013). Table 7 applies a study by Braziotis, et al., (2013) to clarify the difference between supply chains and supply networks.

Table 7: Differences between Supply Chains and Supply Networks

Dimensions	***Supply chain***	***Supply network***
Focal concept	Products (and services)	Relationships
Design and configuration	Linear and ongoing, relatively stable structures (due to established power attributes)	Non-linear and dynamic structures (non-established power attributes)
Complexity	Low	High
Operations	Predictable and stable	Unpredictable/un-solidified
Coordination	Management focuses on the coordination of flow (information, products and finance) and on integration	Management focused on the coordination of the web of inter-firm relationships
Integration	Structured	Ad hoc/unplanned
Means to enhance competitiveness	Cooperation, collaboration, and coordination among SC members involving competition between these members on some occasions	Cooperation, collaboration, and coordination among members of a web of SCs. At the same time, it involves conflict and competition too

Source: Braziotis *et al* (2013)

As shown in Table 7, Braziotis, et al., (2013) provided clarification on the specific characteristics of supply chains and supply networks concepts and provided the key distinguishing factors. Supply chains operations are mainly within a structured and integrated manner. However, SNs are much more complex and involve many more actors; hence, they operate in a dynamic business environment (Braziotis, et al., 2013). This thesis will conduct research from a network perspective. This research will refer to this as the supply chain network (SCN). To summarise, an analysis of the SCM landscape provides a definition and parameters for the study by focusing on SCN.

2.6.1. Theory concepts and applications

Scholars find themselves inundated with terminologies such as “supply chains”, “demand pipelines” (Farmer & Van Amstel, 1991), “value streams” (Womack & Jones, 1994), “support chains”, and many others. The term supply chain management (SCM) was originally introduced by consultants in the early 1980s (Oliver & Webber, 1982) and has subsequently gained tremendous attention (LaLonde, 1998). A number of fields such as purchasing and supply, logistics and transportation, operations management, marketing, organizational theory, management information systems, and strategic management have contributed to the explosion of SCM literature and therefore the development and adaptation of various theories (Chen, 2004). Thus, it is vital to gain grounded understanding of the foundational theories applied in SCM as these inform current research and help map the future directions (Seuring & Müller, 2008; Touboulic & Walker, 2015). Most of the theories applied in SCM literature are adapted from other fields e.g. accounting, management, economics, sociology etc. (Carter, et al., 2015). Due to adaptation, the majority of theories applied in SCM have been in development and use in various research fields before the concept of SCM was conceptualised. Table 8 lists the most common theories applied within SCM.

Table 8: Theories commonly used in SCM research

THEORY	***DEFINITION***
Natural/Resource Based View (N / RBV)	*A firm's competitive advantage lies predominantly in its ability to harness its resources both tangible and intangible* (Hunt & Davis, 2012)
Game Theory	*Economic decisions involving more than one actor (e.g. a buyer and a supplier) take the form of a sequential, strategic game involving anticipation by one player of the other player's actions* (Sanderson, et al., 2015).
Systems Theory	*This theory argues that no system, in this case a supply network, should be thought of in terms of its component parts. Rather, it is argued that the processes and outputs of a system can be understood only by considering it in its totality* (Ketchen & Hult, 2007)
Transaction Cost Economics (TCE)	*TCE aims to reduce the costs associated with carrying out a transaction when deciding whether to make-or-buy. There are three attributes which influence a firm's decision to make or buy: frequency of transaction, asset specificity and degree of uncertainty associated with a transaction* (Sanderson, et al., 2015)
Social Network Theory (SNT)	*The SNT looks at the behavioural and social aspects of many different relationship types, including firm-firm, individual-firm and individual-individual relationships. It helps to analyse these relationships from different perspectives such as technical, financial and social elements* (Ketchen & Hult, 2007)

Agency Theory	*The agency theory implies that the retail chain is a series of agreements between shareholders. This agency relationship arises when groups of owners, known as the principals, hire another group, called agents for the day-to-day operations of a supply outlet some services are delegated to the new decision-making authority. Agency relationships in supply chain management are those between suppliers and management and between buyers and suppliers* (Ketchen & Giunipero, 2004)
Network Theory	*Competitive advantage can only be achieved through efficiently and effectively orchestrated network of supply chains. Therefore the focus of the network theory is to develop long-term, trust based relationship between supply chain firms in a supply network* (Ketchen & Hult, 2007)
Institutional Theory	*Institutional theorists assert that the institutional environment can strongly influence the development of formal structures in an organization, often more profoundly than market pressures* (Ketchen & Hult, 2007)
Dynamic Capability	*"the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments"* (Teece, 2013)

This section will now provide a brief reflexive synopsis of the theories considered for this thesis and the concepts drawn from them by the researcher. SCM is continually evolving and one cannot rely on theory or approach to investigate and explain the phenomena in all its facets (Halldorsson, et al., 2007). Therefore, the researcher applies a pragmatic approach to theory concept selection by answering one simple question; what theoretical concepts work best? The study approach is pragmatic; thus, it requires a theory whose, behavioural assumptions, problem orientation and primary focus of analysis can work best to answer the research questions. Theories are commonly classed in three distinct categories; Grand theories, Middle-range theories and Small-scale theories. To undertake this study robustly the researcher considers four possible theories that would best work to research the SCM phenomenon under investigation:

I. Network Theory
II. Resource Based View Theory
III. Complex Adaptive Systems Theory
IV. Dynamic Capabilities Theory

The study will apply a mix of theoretical concepts to analyse the complex and dynamic perishable food SCN. While the study will draw heavily on supply chain network theory (SCNT) (Hearnshaw & Wilson, 2013; Wellenbrock, 2013), it will apply the theoretical concepts of, resource-based view (RBV), complex adaptive systems (CAS) and dynamic capabilities (DC). This pragmatic approach to analysis relies on the application of theoretical concepts rather than conducting the research from one theoretical lens. By drawing on the various theories, the study can analyse how to build SCRES and sustainability into perishable food SCN effectively. Table 9 illustrates the theories considered for this study.

Table 9: Theory concepts logic

THEORY	Theoretical Assumptions, Orientations and Focus of Analysis	Logic for Consideration
i. Network Theory	Network theory disputes that firms operating within a network can be independent. Instead, NT argues actors are constrained from acting autonomously and are linked through the exchange of information, materials and finances (Hearnshaw & Wilson, 2013; Harland, et al., 2001)	Firms need to mitigate risk appropriately while continuously building resilience and sustainability into their operations. Supply chain managers must fully understand the intricate structure and interactions of their network (Hearnshaw & Wilson, 2013).
ii. Resource Based View Theory (RBV)	RBV attempts to explain firm sustainable competitive advantage as stemming from firm resources that are rare, valuable, hard or impossible to imitate or duplicate, and hard to substitute (Bromiley & Rau, 2016)	Firms are heterogeneous and therefore poses unique resources which can be leveraged to build resilience and sustainability within a supply chain network (Hitt, et al., 2016; Barney, 2001; Wernerfelt, 1984)
iii. Complex Adaptive Systems Theory (CAS)	Three key concepts underpin CAS. 1) Internal Mechanisms 2) External environment 3) Co-evolution (Nair & Reed-Tsochas, 2019; Carter, et al., 2015; Choi, et al., 2001)	A supply chain should be treated not just as a supply chain but also as a complex adaptive supply network (CASN) (Li, et al., 2010)
iv. Dynamic Capabilities Theory (DC)	DC proffers that an organisation's basic competencies should be applied to generate short-term competitive positions that can be exploited into longer-term competitive advantage (Teece, 2013; Teece, et al., 1997)	DCs are concerned with the sensing, seizing and transforming needed to design and implement a business model. Thus, firms in the SCN would be investigated from a DC perspective (Teece, 2018)

2.6.2. Theory Applications

Network Theory

Firms need to mitigate risk appropriately while continuously building resilience and sustainability into their operations. Supply chain managers must fully understand the intricate structure and interactions of their network (Hearnshaw & Wilson, 2013). Thus, Choi & Hong (2002, p. 491), argue, *"if we are to truly practice the management of supply networks, we need to understand the structure of supply networks and be able to build theories of supply networks".* The problem is most research has consistently characterised supply chains as simple linear systems resultant from firms interfacing through dyadic relationships (Cox, et al., 2006). Thus, scholars are advocating for the re-conceptualisation of supply chains from simple linear systems to complex adaptive systems whose characteristics include the embeddedness of interactions between many entities within a supply chain not simply focusing on the strong links between a few firms (Pathak, et al., 2007; Li, et al., 2010). Therefore, this concept of linear, dyadic sequential relationships though convenient, has applied simplicity to supply chains that negate the current complexities within the field (Hearnshaw & Wilson, 2013).

Various research scholars have drawn on different assumptions of the NT in justifying its application to supply chain research. For instance, scholars (Harland, 1996; Wellenbrock, 2013) have identified three key assumptions of the network theory that make it suitable for application in SCM research. These three assumptions are:

I. Firms operating within a network are constrained from acting autonomously. Hence, Harland (1996) identifies four key factors important to the formulation of a functioning network, which is, *"the selection of collaborative partners, the establishment of a competitive position, the monitoring of competitors and correct management of relationships".*

II. Centrality in the network is considered a key competitive advantage

III. Firms in a network will enhance information sharing which will increase efficiency and create significant partnerships, which will result in strategic relationships (Wellenbrock, 2013).

Therefore, network theory argues that firms rely not only on their relationship with direct partners but with the extended network of relationships with supply chain firms (Chicksand, et al., 2012). Furthermore, it posits that a competitive advantage can only be achieved through efficiently and effectively orchestrated a network of supply chains (Wellenbrock, 2013). Hence, the focus of network theory is to develop a long-term, trust-based relationship between supply chain firms in supply networks (Chicksand, et al., 2012; Wellenbrock, 2013; Baez, 2016). In addition, empirical research conducted in real-world settings across various disciplines identifies a number of critical properties that underpin network theory application e.g. social (Newman, 2001), business (Souma, et al., 2003), ecological (Sole´ & Montoya, 2001), mathematical biosciences (Moslonka-Lefebvre, et al., 2012) and supply chain management (Hearnshaw & Wilson, 2013). Various real-world empirical studies identify three key properties necessary for effective supply networks (Hearnshaw & Wilson, 2013). These are:

i. A short characteristic path length

ii. A high clustering coefficient

iii. The presence of a power law connectivity distribution (Ramasco, et al., 2004; Barabasi, 2009)

Dynamic Capabilities (DC) theory

Historically, supply chains have been conceptualised as straightforward linear systems characterised by a dependence of firms transacting through dyadic relationships (Carter, et al., 2015; Cox, et al., 2006). While this characterisation of supply chains as simplified linear systems was applicable in the 20th century, (Pathak, et al., 2007; Li, et al., 2010) research has shown the complexity, and the adaptation of organisations to changing business climates has caused a reconfiguration of supply chains. Most sustainable supply chains are located in complex and dynamic environments; hence, Hammervoll et al., (2012) argue that it is critical to apply dynamic management theories when undertaking SSCM research. Despite this, DC is seldom applied in the SSCM studies yet in sustainability literature it is viewed as a source of competitive advantage (Hammervoll, et al., 2012). This study will analyse both internal (organisational) and external (SCN) capabilities. This approach is critical because supply chains are dynamic and constantly evolving (Masteika & Čepinskis, 2015). Internally, DC can be crucial in analysing an organisation's basic competencies. This will create a strategic approach on how these capabilities can be applied to generate short-term competitive positions. These can be further exploited into longer-term competitive advantage (Teece, 2013; Teece, et al., 1997)

Resource Based View (RBV) theory

RBV attempts to explain a firm's sustainable competitive advantage as stemming from firm resources that are rare, valuable, hard or impossible to imitate or duplicate, and hard to substitute (Bromiley & Rau, 2016). Within a supply chain network, the various firms are unique and poses different resources that make them more competitive over other firms. This view needs to be explored further in a perishable food supply chain where network firms are effectively trading the same product. It is critical to analyse how these resources can be used to build resilience and sustainability into the SCN. However, current research is mostly conceptual regarding this aspect of RBV. Firms are heterogeneous and therefore they pose unique resources, which can be leveraged to build resilience and sustainability within a supply chain network (Hitt, et al., 2016; Barney, 2001; Wernerfelt, 1984). This study aims to advance research in this aspect by drawing on RBV concepts in the analysis.

Complex Adaptive Systems (CAS) theory

Carter et al., (2015) point out the supply chain as a network operates as a complex adaptive system (CAS). This means it is self-organising and actors have control over their sphere of influence, e.g. resources (Nair & Reed-Tsochas, 2019). Three key concepts underpin CAS. 1) Internal Mechanisms 2) External environment 3) Co-evolution (Nair & Reed-Tsochas, 2019; Carter, et al., 2015; Choi, et al., 2001). Hence, supply chain research is changing direction through recognition of the limitations presented by a linear view, which, focuses on dyadic relationships and negates to account for various levels of dependencies that exist between many heterogeneous firms within a supply chain (Choi, et al., 2001; Choi & Wu, 2009). In recognition of these changing dynamics, this study will be conducted from a network theory perspective. Therefore, this study aims to contribute to the re-conceptualisation of supply chains as complex networks. In an attempt to provide supply chain practitioners and researchers with an appropriate depiction of the current, Choi & Wu (2009) developed the '*Network Model*'. Carter, et al., (2015) in an attempt to move the field towards a theory, provide vital characteristics of supply chains. First, they argue the supply chain is broadly a network and therefore, scholars should move away from the dyadic and triadic research approach. Instead, they claim the supply chain is a network, consisting of nodes and links. This study agrees with this analogy; hence, the thesis aims to investigate perishable food supply chains from a network perspective.

However, power and emergence are difficult due to high degrees of complexity and dynamism. Furthermore, the supply chain is relative to a particular product and agent; this is akin to Brusset & Teller, (2017) analysis that states that supply chains are highly contextualised. Hence, this study identifies the uniqueness of perishable food supply chains and the importance of yielding new insights into the field of SCM. Carter et al., (2015) focus on the components of the supply chain by arguing it consists of both a physical and a support supply chain. Thus, they include other often-neglected areas like information systems (IS) as critical, non-physical components of the supply chain. A crucial point is also the limitation of supply chain actors to see beyond their horizon (Carter, et al., 2015). This horizon can constitute physical distance, cultural distance, and closeness centrality (Choi & Krause, 2006).

2.7. Chapter Conclusion

A critical review of the published literature has drawn out a number of research gaps. FSCNs are becoming more vulnerable to disruptions due to increasing complexities from evolving operations, which have progressed from a local/regional level to a global industry (Mangla, et al., 2018; Sundkvist, et al., 2005). Thus, food supply chains are susceptible to disruptions caused by sudden shocks and poorly managed issues due to their interconnectedness and at times intertwinement of actors in the system (Diabat, et al., 2019). While scholars acknowledge the importance of investigating SCM from a network perspective, empirical research remains limited (Carter, et al., 2015; Chicksand, et al., 2012). Therefore, the following the following gaps were identified in relation SCRES and SSCM:

- Despite a significant rise in research focusing on SCRES and SSCM in the last two decades, it still lacks integration and the combinatory effect of these two concepts on SCNs is still underexplored (Ivanov, 2018; Papadopoulos, et al., 2017; Fahimnia & Jabbarzadeh., 2016).
- There is inadequate empirical research focusing on SCRES and SSCM from a network perspective (Wang, et al., 2018; Iakovou, et al., 2016). Most research focuses on dyad and triad supply chain relationships (Stone & Rahimifard, 2018; Chicksand, et al., 2012). Therefore, solutions drawn from linear supply chain analysis may be inadequate to address SCN risks and vulnerabilities.
- Current research lacks a unified operational and functional framework investigating the nexus between resilience and sustainability as well as its ability to manage evolving risks and vulnerabilities (Ali & Shukran, 2016; Brusset & Teller, 2017; Busse, et al., 2017).

- Perishable food supply chains are complex and dynamic and the issues perturbing these networks are highly contextualised, therefore, further research is urgently needed (Rohm & Aschemann-Witzel, 2019; Siddh, et al., 2017; Bowman, 2015)

Therefore, building resilience and sustainability requires an analysis of how food firms can prepare, resist and rebound from disruptions in a complex and dynamic business environment (Ali, et al., 2018). Furthermore, it is crucial that perishable food SCNs be able to maintain TBL functionality over the longest period possible. This thesis aims to address the lack of research exploring the interplay between SCRES, SSCM, and its impact on SCN management. The study draws on the tenets of supply chain network theory (SCNT), dynamic capabilities, and resource-based view (RBV) and complex adaptive systems (CAS) to investigate how firms operating in a SCN can build and sustain resilience and sustainability.

CHAPTER 3: Research Methodology

3.0. Chapter Introduction

The main aim of this thesis is to investigate how actors operating in a perishable food SCN can attain and sustain a resilient and sustainable supply chain network. Therefore, the purpose of this chapter is to elucidate the philosophical positioning and justify the methodological approach undertaken to answer the research questions. To achieve this, an exploratory *cross-sectional* embedded case study is undertaken from a pragmatic philosophical positioning. Data collected were analysed using qualitative content analysis. Chapter 3 maps out the processes and procedures applied to ensure high quality and trustworthiness of the study in fulfilling the main research aim.

3.1. Research Methodological Design

In the field of operations and SCM, case studies are critical in providing an intensive state-of-the-art investigation and exploration of the phenomenon in its real-life (natural environment) setting (Grant, 2016). This study utilises a qualitative cross-sectional study focussing on a case of the perishable food SCN. Philosophically, a pragmatist approach is adapted due to its characteristics as both a lived and living philosophy; this will be explained in detail in the following sections. The case study is a critical method in operations and SCM research. This due to its power and versatility, which is crucial to studying historical or current phenomena (Voss, et al., 2002). This study was conducted in its real-life and natural setting, which allowed the research to draw data from different sources and actors operating within a perishable food SCN. Furthermore, investigations of the same issues within the SCN were conducted from a variety of contexts. Table 10 presents the peer-refereed research that was applied in designing the research methodology to ensure rigour in achieving the study purpose.

Table 10: The research methodology was structured from the following peer-refereed research

Author/s	*Research and Focus Area*	*Methodology*
Choi & Hong (2002)	**Supply Chain Networks** • Automotive industry	**Case Study** • Semi-structured interviews • Documents • Observations Three-dimension analysis utilising within and cross-case analysis
Matopoulos *et al* (2007)	**Supply Chain Collaboration** Agri-food industry	**Single Case Study** Semi-structured interviews
Soosay *et al* (2008)	**Supply Chain Collaboration** Logistics industry	**Exploratory Case Study** Semi-structured interviews
Touboulic & Walker (2016)	**Sustainable Supply Chain Management**	**Qualitative Study** Pragmatic qualitative research
Purvis *et al* (2016)	**Supply Chain Resilience** Beverage industry	**Exploratory Case Study** • Unstructured interviews • Verbal narratives Documents
Ali *et al* (2017)	**Supply Chain Resilience** • Food industry	**Exploratory Case Study** • Semi-structured interviews Content analysis
Ramos Castro & Swart (2017)	**Sustainable Supply Chain Management** • Food industry	**Qualitative Study** • Semi-structured interviews

Table 10 shows the peer-refereed research that influenced my methodological design.

The methodological research design follows a process that culminates with the collection and analysis of data.

Figure 12 illustrates the process through the research onion (Saunders, et al., 2016). The diagram illustrates the five stages of research progression used to formulate and design an effective methodology, which best addresses, the research problem.

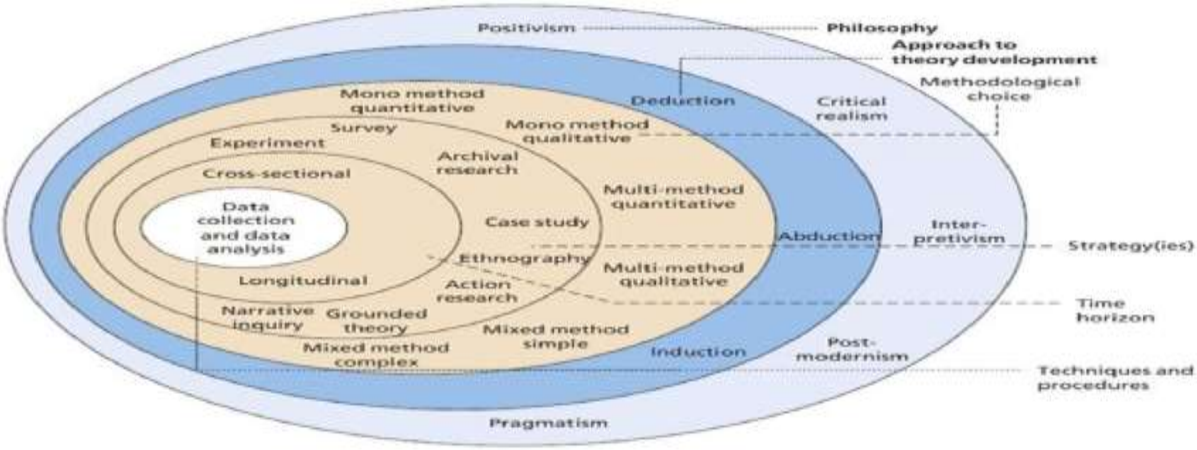


Figure 12: The Research Onion

Source: Saunders *et al* (2016)

Therefore, the aim of the following sections is to:

i. Discuss the researcher's philosophy in relation to other philosophies

ii. Expound on the choice of research methodology and provide justification

iii. Outline the methods undertaken to answer the research questions

To do this effectively, the writer will use the research onion as illustrated in Figure 11 above to formulate an effective methodology.

Table 11 provides a synopsis of the philosophical and methodological approaches adapted to satisfy the thesis main aim and objectives. Therefore, Table 8 outlines the ontology, logic, epistemology, research methodology, methods and data analysis techniques applied to satisfy the thesis research questions.

Table 11: Thesis philosophical and methodological overview

ONTOLOGY	**The Subjectivism Problematic** This thesis will be undertaken from a subjective problematic which views knowledge and reality as culturally situated and highly correlated to a context, time, place and people/individuals (Cunliffe, 2011). Therefore, this study accepts that perishable food SCNs are highly-contextualised and differ from other SCNs in relation to, culture, context, time, place and actors. Furthermore, subjectivism postulates that both researcher and object co-create knowledge. Hence, subjectivism is *"double hermeneutic"* which means, the researcher is embedded in the world and is both shaped by and shapes experiences, accounts and mediates meanings of actors (Cunliffe, 2011).
LOGIC **Approach to theory development**	**Abductive Reasoning** Abductive reasoning starts with consequences and then constructs reasons or propositions that best explain the phenomenon in its situational context (Timmermans & Tavory, 2012). Therefore, this study begins with the known risks and vulnerabilities of perishable food SCNs and seeks to find the best way of attaining resilience and sustainability.
EPISTEMOLOGY • **Philosophy**	**Pragmatism** Pragmatism does not commit to any one system of philosophy or reality; instead, it focuses on the 'what' and 'how' of the research question (Goldkuhl, 2004). This is important as the researcher is attempting to answer the 'what' and 'how' of resilience issues in perishable food SCNs. As a pragmatist, the researcher accepts that there is a common perception of a reality; however, it is subjectively specific and ever changing, due to the actions taken by actors.
METHODOLOGICAL CHOICE	**Case Study** This study applies an exploratory cross-sectional embedded case study of a perishable food SCN based in the US.
DATA COLLECTION • **Strategies** • **Methods**	**Case Study Data Collection** • Semi-structured interviews from participants representing actor-firms operating in the perishable food SCN under investigation • Direct observations of supply chain operations including photographs (only when actors granted permission) as

	per University of Bradford ethics guidelines • Non-confidential company documents
<u>DATA ANALYSIS</u>	**<u>Qualitative Content Analysis</u>** Data will be analysed using an inductive qualitative content analysis technique. The qualitative analysis software NVivo 11 is used to sort out and code the data including the generation of mind maps. Data were analysed using Nicolini (2009)'s zooming in and zooming out (ZIZO) technique. The qualitative content analysis applied both manifest and latent analysis techniques.

The following section will explore the philosophy of the study. This will tease out how this influences the thesis research approach.

3.1.1. Research Ontology

Ontology refers to the study of 'being', it mainly deals with the nature of reality (Cunliffe, 2011; Burrell & Morgan, 1979). Therefore, ontology is a belief-system of how an individual interprets what constitutes the truth (Holden & Lynch, 2004). Mkansi & Acheampong (2012) state that research philosophy classifications such as ontology, epistemology, and axiology and their conflicting applications to the 'quantitative-qualitative' debates, are a major source of predicament to scholars in establishing their relevance to subjects' areas and discipline. This study was undertaken from a subjective researcher perspective. There are several compelling reasons why subjectivism is the most appropriate approach for this study. First, there is a presupposition in subjectivism that relationships are contextualised between people and their environment (Cunliffe, 2011). Supply chains are highly contextualised (Brusset & Teller, 2017) therefore; the relationship between actors in a SCN is highly contextualised to that network. Hence, context is a critical factor in subjectivism and is a cornerstone of conducting high-quality exploratory case study research in SCN. Subjectivism proffers that actors are reflexively embedded in their social world, thus, they both influence and are influenced by discursive practices, interpretative procedures and norms and culture in that SCN (Cunliffe, 2011). The subjective problematic draws meaning and knowledge from the world by accepting that knowledge is generated across time and space through, current social realities this makes knowledge contextual (Cunliffe, 2011). Therefore, subjectivism accepts reality as constructed yet experienced by the actors as objective and relatively stable within their perishable food SCNs.

Thus, subjectivism proffers that reality is perceived, interpreted and enacted by the actors; however, it is always open to change (Cunliffe, 2011). Meaning is derived from the shared meanings of actors through everyday actions, these may be negotiated among actors and are specific to time and place (Cunliffe & Locke, 2016). Consequently, subjectivism is *'doubling hermeneutic'* which means the researcher is embedded in the world they are researching, consistent with an embedded exploratory case study method (Cunliffe & Locke, 2016). Thus, the researcher shapes and is shaped by experiences and accounts, which allows for the mediation of meanings from the actors. This means a subjectivist approach to social science research does not separate the researcher from the object of research. Instead, it regards the subject (researcher) and the object (perishable food SCN) to be intertwined and not independent of each other (Sousa, 2010). This mediation is important, as SCN have become far too complex (Wiese & Toporowski, 2013), which means drawing knowledge requires research embeddedness to understand reality. Furthermore, this research sits within a subjectivist knowledge problematic because the terminology used within the global context of SCNs is highly contextualised (Beske & Seuring, 2014) and is constructed through discursive and non-discursive practices and systems (Dubey, et al., 2017).

The reasoning provides justification to investigate the perishable food SCN effectively from subjectivist knowledge problematic. Hence, the researcher will be embedded in the natural setting and, thus, both shape and be shaped by the experiences and accounts of the actors. This will allow for interpretation of actors' reality from their everyday actions, interpretations and perceptions (Cunliffe & Locke, 2016). Hence, the processes and choices of this study are guided by subjective standards of human beliefs and interest as opposed to a concrete objective lens. Thus, a subjective approach aims to understand what is happening from the perspective of social actors (Holden & Lynch, 2004; Cunliffe, 2011). To conclude the justification of this reasoning approach, the writer can only effectively conduct research form a subjective knowledge problematic as their core ontological assumptions as well as their relationality and sense-making process allows a philosophical sound methodological approach to answer the research questions.

Thus, a researcher's philosophy is their belief on how to undertake data collection, the method of analysis and use of the findings (Burrell & Morgan, 1979; Bryman, 2016). The main objective of science is the processes undertaken to transform knowledge from things believed in-to things known *doxa* to *episteme* (Bryman, 2012).

3.1.2. Research Philosophy - Pragmatism

Following the establishment of the researcher's ontology as subjectivist, a pragmatist epistemology will be adapted as a viable philosophical and methodological avenue for addressing the stated research questions. Epistemology refers to *'what is known to be true'* and how do we extract that information from the world (Bryman, 2012; 2016). Epistemology mainly focuses on the nature, validity and limitations of inquiry (Bryman, 2012). This means, philosophically, the researcher is positioned as a *pragmatist* (see figure 18, above). *"To a pragmatist, the mandate of science is not to find truth or reality, the existence of which is perpetually in dispute, but to facilitate human problem-solving"* (Powell, 2001). This supposition by Powell (2001) is important as it illuminates the main purpose of this thesis, which is to investigate how SCN actors can build resilience and sustainability into perishable food SCNs. Therefore, to a pragmatist, ontological reality is the practical effects of ideas.

Elkjaer & Simpson (2011) drawing on the original contributions of Charles Sanders Peirce, William James, John Dewey and George Herbert Mead describe pragmatism as *"a lived and living philosophy"*. Drawing on all the ideas of the original contributors, they derived four main key themes embedded in pragmatism namely: *experience, inquiry, habit, and transaction*. The importance of these four key themes in answering the research questions within a pragmatist philosophy will be explored in detail in the following sub-section. Therefore, a pragmatist approach is determined to be the most appropriate way to address challenges faced in perishable food SCNs as it facilitates problem solving (Elkjaer & Simpson, 2011; Ruwhiu & Cone, 2010; Powell, 2001).

Furthermore, pragmatism does not commit to any one system of philosophy or reality; instead, it focuses on the 'what' and 'how' of the research question (Goldkuhl, 2004). This is important as the researcher is attempting to answer the 'what' and 'how' of resilience issues in perishable food SCNs. As a pragmatist, the researcher accepts that there is a reality somewhere out there; however, it is ever changing, due to the actions taken by individuals. Thus, any effort to find a durable external reality is bound to be unsuccessful. Dewey (1931) as cited by (Goldkuhl, 2004) called this attempt to find a reality outside of ourselves a "spectator theory". The focus on actions and reactions differentiates pragmatism from most versions of Interpretivism because it does away with the notion that we are free to interpret our experiences in whatever way we see fit (Morgan, 2007). Instead, our actions have outcomes that are often quite predictable, and we build our lives around experiences that link actions and their outcomes (Morgan, 2007; Elkjaer & Simpson, 2011). It is through these experiences, inquiries, habits and transactions (Elkjaer & Simpson, 2011) that supply chain networks have metamorphosed into what there is today, therefore, the writer believes, a pragmatist epistemological approach will be the most appropriate methodological avenue in tackling the research questions.

3.1.3. Pragmatist Approach

A pragmatist approach will be particularly important in answering the research questions propositioned in this thesis because it is a lived and living philosophy (Elkjaer & Simpson, 2011). Pragmatism is therefore concerned with common sense knowledge, observed through everyday actions and dialogues (Cunliffe, 2011). The research focus is on actions, non-replicable knowledge, through a macro and micro-analysis. Nicolini (2009) refers to this macro and micro-analysis as "zooming in and zooming out" (ZIZO). This allows the researcher to obtain knowledge by zooming in and out of the research lens between macro and micro-actions (Nicolini, 2009). Nicolini's Zooming in and Zooming out as an analysis technique.

The zooming in and out is established by shifting analytical lenses and re-positioning actors' actions, to ensure certain facets of the practices are fore-grounded while others are put in a background position and contrariwise moving the background to the foreground. This small but important incremental methodological contribution extends qualitative data analysis approaches in SCM research by adopting techniques from tele-medicine organisational studies. This zooming process will be important in gaining an understanding of the dynamic processes and practices of perishable food SCN. To answer the research questions effectively, the four key tenets of pragmatism namely, 'experience', 'inquiry', 'habit', and 'transaction' (Elkjaer & Simpson, 2011) will be employed to draw out the answers to the research questions. These four key themes are important as they are concerned with how pragmatics derive the meaning of, what it means to be human, and how selves and social surroundings can be viewed as mutually informing and co-creating dynamics (Elkjaer & Simpson, 2011). Figure 13 displays the four key tenets of pragmatism.

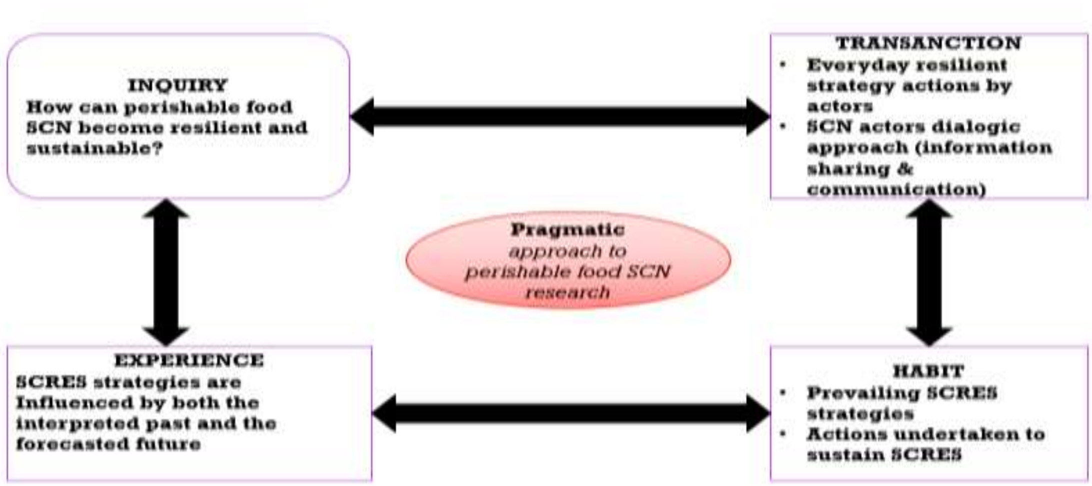


Figure 13: Pragmatist approach to perishable food SCN research for this study

Figure 13 illustrates the tenets underpinning pragmatism and these were applied sequentially throughout the entire research process. The importance of these four key tenets in answering the research questions within a pragmatist epistemology will become evident as systematic data analysis is conducted in the following chapter. Hence, a pragmatist approach is determined to be the most appropriate approach to address the research questions as it facilitates problem solving as illustrated in Figure 14 (Elkjaer & Simpson, 2011; Ruwhiu & Cone, 2010; Powell, 2001).

3.1.3.1. Strengths of Philosophical Approach

The pragmatist approach is the most appropriate approach to answering the research questions, as Touboulic & Walker (2016) argue that it is the most suitable philosophy of investigating SCM. Pragmatism focuses on facts and consequences as opposed to theories and principles (Goldkuhl', 2012; Elkjaer & Simpson, 2011). Pragmatists do not view reality as unchangeable, in fact, knowledge is not only viewed as existing in the present, but it is constantly created by actions (Morgan, 2014). This is important in the action-driven world of perishable food SCNs. Perishable food SCNs have metamorphosed over the last decades, consequently, consumers now have access to food freshly harvested on a different continent within forty-eight hours (Bowman, 2015). To research such a phenomenon a subjectivist, pragmatist approach is the best suited to tackle the complexity.

3.1.4. Research Logic Overview

Research logic dictates an approach from one of three perspectives, deductive, inductive, or abductive. The deductive approach mainly associated with positivism develops a hypothesis from available information or theories and then creates an appropriate research approach to test it (Creswell, 2009). This means a deductive approach is more suited for quantitative research methods (Bryman, 2012). However, a deductive approach application to qualitative research is possible but the formulation and approach will be different from a quantitative method (Saunders, et al., 2016). In contrast, the inductive approach is far less specific and instead employs research methods like interviews and observations as starting points from which the researcher looks for patterns (Creswell, 2009). The framework guide does not rely on pre-existing theories; instead, it draws from primary data collection. This approach may seem geared towards finding and formulating new theories, but the data may also confirm an existing theory.

The inductive method is more suited to Interpretivism philosophy (Barratt, et al., 2011). However, an inductive approach can be applied effectively within positivist methodologies, but instead of starting with a hypostasis, data can instead be analysed first to inform the research or create new theories (Bryman, 2012). Like inductive, the abductive process starts with real-life observations. However, the abductive approach is based on that truth is co-constructed between the researcher and the researched (Saunders, et al., 2016). This means as a starting point an abduction analysis begins with the result i.e. an observed situation then it establishes a rule and uses a case to check the reliability and validity of the result (Kovács & Spens, 2005). Hence, this thesis will adopt an abductive approach. This logical inference shall allow the empirical/observations to inform theory and vis-versa. Abductive reasoning is conducive to diverse ways of knowing, thus, it can yield deeper and more meaningful findings (Mirza, et al., 2014). For the purposes of this study, which will be investigating a perishable food SCN in the US, an abductive logic is the most appropriate. This logic is justified in the following sub-section below.

3.1.6.1. Thesis Research Logic

This study utilizes an abductive reasoning approach, which is a class of logical inference pioneered by one of the original American pragmatists, philosopher Charles Sanders Peirce and he referred to it as *"intelligent guessing"* (Peirce, 1958). This explains the process whereby a hypothesis (quantitative) or proposition (qualitative) is generated to explain an observation or to attain an outcome, hence, abductive reasoning's logical inference allows the empirical/observations to inform theory and vice-versa (Mirza, et al., 2014). In a study on the state of qualitative studies in operations management (OM) research between the years of 1992 – 2007, 82.8% of articles in the top five OM journals were found to use an inductive approach, while 17.2% were deductive (Barratt, et al., 2011). Thus, inductive case studies are the most dominant approach within OM (Barratt, et al., 2011).

This study, however, applies both a deductive and inductive approach. The first stage of this study is outlined in Chapter 2. The process was deductive, starting with a critical literature review that yielded research questions. These research questions are then answered using an embedded exploratory case study. The case study results were analysed inductively. Hence, this multi-method approach is consistent with a pragmatist approach and abductive logic. However, this study proffers that abductive reasoning, widely used in artificial intelligence (AI), anthropology, computer science and engineering design (Lu & Liu, 2012) is the most appropriate reasoning approach. Within SCM, it has mainly been applied to logistics research with Kovács & Spens (2005) arguing that it is very effective in problem-solving and matching theory to real-life observations. Figure 14 illustrates the abductive research process that will be applied to this study.

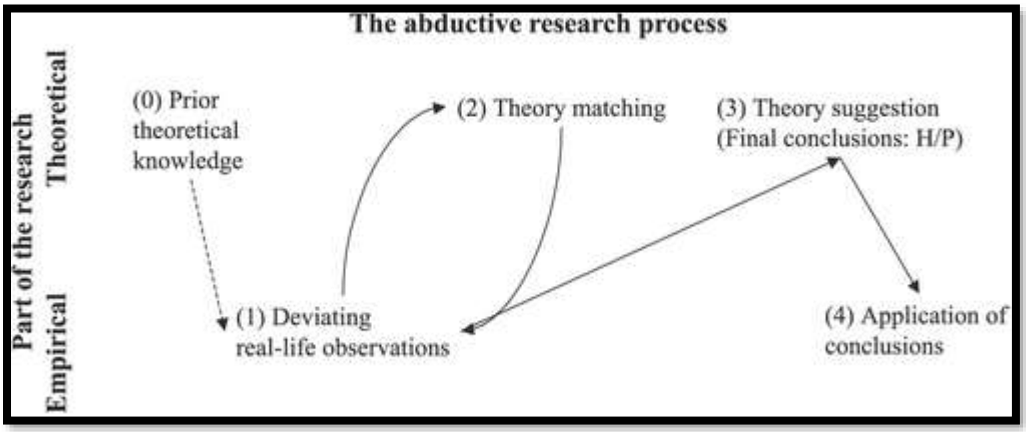


Figure 14: Abductive research processes followed in this thesis

Source: Kovács & Spens (2005)

As illustrated in Figure 14, abductive reasoning will be effective in teasing out meaningful underlying patterns of the SCN phenomena by providing a comprehensive approach to unpacking this complex reality and expanding current theoretical knowledge. Therefore, having fully justified the research logic, this study adopts and modifies, Lu & Liu (2012) *'abduction-based synthesis reasoning approach'* to conduct the research and achieve its aim and objectives. Figure 15 illustrates the adapted model and demonstrates its application in answering and satisfying the research questions.

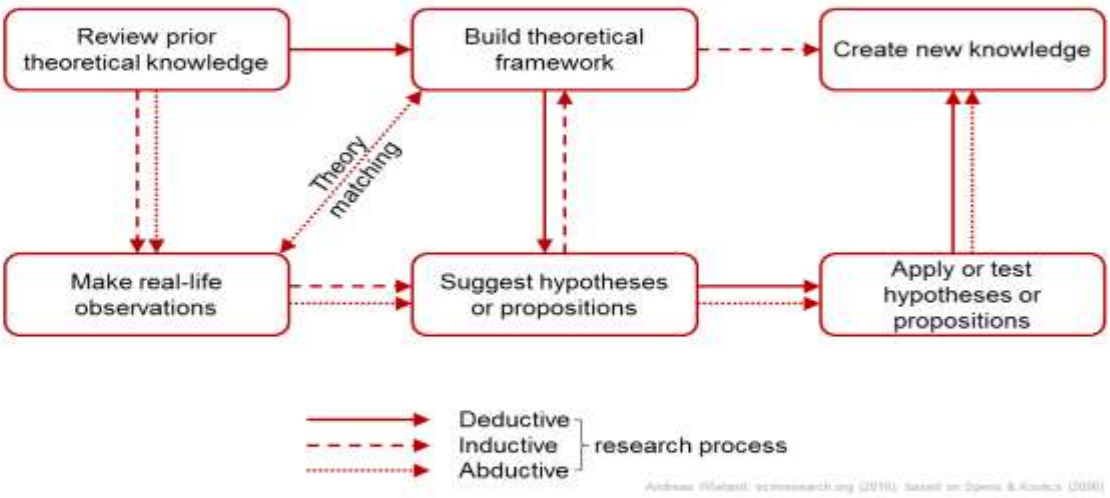


Figure 15: The abductive-based synthesis reasoning process undertaken in this study

Source: Spens & Kovács (2006)

Following their 2005 research, which advocated for the use of abductive research in logistic research Spens & Kovács further undertook a content analysis of the SCM field in their 2006 study. Though they found the majority of SCM was deductive, both inductive and abductive approaches were gaining ground as viable and rigorous alternatives of drawing knowledge from the SCM world. Figure 15 further provides a comparative analysis of the deductive, inductive and abductive process.

This study will apply a qualitative abductive process culminating the generation of proposals. Having clearly set out and justified the research approach and logic, the next section in this chapter will clearly define the empirical setting of this study. This will clearly state, the unit of analysis, sampling approach applied, and the data collection techniques utilized. This will aid in the construction of a comprehensive research framework that will be the fulcrum of a rigorous data analysis.

3.2. Research Methods

The aim of this thesis is to investigate how to build resilient and sustainable perishable food SCNs. This study applies a single, embedded, in-depth, qualitative study in a food processor and its network. Therefore, evidence will be drawn from multiple sources, accumulating to the apex of understanding through triangulation, which enhances validity (Bryman, 2016; Yin, 2014). To address the aim appropriately, a pragmatist philosophical positioning using an abductive reasoning logical inference is adopted. In the original contributions of, Charles Sanders Peirce, William James, John Dewey and George Herbert Mead describe pragmatism as *"a lived and living philosophy"*. In their research, Elkjaer & Simpson (2011) derive four main key themes embedded in pragmatism namely: *experience, inquiry, habit and transaction*.

3.3. Empirical Setting

In this section, the case selection is clearly defined, followed by an in-depth explanation of the data collection process, which will state the unit of analysis, thus, providing logical steps of the data analysis process to follow in the next chapter. This case study was conducted using *"systematic combining"* which is an approach for *"handling the interrelated elements in the research work"* that occurs because *"the intertwined activities in the research process"* require the researcher to be *"constantly going back and forth from one type of research activity to another and between empirical observations and theory"* Dubois & Gadded (2002, pp. 555). Systematic combining is thus *"a non-linear, path-dependent process of combining efforts with the ultimate objective of matching theory and reality"* Dubois & Gadde (2002, pp. 556). This section will conclude by constructing a clear research framework that will provide a concrete foundation and starting point for data analysis.

3.3.1. Case Selection

As illustrated in Figure 15, point (0) ‘prior theoretical knowledge’ the research problem under study in this thesis is derived from a real-world perishable food SCN. The case was selected using theoretical sampling, drawing on the principles of network theory. Therefore, a focal firm, which is a fresh fruit and vegetable processor based in the United States (US), was selected. Additionally, 18 firms operating within its vast network were selected to satisfy all criteria of the supply chain tiers. The fast-moving consumer goods (FMCG) perishable food SCN in this study examines nineteen companies in total (excluding consumers); five suppliers (including main food brokerage firm), one manufacturer/processor (FF), two logistics providers, five retailers, one food brokerage firm (buying food rejects from FF), one food distributor, one recycling company and one general waste (landfill) company.

3.3.1.1. The Pilot Study

The pilot study was conducted after the researcher had received ethical approval from the University of Bradford. The pilot study was conducted according to the guidelines stated and agreed upon in the ethics rules and regulations governing research. Exploratory case studies are notoriously difficult as the researcher does not know what they will encounter in the field (Berg, 2001). Understanding this limitation and approaching the research from a pragmatist perspective, the first important rule was to establish what works, as prescribed by the pragmatism philosophy. Pilot studies have gained wide acceptance amongst academic peers as an effective method of designing and testing interview protocols in qualitative research (Yin, 2009; Bryman, 2016). To design and test the interview protocol; the researcher gained access from a perishable food manufacturer in the US through a Material and Replenishment manager working in the focal firm that shall be referred to, from this point onwards as FF. Using the first interview protocol, an initial interview was conducted. This unearthed several issues with the initial interview protocol e.g.

- there was not an adequate prelude or ice-breakers to the interview questions,

- the language had to be adjusted as British and US terminologies in the supply chain differed
- interview questions had to be less structured and allow participants to clearly state issues they felt were important but excluded from the interview protocol

After a reflective exercise by the researcher, a new interview protocol was designed. This was further tested by two interviews conducted over the first weekend of February 2018 with the Materials and Replenishment manager and Buying Manager of FF. These interviews were critical as they showed the strength of the new protocol. This allowed the research protocol to be validated as fit-for-purpose.

3.3.1.2. The Interview Protocol

The qualitative study interview protocol refers to the interview questions used in this research (Bengtssom, 2016). This study relies heavily on the semi-structured interviews undertaken. These interviews are supplemented by direct observations and documentation outlined in the research design. Two separate protocols were developed, one that was more buyer oriented and another that was more supplier oriented. These protocols were used depending on the participant being interviewed and what actor-firm they represented considering their job role. The questions were designed to fulfil the main aim of the thesis. They rely on the sub-questions to get the necessary information from the participants.

The interview protocol begins by asking general questions around the participants, role, years of industrial experience and every day, mundane job duties. It then progresses to the participant's internal department structures inner workings and their impact on the supply chain. It aims to draw out the short, medium- and long-term challenges regarding SCRES and sustainability issues. The protocol then escalates this to collaboration and relationship questions regarding the actor firm and other actors in the perishable food SCN.

It probes for risks and vulnerabilities and what resilient strategies are employed by the participant's actor-firm to mitigate these. It aims to understand how they sustain these strategies. Finally, the protocol ends with open-ended questions to allow the participants to add any information not asked by the researcher, but they personally think will be valuable to the research. This is an additional aspect of the research protocol that was generated during the pilot study.

Table 12 indicates the participants interviewed from each actor-firm in the SCN. Furthermore, Table 12 provides a turnover value for the actor-firms that made this detail publicly available. However, it is important to note that these values only show the excess amount of turnover by each but have been left deliberately vague to allow anonymity of the actors involved in this study. Table 12 shows the participants, their job role and which actor-firm they represented in the perishable food SCN under investigation. It is important to note that the turnover is not the exact amount but is a general figure that best describes the financial size of the company. This was done to avoid revealing the participating companies' identities.

Table 12: Interview participants and an actor-firms annual turnover

ACTOR-FIRMS	Actor Participants Interviews	ACTOR ROLE	ANNUAL TURNOVER of actor-firms (US$)
1. FARM – RAW PRODUCE SUPPLIER (S1)	1. *Farm Manager*	Farmer	N/A
2. FARM – RAW PRODUCE SUPPLIER (S2)	2. *Production Manager*	Farmer	N/A
3. FARM – RAW PRODUCE SUPPLIER (S3)	3. *Account Manager*	Farmer	N/A
4. FARM – RAW PRODUCE SUPPLIER (S4)	4. *Account Manager*	Farmer	N/A
5. THIRD PARTY LOGISTICS FIRM (3PL)	5. Logistics Manager 6. Fleet Manager	Third Party Logistic Firm	N/A
6. FOOD BROKERAGE FIRM (FB1)	7. *Buyer* 8. *Supply Manager*	Food Brokerage Firm (50% - 80% contract supply to focal firm)	Over 1, billion
7. DISTRIBUTION CENTRE (DC)	9. Warehouse Manager 10. Warehouse Planner	Conducts warehousing operations for the focal firm	100 million
8. FOCAL FIRM (FF)	11. *Buying Manager x 2* ***(Interviewed twice)*** 12. *Materials and Replenishment Manager* 13. *Engineering Manager* 14. *Operations Manager* 15. *Production Manager* 16. *Logistics Manager* 17. *Customer Service Manager (Retail Contracts)* 18. *Planning Manager* 19. *Quality Control Manager*	Fruit and Vegetable food processor and manufacturer	Over 1, billion

	20. *Costing Manager*		
9. FREIGHT/LOGISTICS COMPANY (LC)	21. Fleet Manager 22. Routes Manager	Owned by the focal firm but operates independently. Delivers products to retailers	N/A
10. FOOD CONTRACTOR (FC1)	*23. Operations Manager* *24. Retail Manager* 25. *Quality Manager*	Competitor, Supplier and Customer of the focal firm.	Over 1, billion
11. Retailer 1 (R1)	*26. Account Manager* 27. *Regional Manager*	Multinational Corporation	Over 10, billion
12. Retailer 2 (R2)	*28. Account Manager* 29. *Buyer*	Multinational Corporation	Over 10, billion
13. Retailer 3 (R3)	*30. Account Manager* 31. *Buyer*	Multinational Corporation	Over 10, billion
14. Retailer 4 (R4)	*32. Account Manager* 33. *Buyer*	Major US Retailer	Over 10, billion
15. Retailer 5 (R5)	*34. Account Manager* 35. *Buyer*	Major US Retailer	Over 5, billion
16. Food Broker 2 (FB2)	36. Food Broker	Buys food rejects from the focal firm	10, Million
17. Edible Waste (AFC)	37. Production Manager	Buys edible food waste e.g. fruit skin, which is processed for animal feed	8, Million
18. Recycling Firm - Plastics and Cardboards (PCR)	38. Operations Manager	Recycles focal firm's plastic and cardboard waste	5, Million
19. LANDFILL (LF)	39. Site Supervisor	Processes waste which cannot be recycled	N/A
TOTAL INTERVIEWS	**40**		

3.3.2. Data Collection

Ethical Considerations

As per the request of the participants and in accordance with the University of Bradford's ethical guidelines and ethical approval form signed in 2017[1]*, all companies and participants in this study have been granted full anonymity to safeguard their privacy and protect the interest of their organisations from any harm.*

Data collection was conducted from end of January 2018 to beginning of April 2018. The researcher was embedded in the focal firm (FF) a fruit and vegetable processor and ready meal manufacturer with revenues more than $US 1, billion. FF offered the researcher an office and allowed research to be conducted from one of their sites. The researcher was in FF every Monday to Friday 9.am – 5.pm over the period of data collection. Often, the researcher travelled with the focal firm managers to their meetings with other actors in the SCN, which allowed for introductions to other actors operating in the supply chain (snowballing). As outlined in section 3.3.1.1, an initial pilot study was conducted to help the researcher design an effective interview protocol that would yield meaningful data and would be able to draw out reality as perceived and enacted by the participants. Initial data about the SCN were collected from, two pilot interviews with the FF's gatekeepers, in addition, to reading through, archival records and annual reports. This process allowed the researcher to gain an understanding of FF and its various business operations. The gatekeepers then facilitated introductions with the Vice President of Quality and Operations Manager in FF who granted permission and arranged for the researcher to have an office in the focal firm and be embedded in the organization for a period of 10 weeks (2½ months).

[1] To access the detailed University of Bradford ethics policy and procedure, please follow this link: https://unibradfordac.sharepoint.com/sites/research-and-knowledge-transfer-support-intranet/SitePages/Ethics-University-Policy-%26-Procedure.aspx?web=1

Furthermore, the gatekeepers' facilitated introductory meetings with all the key informants in FF, this allowed the researcher to gain an understanding of the focal firm, its operations and the companies operating within its network. The key informants in FF then introduced the researcher to various actors from organizations supplying, buying and conducting business with the focal firm. Using this snowball approach, participants were identified and approached with most interviews conducted face to face and four were conducted via Zoom software calls (All the Tier 2 suppliers, the farmers and their agents) and one through a phone call (Food Broker from food brokerage firm).

Thus, data were collected through 40 semi-structured interviews from 39 participants (FF Buying Manager was interviewed twice) which lasted approximately 30 - 45 minutes on average with various middle and senior level managers from the 19 actor-firms operating in the perishable food SCN in this study. In addition to semi-structured interviews, the researcher also gained data from, sitting in meetings and presentations, taking photographs, undertaking observations and reading documents, e.g. standard operating procedures (SOP), annual reports, etc.

As shown in Table 12, the interviews gathered information on the SCN actors, the processes and actions as expressed by the interviewees as representatives of their organizations. The main categories tackled in the interviews revolved around the interviewees' understanding and perspective of issues pertaining to, supply chain risk, resilience and sustainability. Furthermore, FF also granted permission to observe and analyse the firm's information systems, primarily its ERP software (business operations software) and warehouse management system (WMS). Table 13 provides a brief overview of the tier and activities of firms involved in this study.

Table 13: An overview of organisations involved in the study

Organization	*Tier & Location*	*Description*
FOCAL FIRM (Food manufacturer & processor) (FF)	Food Manufacturer	Supplies fresh fruit, vegetables, value-added fresh-cut fruits and vegetables and prepared meals to 21 US states
Farm 1 (S1)	Tier 2 - Farm – Florida, US	Vegetable Farm
Farm 2 (S2)	Tier 2 - Farm – California, US	Fruit Farm
Farm 3 (S3)	Tier 2 - Farm – Mexico	Fruit and vegetable Farm
Farm 4 (S4)	Tier 2 – Costa Rica	Fruit Farm
Food Brokerage Firm (Contractor – supplies50% - 80% of FF raw products) (FB1)	Tier 1 – Chicago, US	Supplies over 200 diverse types and varieties of fruit and vegetables to FF e.g. Cantaloupe, Mango, Honeydew, Kiwi, Zucchini Squash, Parsley, etc. from global producers e.g. New Zealand, Jamaica, Greece, Guatemala, Honduras, Canada, USA, Chile, etc.
Food Broker (Buys Fruit & Veg rejects) (FB2)	Tier 2 – Chicago, US	Buys most rejects by FF which do not meet their delivery specifications, e.g., high sugar content which reduces shelf-life
Distribution Centre (DC)	Distributor	Located at FF site and distributes whole produce to 21 USA states
Third Party Logistics Company (3PL)	Logistics Service Provider	Independent trucking company which, brings produce from other USA states
Logistics & Freight Company (LC)	C1 Delivery Trucks	Freight company owned by FF
Food Contractor (Processing and Packaging) (FC1)	Tier 1 - Food Manufacturer/Processor (Nationwide, USA)	Nationwide food processor and a competitor to FF who sub-contracts some of its product lines to FF
Retailer 1 (R1)	USA Multinational Retailer – FF supplies locations in the Southeast, Midwest and Eastern US	US Multinational Retail Corporation (US Top 5 by value and size)

Retailer 2 (R2)	USA Multinational Retailer – FF only supplies locations in the Midwest, US	US Supermarket Chain
Retailer 3 (R3)	USA Nationwide Retailer – FF only supplies locations in the Midwest, US	US Pharmaceutical Company (Healthy Foods Specialist)
Retailer 4 (R4)	USA Nationwide Retailer – FF supplies locations in the Southeast, Midwest and Eastern USA	US major Hypermarket Chain **Contracts both FF & FC1**
Retailer 5 (R5)	USA Regional Retailer – FF only supplies locations in the Midwest, US	US Regional Supercentre chain (Majority of food products sold to the Midwest stores) **Contracts both FF & FC1**
Plastic/Cardboard recycling (PCR)	Recycling – Indiana, USA	Recycles food delivery cardboard and plastics
Edible Food by-products recycling (AFC)	Animal Feed Manufacturer – Kentucky, US	Buys all food by-products, e.g. watermelon and apple skin
General waste - Landfill (LF)	Waste disposal to landfill – Indiana, US	Disposes of general waste e.g. rotten food, non-recyclable products, etc.

3.3.3. Unit of Analysis

The unit of analysis is the focal firm and its wider network. However, as this study is an embedded case study it also draws from the highly regarded case study of Union Democracy (1956) by three very prominent academics, Seymour Martin Lipset, Martin Trow and James Coleman (Marks, et al., 1992). Their case study was mainly focused on the factors influencing power structures and decision-making processes inside the politics of the typographical union (Yin, 2014; Marks, et al., 1992). The Union Democracy (1956) case study is important as it introduced the concept of having several units of analysis in one study. The study-analysed data from various levels, with the organization being the main unit and the individual being the smallest (Yin, 2014). As this study uses an abductive approach as applied by Chakkol, et al., (2014) in their empirical study of network configuration involving a truck manufacturer and its network, this study will use the unit of analysis as a starting point of analysis. However, as the abductive process unfolds, other smaller units may be investigated to tease out underlying meanings in various data collected in this study.

Furthermore, this study is theoretically grounded and draws from the principles of network theory. Dynamic capabilities, resource-based theory and complex adaptive theory as clearly illustrated in stage (0) of the abductive research approach in Figure 14 & 15. This requires a foundation of prior research knowledge to guide the process and implements principles drawn from both inductive and deductive research approaches to allow for a systematic but less constrained process that yields deeper meanings (Dubois & Gadde, 2014; 2002). Therefore, drawing on network theory principles, a central point of an analysis is required as a focal point this has been referred to in the literature as a 'primary actor'. The category of *"primary actor of analysis"* (Stentoft Arlbjørn & Halldorsson, 2005) denotes what type of company the *"focal firm"* is in any study. In this study, the focal firm, which will be referred to as 'FF', is the primary actor of analysis as it is the starting and focal point from which data was collected and will be analysed. This will allow analysis to be conducted in a methodical way that is logically coherent and enhances the reliability and validity of the results.

3.4. Data Analysis

The research analysis approach for this study is adapted from a number of research papers that applied abductive approaches to complex and unique, supply chain investigations (Reefke & Sundaram, 2017; Karatzas, et al., 2017; Manders, et al., 2016; Chakkol, et al., 2014; Gündüz-Ögüdücü & Etaner-Uyar, 2014; Galaskiewicz, 2011; Kovács & Spens, 2005). To conduct a valid and rigorous data analysis, a content analysis was undertaken. Content analysis is a very robust and flexible approach (Finfgeld-Connett, 2014) that will be the most suitable analytical approach for this study due to its highly contextualized and organized nature. Content analysis will allow for the building of knowledge and generation of theory from an abductive logical inference (Walton & Gore, 2013).

Various researchers have prescribed and subscribed to different stages and means of conducting content analysis (Bengtssom, 2016; Finfgeld-Connett, 2014; Berg, 2001; Burnard, 1991; Catanzaro, 1988), however, for this study, Nicolini (2009)'s zooming in and zooming out (ZIZO) pragmatic approach is adapted. Using Nicolini (2009)'s approach to investigate telemdicine in Italy, this study applies the principles of zooming into one actor-firm and their daily micro and macro activities and then zooming out to the impact those practicess have on the perishable food SCN. Thus, ZIZO focuses on the actions of actors and the impact these have on the perishable food SCN.

3.5. Research Quality

The quality of qualitative research is a matter of debate hence scholars have over the past decades developed and proffered best practices to conduct high-quality research (Bryman, 2016; Creswell, 2009).

This study will apply Sarah J. Tracy's criteria for assessing the quality of research as shown in Table 14 below. The application of these criteria will be constant throughout the thesis to ensure research rigour. What constitutes high-quality research is ever changing and highly contextualised driven by current dialogues and debates (Tracy, 2010). To ensure this thesis is of the highest quality and is worthy of attention from both scholars and practitioners. To attain the highest possible quality, this thesis will measure its contribution by adhering to the eight-point criteria proffered by Tracy (2010) which conceptualises what can be considered and accepted as high-quality research. This eight-point criterion is critical, as it is versatile and universal in its application of ensuring rigour and quality in qualitative research across differing philosophies and paradigms (Tracy, 2010). Therefore, the purpose of the methodology selected for this study is to provide genuine and authentic findings, which can be trusted by the participants in this research as an accurate representation of their expressions.

This trust allows study findings to be useful and viable for, social policy construction, legislation and theoretical advancements (Lincoln & Guba, 2005). Qualitative research literature has over the decades introduced critical concepts to help and aid the quality of research e.g. empathetic validity (Dadds, 2008), crystallisation and triangulation (Richardson, 2000), tacit knowledge (Altheide & Johnson, 1994), catalytic validity (Lather, 1986) and Transferability (Lincoln & Guba, 1985) etc. Due to this conceptual proliferation, it is critical to for any qualitative study to state what criteria will be applied clearly to ensure high-quality research is attained. It is worth noting the complicated research problematics and equally the available complex mixes of methods available to qualitative researchers. Therefore, the following eight-point criteria developed by Tracy (2010) in her seminal paper on the criteria of good qualitative will be undertaken.

3.5.1. Worthy Topic

According to Tracy (2010, p.840*) "good qualitative research is relevant, timely, significant, interesting or evocative"*. This thesis undertakes research of a worthy topic as it advances knowledge in SCM by joining scholars who are moving the needle from focusing on linear supply chains (dyadic, triads) to SCN. This thesis focuses on building knowledge critical to building resilient and sustainable perishable food SCNs. As Miles & Huberman (1994) argue, research that focuses on concepts, questions taken for granted, or questions and challenges well-accepted ideas is considered worthwhile research. Hence, by questioning and challenging the foci of SCM, research and bringing to the fore risks and vulnerabilities associated with perishable food SCN and how best to build resilience and sustainability this topic is 'worthy'.

3.5.2. Rich Rigour

Rich rigour in qualitative research is defined by a rich complexity of abundance (Tracy, 2010). Thus, richness in qualitative research is characterised by a high degree of variety comprised of theoretical constructs, data sources, contexts and samples (Weick, 2007). This concept is referred to as 'requisite variety', which was developed and adapted from cybernetics and essentially argues that a tool or instrument for research must be as complex as the phenomenon under investigation (Tracy, 2010). Hence, this thesis applies flexible and multifaceted research tools e.g. interviews, observations, field notes and document analysis. Furthermore, Golafshani (2003) connects rich rigour to 'face validity' which is a concept that checks whether a study can be viewed as reasonable and appropriate on its face. Thus, rich rigour requires this thesis to be well-evidenced. This was achieved by apportioning and spending appropriate time in the field, great effort thought and care was taken to ensure a rigorous study was undertaken. Therefore, to ensure the rich rigour of this thesis, the following steps were taken:

i. Appropriate and enough data were gathered (e.g. 40 interviews, observations etc..) to support the findings provided in this thesis

ii. Enough time was spent in the field and the researcher was embedded within the focal firm (FF) for approximately 3 months
iii. The context (Perishable food SCN) is appropriate to answer the research questions put forward by the thesis
iv. Finally, the researcher took great care to ensure appropriate procedures were undertaken in the field by conducting ethical interviews guided by the University of Bradford (UoB) ethical guidelines. Furthermore, appropriate and enough field notes were taken which enabled an adequate analysis

3.5.3. Sincerity

Sincerity is concerned with the authenticity and honesty of the study (Tracy, 2010). As Tracy (2010) states, a researcher requires a high degree of se*lf-reflexivity, honesty and vulnerability regarding* their own limitations. Thus, sincerity in qualitative research is attained through the researcher's honesty, transparency and data auditing of biases, goals and shortcomings of the study (Tracy, 2010). Therefore, to achieve sincerity, the researcher applied self-reflexivity throughout the research process by examining their capabilities, biases and conduct with participants before and after interviews. The pilot study was critical in fully understanding not only the limitations of the interview protocol but that of the researcher. It allowed the researcher to reflect on their approach, body language, word use. Importantly, it allows the participants to feel they were undertaking an honest process.

3.5.4. Credibility

The credibility of a study refers to the trustworthiness, exactitudes and plausibility of the research findings (Tracy, 2010). Though qualitative scholars have used different terms about credibility, e.g. Lincoln & Guba (1985) refer to this criterion as a 'credible account', which means good research is dependable. One of the key criteria for achieving credibility in qualitative research is 'thick description'. Thick description refers to in-depth illustrations that explain the study under investigation within its cultural situated meanings (Geertz, 1973).

To avoid mischaracterisation and misunderstanding of data collected which may occur when single/particular behaviour is analysed in isolation, devoid of its context. Thick description requires a complex set of well-described data that allows readers to be able to generate their own conclusions (Tracy, 2010). Thus, to attain thick description, the researcher immersed himself or herself in the study through embeddedness to attain concrete knowledge, which teases out tacit knowledge. The embedded case study allows for the discernment of tacit knowledge which Atheide & Johnson (1994) argue is ignored by most researchers as it manifests in non-conventional ways e.g. body language, facial expressions etc. Thus, by embedding in the field for approximately 3 months, the researcher was able to gain understanding of US customs and norms of communication within the context of the perishable food SCN under investigation. This allowed for self-reflexivity, which was accomplished by learning cultural norms and traditions e.g. tacit jokes (humour), idioms, cultural expressions and naughty nuances (Atheide & Johnson, 1994). Hence, qualitative scholars argue that accessing and understanding tacit knowledge takes time (Tracy, 2010; Atheide & Johnson, 1994) that is why it was critical for the researcher to be embedded in the perishable food SCN under investigation for approximately 3 months. This allowed the researcher to be fully immersed within the real-life setting of the context under investigations. Furthermore, this allowed observation to go past what was said in interviews but what was not said and more importantly from a pragmatic approach, the actions of the actors. Another method of achieving credibility is 'crystallisation and triangulation'. Crystallisation and triangulation both perform critical roles in attaining credibility; however, these roles are distinct and address different problems (Tracy, 2010). Triangulation postulates that if two or more data sources, theoretical frameworks or data analysis converge on the same conclusion, then it is considered credible (Bryman, 2016).

Therefore, this thesis, which applies a multimethod approach through interviews, observations, and document analysis and field notes, achieves credibility when all these data sources converge to provide conclusions after analysis. Crystallisation like triangulation encourages the researcher to use multiple sources of data;

however, crystallisation is concerned with the view gained from the multiple angles (Tracy, 2010). Thus, Richardson (2000) points the qualities of a crystal that reflects on the inside but refracts on the outside. Finally, credibility was achieved in this thesis through multi-vocality. Multi-vocality advocates for attaining data about a phenomenon from many different voices (Bryman, 2012). To attain multi-vocality this study conducted 40 interviews from 39 participants thereby allowing many voices to inform the investigation and provide a deeper understanding from differing and varying points of view.

3.5.5. Resonance

According to Tracy (2010) resonance refers to the ability of a study to reverberate and affect the intellectual audience it is intended for. No matter how well written any report is, it's still a major challenge for many scholars to convey a true depiction and insight of the participant/s as expressed or intended during the study (Schutz, 1967). The ability of researchers to produce research that conveys participants' emotional dispositions is regarded as empathic validity (Dadds, 2008). Resonance can be achieved through, *'aesthetic merit, evocative writing, formal generalisations and transferability'* (Bochier, 2000). Though scholars attain resonance in different ways, all qualitative reports must have an impact on the audience (Tracy, 2010). The following key principles were followed in this thesis to ensure resonance was achieved throughout the study:

i. Aesthetic Merit – The researcher attempted to present the work in an artistic and beautifully written way that evokes the reader to ponder on the key areas of resilience and sustainability in perishable food SCN.
ii. Transferability and naturalistic generalisations – The study aims to be valuable across different context and situations e.g. Thus, the aim is for the study findings to be applicable and transferrable to other SCM contexts e.g. pharmaceutical supply chain etc.

Resonance allows this study to be generalised within the case. Thus, other scholars or practitioners can take concepts from the study and apply them within contexts.

3.5.6. Significant **Contribution**

Significance of contribution is attained by answering the 'so what' question? To answer this problematic question for most research, this study is influenced by the current issues within SCM and problems surrounding the food industry perishable food SCNs. Consequently, this thesis aims to extend knowledge regarding SCNs, contribute towards practice and generate avenues for further research. It is through attaining the aim that Richardson (2000) states a significant contribution to knowledge has been attained. First, this thesis aims to produce a theoretically significant study. Tracy (1995) states theoretical significance is attained when a piece of research is intellectually stimulating to fellow academics. Thus, Tracy (1995) argues that as a bare minimum, a study may make use of existing theories and concepts and investigate them in a different context. This study intends to go further than the minimum contribution to knowledge by extending SCM knowledge through examination and exploration of perishable food SCNs. Hence, this study aims to provide insights that could be useful to other case studies and research though within case generalisations which can be applied to other complex and dynamic SCNs.

Second, this study aims to make a significant contribution through 'heuristic significance'. Tracy (2010) defines heuristic significance as producing research that ignites the need for more exploration and explanation of the research area from academics and practitioners alike. This is a concept Abbot (2004) refers to as igniting curiosity or helping to inspire new discoveries. Heuristic research brings to the fore novel concepts that can open the door for other academics to pursue further research (Tracy, 2010). Signposting readers in the concluding chapters to further research avenues attain this in this thesis. Finally, this thesis aims to make a significant contribution through advancing practice knowledge. Practical significance will be achieved in this study by producing work that is of practical application to both academics and food industry practitioners.

Hence, Schwandt (1996) puts forward a proposition that good qualitative research should not displace existing knowledge, rather it should supplement and complement, thus, probing and uncovering SCM problems that need attention.

3.5.7. Ethical

It is an absolute requirement of all researchers to *'do no harm'*. Therefore, the following ethical procedures identified by Tracy (2010) were followed:

i. **Procedural Ethics** – Fieldwork for this thesis was only undertaken after the proposed methodology was scrutinised and approved by the University of Bradford (UoB) ethics panel. All the stipulated guidelines and procedures to ensure the data collection was ethical were followed.
ii. **Situated Ethics** – Every situation and context are different, therefore, the researcher ensured that they understood the norms and culture of the participants to ensure they were accorded due respect during the interview process.
iii. **Relational Ethics** – All researchers' behaviours and actions affect the participants. Therefore, the researcher ensured rapport was built with the participants and all their preferences were respected. Great care was taken to make participants comfortable by making sure they selected the location of the interview and had the ability to stop the interview at any point. Gonzalez (2000) argues that researchers should take great care not to pressurise co-opt participants to review uncomfortable information solely to get a great story or an interesting piece of research.
iv. **Exiting Ethics** – This is concerned with how researchers leave the field. After conducting fieldwork, all participants were thanked and though one cannot control how their work is read, great care has been taken to ensure no unintended harm is caused to the participants.

3.5.8. Meaningful Coherence

Tracy (2010) identifies the following as critical for qualitative studies to achieve meaningful coherence:

i. A study must achieve its stated aim
ii. Conduct research that is philosophically sound and follows the tenets of the stated philosophy
iii. The study must follow a methodology that espouses the chosen philosophy, theories and paradigms
iv. Critically connect literature reviewed in the study with the main research focus, methodology applied, and conclusions drawn from the analysis and findings.

Table 14 summarises the eight key principles of Tracy (2010)'s big tent criteria applied in this thesis.

Table 14: Tracy's 8 "Big Tent Criteria"

Quality – 8 "Big Tent" Criteria	Critique
Worthy topic	The topic is clear and straightforward. The main aim is to build resilience and sustainability in perishable food SCN. This an important topic in the field of SCM and requires further development
Rich rigour	An exploratory single embedded case study was undertaken in a perishable food SCN drawing on knowledge from 19 actor firms through 39 participants. Furthermore, the phenomena were investigated within its natural-setting, thereby enhancing the rich rigour of this study
Sincerity	The researcher is clear about what the research can and cannot accomplish and this is clearly articulated in the study
Credibility	The basis of this thesis is underpinned by prior research from peer-refereed articles and contemporary issues perturbing food SCNs as identified by industry practitioners
Resonance	The researcher anticipates the thesis will provide resonance to research and practice in SCNs despite the study's focus on perishable food SCN
Significant contribution	Proposing ways to enhance the resilience and sustainability of actors operating within a perishable food SCN
Ethical	The thesis has no unethical implications. The major ethical issues in conducting this study were: a) Informed consent, b) Beneficence - Do not harm c) Respect for anonymity and confidentiality d) Respect for privacy as per University of Bradford research ethics guidelines
Meaningful coherence	The thesis is undertaken from a subjective ontology while utilising a philosophy of pragmatism. Using an abductive approach, an exploratory single-embedded case study was undertaken. Data collected were analysed using an inductive content analysis technique. Abduction allows for the use of both deductive and inductive approaches in a systematic and coherent way

Source: Tracy (2010)

3.6. Chapter Conclusion

This thesis aims to explore the implications for practitioners and future research on how actors within a perishable food SCN can attain and sustain SCRES. The research concentrates mainly on how network actors can enhance sustainability and resilience. This study will be conducted in the context of perishable food SCN. Supply chains are highly contextualised (Brusset & Teller, 2017) and therefore, analysis of the perishable food SCN allows in-depth exploration of the phenomenon. This thesis will adopt a pragmatic research approach from a subjective ontology. The study will use an exploratory cross-sectional embedded case study method based in a perishable food SCN. Therefore, the thesis will use qualitative methods to address the research questions and achieve the main aim.

In the following Chapter 4, the first level of data analysis will be conducted as outlined in this chapter. Chapter 4 will provide the first stage of analysis, which configures the perishable food SCN under investigation, thus, setting the scene for the second stage in-depth analysis in Chapter 5.

CHAPTER 4: Zooming In - Configuring the Supply Chain Network

4.0. Chapter Introduction

The main purpose of this chapter is to conduct the first of a three-phase data analysis process to answer the research questions. The first phase conducted in this chapter will zoom into the praxis of actors and use qualitative content analysis to code the data through manifest analysis. Chapter 4 will configure the perishable food SCN under investigation to facilitate a coherent analysis process in the second phase by applying latent analytical techniques. This chapter will apply within and across-case analysis strategies to answer the following research sub-questions (1a & 2a):

1. What resilience practices do actors operating in a perishable food supply chain network adopt to mitigate risks and vulnerabilities?
2. What are the current issues perturbing actor-firms' capability to build sustainability in perishable food supply chain networks?

4.1. Configuring the Perishable Food SCN

The aim of this thesis is to investigate how supply chain actors can build resilient and sustainable perishable food SCN. This study applies a cross-sectional, embedded, in-depth, exploratory case study in a food processor and its network. Therefore, evidence was drawn from multiple sources, culminating to the apex of understanding through methodological triangulation, which enhances validity (Yin, 2014). To address the aim appropriately, a pragmatist philosophical positioning using an abductive reasoning logical inference is adopted. To begin the analysis, data will first be grouped and analysed in tiers. This will provide a clear, manifest analysis, which will allow for the generation of meaning units, which can then be systematically categorised to achieve the research aim. First, the focal firm (FF) will be analysed as a separate entity followed by all other grouped tiers. This follows network theory principles and the within and cross-case analysis technique.

Once this first stage is complete, the identified meaning units will then be examined in the context of building resilient and sustainable perishable food SCN. Table 15 shows all the actor-firms, their representative node and the network role.

Table 15: Actor-firms in the perishable food SCN

NODE	ACTOR- FIRM	NETWORK ROLE
1. FF	1. Focal Firm	Food Manufacturer
2. DC	2. Distribution Centre (Warehousing)	Warehousing (Subsidiary of Focal Firm)
3. LC	3. Logistics Company	Outward Logistics (Subsidiary of Focal Firm)
4. FC1	4. Food Contractor	Competitor, Buyer and Supplier of Focal Firm
5. FB1	5. Food Brokerage Firm	50% Contract to supply focal firm
6. 3PL	6. Third Party Logistics (3PL)	Inward Logistics
7. FB2	7. Food Broker	Buys food rejects from the focal firm
8. R1	8. Retailer 1	Supermarket Chain
9. R2	9. Retailer 2	Supermarket Chain
10. R3	10. Retailer 3	Supermarket Chain
11. R4	11. Retailer 4	Supermarket Chain
12. R5	12. Retailer 5	Supermarket Chain
13. S1	13. Food Producer 1	Farmer
14. S2	14. Food Producer 2	Farmer
15. S3	15. Food Producer 3	Farmer
16. S4	16. Food Producer 4	Farmer
17. PCR	17. Recycling Company	Plastic and cardboard recycling company
18. LF	18. Non-Recyclable Waste Company	General waste that cannot be recycled (Landfill)
19. AFC	19. Edible by-products company (Animal Feed)	Animal feed company that purchases edible processing by-products e.g. fruit skins, seeds

The following sub-sections will provide a brief description of each actor-firm involved in this study beginning with the focal firm (FF). To undertake this analysis, ZIZO principles will be applied as shown.

ZOOMING IN

Focus on

Within case analysis
Daily micro-activities
Organisational strategies
Organisational practices
Actors' perceptions

ZOOMING OUT

Focus on

Across case analysis
Association between actor-firms
Impact of actors' praxis on the wider network
Effects of the local on the global
Effects of the global on the local
Interdependencies

4.1.1. FF (Focal firm) – The Network CenterPoint

FF is a leading supplier of fresh fruit and vegetables as well as value-added fresh-cut fruits and vegetables and prepared meals to retailers and foodservice distributors across 21 states in the Southeast, Midwest and Eastern USA. A US Fortune 350 company whose core businesses include distributing grocery products to independent grocery retailers (independent retailers), national retailers, food service distributors, its corporate-owned retail stores, and US military commissaries and exchanges recently acquired it. The entire organisation serves customers in 47 US states and the District of Columbia as well as Europe, Cuba, Puerto Rico, Italy, Bahrain, Djibouti and Egypt.

To begin the analysis, data drawn from the different actors representing the actor-firms operating within FF's supply chain are separately examined. Meaning units were generated from FF actors (interview participants, mid-senior level managers) interview responses, memos from observations', documentation and photographs taken during daily operations[2] (see appendix section). Collected data were analysed firstly using within case analysis, which looked at the actor-firms then cross-case analysis from both a dyadic perspective *'buyer-supplier relationship' and triad 'buyer-supplier-supplier relationship'* as a means of purposefully examining the breadth and depth of actions undertaken by various actors with the network. This follows the method employed in the Union Democracy (1956) embedded case study which used multiple units of analysis to examine the distinct levels of power in a single case (Yin, 2014) as explained in Chapter 3.

Following the tenets of abductive reasoning and utilising content analysis, a within-case analysis was first conducted as the first stage of analysis. FF employs a just-in-time sourcing strategy in relation to all its fruit and vegetable products. All the participants within FF despite expressing key concerns over the vulnerability of this approach concede there are no other alternatives as food products are perishable with a shelf-life of 4-10 days. This is evident from the statement made by the Materials and Replenishment Manager below:

"We really do not have any other choice except to use just in time that's why we go back to those challenges we face of not knowing exactly what the customer is going to ask for, it's a balancing act, yeah, everything we do here I would say 80% of our products are just in time, that's the system we use for our production"

The sourcing process is meticulous and involves several trade-offs as C1 attempts to ensure that it receives the right amount of fresh raw products that adhere to its safety and quality standards. The quality team in the receiving docks inspects all inbound fresh produce.

[2] An excerpt from the observations undertaken in the field is available in the Appendices section to provide a detailed explanation of the food safety and quality checks undertaken for every delivery of fresh fruit and vegetables for FF

Different fruits and vegetables have a different quality test, the researcher for blueberries, onions, watermelons, jicamas, apples and pineapples, undertook observations of these test. Delivery of inbound raw materials (fresh produce) starts at 4.am. and the last inbound deliveries are received at 3.pm as FF use the same docking for receiving and shipping it is critical that timing does not overlap as this creates cascading issues. Regarding food safety and quality if any product fails the safety and quality checks it is immediately put back on the truck and officially rejected. FB2, the food broker often buys the rejects from the suppliers at below market value. Once inspections have been conducted and products are deemed safe for human consumption, there are then moved to different lines for processing. Depending on the fresh produce, there are handled differently. For, instance, watermelons and cantaloupe are notorious for harbouring bacteria and therefore, need to be washed (referred to by actors as a bath); they are dipped in water that has specific chemicals to kill all bacteria (see Appendix 1 which provides an excerpt from observations and field notes taken).

Fruits are first washed and then cut and diced depending on the product specification. Retailers often require different processing standards as well as product specifications. Due to food regulations there are strict regulations as to the handling of foods, allergens must be separated. All received goods are arranged in order as FF uses first in – first out (FIFO) for all its products. This is crucial for quality and inventory control because FF is handling perishable products. Before the products go on to the production floor there are washed in a chemical bath to kill off any bacteria, fungi or virus. Once this process is complete, the products are fed into the machines and conveyor belts for processing on the production floor. Once packaging is complete, the products have to be with the retailers within 24 hours. As the Production Manager put it:

> *"Once the raw materials get on the production floor, we must make sure they are with our customers within 24 hours because the quality is everything to us, the customers must taste the freshness"*

Food processing is the core business of FF and is naturally the most intensive of its operations. Most of the data on production were collected from non-participatory observations over a one-month period. In this month, the researcher observed the process from receiving raw materials to processing, packaging, quality controls and dispatch. Upon receipt of a product e.g. watermelon, jicama, pineapple, red onions etc., a visual and scientific test is conducted. Visually, to check the quality of deliveries, dock supervisors use a fruit and vegetables spec-sheet. This involves random sampling, where the dock inspectors will get into a truck and pick random fruits from different batches. Fruit and vegetable deliveries are cut open during inspection and their sugar content is tested using a brixometer. For instance, the brixometer test would require watermelons and cantaloupes to register 8-10 while red grapes should not exceed 14. If any delivery fails a quality check due to disease, deformity etc., the load is immediately rejected and not offloaded. The driver must return it to the farmer or food broker. All products must have a label that clearly states their country of origin and if possible farm, this data is immediately logged into the system and the products assigned barcodes. These serve as tracking codes for transparency both for legal and business ethical reasons.

4.1.2. DC – The Distribution Centre (Warehouse)

The distribution centre (DC) is a wholly owned subsidiary of the focal firm but operates independently. Its main function is to conduct most warehousing operations for the focal firm. This is mainly for whole products, i.e. fruits and vegetables that do not need to be processed into ready-to-eat packs but can be sold whole to retailers and independent grocers. It also works in conjunction with the logistics company (LC) referred to by actors in interviews as the freight company. DC and LC operate a cross-docking system to deliver fresh produce to C8 a major retailer. The warehouse system is huge and relies heavily on technology operated by a warehouse management system (WMS). For instance, at any one time the warehouse can store up to 1 million bananas and this is just one fruit, on average DC will have 70 different fruits and vegetables (this count includes different varieties of the same fruit and vegetables).

Every morning around 4.am deliveries of produce begin to arrive at DC. On a single day, DC receives approximately 50 – 70 semi-trucks (referred to as heavy goods vehicle (HGV) in the UK) of deliveries. Upon delivery, all goods are inspected for quality including conducting sugar content tests (brixometer test) to ensure the safety of the products.

Any products that fail the safety and quality checks are rejected on the spot and sometimes drivers may abandon the truckload if they have another delivery. However, in most cases, FB2 a food broker based in Chicago purchases these rejects for less than market value and pays for delivery to their warehouse. Fresh produce that meets the delivery standard is allocated a license plate number (LPN) which has a unique barcode, and this is very critical for transparency as it creates a 'track and trace' system for each pallet and or product delivered.

Due to the sheer size of the distribution centre, warehouse operatives use a voice-operated technology (RFgen) that only recognises the warehouse operative's voice to conduct warehouse operations e.g. unloading, storing inventory and executing sales orders. Warehouse operatives receive voice commands via their earpieces on where to drop pallets or product via technology that tracks and traces each pallet through its LPN. On an average day, the warehouse processes up to 5,000 orders, some which are delivered on the same day if perishable and other products like watermelons and honeydew, can be delivered in a week. DC delivers directly via LC to R1, R2, R3, FC1 and other independent grocers that were not interviewed for this study.

4.1.3. LC – Logistics/Freight Company

LC is a wholly owned subsidiary freight company of FF that undertakes logistics operations for all FF processed products, DC and FC1 products. It operates a highly modern distribution fleet that delivers fresh fruit and vegetables to, wholesale markets, independent grocers, regional and national retailers. LC delivers food products on either the same day or next day delivery service six days a week except on Sundays. FF specifically acquired LC to gain control over its distribution and ensure it fulfilled its contractual obligations especially to its major customers (R1, R2, R3, R4 and R5).

Due to past issues with missed deliveries and products delivered with diminished quality due to trailer conditions, all of LC's fleet directly delivering to the retailers are refrigerated and set to the appropriate optimum temperature. Furthermore, using GPS technology, each load can be tracked from dispatch to delivery allowing for real-time information concerning each load. Most communication with fleet drivers is via mobile phones; therefore, mobile communications are crucial as FF, DC and FC1 can attain and relay real-time information to their customers (retailers). Figure 16 illustrates the role LC plays in the perishable food SCN and its nodes.

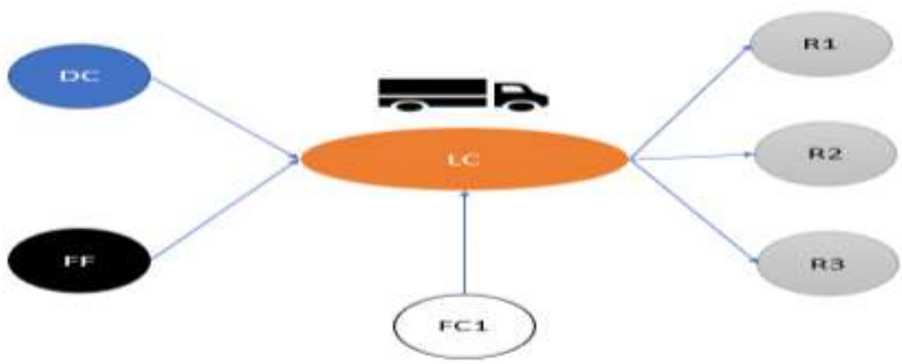


Figure 16: LC's supply chain nodes in the network

Figure 16 illustrates the nodes of LC's SCN. Though LC is a subsidiary freight/logistics company, it operates autonomously but its information systems (IS) are interlinked with FF. Hence, the manager stated:

"We work independently but if [focal name deleted] want any information from us we give them, it's a good relationship because the way its setup we have a 98.7% delivery rate at the moment and that is really good, we hardly miss a delivery"

Furthermore, LC is responsible for delivering finished products and raw materials between FF and FC1. FC1 contracts FF to produce some of its product ranges. This requires a high volume of product freight between the two companies, which LC fulfils. Of great importance is that all of LC's semi-trucks are fully fitted with temperature monitoring devices.

This is critical as it allows for the monitoring of trailer conditions throughout the delivery. This is critical in food safety and quality as often when issues arise in the supply chain; actor-firms often struggle to find the exact source especially when the product has passed through a number of companies in a SCN.

4.1.4. FC1 – Food Contractor

FC1 is a food contractor to FF but is also a food manufacturer. FC1 is larger than FF in turnover comparisons and both actor-firms are direct competitors. However, the two firms have a complex relationship, which means there are, competitors, buyer-buyer and supplier-supplier. FC1 has 14 food manufacturing sites throughout the US as it aims to make products in regionally located facilities. FC1 like FF operates a just-in-time food manufacturing and processing strategy, ensuring its customers receive the freshest product possible. This study interviewed actors from FC1's site based in Indiana, US. Food quality and safety are critical to all operations in FC1 as the Quality Manager stated:

"Here at [company name deleted], we operate one of the most comprehensive Quality Management Systems in the fresh produce and food industry We only sell and ship the safest, freshest, highest-quality products from our facilities, our standards are just really high"

FC1 uses the Global Food Safety Initiative (GFSI) system as a food safety quality management system (FSQM). Due to its reputation, FC1 can secure contracts with retailers (R4 & R5) that it can fully satisfy within its own food manufacturing facilities. Therefore, FC1 contracts FF to produce some of the food products that it cannot fully satisfy. FC1 supplies all the raw fresh produce and FF process and package the products. Figure 19 depicts some of the food products FF processes and packages on behalf of FC1 for R4 and R5. Both FF and FC1 have separate contracts to supply R4 and R5, however, FC1 also contracts FF to process extra orders to fulfil its contractual obligations.

FC1 supplies over 30 national, regional and local retailers. As the Operations Manager also stated there are various sustainability initiatives FC1 is involved in that focus on enhancing sustainable operations e.g. waste composting, water usage reduction, energy and utility usage reduction and recycling programs.

4.1.5. FB1 – Food Brokerage Firm

FB1 is a food brokerage firm that is based in Chicago and is contracted to supply 50% - 80% of FF's fresh fruit and vegetables. The exact amount depends on the product and varieties, for instance, FB1 is contracted to supply 50% of FF's broccoli supply and the other 50% FF sources from local US growers, in contrast, FB1 is contracted to supply 100% of FF's kiwis as these are sourced from Greece and New Zealand. FB1 is an international produce market that offers both direct and indirect sales. It has massive warehouses, refrigerated cooler rooms and receives produce directly by road, air and shipping. Furthermore, it provides merchants with space and location to come and vend their fresh produce at wholesale price to various food businesses. Therefore, farmers deliver fresh fruit and vegetables early in the morning and sell their produce to various food businesses. FB1 is contracted directly to deliver the majority of FF's required raw materials and FF will source the remainder from their PFL and the open market. This is a critical strategy to balance cost and manage perishable food market volatility. As the Buyer stated:

We are responsible for providing all the fruit and veg [company name deleted] need, they really don't care how we get it, they expect the right product in the right amount with the highest quality…. And we have delivered for them over the last 5 years that's why our relationship is good

FB1 is the main supplier for FF especially for products that are not sourced from the US. FF has contractors with shippers and will pick up products directly from the port and bring them to their facilities. The largest supply countries for their raw fresh produce outside the US are Canada and Mexico. Figure 17 illustrates the nodes that makeup FB1's SCN.

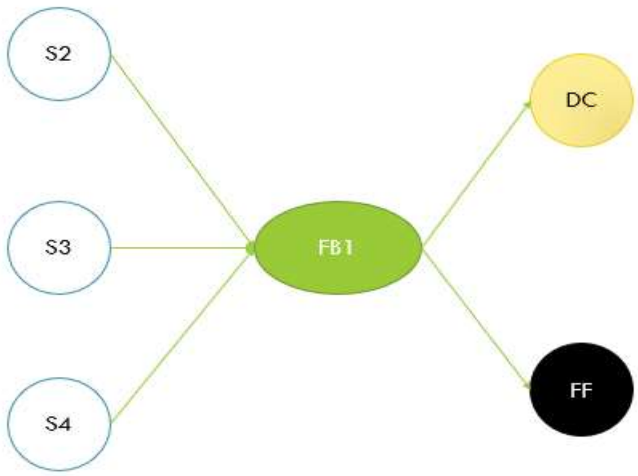


Figure 17: Nodes that makeup Food Brokerage Firm's SCN

Figure 17 depicts the nodes that makeup FB1's supply chain. S2, S3, & S4 supply directly to FB1, which holds a contract to supply both FF and DC. FB1 is critical to FF's operations as it is contracted to supply 50 – 80% of its raw materials (fresh fruit and vegetables) depending on type and variety. This makes FB1 a vital node in the SCN as it is the major supplier of most raw materials. It eliminates the bureaucratic process and costs that FF would incur if were responsible for its own sourcing. There are a lot of procedures and costs, which revolve around food imports especially regarding food safety and quality. Therefore, by contracting FB1, FF offloads the risks associated with sourcing and this allows FF to focus on its core capabilities, which are food manufacturing and distribution.

4.1.6. 3PL – Third Party Logistics Firm (3PL)

3PL is a third-party logistics provider as well as a non-asset-based company, meaning they do not own the equipment used to transport freight. Instead, 3PL have access to thousands of transportation providers and can select the best, most cost-effective solution for actor-firms using their service. Due to the diverse range of suppliers FF deals with daily and relying on a JIT sourcing strategy 3PL is the most effective way of shipping in their raw materials. 3PL transports produce from FB1 in Chicago, as well as farms in California, Texas and Iowa etc. As the Logistics Manager stated:

"What we do is unique and efficient, without the services we provide companies would spend thousands extra on their freight, this works for the drivers, this works for companies, it works for everyone"

Due to the diverse routes of the fleet, 3PL relies heavily on telecommunications to keep their drivers and clients in contact, updated on delivery information it is a 24-hour business, and operates all year round. However, information is very important in 3PL operations as actor-firms make decisions based on real-time information they receive from 3PL. Figure 18 below illustrates 3PL's supply chain and how it applies IS to ensure it coordinates relevant materials between actor-firms in the perishable SCN.

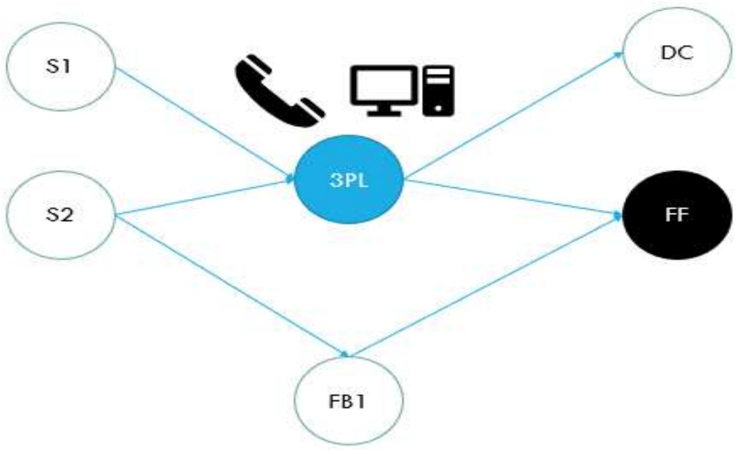


Figure 18: Nodes configuring 3PL's supply chain

As illustrated in Figure 18, 3PL operates a non-asset-based company that is heavily reliant upon IS.

Their main role for a membership fee is to facilitate collaboration between independent truck owners and various customers e.g. the focal firm, food brokerage firm, independent grocers etc. This arrangement benefits both firms and truck owners through various cost and timesaving mechanisms. For instance, it takes a semi-truck approximately 33 – 35 hours for a direct journey from California to Indiana, however, US transport regulations forbid drivers from driving over 8 hours and they are constantly monitored.

All trucks have a log panel fitted to the dashboard that monitors how long they have been driving for and both police and the responsible freight company constantly monitor it. To circumvent these restrictions as the products been transported have a short shelf-life due to their perishability 3PL plays a crucial role. 3PL facilitates for drivers to drive only 7.5 hours up to a certain point then another driver takes over the trailer of products. 3PL then facilitates for the driver who has dropped the trailer to get another load from that point back to their original location. This ensures that deliveries are made on time; drivers are paid fairly as they do not conduct one-delivery journeys but are always provided with a return journey load. 3PL, therefore, plays a crucial role in ensuring efficient and effective logistical management for the perishable food SCN under investigation.

4.1.7. FB2 – Food Broker

FB2 is a food broker based in Chicago and its main business model is to purchase food rejects from suppliers, FF and DC that meet safety and quality requirements. Due to the strict food quality criteria FF and DC operate, they may reject food for not meeting colour requirements, sugar content, size criteria or weight; hence, supplier to avoid total loss may sell to FB2 who may purchase the product for 20 – 50 cents on the dollar. This does not mean the food product is inedible or unhealthy, rather it just means the products have failed to meet the customer specifications and may not be suitable for processing hence the rejection. FB2 buys these rejects from the suppliers and resales it to smaller independent grocers at their vendor warehouse in Chicago. Furthermore, they buy overstocked produce from FF, for instance, if FF had predicted their order for strawberries would be 20,000 cases but FF only receives an order for 15,000 cases, FF would sell the extra strawberries to FB2. As the Food Broker from FB2 stated:

"We play an important role in reducing food waste in the supply chain, we offer our customer cheap good quality produce while saving the big companies from wasting tonnes of food"

The above excerpt from an interview with the food broker shows just how critical FB2 is to the supply chain. When products are rejected by the supermarkets as was stated by FF's Customer Service Manager:

"Most of the time if products are rejected by the customer its usually 2 or 3 cases of a product, so rather than bringing them back here, we just tell the driver to throw them away"

This highlights a critical problem inherent in perishable food SCN that is food waste and loss. Due to the perishability of products, it is cost effective for actor-firms to discard of unused products than to pay the transportation costs to return them back to their firm and then sell them at a loss to a food broker.

Hence, FB2's role is critical in preventing suppliers from incurring total losses on rejected deliveries and by ensuring FF and DC can offload excess stock at a price thereby avoiding the risk of financial loss.

4.1.8. R1 – Retailer 1

R1 is a US multinational retail corporation that operates a chain of hypermarkets, discount department stores, and grocery stores. R1 contracts FF to supply 64 stores in the US Midwest with fresh vegetables, cut fruit and vegetables and ready-made meals. R1 employs a cross-docking supply chain strategy, which allows it to get products faster and cheaper to their customers with the least possible amount of product handling.

To accomplish this, R1 uses a powerful technological tool known as a TU (real name withheld to protect confidentiality). This allows it to keep track of inventory in real time. Whenever customers purchase any fresh produce or food items manufactured by FF, the technology system TU gathers this information from the product's barcode. At midnight on each day, the system generates an automatic order that is sent directly to FF. FF will have to process the order and deliver fresh food to R1 within a 12 – 24-hour period. This allows FF to access R1's systems directly in relation to their inventory and monitor the stock levels on an hourly basis.

Therefore, FF's planning team can plan for next day production through forecasting and FF uses an enterprise resource planning (ERP) software. Cross-docking means R1 has limited storage facilities for food products in their stores, as soon as products are received in a handling area for quality inspection, there are immediately stocked on to the shelves. Hence, the Regional Manager remarked in the interview:

"about 50% -70% of our inventory is in transit at any given time"

However, this system puts pressure on FF who do not have time to wait for R1's actual order as there have to order and process in advance.

Therefore, FF relies on forecasting techniques to predict R1's demand patterns, which means sometimes FF over-produces or under-produces the required food products. As the FF's production, Manager stated:

"Our biggest problem is that actual orders only come in the morning when we have already started production, so if the planning office does not get the product forecasting right we end up having to rerun the line after we had moved on to another product to make up for the shortfall"

This uncertainty revolving around the planning process was a matter of concern that FF was trying to solve by introducing powerful software to enhance their forecasting and planning capabilities.

4.1.9. R2 - Retailer 2

R2 is a US chain of grocery stores that contracts FF to supply fresh fruit and vegetables to its stores in four Midwest states. R2 contracts FF to provide, bananas, sliced mangos, pineapples, apples, berries, carrots, tomatoes and Persian cucumbers. Unlike R1, R2 does not allow FF access it IS to check inventory levels therefore; information sharing is limited in this regard. R2 orders are normally sent via email in the morning the day of production. As R2’s buyer stated:

> *“We take data protection very seriously and cannot risk a breach, therefore, all our communications are on a need to know basis. I know there is the talk of collaboration but there are other ways of collaborating without giving your vendors access, you know we deal with hundreds of different vendors so we cannot afford to open up our systems because it's supposed to be beneficial…. you know there are legal issues around that I think”*

Evidently, different actor-firms approach issues surrounding information sharing and access differently. R1’s system allows for inventory management sharing while R2 considers this practice risky and resorts to the use of emails for making and receiving daily orders.

However, this practice has its limitations as FF must plan and organise for production the day before at the very latest. This means FF heavily relies on forecasting and when the order comes through they must adjust. While they may be an issue surrounding forecasting and production planning with R1, it fares more problematic in R2 due to the limited information sharing capacity.

4.1.10. R3 - Retailer 3

R3 is a US pharmaceutical company that also sells fresh fruit and vegetables to its customers in a small fresh healthy food section. FF via DC supplies R3 whole fruits mainly bananas, apples and oranges.

R3 mainly orders organic bananas and DC is responsible for the warehousing process, which includes receiving, ripening and delivering the bananas, which are mainly sorted by colour for quality. As R3's Account Manager noted:

"[company name deleted] provides us with high-quality bananas that have proved a popular snack choice in our stores, it's what we are looking for, fresh, healthy and organic, and that's what our customers expect really"

R3 is a new customer for FF who have had the contract for two years at the time of data collection. This meant both actor-firms are still in the process of establishing a strong and dependable supply chain relationship.

Due to the infancy in the relationship, FF has to still bid for the contract renewal as R2 only awards FF an annual contract, which is up for review every September. After the first year, FF initially lost the bid to retain R3 and the contract was awarded to another competitor who was offering the same product at a cheaper cost. However, after just six weeks, R3 returned to reopen the negotiations as they were having problems with multiple contract breaches with the new supplier. On many occasions throughout the six-week period, the new supplier had failed to make adequate delivery. Therefore, facing these challenges, R3 returned to have their contract reinstated. Surprisingly, FF did not take advantage of the situation to hike their original quotation as the Costing Manager stated:

"When [company name deleted] approached us again to reopen the failed negotiations, we saw it as an opportunity to show our integrity so we gave them the same quotation they had rejected earlier"

Following this incident, it is evident from the responses provided by the actors in their responses that their relationship is strengthening. This was reflected by FF's Quality Manager who was convinced they would be able to retain the contract in the coming contractual review and negotiation process:

"We have really been able to wow them with our products, as you know [company name deleted] is all about organic, fresh products and we deliver for them, we have

not had any issues so far so hopefully we can keep this going because it benefits both of us"

Though this was a buyer-supplier relationship in its infancy, both FF and R2 expressed high levels of optimism regarding their future supply chain relationship.

4.1.11. R4 - Retailer 4

R4 is a major American retailing company and is a major customer for both FF and R4. R4 is an important and major customer to the extent that FF and FC1 who are competitors have an agreement to collaborate to satisfy R4's demand.

This synergistic relationship to satisfy R4's demand has created a hybrid supply chain relationship that is buyer-supplier-customer in its set-up. However, the products FF processes on behalf of FC1 are fully labelled with FC1's brand. R4 is such a critical customer that FF's Customer Service Manager stated:

"This customer, in particular, is important to our sales, they are important as they have been consistent, and their orders are huge not counting what we supply them via [name of company deleted]"

Like R3, the majority of R4's orders are sent via email at the very latest by 12.pm at midday on the day of production.

However, due to the supply chain planning process, FF must estimate how much product R4 will order using various techniques through ERP software. The biggest order comes through the fresh fruit and vegetable trays. These products, which may be made up of watermelon, pineapple, mango, and strawberry for the fruit tray and broccoli, cauliflower, carrot and green beans for the vegetable tray, are the biggest order product from R4. Due to the variety of products on the tray, occasionally, FF may not have all the ingredients, which create order fulfilment issues.

4.1.12. R5 - Retailer 5

R5 is a US supercentre chain mainly based in the Midwest. R5 hypermarkets contract FF to satisfy all their fresh fruit and vegetable demand. R5's business model emphasises local supply chains for their fruit and vegetables. While orders may include exotic fruits, R5 requires locally sourced produce as the first choice as emphasised by the Buyer:

"We have always purchased from local growers big and small since our company was formed, but this has become a big deal lately especially over the past decade, we have had to significantly increase our local sourcing in response to customer demands as we have grown into new markets and the focus on local became more important to our customers."

R5's marketing also touts its short-food supply chains for local in-season produce which FF always endeavours to fulfil. Through collaborating with FC1, FF satisfies R5's supply demand. As FC1's Manager explained:

"We have a very good and long relationship with [company name deleted] because as you have seen our company has a very massive operation and we simply cannot fully satisfy all the contracts we get but our customers know we are the best at what we do, so we have established a very strong relationship with [company name deleted] to help us fulfil the huge demand we get for our products"

FF and FC1 collaborate to fulfil both R4 & R5's supply demand which have allowed for a high degree of trust to develop which was expressed by FF and FC actors in their interview responses. Despite both actor-firms been direct competitors, they fully to collaborate to fulfil R4 and R5's orders both separately and jointly.

4.1.13. S1 – Food Producer (Farmer 1)

S1 is a small-scale farm based in Florida, USA. It specialises in growing bell pepper, cauliflower, broccoli and celery. S1 supplies its products directly to FF when an order is placed. Most of S1's buyers are within Florida; however, it is on the PSL of FF and occasionally gets calls for orders. S1 delivers the orders via the logistic services of 3PL. S1 grow all their crops from the seed process to the final sale. Therefore, S1 grow and harvest all produce on the farm, depending on the order, harvest times vary. Normally, after harvest produce is cooled immediately and transferred to an onsite-refrigerated warehouse. This facility is used for sorting and packing across the U.S. staff in warehouse facilities regrade and repack to customer specifications. Thus, 3PL follow a "Just in Time Delivery" program, which delivers the product as soon as buyers order it, allowing for low inventories. 3PL has a team of experienced agronomist in place to ensure a quality product and timely delivery. Interview with the manager was conducted using the video calling software Zoom; they expressed the process they go through:

"As a business, we have a website and we mainly receive our orders online. We also get orders via the phone especially from [company name deleted] (the focal firm). Once we get the orders depending on the location, for example if its local and in Florida we aim to do same day deliveries, however, when its across state lines we use [company name deleted] (3PL), its good because you don't need a fixed contract to use them it's a when and is if business arrangement"

Furthermore, a key issue raised in the interview was the importance of mitigating environmental risks. Of key importance was water management, which the manager emphasised, was a major issue.

It was evident from the interview that good agricultural practices were crucial and environmental sustainability was a top priority for S1. As the manager stated on the Zoom call:

"For us, good agricultural practices, especially water, are critical to meeting our business needs"

This statement shows how critical environmental sustainability is for tier 2 suppliers in the perishable food SCN.

4.1.14. S2 - Food Producer (Farmer 2)

S2 is a tier 2 supplier of oranges to FF. It is on the approved supplier list (ASL) and is a trusted supplier that makes up for the shortfall in the contractual supply of oranges by FB1 to FF. The oranges are delivered by road from California and it usually takes 3PL one and a half to two days to deliver the pallets to FF. S2 supplies FF with oranges mainly between the periods of December to June. As S2's Production Manager stated:

> *"We mainly supply businesses in the West Coast, these are our core customers, however, we have developed a good relationship with [company name deleted] FF and we supply them when an order is put through"*

Despite S2 been a small supplier to FF in terms of volume, it plays a crucial role and helps meet the demand requirement shortfalls of the focal firm's customers who prefer fresh fruit and vegetables sourced in the US. S2 also has a separate contract with FB1 independent of FF. Therefore, S2 delivers oranges to the food brokerage firm which in turn suppliers' other buyers. This is illustrated in Figure 19 below

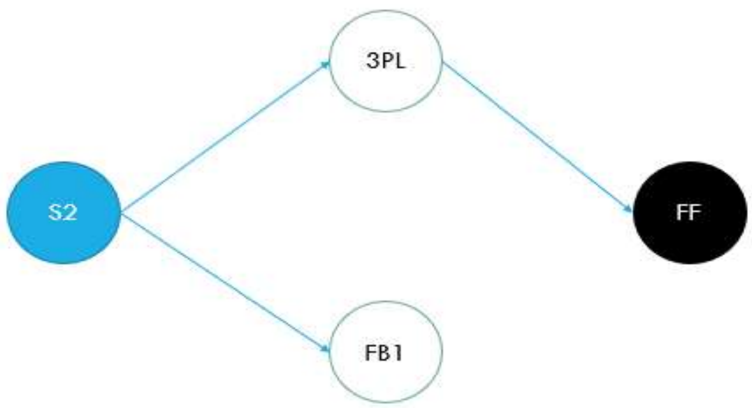


Figure 19: S2's supply chain network

Figure 19 illustrates S2's supply chain. As depicted above, S2 has a contract to supply oranges to FB1; in addition, S2 supplies FF to satisfy any shortfall arising from fluctuating demand.

Most of FF's orders are via through the phone early in the morning on the day the order is required. It normally takes 48 hours for S2 to make delivery on the order.

4.1.15. S3 - Food Producer (Farmer 3)

S3 is a cooperative of farms based in Mexico that supply FB1 with, jalapenos, papayas, blackberries, strawberries and blueberries. Due to the complexities of exporting, S3 has an agent who works out of FB1 and their main duty is to ensure that fresh fruit and vegetables are delivered on time. Furthermore, they must adhere to the U.S. Department of Agricultural - Animal and Plant Health Inspection Service (APHIS) and Agricultural Marketing Service (AMS), U.S. Food and Drug Administration (FDA) and U.S. Customs and Border Protection (CBP).

APHIS and FDA determine what food products are admissible into the US and all food products must meet or exceed the standard of products produced in the USA. When produce is exported from Mexico, CBP officers inspect the cargo and ensure that adheres to all the requirements including having all the correct paperwork. A food broker, representing S3 stated:

"Exporting fruit and vegetables to America is complicated, you have to really understand the US requirements and regulations, I mean really understand them, we are in the perishable industry, one screw up and you lose the entire load, the border agents have agriculture specialists to inspect shipments"

Due to the cost and regulatory pressures of importing agricultural produce, FF has opted to sub-contract all their sourcing involving importing raw materials to FB1 to minimise risk and increase capacity in their core competency, which is food manufacturing and processing.

4.1.16. S4 - Food Producer (Farmer 4)

S4 is a tier 2 Pineapple Farm based in Costa Rica which suppliers to FF via FB1. It supplies its products directly to FB1 and like S3; S4 has an Account Manager based at FB1 that ensures product sales and delivery. S4 is a vast exclusive pineapple farm and all their shipments are imported to the US via the ocean. S4 pay for containers and are responsible for the product right up to delivery at the port. Like S3, S4 must meet the requirements and regulations set out by the U.S. Department of Agricultural -APHIS and AMS, as well as the FDA and CBP. Hence, the Account Manager noted,

"The US is an important market for us but it's a constant battle to balance the costs, we have to always be profitable"

Cost of doing business was a major concern for S4 as economic sustainability was a major factor. Ensuring their pineapple were delivered to FB1 and met the required product specification which is mainly determined by the size and shell colour. Furthermore, sugar test is conducted using a brixometer. It is critical that the pineapples pass this test as the sugar content is directly linked to shelf life. The higher the sugars content the less product shelf life. Hence, pineapple quality was also the main issue for S4 as product rejects are costly.

4.1.17. PCR – Plastic and Cardboards Recycling Company

PCR is a recycling company based in eight locations throughout the US Midwest, which specialises in recycling industrial waste. PCR recycles FF's food delivery cardboards and plastics waste mainly generated from pallets and packaging. FF pays for the recycling, however, PCR stated that the recycling rates were low, and this impacts the growth of the company. PCR recycles industrial plastic mainly bulk industrial scrap plastic and turns it into durable material handling products.

PCR is a specialist-recycling firm that converts scrap back into reliable feedstock for the preferred manufacturing process, providing ecological benefits and cost efficiency for operations of all sizes and volumes. PCR recycles a variety of plastic types, which include HDPE, PP, LLDPE, PS, GPPS, HIPS, PC, ABS, and PC/ABS. However, recycling prices vary from state to state depending on legislation and incentives offered by the various counties. Hence, the Operations Manager stated:

"recycling rates vary between states, however, in [name of state withheld] the rates and support is low, […] instead of creating an incentive to recycle, the city's trash haulier charges residents for the privilege, so there is no appetite to recycle which decreases demand for our services"

The above statements show the dependence of recycling firms are on a favourable legislation and state or municipal support. Favourable legislation and or incentives from the state enhance the business environment of recycling companies.

4.1.18. LF – Land-Fill Waste Company

LF is a privately owned, permitted municipal solid waste (MSW) landfill operating under a permit. As an MSW landfill, LF is permitted to accept many different types of waste, from general household waste and debris to large-scale construction and demolition wastes.

FF pays LF for its waste disposal to landfill, which is mainly general waste e.g. rotten food, non-recyclable products, etc. Due to the nature of their business, LF is attempting to adopt sustainable practices as burying huge amounts of waste is not sustainable in the long-term, hence, the Site Supervisor states:

"We are currently looking into investment opportunities to partner with a big player in the industry to upgrade our facilities and capture methane gas and turn it into renewable natural gas for transportation fleets and various other uses"

This concept, which has been referred to as circular economy (CE), advocates for the reuse of by-products to create value in the supply chain. Instead of simply burying waste in landfill, LF aims to use this waste to build a capability to turn that waste into energy; however, investment remained a limitation.

4.1.19. AFC – Animal Feed Company (Edible by-products processing)

AFC is an independent, family-owned business with more than 170 years of experience in manufacturing animal feeds. AFC, which is based in Kentucky, US, buys all fresh fruit and vegetable by-products from FF e.g. watermelon skins, pineapple skins, apple skins etc. and uses them to make high-quality equine feed. Quality control is critical to their business model and AFC assures its customers through annual quality audits to ensure the company is adhering to United Feed Assurance Scheme (UFAS) and BETA NOPS Code of Practice. As the Production Manager stated:

"We specifically chose [company name deleted] (FF) to be our supplier for part of our ingredients because we trust the quality of their raw materials, we have been working with them for 5 years, well… eh. more or less 5 years"

FF's Materials and Replenishment Manager stated that the money generated from by-product sales to AFC is used to offset the cost of recycling to PCR and LF.

4.1.20. The Perishable Food SCN under investigation

After providing qualitative descriptive analysis of the actor-firms involved in the perishable food SCN under investigation, the network relationships can now be accurately configured. Figure 21 depicts the perishable SCN under investigation. Table 16 explains the different supply chain relationships depicted by the SCN diagram. It is critical to understand the different relationships as the units of analysis include buyer-supplier, buyer-supplier-supplier relationships and the entire network.

The focal firm is a fresh fruit and vegetable processor and is the starting point of analysis as per network theory principles (Harland, 1996). Additionally, 18 firms operating within FF's supply chain network were selected to satisfy all criteria of the supply chain tiers. The FMCG perishable food SCN in this study examines nineteen companies in total (excluding consumers); five suppliers (including main food brokerage firm), one manufacturer/processor (FF), two logistics providers, five retailers, one food brokerage firm (buying food rejects from FF), one food distributor, one recycling company and one general waste (landfill) company. Figure 20 depicts the configured network.

The following section 4.2 presents the manifest codes generated in the first level of analysis. These were purely based on the actors' words and therefore, are a surface structure analysis. Therefore, research questions 1a & 2a are answered which to investigate the prevailing risks and vulnerabilities as well as the resilience and sustainable praxis undertaken by actors operating in the perishable SCN under investigation.

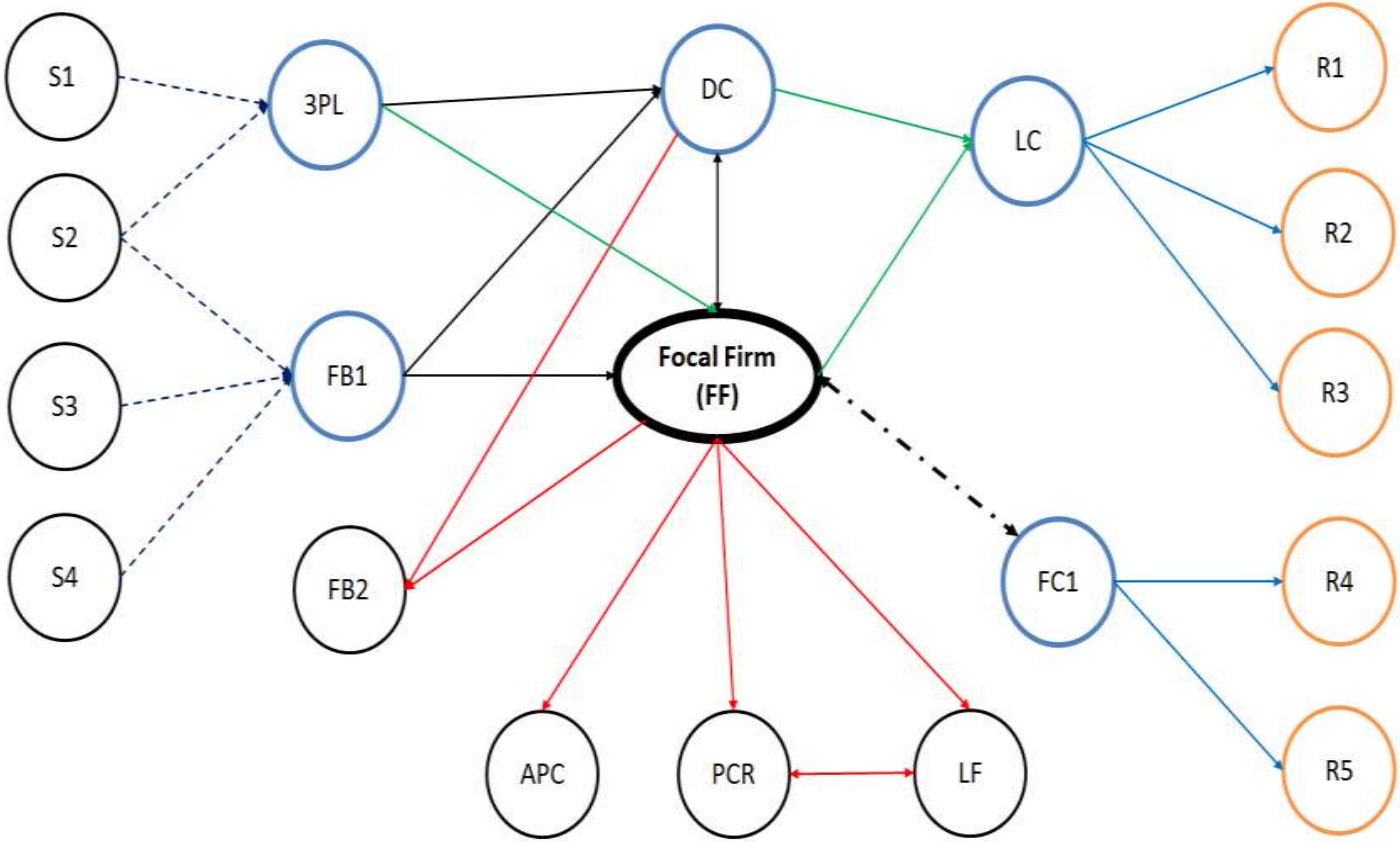


Figure 20: The perishable food SCN under investigation

Figure 20 depicts the configured supply chain network under investigation in this study. Table 16 provides a key for the different supply chain relationships depicted by the SCN diagram.

Table 16: Key to Figure 20 depicted SCN relationships

- - - - - - - ->	Represents **Tier 2 fresh produce suppliers**. Farms supplying fresh fruit and vegetables to the perishable food SCN
———————>	Represents **Tier 1 suppliers** of fresh fruit and vegetables to and from FF (Focal Firm)
———————>	Represents **Buyers** of food manufacturing by-products e.g. food rejects and edible by-products and recycling actor-firms
———————>	Represents the **Logistics/Freight** actor-firms operating in the perishable food SCN
———————>	Represents the **Retailers (Customers)** in the perishable food SCN under investigation
<· — · — ·>	Represents the food contractor who has a **buyer-buyer, supplier-supplier relationship and is also a major competitor** of FF (Focal Firm)

4.2. Perishable Food SCN Risks and Vulnerabilities

The results in this section were derived from an in-depth, two-layered inductive content analysis. The first layer of analysis focused on the manifest content of all the interviews, field-related documents and photographs as shown in Table 15. The second layer excavated the latent content of the data through an interpretation of the underlying meaning of terms and arguments. First, the process identified all risks prevailing in the perishable food SCN as shown in Figure 20. Second, by zooming in an in-depth explanation of all the prevailing risks and vulnerabilities in the perishable food SCN under investigation are provided in the following sub-sections. The risks generated from the analysis in Table 15 can be categorised into three distinct categories, deliberate, operational and random as shown in Table 16.

First, an analysis of the risks perturbing the SCN by other actor-firms those are deliberate. These risks are mainly inflicted on the perishable food SCN for strategic reasons of the actor-firm without adequate analysis or regard of their impact on their wider network. Therefore, these are usually undertaken for an actor-firm's business competitive advantage. Secondly, risks and vulnerabilities will be examined from a normal everyday operations perspective. This is a key aspect of pragmatism as the normal everyday actions of actors have a profound impact on the reality of operations within a SCN. Finally, random and sudden disruptions will be examined. These are exogenous to the perishable food SCN and no one actor has control over them. However, how different actor-firms react to these types of risks has a cascading effect on the overall performance of the perishable food SCN. Drawing on the coding that was undertaken using NVivo 11, codes concerning risk and vulnerability were clustered based on the response generated from the actors. These coded responses that were prominent from the actors' responses are shown below. As shown in Table 17, the next sub-section shall focus on adequately answering the research sub-question concerned with current risks and vulnerabilities prevalent in the perishable food supply chain.

Table 17: Codes generated from manifest analysis using NVivo 11

Table 18: Codes generated from manifest analysis using NVivo 11

NODES	SOURCES	REFERENCES
3PL Customer Service Support	4	12
Balancing Risk vs Reward	11	27
Barganing Power	9	33
Clear communication of expectations and capabilities (Prorate Strategies)	14	40
Complexities of operations	36	97
Continuos Improvement	7	14
Contracts ensure low cost and stable supply for buyers	21	40
Contractual Leniency and Flexibility (Prorate) for suppliers	7	16
Customer Satisfaction for Buyers	4	22
Customer Satisfaction for Suppliers	3	12
Demand Risks	10	40
Difficult to predict right inventory levels - Inventory Management	12	44
Dynamic Environment	31	72
Economic Sustainability - Profit	34	90
Environmental Sustainability	12	34
Experienced and Well Trained Staff	8	42
Flexibility - ability to react to disruptions and sudden changes	30	49
Food Recalls	3	10
Food Waste	15	42
Food Legislation and Regulations	10	22
Food Quality and Safety	36	122
Food Safety Management System (Information Systems)	14	44
Geographic Location	6	27
High Customer Order Variance	5	14
High Demand Variance	7	19
Immediate communication when disruption occurs	14	40
Information sharing is a balancing act	4	17
Information confidentiality is important	21	23
Information Systames and Technology	30	51
IS - Failure to fully utilise IS capabilities	3	12
IS - Human errors are a big issue	8	33
IS - Lack of IS and technological alignments	10	19
Technological adaptions and advancements	13	23
Joint Contigency Plannng	8	24
Joint Business Continuity Plan	12	27
Joint Decision Making	9	17
Joint Operations Planning	8	30
Joint Problem Solving	10	22
Just-in-time sourcing (JIT)	31	69
JIT - Limited flexibility - Same day sourcing	11	22
Logistics capabilities	12	40
On demanad transport capabilities	4	14
Longterm partnerships are crucial for building network strength	6	17
Natural Disasters	15	29
Delivery disruptions	25	49
Lack of collaboration, actors have to be self reliant	10	23
Supply disruption	15	25
Manufacturing disruption	3	10
Negotiating Power	10	23
Non-Asset based transport collaboration	4	17
Packaging innovation	5	24
Social Sustainability - People are key to supply chain success	12	30
People - Skills training	7	15
Recovery time after disruptions can be long	31	80
Recovery dependant on control mechanisms	9	16
Reliance on experience for decision making	10	31
Reputational Damage	2	12
Resource Sharing	6	14

From the codes generated in the analysis, a further latent analysis was undertaken using the categorisations shown in Table 17. These identified the prevailing risks and vulnerabilities that could be traced throughout the network. Table 18 classifies the prevailing risks uncovered during the study. Thus, by zooming in and out of the actors' practices, the significant risks and vulnerabilities were identified. Figure 21 depicts the mind-map of the key risks and vulnerabilities prevailing in the perishable food supply chain under investigation.

Table 18: Risk Classifications prevailing in Perishable Food SCN

Risk Category	Definition	Examples
i. Deliberate	These occur when actors take deliberate negative actions on a network actor-firm's business interest. These are often done at a strategic level	• Aggressive competitive manoeuvring e.g. using coercion in negotiations • Hostile business practices e.g. opportunistic price hikes, • Information breaches e.g. disclosing confidential information for firm's benefit • Food fraud – Dishonest food suppliers
ii. Normal Operations Disruptions	These arise from everyday business operations and normally affect the operational functionality	• Loss and damage of goods in transit • Transport delays • Poor production quality • Technology malfunction or machine breakdowns • Lack of collaboration between actor-firms • Lack of information for decision making
iii. Random & Sudden Disruptions	These are random and sudden disruptions which usually trigger cascading effects on the perishable food SCN	• Floods, Hurricanes, Earthquakes etc. • Loss of power or water • Transport accidents e.g. road collision • Fires

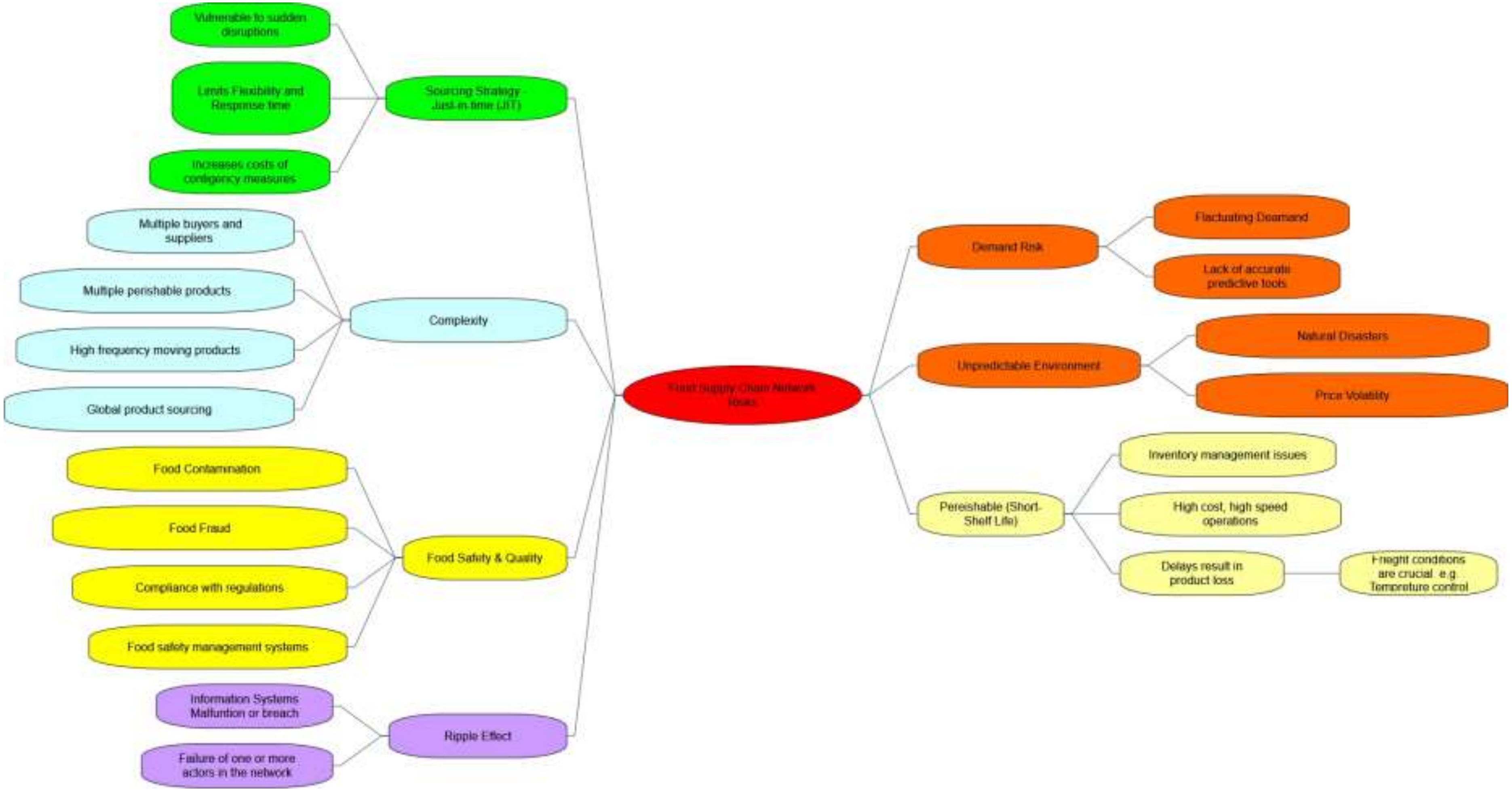


Figure 21 : Risks and vulnerabilities found to be the most significant from the analysis

Figure 21 depicts the various risks mentioned by the actors in the perishable food SCN under investigation across all tiers. It shows the main codes generated in relation to the risk and vulnerability of the perishable food SCN under investigation. As shown, food safety and quality were the most prominent concern of actor-firms from farm to retailer. Actor-firms stressed the importance of food quality safety as products move along the supply chain and are handled by various actor-firms at different locations and in some cases different countries. Furthermore, the vulnerability of the network to the sourcing strategy was expressed.

All respondents conceded there was no viable option to the JIT sourcing strategy, however, the vulnerability this sourcing strategy has on the perishable food SCN was of concern to actor-firms. Demand risks, which ultimately create price fluctuations, were another factor. Furthermore, issues regarding logistics, warehousing and delivery of food products were significant in the responses obtained. The following sub-sections will therefore, explicate all the risks and vulnerabilities as raised by various actors in their responses. To display the various risk concerns further as expressed by the actors in the interviews, Figure 22 below displays nodes clustered by word frequency of actors' interview. Thus, the most raised issues by actors are displayed in Figure 22.

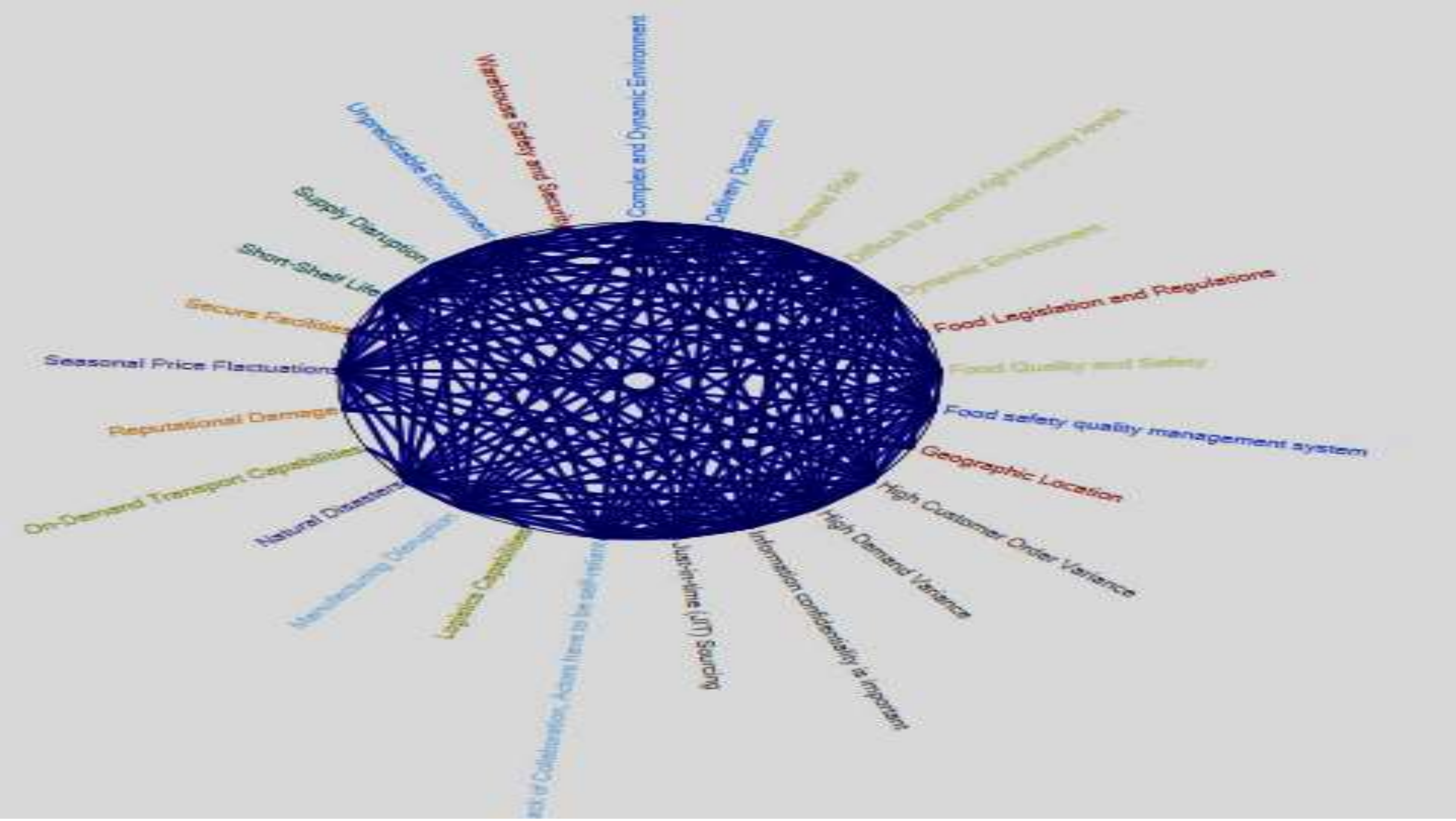


Figure 22: Nodes clustered by word frequency of actors' interviews

4.2.1. Deliberately Targeted Attacks

4.2.1.1 Deliberate price hiking

Deliberate price hiking is an issue within perishable food SCN. The genesis of this issue is rooted in the dynamic nature of the supply chain network, which is very nebulous, fragile and lacks permanent relationships between actors. When analysing buyer-supplier product pricing in the absence of a contract, there is a lack of an agreed price between actor-firms when dealing with last minute, out of contract orders. This means the supplier has the free latitude to demand the best price they can get despite the actual value of the product. As S1's, farm manager stated

"Our prices are very much seasonal so sometimes sell broccoli for as low as $4 and we take a hit but as soon as demand rises we can sell for $15"

Hence, in summer broccoli producers can demand high prices due to heat however, when seasons change suppliers dictate the price. This indicates how shifting power dynamics dictate pricing and are solely applied to the benefit of the actor-firm with the power at that moment in time. The lack of long-term relationships in perishable food SCN means that despite having some buyers and suppliers operating in the same supply chain network, there is a lack of mutual dependence. This means actor-firms exert power on each other depending on which actor-firm has seasonal dominance. This operational dynamic of 'order and chaos' promotes the use of power which may be negative or positive depending on its application outcomes. However, pricing has a huge impact on the economic sustainability of the perishable food SCN as FF's Planning Manager remarked:

"Costing, pricing and forecasting are the backbones of our return on investment…"

Therefore, pricing practices have a huge impact on the economic sustainability of perishable food SCN.

4.2.1.2. Food Fraud

Food fraud emerged as a major risk for actor-firms operating in the perishable food SCN. Retailers and manufactures as depicted in Figure 23 raised most concerns.

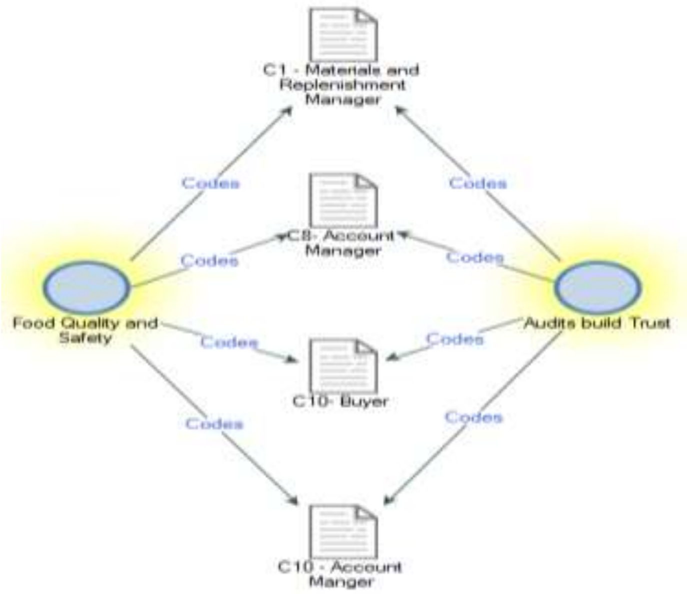


Figure 23: Transcripts with most codes regarding food fraud and the need to audit

Figure 23 shows that the focal firm a food manufacturer raised most concerns regarding food fraud and retailers. These actor-firms tend to suffer the most when there is an incident regarding food safety or quality; as there are the faces of the food industry to the public. Food fraud has become more sophisticated and is much more difficult to detect. As R3's Buyer stated:

> *"Fraud takes on many forms, sometimes a supplier can sell produce as organic when it has not been farmed organically or they put the bad product under the good product in a massive shipment and your dock inspectors miss it"*

Consequently, food fraud is a cascading risk, which means once it enters the food SCN, it affects all actor-firms including the consumers and it is at times very difficult to detect the origin of the bad product, as actor-firms tend to pass blame around as stated by FF's Materials and Replenishment Manager:

> *"It is difficult to trace where exactly a product was contaminated in the supply chain"*

4.2.2. Normal Operational Disruptions

4.2.2.1. Mixed Degrees of Collaboration

Lack of collaboration causes operational disruptions when actor-firms cannot come together to effectively resist or recover from a disruption. This is mainly because actor-firms have a mixed degree of collaboration, therefore, certain actors can combat certain disruptions e.g. product shortfalls together while others will penalise each other and look for an alternative. This lack of collaboration creates vulnerability in the network as there is little information sharing outside the 'need to know' approach. Figure 25 depicts actor-firms that directly responded to the question regarding collaboration to mitigate risks and build resilience. Figure 24 depicts the various degrees of collaboration deduced from the analysis. Table 19 shows the meaning units used to draw conclusions from the analysis.

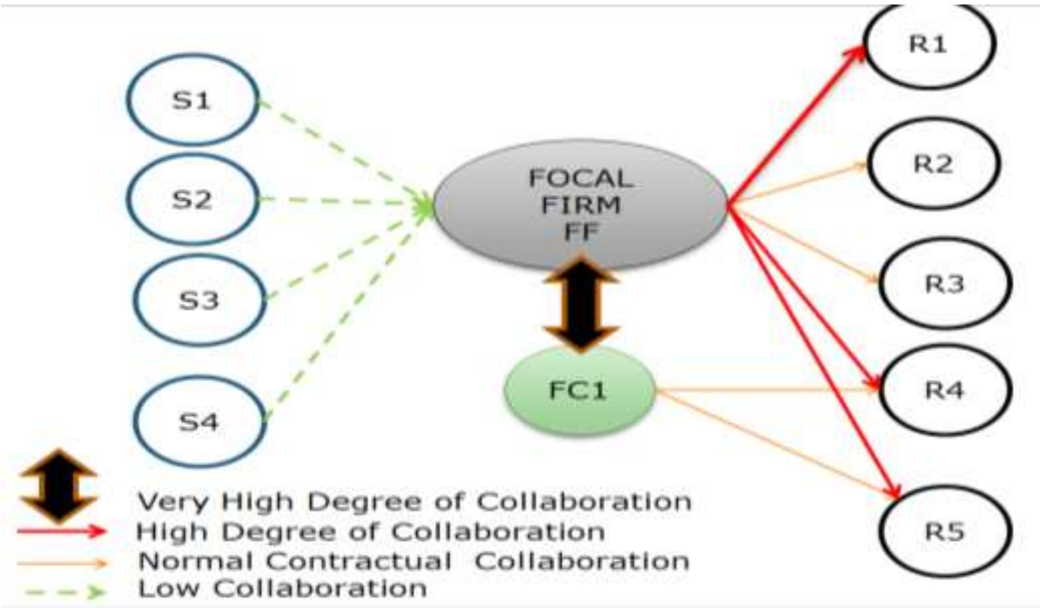


Figure 24: Mixed degree of collaboration in perishable food SCN

Figure 24 depicts various degrees of collaboration and how, these create vulnerabilities when dealing with cascading risks. This means actor-firms are more resilient only with the first tier, but the network becomes weak past the second tier.

Table 19 provides a number of excerpts from the interview transcripts of actors. These show the meaning units, condensed meaning units and codes used to generate the results depicted in Figure 25 showing the mixed degree of collaboration in perishable food SCN.

Lack of collaboration means actors often make decisions based on incomplete information. For instance, FF often uses estimates to cost its products as neither suppliers nor customers share their cost or product profit margin. Therefore, negotiations become a power play and whoever can impose their price wins the costing tangle. This clear for FF who expressed how traditional intra-firm costing was not appropriate given the way perishable food SCN operate as expressed by the Costing Manager:

Table 19: Excerpts of meaning units, condensed meaning units and codes from the data analysis

ACTOR FIRM	Meaning Unit	Condensed Meaning Unit	Code – Collaboration with Focal Firm
FF	*We collaborate heavily with some companies but others not so much*	Mixed degree of collaboration in perishable food SCN	Mixed degree of collaboration
FC1	*Our relationship with [FF] is unique because we contract them but we work very closely together to develop products for our mutual customers*	A coopetive and collaborative relationship that is defined by competition and collaboration	A very high degree of collaboration with the focal firm
R1	*We allow [FF] access to our inventory system so we don't send them any orders, they know exactly what we need, sometimes before we do*	Integrated information systems (IS) which allow for real-time information sharing	A high degree of collaboration with focal firm
R2	*I mean besides what is in the contract, we don't really share any extra information*	Contractual obligations and need to do business determine collaboration	Normal contractual collaboration with focal firm
R3	*We avoid sharing more information than we need to, we have to protect our business interest, we have thousands of suppliers we just can't give everyone access to our systems*	Contractual obligations and need to do business determine collaboration	Normal contractual collaboration with focal firm
R4	*Our company works in conjunction with [FF] and [FC1] to ensure our products are of the highest quality*	Actor-firms collaborating to provide high-quality food products	High degree of collaboration with focal firm

R5	*We work with [FF] to ensure most of our products are locally sourced; we can trace our products to the farm of origin .... We are proud of that*	High levels of collaboration in supplier selection and visibility throughout the supply chain	High degree of collaboration with focal firm
S1	*When [FF] need fresh produce they usually call us, we have a good understanding and they know the quality of our produce is very good ....*	Collaboration based on need and is not consistent	Low collaboration with focal firm
S2	*The majority of our customers are in the East Coast but [FF] order oranges from us weekly during December and March mainly*	Collaboration based on need and is not consistent	Low collaboration with focal firm
S3	*We deal with [FB1] directly and only communicate with [FF] in regards to quality or traceability issues which is not that much*	Contact is very minimal and usually via C5	Low collaboration with focal firm
S4	*[FB1] is our point of contact but we might get an email here and there from [FF]*	Contact is very minimal and usually via email	Low collaboration with focal firm

*“**Most of our costing is based on estimates** because **we always don’t have the information** and our suppliers never want us to know how much they are sourcing the raw produce for. **So, we must have three separate negotiations to come out with one price,** we have to negotiate with the suppliers, then verify with production managers how much it will cost to process the product, then negotiate with our customers on the adequate pricing. **Right now, the process is driven by estimation** but hopefully when [name withheld of ERP system] an enterprise resource planning (ERP) system is installed the process will be easier”.*

This indicates the vital role of collaboration in costing and pricing procedures and the impact of lacking adequate resources and tools to manage the process and collaborate effectively. Furthermore, forecasting is also an essential element as it dictates how much the buying managers must purchase daily. Timeframes are extremely tight in a dynamic FMCG operation therefore, FF cannot wait for its customers to send in orders instead, and FF must forecast and then adjust accordingly when orders are received. Forecasting in a FMCG operation is vital in sustaining the flow of goods especially when there is an information lapse. Due to the dynamic nature of the food industry, information can sometimes move slower than the goods, so forecasting becomes vital in addressing this anomaly.

4.2.2.2. Sourcing Strategies

The perishable food SCN employs a just-in-time sourcing strategy in relation to all its fruit and vegetable products. All the participants within the network despite expressing key concerns over the vulnerability of this approach concede, there are no other alternatives as their products are perishable with a shelf life of 4-10 days. This is evident from the statement made by the Operations Manager below:

“We really do not have any other choice except to use just in time that’s why we go back to those challenges we face of not knowing exactly what the customer is going

to ask for, it's a balancing act, yeah, everything we do here I would say 80% of our products are just in time, that's the system we use for our production"

The sourcing process is meticulous and involves several trade-offs as FF attempts to ensure that it receives the right amount of fresh raw products that adhere to its safety and quality standards. However, this creates vulnerability for the network if it suffers a disruption or surge in demand.

4.2.2.3. Demand Risks

Fluctuating demand for products by retailers (referred to as customers by FF) emerged as a challenging issue for FF. This emanates from the type of contracts they have with their retailers, which stipulate a minimum supply of products, but excludes a maximum clause, which provides flexibility but when orders are irregular and defy the forecast patterns then challenges arise. Hence, when retailers face unexpected consumer demand surges, e.g. an increase in watermelon or pineapple demand due to hot weather; the retailers order more products from FF in short notice, sometimes as little as 8 – 12 hours' notice time. This means FF must continuously adapt to demand as the firm uses a forecasting software system, which relies on past trends and simulations to predict orders. However, this is not always accurate as FF Buying Manager expressed when asked about demand challenges:

"Yes, we have, ***we have our challenges, normally around holidays****, which means* ***customers can't predict what they are going to order****, so that means you have to balance not having too little material and too much inventory so that's the constant challenge we are facing most of the time. We also must make sure that we are producing superior quality products that meet our customers' requirements and expectations.* ***Furthermore, having a product whose shelf-life only ranges from 4 – 10 days, that means we cannot produce something a week in adva****nce, the most we can do is 1 day in advance, so those are the challenges we meet".*

The issue of demand is affected by numerous factors within the perishable food SCN; it's not only an issue of sudden consumer demand changes but also of upstream capacity.

4.2.2.4. Perishable Food SCN Complexity

Perishable food SCN has a very high degree of complexity. As FF's Supply Manager stated:

"This industry is a different beast from other industries, where there is stability and they can know their orders even months ahead, not, here I have had buyers change their mind on the number of products or the location those products should be delivered after we had finished production and the products were on the road"

It is common for retailers to adjust orders and depending on the contractual agreement, FF may or may not rectify the order. Another issue that emerged mainly from the tier 1 suppliers (farms) was that they do not receive payment until buyers have received the product. This is unique from other industries were buyers pay in advance. This payment system means if suppliers are let down by buyer they encounter food wastage as the product rots and this is a loss of money. Furthermore, FF actors stated that daily supply chain operations are increasingly complex and dynamic due to a variety of reasons. The increasing product proliferation requires us to service an ever-diversifying product portfolio of retailers' requirements who are responding to changing customer needs is challenging. This increases the transactions and flows of raw materials, ingredients, products and packaging material. The Planning Manager explained this:

"Right now, we supply around 27 or 28 customers, yes on average about 24 or 25 orders daily that means we ship product to them daily, but it fluctuates sometimes it goes up to 30 they are certain customers who are seasonal and only want products at certain times of the year but on average we supply is 30 customers a year but remember each customer might be ordering over 20 different variety of fruit and vegetables"

Furthermore, legislation regarding food safety, human resources and environmental requirements increase the difficulty of operating in an already fast-moving supply chain. In addition, most actor-firms in the SCN are subject to the various retailers and food quality auditing boards, for example, FF is audited and certified by the British Retail Consortium (BRC). These food safety and quality management schemes also impose their own operational requirements, which increase the operational burden. For instance, a crucial condition of BRC certification is the ability of FF to provide full transparency of all food quality and provenance to all its buyers and consumers of its food products. To achieve this, FF has intensified information sharing and integrated information systems involving all chain actors regarding food provenance and quality. This will be explored fully in the resilience section.

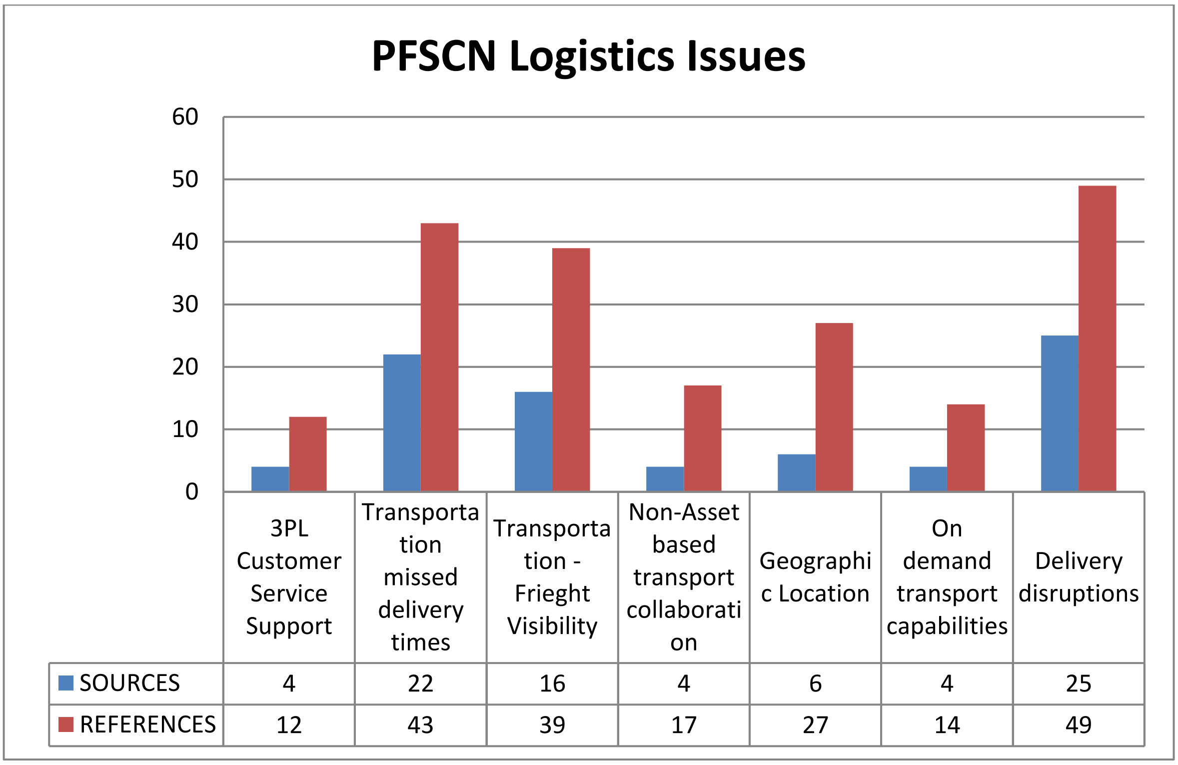
4.2.2.5. Logistics (Transportation issues)

Fifteen actor-firms in the perishable food SCN signifying the importance of this issue mentioned logistics issues. Tier 1 suppliers were concerned with the quality of their products during shipping as they mostly rely on 3PL, which a third-party logistics company is. However, due to the number of loads 3PL truck drivers take on their trailers, sometimes produce gets damaged or soiled. As S1's Farm manager stated:

"The problem is I could load my produce first and the truck goes to another farm, but my produce maybe the first to be offload according to the route the driver is taking, this means produce is moved around a lot"

This is problematic for tier 1 suppliers as they are only paid upon receipt of produce. If their product is rejected, they lose money and must most likely sell it to a broker like FB2 for a reduced price. Another key concern mainly raised by FF, FC1, R1, R2 and R3 was the issue of making delivery on time. If delivery is not made on time at FF they lose production time which cascades to late deliveries to the retailers.

They can be penalties for late delivery e.g. the store refuses to offload the food products which is a double loss for FF as they lose income because payment is only made upon receipt and the production costs. Figure 26 shows a bar chart of the logistic issues most raised by the actors. The ability to make delivery time was the biggest concern of most actors interviewed. This was followed by freight visibility and logistics capabilities. Freight visibility is concerned with the ability of actor-firms to be able to trace any delivery while it is in transit. This relies heavily on the information systems (IS) capabilities of the logistic company. Furthermore, logistic capabilities refer to the monitoring capabilities of the truck. It means are actor-firms able to accurately measure the temperature of each truck as it travels to deliver its produce. This is a key requirement regarding food safety and quality and helps track the source of poor-quality deliveries. Figure 25 depicts a bar chart of the main issues raised by actors regarding logistics and transportation issues.



	3PL Customer Service Support	Transportation missed delivery times	Transportation - Frieght Visibility	Non-Asset based transport collaboration	Geographic Location	On demand transport capabilities	Delivery disruptions
SOURCES	4	22	16	4	6	4	25
REFERENCES	12	43	39	17	27	14	49

Figure 25: Bar chart of the main issues regarding logistics from the actors' responses

4.2.2.6. Human Errors

Human error in the perishable food SCN emerged as one of the major vulnerabilities cited by actors. As new technologies are introduced to increase supply chain performance, the capacity for human error is increasing and with much more significant consequences as compared to manual handling. This is especially a problem in warehousing which is comprised of thousands of square metres (sq.m) in space, thus, making it challenging to manage. As DC's Warehouse Planner recalled an incident that had happened in the last year (2017)

"Human error is a big issue for us, a really big issue, we had a warehouse stock supervisor incorrectly change the system from FIFO (first in first out) to LIFO (last in first out) and we lost hundreds of thousands worth of bananas as they overstayed in stock and failed our customers' quality checks"

This example shows the impact of human error. It was also a problem for FF that relies on a human resources agency to supply them with staffs who are mostly foreign nationals. This meant language barriers decreased the efficiency of training which in turn caused human errors in the quality of the product as well as machine operations. Human error was also an issue for logistic companies as LC and 3PL had incidents with missed or late deliveries due to routing problems and the drivers getting lost or missing a delivery on the system because they overlooked it.

4.2.3. Random and Sudden Disruptions

4.2.3.1. Natural Disasters

Natural disasters are a recurring problematic phenomenon for FF and its supply network. There are difficult to predict and usually cause huge operational disruptions resulting in severe monetary loss. While FF puts in contingency measures to act as a buffer in case of natural disasters, the Operations Manager acknowledged it is difficult to manage:

“We have been affected by a lot of natural disasters, it happens frequently every year, we get affected by floods in one area and we get affected by heat in another area. Mother-Nature is one of the biggest problems that affect us because when we getting certain commodities from a certain region and if it’s affected, it creates challenges”.

The problem is that FF’s contract with its food broker varies for certain products e.g. 50% - 80% which means FF must acquire the balance of the product. So, when there are natural disasters, retailers still expect their delivery as per contract which means FF must order from any supplier that has the product which brings power dynamics into play. Bargaining power shifts to the supplier and they hike prices which affect FF’s bottom line.

Hence, the Buying Manager stated:

“For instance, ***we have contracts with our customers but we may not always have contracts with our suppliers*** *so when challenges arise it means the price is going to rise, but we get around this by signing contracts to keep the price low for everybody, so* ***we get a lot of challenges emanating from the weather*** *but of course its mother-nature there is nothing we can do about it. I can’t say which, commodities but a lot of commodities get affected by nature and* ***sometimes we have to stop certain machines from runn****ing because of Mother Nature”*

FF managers grudgingly concede that natural disasters are largely out of their control, though they prepare as much as possible for any disruptions, every year FF lose business due to severe weather. The Operations Manager expanded further:

“Unfortunately, there is no work around it, honestly, there is no work around it we just have to adjust and adapt and this happens every year so we prepare as much as we can but you know we can never be prepared enough 100% but our customers that we deal with they understand, Mother-nature or some other outside factors that can affect the way we supply to them but we don’t have any other way around it the only way around it is to give a product that’s not satisfactory and that’s not how we handle business.”

The following section now analyses the resilient strategies applied in the perishable food SCN.

4.3. Current Perishable Food SCN Resilient Practices

4.3.1. Resilience through Collaboration

Responses from the actors showed that SCC was an important factor in building synergies by facilitating collaborative activities like joint planning which enables real-time information exchange. FF's Quality Manager stated:

"Basically, every supplier and customer of ours has been here we encourage them to come here and to see their products in action ***for them to be able to tell us what we can do to improve, so give us their opinion****, for us to also give them feedback,* ***we work very closely with our suppliers we visit their facilities to make sure their doing everything in a very clean way*** *we have visited just about every customer who suppliers us and* ***we are inspected by very distinguished companies BRI, and SQF which is Safe Quality Foods*** *they all come to our facilities to make sure as well we are producing in a very clean safe environment so our suppliers we sometimes call them our customers because they strive to give us their best so we have a very very tight relationship with our suppliers"*

However, the issue of collaboration is not coherent amongst the different actors in the FF supply network. FF collaborates with other actors on a more deep and meaningful way e.g. information-sharing, decision synchronization and incentive alignment with FC1 and R1 but with other actors, there are seemingly no collaborative activities e.g. S1 that go beyond the transactional. Most of the collaboration was at a dyadic level, there was some triad collaboration but that was mainly between FF, DC and a retailer or FF, FC1 and a retailer. It is critical to note that in supply networks competitors often collaborate to attain mutually beneficial goals e.g. FF and FC1, this creates coopetitive relationships.

Table 20: Examples of collaboration from data

Collaboration Activity	Praxis	Code Excerpt
Information Sharing	DC and FB2 sharing inventory information	*If we have any excess stock we let them know*
Joint Knowledge Creation	FF and FC1 designing new packaging for R5 products	*we have a win-win relationship*
Decision Synchronisation	FF and R1 sharing inventory information	*we have access to their systems*
Incentive Alignment	R4 & R5 offer higher prices for sustainable produce	*The price is worth it so will farm organically*
Resources Sharing	FF and FC1 sharing production equipment	*[…] have installed the machinery so we can satisfy our customer*
Goal Congruence	PCR and LF working together in regards to waste sorting	*If there is any recyclable material we pass it on […]*

Table 20 provides examples of collaboration extracted from the data analysis.

4.3.2. Contractual agreements

Contractual agreements are a vital part of both the buying of products from suppliers and supplying of processed products to the retailers. The buying contracts are structured differently from the supply contracts. To tackle the demand challenges, 80% of FF's products are sourced under contract from a food brokerage firm (FB1) in Chicago and various other farmers (S1, S2, S3 & S4) who supply 80% of their raw materials. The other 20% is sourced on a negotiation basis with various vendors who are on an approved supplier list (ASL). These vendors are vetted at the beginning of every season to ensure they conform to the expected standards in regards, to food safety, food quality and capacity to deliver. Once vetted and approved for the PSL, FF will call or email them daily or when and if needed to satisfy the supply shortfall in their product demand. The Buying Manager outlined the process by stating;

"A lot of the times we contract for a year or 6 months, uhm, it depends on the commodity, so, for instance, let's say we want to negotiate a contract for broccoli and that person grows broccoli in Southern California or Northern California, we'll go for someone who can supply our needs all year round but we also diversify the contracts, so we will offer contracts from farmers from Arkansas to Los Angeles (LA) down right to the Desert Valley, where they just grow acres of product. In a year we are usually supplied by 20 – 30 suppliers including the brokers from Chicago but if things got tight like let's say there is a freeze our supply chain gets tighter we could go down to 15 suppliers a week that's when we really rely on our PSL".

The importance and reliance of contracts were also stated by the Customer Service Manager (CSM) who expressed the importance of business synchronisation in negotiating contractual timeframes because if there are not in sync issues will arise.

"Well, as a minimum we have to a have a year's contract because when we make contracts with our suppliers we have to know how to plan our operations its always beneficial for us when the contract is longer but as a minimum, it has to a year for both our customers and suppliers"

Contracts are a vital part of planning especially when dealing with the supply of perishable goods to various customers with different demands, as there are sources of planning and operational stability.

4.2.3. Trust as a resilient tool

An important latent unit that emerged was the importance of buyer-supplier and supplier-supplier trust. Whether negative or positive, daily relational transactions foster trust, which is eventually exhibited in business operational decisions within the supply network. For instance, the buying managers indicated they are certain suppliers they would just never consider even though they are on PSL due to experience. This is what the buying manager stated;

"I have this one farmer, for the life of me I do not why he keeps passing the audits to be on the PSL, that guy once supplied me dried out bad broccoli and he put the good one on top and once we accept it at inspection we can't send it back. The second time he sent me bad cauliflower, even if he was the last farmer on earth I won't buy from him… No way"

This indicates how bad rapport leads to mistrust which impacts on the decision-making process. On the contrary, the CSM expressed confidence in a customer whose relationship with the firm had evolved into one of collaboration; however, this customer is also FF's competitor, which makes the relationship unique. The CSM stated:

"One customer is probably 75-80% of our business we have built a relationship over the years and found out that's it's beneficial to both of us they are our customer, but we are also their customer, it's a customer-customer. The supplier-supplier relationship of this customer is very crucial in our business they help us develop some of the best ways to produce our products which helps their customers with cheaper prices and ever I started here over 10 years ago business with this customer has grown by over 300% in terms of production. We have other clients that we have done business for about the same time as them, so we value all our customers but at least 2 or 3 customers have been with us for 10 years"

As stated above, the emphasis on the time spent nurturing this business relationship and the accomplishments achieved together by both parties denotes how important rapport to supply chain partnerships.

4.3.4. Flexibility

Flexibility emerged as a major factor in business operations. Within the network operations, FF managers expressed an expectation that other actors within the network will be flexible especially during a disruption.

The food supply chain is prone to natural disasters and various reasons, which will result in suppliers unable to fulfil their supply obligations or customers changing their product order requirements. The Vice President (VP) of Quality explained it by stating:

"Yes, we have one customer in particular, they order their order today and they want it tonight so we had a situation when they ordered three times their normal order size, including holidays so we had a massive challenge and had to reach out to the customer, we were upfront with them and told them there is no way we will be able to meet your demand in 1 day, is there a way we can spread this out over 2 days and the customer understood and appreciated the heads up because we always try hard to satisfy our customers. Those are the issues we face constantly, and this is a constant issue we have with this customer".

As expressed by the VP, communication is a very important aspect of achieving flexibility. Due to the complexity and dynamics of food supply chains, flexibility is a key component of maintaining functioning relationships, but this is underpinned by effective communication. This is an important aspect of collaboration. Actors were collaborating in different ways, sometimes, through joint decision-making or simply information sharing. As the Buying manager stated:

"Definitely, ***there will always be challenges*** *but it's much easier when your customer or supplier understands you, these challenges will never go away there will always be there it's how you deal with them* ***our customers they are actually very proactive*** *they know that at certain times of the year, even if you look at what they ask us to do 'if you ever run into a problem, do this and do this' so we have options just because our customers understand us so they have given us options and the flexibility to change but when we change we have to inform them that we ran into that wall, that obstacle that we told you we might run into do you want us to solve it this way we already have your spec (specifications) that tell us to go this way but we need your permission, do you want us to go ahead, if they say go ahead then we have plans in place, so that moment it doesn't really affect the efficiency because we already have a plan the challenges never go away from day one in the food industry, there are there 365 days a year it is just how we deal with them"*

As stated above, actor-firms appreciate the terrain they operate in and realise that perishable food SCN can be unpredictable therefore they collaborate to provide flexibility. Supply chain flexibility through collaboration was strongly indicated amongst actors during interviews.

4.3.5. Food Safety Management Systems

Production is the core business of FF and FC1 therefore, naturally the most intensive of their operations. Most of the data on production were collected from non-participatory observations over a one-month period. In this month, the researcher observed the process from receiving raw materials to processing, packaging, quality controls and dispatch. Upon receipt of a product e.g. watermelon, jicama, pineapple, red onions etc., a visual and scientific test is conducted. Dock supervisors to check all fruit and vegetables visually use a guide and they must adhere to the specifications. This is done by means of random sampling, where the dock inspectors will get into a truck and pick random fruits from different batches. These are then checked visually, cut open and their sugar content is tested using a brixometer.

For instance, the brixometer test would require watermelons and cantaloupes to register a measurement of 8-10 while red grapes should not exceed 14 regarding sugars content. If any delivery fails a quality check due to disease, deformity etc., the load is immediately rejected and not offloaded. The driver must return it to the farmer or food broker. All products must have a label that clearly states their country of origin and if possible farm, this data is immediately logged into the system and the products assigned barcodes. These serve as tracking codes for transparency both for legal and business ethical reasons.

Due to stringent regulations regarding handling of foods, allergens must be separated. All received goods are arranged in order as FF uses first in – first out (FIFO) for its entire inventory.

This is crucial for quality and inventory control because FF is handling perishable products. Before the products go on to the production floor there are washed in a chemical bath to kill off any bacteria, fungi or virus. Once this process is complete, the products are fed into the machines and conveyor belts for processing on the production floor. Once packaging is done, the products have to be with the retailers within 24 hours. As the Production Manager put it:

"Once the raw materials get on the production floor, we must make sure there with our customers within 24 hours because the quality is everything to us, the customers must taste the freshness"

Product quality and safety are vital from both a legislative and organisational perspective. Three managers within FF mentioned food quality and safety as the biggest risk FF will tackle in the next five years. Due to pressure from

"The biggest challenge these days is food safety, from supplier to the customer food safety cannot be compromised. How do we get our food safely here?"

Food safety was cited by fifteen actors has been the most critical aspect of their supply chain operations.

4.3.6. Resilience through Information Systems

IS plays a vital role in managing FF's processes due to the number of products the firm handles in a day. However, because FF was taken over by a public company it had to comply with reporting regulations, which meant aligning its ICT infrastructure with the main firm. This resulted in the overhauling the old ICT infrastructure and installing a new JD Edwards system, which was still underway during the study. Although the system brought many improvements as stated by the Planning Manager below:

"We cannot survive without [ERP System], so every day I come in and pull reports of [ERP System] and we call it the 'production board report' that shows our actual sales that are in the system for today's demand then I take the total pounds for each room,

so I do one for fruit, vegetables and the flex-line. So basically, I tell them the sales for today and the projected extra pounds coming in later, because we get 84% of our orders the day before so we have somewhat of a lead-time, but we get 3 customers that come in the same day we need to produce so that's hectic"

However, the lack of inter-organisational integration of JDE between various departments was a huge challenge. The system was not fully synced throughout the organisation, so information was not easily shared. This led to relying on estimation formulas for forecasting, pricing and costing.

This was a major concern raised by FF managers who were optimistic that once the full implementation of JDE took place there would be communication that is much more effective and planning and ease of operational transactions. Technology plays a vital role in FF due to the dynamic and complex nature of daily operations. It is vital to seek new and more efficient ways of production and transportation of products. There have been dyadic collaborations between FF and FC1 in sourcing new equipment and exploring efficient ways of production. Furthermore, IS are very critical in managing food safety and quality. As DC Warehouse Manager stated:

"From the supplier to here, food safety is very important, we have items that are susceptible to certain bacteria and have to be handled in a certain way in regards to temperatures, every product that we receive here has to have a temperature recorder we want to know the activity (temp recorder) it tells you every single second of that truck what the temperature was from the minute it comes from the supplier to the minute it gets here"

This explains how critical IS are to logistics operations. Poor temperatures pose a logistical risk regarding food safety and quality during transit. Both 3PL and LC transport products over long periods, sometimes the Lorries must travel 30 hours. This means if temperature controls are not monitored properly, the product could lose quality and consequently shelf life in transit. The Quality Manager further emphasized this:

"our products come from the field so as soon as there are loaded on to the truck we require a temp recorder that we can download the details ourselves and it will tell us,

so we get those challenges were product gets here, it might not be exactly to the spec, like the temperature might have spiked so much that even if you try to cool it and bring down the temperature it's too late the 'critical point' has been reached already and it doesn't matter what you do after that. So, food safety, whenever we go to our suppliers and customers its number one it can never be compromised"

4.3.7. Planning, Production and Inventory Management

Efficient production was a key area of concern for the focal firm. It was crucial in building resilience as any lapses in production had cascading effects for the downstream supply chain. Due to the sourcing strategy and perishability of the products planning, production and inventory management had to be viewed from a resilience perspective as these can be managed to mitigate network risks. As the Materials and Replenishment Manager stated:

"Usually we buy in bulk to save money we buy just-in-time (JIT) (12 – 24 hour lead time) so depending on the shelf-life of a product before its sold to the customer, we determine how much we buy and for how long we keep it in stock, like I said most of our products are very delicate and sensitive to shelf life so you will find out that most of our items are not stored for more than 2 weeks in the facility unless you go to dry goods or frozen items which may stay for longer but in terms of freshness, fresh produce, all that stuff has to be used within 2 weeks some have to be processed within a week"

As stated above the maximum shelf life of most perishable produce processed by C1 is 2 weeks and the firm on has a lead time of 12-24 hours. Thus, planning and inventory management become a crucial resilience strategy as too little stock slows down production and shorts the purchase orders for the downstream supply chain. Reversely, stock counts as food waste and the company lose money due to poor quality stock that most likely rots and is discarded. Therefore, with the aid of IS, planning, production and inventory management can be applied as a pure resilience strategy.

4.3.8. Logistics Resilience Practices

Transportation and logistics issues were a major concern amongst eleven respondents. Actors stated that not only was logistics important for produce from point A to point B, but it was crucial in maintaining product quality in route FF is not responsible for any delivery of the products that is contractually the responsibility of the farmers and food brokers who are contracted to supply them. However, FF is responsible for the delivery of finished products to its customers (retailers). FF owns its freight company; however, LC operates autonomously. This development was important in reducing freight-related risks as explained by the Logistics Manager:

"Previously we relied on third-party fright companies, but not that we own [….] it's made life easier because communication has improved. Before there were serious issues with freight"

FF as a resilience contributor to its supply chain views the purchasing of LC as it mitigated the risks of product delays, food diminishing in quality while in transit and a lot of overhead

4.4. Perishable Food SCN Sustainable Praxis

In this section, an analysis of the sustainable practices undertaken by actor-firms in the perishable food SCN is conducted. To conduct a coherent and meaningful analysis, the TBL principles are followed thus, the economic, environmental and social (people) are analysed separately.

4.4.1. Economic Sustainability

Economic sustainability was a major priority for most actors operating in the perishable food SCN. 34 participants either directly or indirectly alluded to economic sustainability as been a core and key consideration in all business operations.

Thus, economic sustainability is viewed as the prerequisite of attaining the actor-firm's organisational goals. Actors in their interview responses state how critical this pillar is as emphasised by FF's Quality Manager below;

"Number 1 thing is that we have to do is sustain our operations and to sustain our operation we know the type of industry we are in and we are not the only ones in this industry but to stay competitive you have to be able to adapt, understand all these challenges that in your industry and how to deal with them there will be bad times and good times (ability to adapt) but especially in bad times you really need to know how to sustain your business"

All actors associated sustainability with the profitability of their firms at varying degrees. Most actors clearly viewed sustainability as business continuity regardless of the operating environment. This was more important than anything else as all other goals could only be achieved if there was economic sustainability. This view was especially important in relation to environmental sustainability issues.

The more a firm was economically strong, the more likely it was to engage in green sustainable initiatives. FF, DC, LC, FC1, R1, R2, R3, R4 and R5 clearly stated in their responses that they understood sustainability to mean business continuity. Thus, in the event of a disruption which results in the perishable food SCN facing reconfiguration in any way, shape or form, the individual actor-firms can continue performing and operating at optimum levels. This evident from FC1, which is a direct competitor, and larger in terms of annual turnover in comparison to FF yet the manager stated:

"Our relationship with [company name deleted] is complicated, they are our direct competitor, but the market is big enough for all of us, we can't satisfy the demand so the decision was logical to make in the end…. Even though initially there were trust issues, you know it's difficult to negotiate a high degree of coordination or should I say collaboration with a competitor but this was 10 years ago and today it has been one of if not our most profitable partnerships"

From the interviews, it was clear actors associated collaboration with the ability to achieve economic sustainability in their respective firms. Actor-firms viewed collaboration amongst actors as key in maintaining profitability. As the Operations Manager of FF stated:

"It's a very volatile and dynamic industry and we have lost some customers and we have also gained some customers, but we have managed to sustain our business due to the contracts we have with our suppliers. Our prices almost stay the same, so even when we are in the tough times we always end-up retaining our suppliers and sometimes they give us discounts because they know we are one of their biggest customers, they always give us discounts because they understand how our business works"

As stated above, the key concern for food firms operating in a perishable food SCN is economic sustainability due to the volatility and unpredictable nature of the SCN. Hence, R1's manager expressed the importance of profitability on each product range they have:

We have thousands of suppliers and we have to ensure that all the products we have on our shelves are profiting our operations

This reverberated throughout the interviews conducted with different actors operating in the perishable food SCN. This is evident from the interview with S1 farm manager who expressed the importance of running a financially viable operation. As the farm manager stated:

"It's increasingly difficult to run a profitable farm business, we are getting killed with many things, our customers expect high-quality product but it is difficult to meet product specifications with the resources we got"

It is evident from the responses obtained from the agricultural actors that farming costs are rising yet profits are getting squeezed due to various issues among them are imported due to globalisation. This was evident from the response by the production manager at S2:

“It is a really tough environment out there now, we have to compete with imports from Mexico which are cheaper, but do they have the quality that our products have, I don’t think so…”

This aspect of the margins been squeezed due to globalisation was evident from the interview with the broker from the food brokerage firm.

As their firm is involved with the direct import and export of products, their profit margins are susceptible to global volatilities created by currency fluctuations, loss of product in transit and price fluctuations. As stated by the broker:

“To be an effective broker, you have to fully understand that commodities are affected by everything, whatever happens in China affects you, what happens in Mexico affects you even Guatemala, so your job is to always understand what is going on globally and how to create profit from that situation”

From the analysis conducted, it is evident that most actors interviewed considered economic sustainability key and the foundation of business survivability.

4.4.2. Environmentally Sustainable Practices

Upstream supply chain actor-firms mainly expressed environmental concerns. Amongst the most critical environmental concern was the issue of water, disease and pest control. As S1’s Farm Manager stated.

“Good pest and disease control and efficient water management is the key to profitability”

The above statement reflects the upstream actor-firms’ view of environmental issues. Moreover, environmental challenges were a source of insecurity for upstream actors, as in the event of floods or any other natural disaster, they lose sales as food manufacturers and retailers seek other suppliers or alternative sources for their supply. Retailers also expressed concern for environmental issues, however, it was clear the motivation and reasoning for these concerns was much different to that of upstream actors.

For retailers, many of their environmental concerns are mainly driven by stakeholder pressure. For instance, increasing demand for crops with fewer fertilisers and chemicals means retailers now encourage farmers to use fewer chemicals. Despite retailers expressing a preference of certain sustainable practices and insisted on these measures when negotiating contracts, upstream supply chain actor-firms stated more strongly the impact of environmental sustainability directly on their businesses. Food producers mainly concerned themselves with agri-sustainable schemes. Like water conservation, using fewer chemicals, applying recycling schemes e.g. generating manure. Food manufacturers were more concerned with reducing food waste. They attained this by not wasting food by-products and selling all by-products to a feed company. As the Operations Manager stated:

> *"Yes, our by-products of course most of our products are edible whether it's a by-product or not they are edible so we have another client who uses that because it's still very clean product though we can't use it because of the specific requirements and standards of our customers so some of it goes for animal feed for example horses because it's very clean it also helps us financially and also we do a lot of recycling nothing goes to waste so we recycle everything our recycling program you'll find out it also helps our business stay afloat. We come up with a lot of programs that help us, but I strongly believe in economic sustainability everything else is secondary"*

While the main motivation is economic sustainability, the by-product of this is environmental sustainability. This reinforces what was found in the previous subsection data analysis that most actor firms are mainly driven by economic sustainability. Another measure applied by actor-firms was using appropriate packaging that was recyclable. The packaging is critical in maintaining product quality and safety. Using appropriate packaging helps extend product life and allows for less product tempering and contamination.

AFC, PCR and LF all worked in a various way to ensure the SCN was environmentally sustainable through their recycling and disposing schemes.

4.4.3. Actors Sustainable Practices (People)

Many of the actors interviewed expressed people management and the social condition of the perishable food SCN clearly. Issues surrounding the welfare of actors within the supply chain were reviewed. For instance, there was an issue of truck drivers working long hours due to delays in traffic or other unexpected risks e.g. bad weather. This meant that for the driver to make delivery of the products, they had to keep driving regardless of the 8-hour work requirement. To resolve this issue, IS was applied, by 3PL. All drivers were given codes to enter a special panel fitted onto their truck's dashboard at the start of each journey. This meant that countdown would begin 15 minutes after the driver starts driving and when the panel, regardless of the location of the truck, registered 8-hours, it would give four warnings every 15 minutes in the last hour for the driver stop and rest or change shift with another driver.

After registering 8 hours on the panel the truck would automatically shut down. The truck could only be restarted after 12 hours or if a new driver came in with their code thereby relieving the first driver. This shows how logistic companies operating in the perishable food SCN apply IS to enable actors to undertake their duties in an efficient and safe way. The focal firm (FF) had a lot of foreign labour working on their processing floors. This created an issue regarding language and the impact this had on the ability of supervisors to train new staff. It created variances in production speed and quality. A key issue was food wastage, the more skilled workers were able to process food products with minimal wastage e.g. cutting the fruit too deep thereby losing product and weight; as opposed to new or less skilled staff would generate more wastage in comparison due to inexperience. As FF's Production Manager stated:

"[company name deleted] make sure we are profitable like this time of the year with those challenges our staffing varies because our business volume varies, sometimes it goes up and sometimes it's slow, so we have to rely on agency staff and they may be unskilled in most cases"

Figure 26 illustrates the effects of a lack in staff learning and development on the supply chain operations which have a cascading effect on the network regarding yield and efficiency. Moreover, it impacts FF negatively regarding product yield and cost of production and the ability to react to disruptions in a timely manner. However, it is not isolated to FF but throughout the SCN. S1 and S2 expressed the importance of skilled labour in attaining high yield and crop quality. It is evident that skilled labour is viewed as a strategic resilience capability. In contrast when there is understaffing or under-skilled labour actors viewed that as supply chain vulnerability.

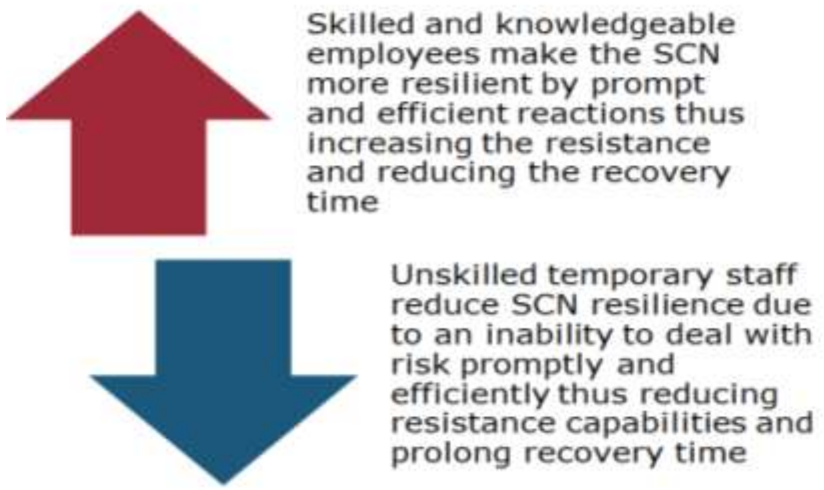


Figure 26: Effect of people skills on SCRES

4.5. Latent Analysis

This chapter configured the perishable food SCN under investigation to examine the risks and vulnerabilities actor-firms operating in the supply network encounter. This was followed by an analysis of the resilience and sustainability views and practices of actors. Through the application of within and cross-case analysis techniques first, the prevalent risks and vulnerabilities in the network were identified. This was then followed by analysing how actors respond to these risks and vulnerabilities by exploring and examining the resilience and sustainability praxis.

In this section, all the findings of this chapter will be systematically put together to create a compilation that can be further analysed using latent techniques to tease out details underneath the surface.

4.5.1. Power Dynamics

As shown in the analysis, many risks and vulnerabilities prevalent in the perishable food SCN under investigation were uncovered. Issues regarding the shortfalls of JIT sourcing strategies were expressed by actors in their interview responses throughout the various tiers of the SCN. Of major concern was the vulnerability of sudden disruptions to supply. As R2's manager stated:

"There is always a problem if demand suddenly increases for a particular food product because what we absolutely aim to avoid as a business is empty shelves"

However, if there is a sudden disruption or an unexpected increase in demand levels, it becomes very difficult and costly to rectify the situation. This creates what can be best described as *'power dynamics' (*see Table 21) in the perishable food SCN. This is evident from opportunistic price hikes. These are in reaction to the sudden demand for products. By deliberately hiking prices, it is evident that power flows are temporal and in a state of flux in perishable food SCN and power is constantly shifting between buyers and suppliers.

Furthermore, due to JIT sourcing strategies, contingency measures are expensive to implement due to the high degree of supply chain velocity required to rectify any shortfall in raw materials. In addition, response time is also very limited as actor-firms do not keep buffer-inventory to combat a sudden shortfall. This is due to the perishability of products. This means, when raw material replenishment is required, the order has to go through the supply chain right up to the supplier. If this is outside the contractually agreed amount then the supplier is free to charge any price they desire. Depending on how desperate the situation is, the buyer may agree or decline to the costing of the raw materials (fresh fruit and vegetables).

Table 21: SCN Power Dynamics analysis excerpt

Meaning Unit	Condensed Meaning Unit	Code	Sub-Category	Main-Category
They are just some suppliers who we'll never order from, even if they were the last vendors on earth…	Withholding orders from some vendors on the preferred vendor list (PVL)	Punishment for past supply or contractual breaches	Discretionary power to punish	Coercive Power
We have to process this customer's products first because they want us to test every batch which is time-consuming and expensive because the lab is in Chicago	Retailers have the power to demand stringent and difficult conditions from suppliers	Rewarded with a contract for agreeing to fulfil certain conditions	Ability to offer lucrative contracts to compliant suppliers	Reward power
We have to deliver the products on time, if not it's serious… we have had drivers turn up a couple of hours late the store refused to take the delivery	Despite how minor certain delays may seem, there severe penalties imposed on the freight company	Serious consequences for failing to make delivery time	Contractual breach penalty	Legitimate power
Nobody does bananas like us, we have the speciality equipment and technique to process almost a million bananas… it took us years to get to this point	The actor has developed skills and capabilities to handle and process bananas in an efficient way	Acquired specialist technology and skills to handle bananas	Specialist technology, skills and knowledge in bananas	Expert power

For our key accounts, we are now insisting that freight have some sort of wireless and real-time temperature monitoring system that can display critical data to us on the conditions in that trailer at any given time	The focal firm now moving towards monitoring truck and trailer condition to ensure food safety and quality	The actor uses technology to monitor and control the logistics provider's actions and compliance	Technology as a means of ensuring food safety and quality	Power of technology

4.5.2. Information Systems (IS)

Another issue identified from coding as contributing to shortfalls in supply was an inability of FF and FC1 to forecast demand accurately. This inability is caused by retailers' constant order-changes as a response to direct sales in their stores. Retailers can only confirm the actual orders required for each of their stores by latest midday (12.pm.) on the day of delivery. Unfortunately, FF and FC1 cannot wait to plan and conduct production as this will create a backlog, which leads to bottlenecks. To mitigate this vulnerability, FF conducts forecasting. Table 22 provides the forecasting processes followed by FF to mitigate demand risk and was taken from a forecasting blueprint used in the focal firm to conduct production planning.

Table 22: FF Forecasting techniques - *(Document courtesy of FF)*

Forecast Method	When to apply the method
1. Percent Over Last Year	Recommended for items with growth or decline
2. Calculated Percent Over Last Year	Recommended for short-term forecast
3. Last Year to This Year	Recommended for items with level demand
4. Moving Average	Recommended for mature products without trend
5. Linear Approximation	Recommended for additional items, or trends not based on seasonality
6. Least Squares Regression	For lifting straight line to fluctuating data
7. Second Degree Approximation	Recommended for short-term forecast
8. Flexible Method	Recommended for items with a planned trend
9. Weighted Moving Average	Recommended for mature products with stable demand
10. Linear Smoothing	Recommended for short-term forecast of mature products
11. Exponential Smoothing	Recommended for products that do not exhibit trend or seasonality
12. Exponential Smoothing with Trend and Seasonality	Recommended for products that do not exhibit trend and seasonality

Table 22 shows the forecasting processes applied by FF to conduct production planning, mitigate demand, and supply risks. Complexity is another key risk identified by many actors (3PL, FB1, FF, DC, FC1, R1, R2, and R5) in their interviews as a major concern. Complexity in perishable food SCN is driven by the configuration, which comprises of multiple buyers and suppliers spread across global geographical locations. In addition, the products are perishable and susceptible to contamination from, farm to consumption through either degradation or rotting and/or fungi, bacterial or viral contamination. This makes the perishable food SCN fragile and delicate and requires high degrees of safety and quality protocols. Complexity requires a high degree of adaptability for actor-firms to be able to combat emerging risks. Hence, R1's manager stated:

We have conceded that for us to achieve the most effective inventory management processes we should allow our suppliers a certain degree of access, obviously they may be risks but we only do this with thoroughly vetted suppliers

Thus, by acknowledging the complexity of inventory management and replenishment, R1 has adopted by enhancing collaboration with its suppliers. In addition, uncertainty due to natural disasters and currency fluctuations make the perishable food SCN vulnerable. As S2's production manager stated:

"I can honestly say over the last decade the weather has become more volatile and unpredictable, I think its climate change because the weather has become more vicious"

Thus, natural disasters cause disruptions to supply chains that are often difficult to mitigate and can normally always be measured after the fact in regards to the damage caused to the supply chain. Food quality and safety also recorded high codes by been mentioned over 300 times across all interviews with the actors. A critical element that emerged in ensuring food quality and safety was the application of food safety management systems (FSMS). This was mainly applied to the use of information systems (IS). IS, emerged as a major enabler of many processes throughout the perishable food SCN.

From costing, forecasting, planning, food safety inspections and quality monitoring etc. IS was critical in mitigating risks and enhancing resilience strategies. In particular, IS was critical in generating and applying supply chain visibility. Visibility is a critical safety issue as it allows products to be monitored from farm to consumer. This means as soon as raw materials are delivered, paperwork, which comes with the products, clearly identifies their provenance. This identification of origin is used to create an LPN, which is encoded into the products' barcodes and is maintained throughout the production and distribution stage right up-to consumption. IS are also critical in inventory and replenishment management as is evident from the collaboration between FF and R1. Furthermore, IS facilitated collaboration by providing a secure, easy and reliable method of information sharing and joint planning and decision making. For instance, in logistics operations, IS was critical in monitoring trailer conditions for products and also driving times. Monitoring gadgets were fitted on the dashboard of most semi-trucks in the freight company to ensure drivers could not drive more than eight hours. After eight hours the system shut down the truck up-to a certain time or until a new driver came with a new code.

4.5.3. SCN Culture

Perishable food SCNs are laborious, hence, actors are critical to success, and therefore, resilience and sustainability are affected by the level of skill, which limits human error. Hence, a critical issue identified from the analysis was the importance of training and development amongst actors in the perishable food SCN. Training and development were identified as critical in supply chain resilience as it created a risk-averse culture, which allowed for the implication of resilient strategies. By having more skilled people in the SCN, actors were more flexible and adaptable to respond to emerging risks. As the FC1 manager stated:

"when you have the right people…. nothing can go wrong"

The culture of actor-firms directly influenced what strategies and actions they undertook in the SCN.

If building flexibility was an organisational culture as in DC, then all employees are immersed into that flexible approach style of working and making decisions. Another key area that reflected culture was the ability to collaborate, despite FF and FC1 been competitors, the firms were able to collaborate effectively to achieve their organisational goals. This ability stemmed from a collaborative culture embedded in both their organisations. Another key finding was how the power of bigger actor-firms by resources and turnover could influence their SCN to adopt sustainable initiatives. While most farmers understood the importance of environmental sustainability, the majority of the actor-firms were more interested in economic and social sustainability. By creating incentives for smaller actors to engage in sustainable initiatives, the big actor-firms were fostering a SCN sustainability culture.

4.5.4. SCN Collaboration

Figure 27 depicts the various methods of collaboration identified by the actors in their interview responses, Different actor-firms collaborated to varying degrees depending on the supply chain relationship. Using NVivo 11 Figure 26 depicts the different ways in which actor-firms collaborated with each other in the perishable food SCN under investigation. Such collaborations included joint decision-making, joint planning, joint contingency planning, information and cost-sharing etc. Most of the collaborative activities were between dyadic and a few triadic relationships. For instance, FB1's supply contracts with S2, S3 and S4 had risk sharing clauses in them. As the FB1 broker explained

“when you rely on imports you have to share risks especially with your long-term supplier, this build trust and a good relationship”

Collaboration was viewed as a key enabler of both SSCM and SCRES. Though the definition of collaboration differed drastically amongst actor-firms and each supply chain relationship was characterised by varying degrees and forms of collaboration, it is still regarded as very important. Especially in regards to delivering safe and high-quality food products.

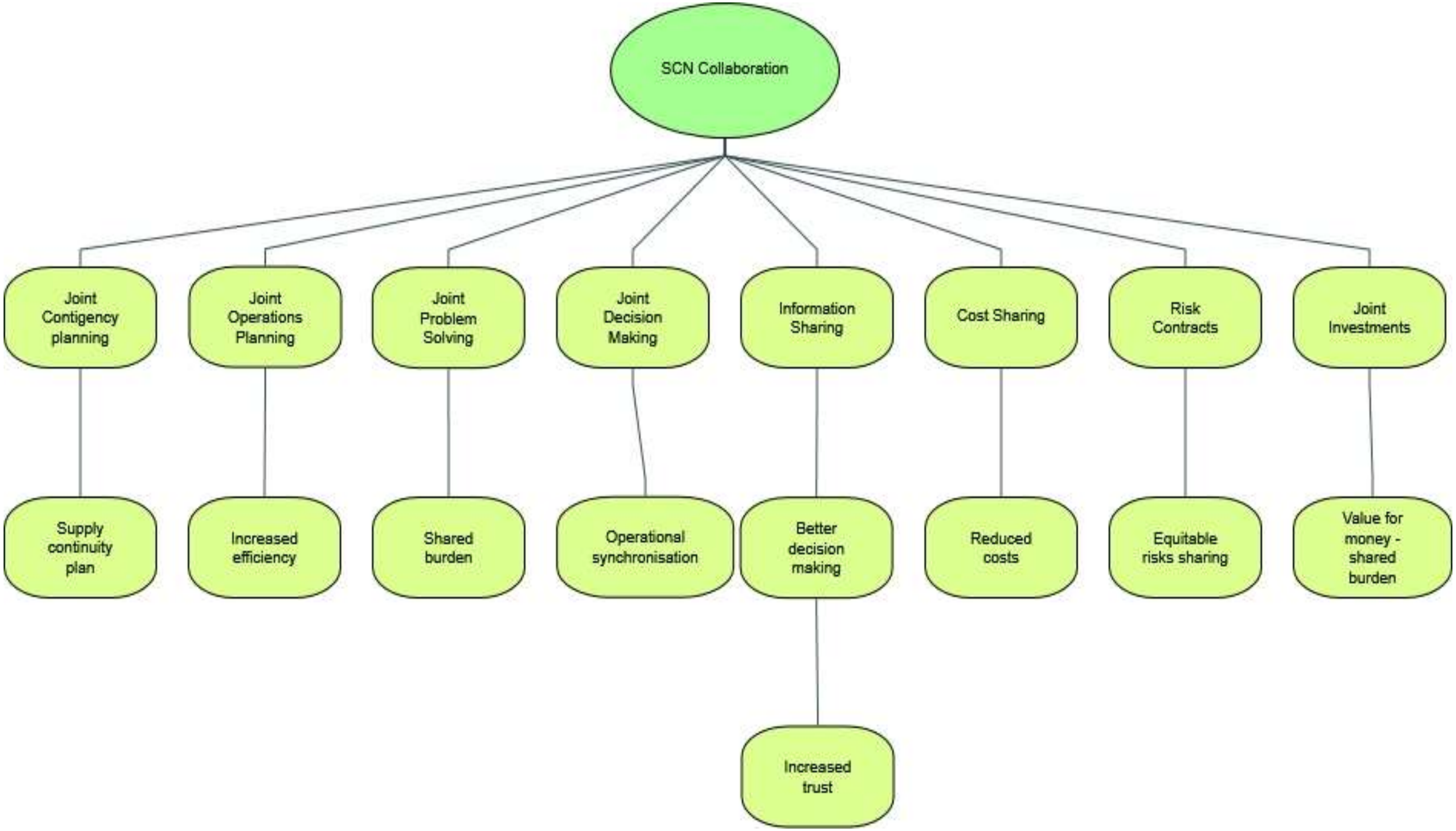


Figure 27: Different collaborative activities stated by actors

4.6. Concluding Remarks

Chapter 4 has teased out four key category findings that are critical in building resilient and sustainable perishable food SCN. These four key categories are Power Dynamics, SCN Culture, SCN Collaboration and Information Systems. Figure 28 depicts the four main key categories and their impact in generating resilient and sustainable perishable food SCNs.

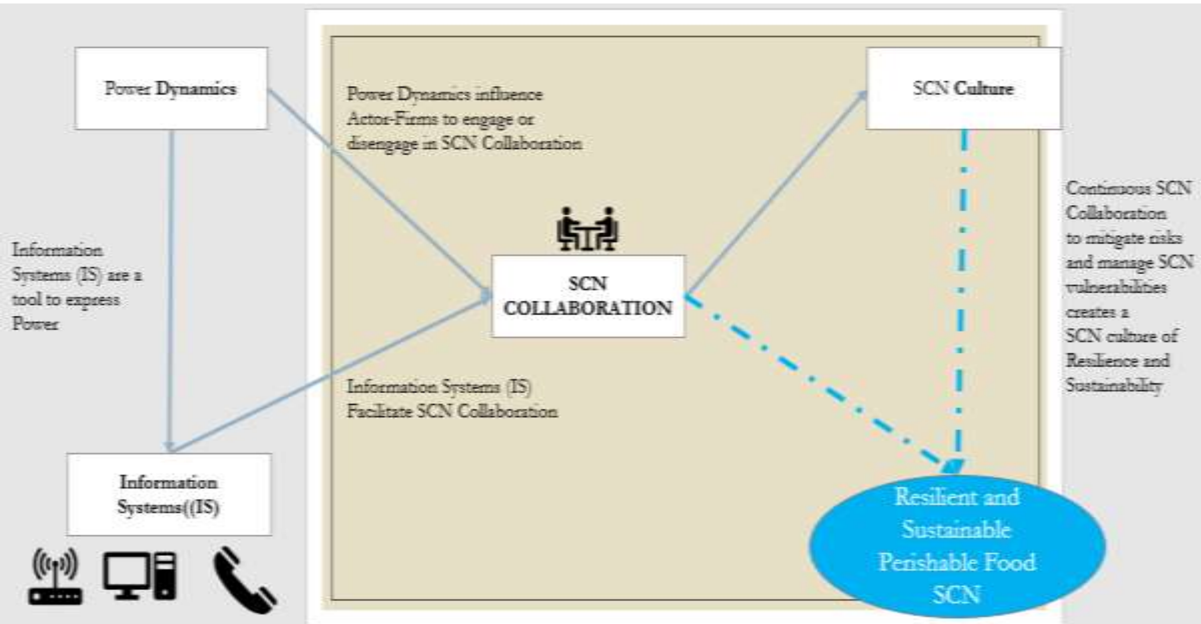


Figure 28: Interplay of Power Dynamics, IS, SCN Collaboration and SCN Culture in building SCN Resilience and Sustainability

Figure 28 depicts the interplay of the main categories identified in this chapter, power dynamics, collaboration, IS and SCN culture with collaboration identified as the main enabler of building resilience and sustainability. To effectively mitigate SCN risks, actors must collaborate in implementing SCRES strategies and capabilities to limit the impact of SCN disruptions and allow the network to return normal or exceed the previous level of functionality.

Chapter 5 will analyse these categories in detail to explain how these categories build on resilient and sustainable perishable food SCN. Chapter 5 will conduct the second level of analysis, which will be the categorisation stage. This analyses the four selected key categories generated from the first level of analysis conducted in Chapter 4.

CHAPTER 5: Zooming Out – Analysing the Perishable Food SCN

5.0. Chapter Introduction

This chapter presents key findings drawn from the data analysis as outlined in Chapter 3 and conducted in Chapter 4. The data analysis generated four main categories through conducting both manifest and latent content analysis. These categories are further analysed in a second and deeper level by zooming out to see the impact of actors' praxis on the SCN. The four main categories generated from the analysis were **Collaboration, Power Dynamics, SCN Culture and Information Systems (IS).** Using cross-case analysis, this chapter assesses how these four main categories can enhance resilience and sustainability. Figure 30 provides a brief synopsis of how collaboration, power dynamics, SCN culture and IS enhance the key areas identified as critical in building a resilient and sustainable perishable food SCN. These four identified main categories will be further explored individually in the following sections of this chapter.

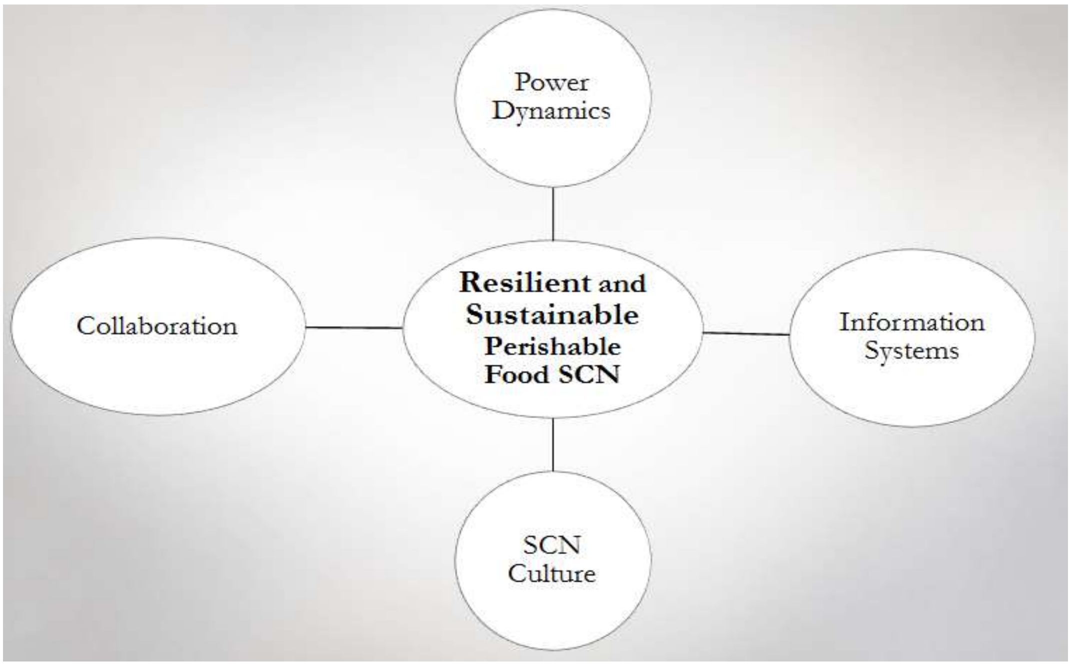


Figure 29: Four main categories identified as critical for resilience and sustainability

5.1. Power Dynamics

The within and cross-case analysis technique applied to the participants' interviews revealed power dynamics as a critical factor in supply chain operations within the perishable food network. This was a surprising finding as power was not associated largely with SCRES and SSCM during the critical review of the published literature. However, the impact of power on short and long-term decision-making and supply chain relationships between actors in the SCN became evident during analysis. It is important to note in SCNT theory, a 'power law' is viewed as vital for the connectivity of nodes (Hearnshaw & Wilson, 2013). However, in network theory the power law is assessed using two critical measurement factors, volume and frequency. Volume refers to the amount of flow between two nodes (actor-firms) while frequency refers to the rate of exchange (Hearnshaw & Wilson, 2013). It is important to note that SCNT theory focuses on three exchanges, financial, information and materials. These three exchanges were used to assess buyer-supplier activities in the SCN under investigation. Furthermore, many studies also consider other qualitative factors like, trust and reciprocity when investigating power dynamics in supply chains (Brooks, et al., 2017; Ireland & Webb, 2007).

In relation to power, the findings go much deeper than simply explaining connectivity in the network. The effect of power uncovered in this research is much more embedded and is consequential to SCRES and SSCM praxis. Though most participants representing various actor-firms operating within the SCN seldom overtly used the word or term 'power' in their responses, it was evident from their perceptions, descriptions and elaborations they were covertly referring to this phenomenon. A re-examination of the literature to assess power dynamics in SCM research uncovered that scholars are beginning to acknowledge its importance in SCM (Huo, et al., 2017; Matheus, et al., 2017; Crook & Combs, 2007). Furthermore, research seems to be focused on direct outcomes of power e.g. supply chain performance in dyads (Huo, et al., 2017), trust (Pulles, et al., 2014; Ireland & Webb, 2007), power asymmetries in dyadic relationships (Nyaga, et al., 2013).

Critically, most research on power in SCM only focuses on dyads, triads or linear supply chains (Huo, et al., 2017; Pulles, et al., 2014; Nyaga, et al., 2013; Benton & Maloni, 2005). Therefore, a dearth of research that investigates power from a network perspective is prevalent. The need for more research that investigates power from a network perspective within SCM is evident (Reimann & Ketchen, 2017). This study fulfils this gap, it is novel as it analyses the effects of power dynamics on building resilience and sustainability in SCN. It also extends on Anthony Giddens work which envisages resources as a form of power (Giddens, 1984). Giddens make a clear distinction between, "authoritative resources" which allow actors to control people, while "allocative resources" allow actors to control materials (Giddens, 1984).

To tease out the power dynamics of the perishable food SCN under investigation, the theoretical lens *'zoomed out'* and applied latent content analysis techniques to allow for deep structural examination of the underlying meaning behind the participants' interviews. The results show power is precarious, and its application can yield negative or positive outcomes for the actor-firms operating in the perishable food SCN. Matopoulos *et al* (2007) in their study of SCC found power to be critical in managing trust, risks, dependancies and how rewards are shared in supply chain relationships. The results obtained build on Matopoulos *et al* (2007) study by navigating the analystical lens via ZIZO technique to assess the hidden role of power.

This was evident when R2 rejected to renew their annual contract with FF upon its expiration due to disagreements over costs presented in the new contract. R2 proceeded to negotiate a deal with a new supplier. However, due to contractual breaches by the new supplier e.g. missed deliveries, product quality issues etc. R2 cancelled the contract and reopened negotiations with FF. Thus, R2 was back at the negotiating table within six weeks after multiple disruptions and poor product quality deliveries from their new supplier. FF negotiated a much better contract in terms of security though they did not increase the original quotation, the power dynamics had shifted.

This approach is advocated for dyadic supply chain relationships and can be crucial for pricing and information sharing outcomes (Zhang, et al., 2019; Fawcett, et al., 2009). Hence, powerful actor-firms can apply their power for the mutual benefit of the SCN by promoting information sharing and supporting sustainability schemes. However, power can also be used as a bargaining tool in either buying or contract negotiation, this form of negative application creates difficulty in fostering mutually dependent relationships. The complexities of bargaining and negotiating power in the FSC are explored in Fałkowski *et al* (2017) study of milk farmers and contractors. Though all the farmers were selling the same product, they were offered different prices depending on their negotiating capabilities. The study found a farmer's bargaining power was related to their confidence level (Fałkowski, et al., 2017). This shows the subjective but consequential effect of power.

Drawing from the analysis, the researcher postulates that actor-firms must endeavour to avoid opportunistic behaviours like price hikes when there are disruptions to the supply chain; instead, they must aim to build interdependencies, which help towards creating trust. There seems to be consensus on the positive impact of trust within SCM power dynamics (Meqdadi, et al., 2017; Ghosh & Fedorowicz, 2008). Trust is an evident factor in the supply chain relationship between FF and FC1. Thus, trust is a precursor for deeper and more meaningful collaboration. This supports current literature assertions on the effect of trust in supply chain dyadic relationships (Panahifar, et al., 2018; Fawcett & Magnan, 2002).

Furthermore, retailers are the most powerful actors in terms of resources e.g. revenue and assets within a perishable food SCN. Environmentally sustainable schemes undertaken by PCR and AFC that had direct support and funding from R2, R3, and R5 were flourishing and created a mutually beneficial sustainable scheme that was economically viable. This allowed FF to award LF a contract to dispose of their waste in an environmentally friendly way. However, environmental schemes are much more difficult to execute in a SCN when the support of the larger actors is absent.

This makes these undertakings less economically attractive, especially for the peripheral actor-firms e.g. recycling and landfill companies. Figure 31 illustrates the impact of power dynamics in establishing environmentally sustainable initiates.

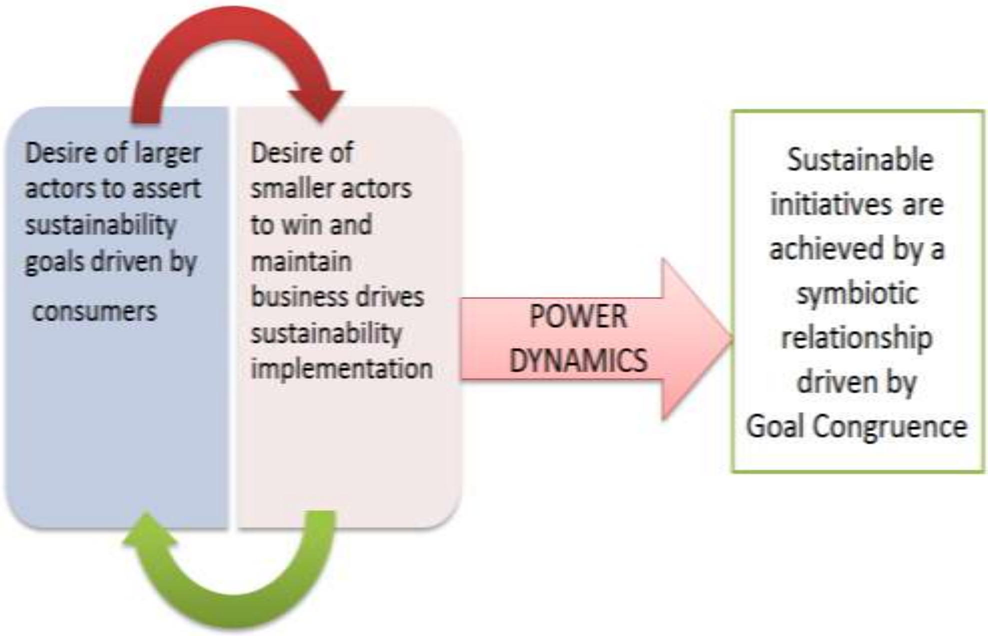


Figure 30: Large and small actor-firms sustainability power dynamics

Drawing from the qualitative latent analysis conducted, two key categories emerge, retailer power and the impact of power dynamics to influence collaborative actives within the SCN. The following section fully presents these category sub-findings to provide a clear expression of power dynamics by actors within the perishable food SCN under investigation. The analysis treated each actor-firm as a case thereby allowing for within-case analysis. This was followed by a network analysis (zooming out) which allowed for a cross-case analytical technique to be fully applied. The smallest unit of analysis was an actor, and this was then escalated to buyer-supplier, buyer-suppler-supplier unit of analysis and finally the entire network. Drawing from the analysis conducted, the two categories generated explain the main category of power dynamics in the perishable food SCN as retailer power and power's effect on collaboration. The following sub-section will present the categories of power dynamics in detail. The first category below is *'retailer power'* and its impact on the perishable food SCN.

5.1.1. Retailer Power as a driver of Sustainable Practices

A significant number of participants evidently expressed the power of retailers within the perishable food SCN. Though this was not stated explicitly, it was evident from the participants' responses that supply chain decisions were made with retailers' expectations in mind. This aligns with Ghosh & Eriksson (2019)'s study on the use of coercive power by retailers who had an abundant choice of bread suppliers. The study revealed that over-ordering and take-back-agreements led to excessive food waste averaging 30% over four-year period. This concurred with this study, which found that while contracts provide a clear legal and legitimate outline of the expectations of suppliers to retailers, it was evident that suppliers not only adhered to contractual stipulations but also made decisions based on tacit expectations. However, these codes are drawn specifically from the category related to power. Table 24 shows an excerpt of the content analysis regarding retailer power and its impact on the perishable food SCN.

Retailers yield the most power within the perishable food SCN. While all actors concede that it is the end-consumer that has the most power; as they determine demand and supply, their interactions are exclusive with retailers. Therefore, the retailers mostly determine the demand and supply of the SCN and this affords these actor-firms power to influence sustainable initiatives and actives throughout the network. The antecedents of generating a sustainable perishable food SCN emanated from external triggers mainly triggered by various stakeholders. Mainly, these sustainable issues were concerned with food safety and quality, agriculture practices and environmental concerns. Sustainable SCNs are grounded on the three bottom line principles, economic, people and environments. Retailers have a huge impact on two of these pillars namely, economic and environmental. Figure 32 depicts how retailers influence sustainable activities and these trickles down the SCN. The economic sustainability of perishable food SCN is determined by demand and supply. To increase demand, retailers rely on the information they receive from consumers.

Table 23: Content analysis data excerpt on Retailer Power within the Perishable Food SCN

Main Category	Power Dynamics			
Category	Retailer Power			
Sub-Category	*Power Imbalance/Asymmetry*	*Tacit Control*	*Information Imbalance*	*Process Control*
Codes	FF – Retailers set the rules of the game	FC1 – Unforced Commitments	FF – Our customers (Retailers) have all the information	R3 – We want all our food products processed this way
	S1 – Compliance Pressure	R1 – They know what we are looking for	LC – We rely on their (retailers) information for our routing	R5 – This is the processing we consider adequate to put food product on our shelves
	FC1 – Contractual obligations	LC – it's better to deliver much earlier than the stated time	R4 – Our systems can pick up data from thousands of suppliers and customers every day	

They use this information to determine the food product specifications they require from food manufacturers when they renegotiate contracts every 6 months to 1-year period. This then trickles upstream to the different tiers of suppliers. Therefore, stakeholders mainly consumers and food regulatory agencies influence the retailer product specifications on offer. Figure 31 shows how retailers influence sustainable activities through incentives and pressure. This indicates the episodic and systemic power dynamics at play within the perishable food SCN,

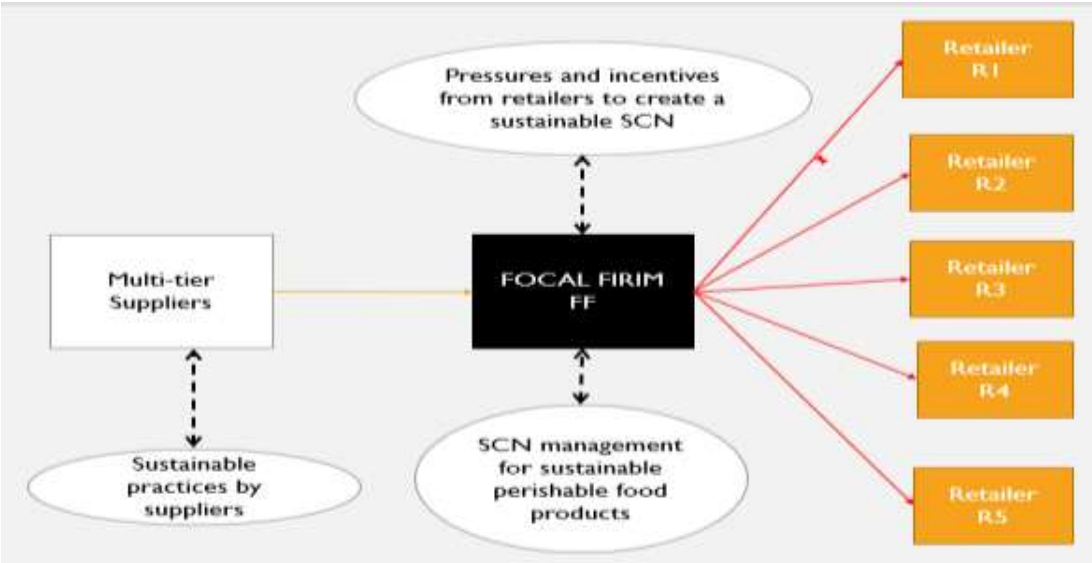


Figure 31: Impact of retailer power on building a sustainable perishable food SCN

To increase demand for their products, retailers are under pressure to adapt to the changing demands of consumers. However, this pressure is transferred to the focal firm (food manufacturer) who in turn transfers the pressure onto suppliers operating in the network. Hence, this power exertion creates a ripple effect that cascades throughout the SCN. However, these power exertions whether episodic or systemic can be applied towards building sustainable and resilient SCN. For instance, when retailers demand recyclable packaging or insist on insisting on sustainable procurement, this puts pressure on the entire SCN to comply with these requirements or the retailers will move their business to another supplier. Therefore, whether suppliers would want to adopt certain sustainable practices or not, the business environment created through retailer power forces them to comply.

This means upstream suppliers like farmers must adjust the ways and methods they use to grow their crops to ensure their products are compliant to the preferred specifications or they lose business. In other instances, retailers used systemic power to ensure compliance. For instance, retailers e.g. R4 offered higher prices to local producers who were growing organic produce. These meant farmers could adapt organic farming, which is much more expensive and produces lesser yield as compared to conventional farming with the full knowledge that they would attain better prices. Another issue was retailers drive to conduct sustainable procurement. For instance, R2 would only purchase produce from farms where they adhered to good labour practices and had to commit they would not conduct modern-day slavery. This meant that for suppliers to be allowed onto the PSL of the focal firm, they had to provide evidence of good and acceptable labour practices at the farm of origin and throughout the SCN. As illustrated in figure 35 above, retailers' power is crucial in creating sustainable practices.

Retailer power could also be negative as it at times created food wastage in the SCN. For instance, due to the strict delivery time schedule of retailers, when a truck turned up late for delivery the retailer could reject the order and therefore refuse to offload it. In most cases, the drive will be hundreds of miles from the focal firm or distribution centre (warehouse). When this happened, and the truck-drivers called to inform the focal firm of the warehouse, they were more often instructed to dispose of the load as it would be more expensive to drive back with a few pallets of products. This created a lot of food wastage as perfectly edible but perishable food was rejected. However, retailers emphasised in their responses that they have thousands of suppliers supplying thousands of different products a day, they cannot give preference to anyone order as this creates a backlog that will cost their businesses money. Despite this justified reasoning, these tight delivery schedules create food wastage along the perishable food SCN. Consequently, perishable food is unique due to short shelf life, this means once the products are rejected it automatically becomes waste as it cannot be preserved for alternative use.

5.1.2. Power as an Enabler of SCN Collaboration

5.1.2.1. The state of Power in perishable Food SCN

Findings from the study teased out the overt and covert power dynamics prevalent in the perishable food SCN under investigation. The perishable food SCN is unique as it is dynamic and complex. This is a uniqueness pointed out by several scholars (Manders, et al., 2016; Dani, 2015). It is constantly changing and reconfiguring with tier 2 suppliers and beyond constantly joining and leaving the network, hence, Carter *et al* (2015) argued supply chains are becoming complex adaptive networks. Contracts are normally between 6 months to 1 year; this creates uncertainty, which means actors normally make decisions based on immediate needs rather than the sustainability of the SCN.

Hence, the analysis uncovered that power within perishable SCN is temporal and is in a constant state of flux. Therefore, depending on the prevailing situation, which for instance could be driven by demand or prevailing market conditions, power often shifts between buyer and supplier. Hence, when analysing buyer-supplier dominance in the absence of a contract between actor-firms, the power dynamics are temporal and shift dependant on the prevailing demand and supply dynamics in the SCN. This is a significant finding as it departs from the dyadic analysis of power exertion (Huo, et al., 2017; Pulles, et al., 2014; Crook & Combs, 2007) which views buyer-supplier power dynamics as static with one party having the constant ability to exert coercive power.

For instance, between March and August, pineapple producers can demand a price but when the season changes to the winter months and the demand for fresh-cut pineapple declines suppliers dictate the price. Despite some buyers and suppliers operating in the same perishable food SCN, the lack of mutual dependence meant they exerted mediated power on each other depending on which actor had seasonal dominance. This is a prevalent behaviour amongst different actor-firms as most actors when dealing with suppliers or buyers who are spot buying do not see the impact of their decision past the transaction.

The effects cascades throughout the SCN as cost are passed from actor-firm to another. This creates an opportunistic environment were whoever holds the most power will use it for the benefit of their firm. This is supported by the findings in Chapter 4 which indicated that collaboration became weaker past the first tier and continues to show that trend throughout the network.

5.1.2.2. Using the state of power to build SCN collaboration

As illustrated in Chapter 4, collaboration within the perishable food SCN is mixed. There are varying degrees of collaboration with the highest degree prevalent amongst buyer-supplier and buyer-supplier-supplier relationships. However, the operational dynamic of *'order and chaos'* can promote the use of positive (non-mediated[3]) power to build mutually dependant supply chain relationships. In such cases, buyers negotiate on behalf of other suppliers when they have advantage over another supplier in the SCN. This creates co-evolutionary behaviours whereby actor-firms influence each other to generate mutually beneficial relationships, which can enhance resilience and sustainability.

Due to the intertwined nature of food SCNs, there is the constant use of both negative (mediated[4]) and non-mediated power that constantly shifts between actors in this volatile industry. This creates both opportunities and threats in the SCN. However, analysis of the actors' interviews clearly shows actor-firms that collaborate have an increased level of resilience through various dependencies like joint decision sharing, risk and reward sharing and information sharing. This aligns with Kähkönen (2014)'s study on the finnish food SCN which concluded that power influences the depth of collaboration. Simmillar to this study, Kähkönen (2014) reveals the power of retailers with food networks and their capability to influence nwtork dynamics. This is mainly driven by the balance of power in which the retailers' purchases of the focal firm's products constitute a large proportion of their business while the products supplied make up a small proportion of the retailer's purchases.

[3] Non-mediated power is often referred to as positive and is derived from expertise, information or reference
[4] Mediated power is often viewed as negative and is derived from coercion, legitimacy or the power to reward behaviour (Maloni & Benton, 2000)

Therefore, the use of non-mediated power can foster deeper collaborative activities. This creates an environment that allows a sustainable supply chain relationship to develop. When actors use non-mediated power, e.g. showing leniency for non-consequential contractual breaches, for instance, because of the relationship DC has with R1, if DC shorts an order R1 will notify them but will not charge a contractual breach penalty. This means when they receive the debit slip it will be minus whatever the order was meant to be. Likewise, DC's warehouse manager explained that if there is an error and they deliver more products that were ordered by R1, instead of returning the excess pallets, R1 would credit the order and pay for the extra delivery. This type of collaboration comes from continual use of non-mediated power, which creates a high degree of collaboration. Despite, actor-firms having the legitimate power to punish contractual breaches, they show leniency which helps to build trust in the SCN operations. When a strong bilateral supply chain relationship is established, it allows for actor-firms to leverage their relationship to build stronger collaborations with other SCN members. This allows for risk and reward sharing which helps build network resilience. Figure 32 below illustrates how power can be used to initiate collaborative activities initially between dyadic buyer-supplier relationships, but this could then be leveraged into the triad relationship.

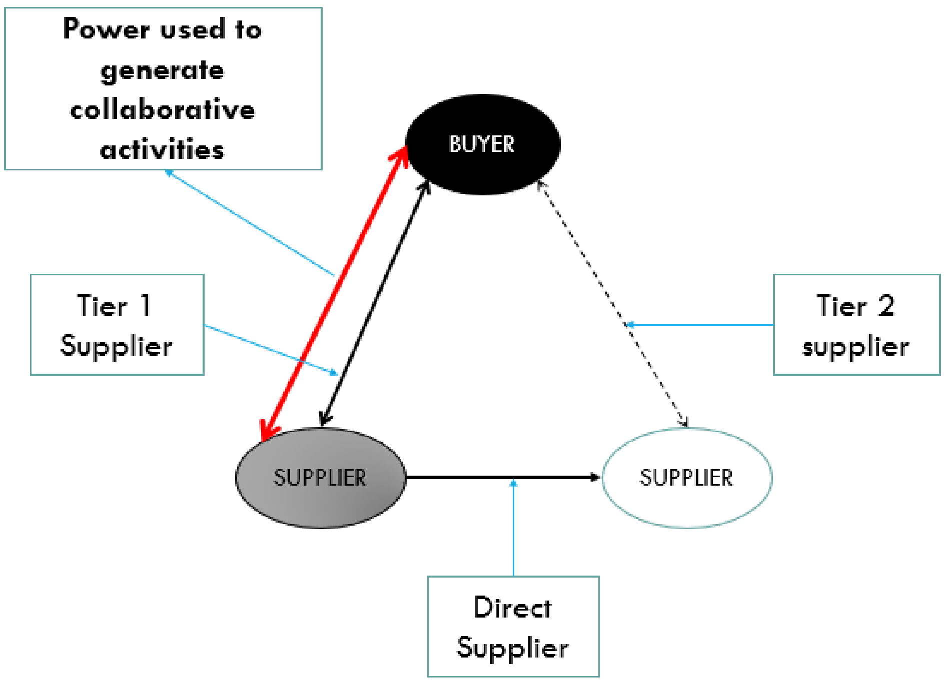


Figure 32: Using Power to generate collaborative activities

As illustrated in Figure 32, power is a crucial underlying and often-ignored factor in generating effective SCC. This agrees with various studies (Kähkönen, 2014; Nyaga, et al., 2013; Matopoulos, et al., 2007). Collaborative activities throughout a perishable food SCN vary and are diverse in practice depending on the intended goal and outcome. The following section will delve deeper into collaboration and its varying impacts and outcomes in relation to building resilience and sustainability in a perishable food SCN.

5.2. Collaboration as an enabler of Resilience and Sustainability

This study goes further than previous studies that made the link between power and collaboration (Kähkönen, 2014; Nyaga, et al., 2013; Matopoulos, et al., 2007). This study makes the tri-linkage between power dynamics fostering deeper collaboration, which is an enabler of resilience and sustainability. From the extensive literature review conducted in Chapter 2, collaboration was proposed as a catalyst for resilience and sustainability (Stone & Rahimifard, 2018; Scholten & Schilder, 2015; Beske & Seuring, 2014; Leat & Revoredo-Giha, 2013). Though literature acknowledges the importance of collaboration, as revealed in Chapter 4, its application in the SCN was mixed. For instance, information exchange in supply chain operations within the SCN was a very peculiar subject as it invoked a wide range of views amongst the managers interviewed.

While research advocates for the benefits of information sharing in SCRES (Kamalahmadi & Parast, 2016; Soni, et al., 2014), actors were averse to considering any form of exchange that went beyond the required transactional and material information. However, it was evident that actors who had elevated levels of information exchange e.g. FF and FC1 could resolve logistical issues much more quickly, compared to FF and 3PL who found it more complicated to resolve freight issues due to low information exchange. This resulted in trucks been turned away for late delivery as the product would have diminished in value (perishability). Environmental issues are one of the few areas actors are not hesitant to share information.

Due to the drive of corporate social responsibility (CSR) over the last decade, most actors expressed a desire to sync their environmental initiatives. Water conservation is one such area, R1 and R5 are involved with tier 2 suppliers to help them undertake schemes that will improve water conservation Actors who engaged in joint knowledge creation and sharing resolved disruptions much quicker than actors who were averse to this approach. This was evident in the relationship between FF and R1 and FF and FC2. Whenever FF could not satisfy demand, despite contractual obligations stipulating a penalty of negative balance for that transaction would be instituted, FF relying on good rapport and trust could negotiate with FC2 or R1 to *'prorate'*. Prorate is when there is not enough product, this may be caused by a variety of reasons e.g. natural disaster, failed deliveries, sudden increases in orders etc. To manage the shortfall, FF calls its customers and asks them to spread the order so for example if a customer ordered 200 packs of pineapples per store to be delivered in 20 stores FF gets the approval to deliver only 100 per store, but this requires prior approval from the customer e.g. R5.

Another strategy of dealing with daily product shortages is a substitution, so if FF is making a vegetable tray for a customer and there is no broccoli FF can get permission to substitute that for cauliflower. However, with its upstream suppliers, this was different when there were hurricanes in Texas resulting in 100% crop loss, FF did not request alternatives from FB1, which resulted in the loss of revenue. Therefore, when there is an engagement in relation to knowledge creation and sharing, actors will accommodate each other if there are disruptions in the supply chain as it is much easier to compromise when you view your interest as aligned to other actor-firms. Fright was consistently flagged as a major concern for all supply chain actors. There is an overreliance on road transportation for the delivery of perishable foods with a 24-hour window in the US as indicated by 3PL managers. 3PL is a transport-brokering firm that has multiple independent drivers.

It relies heavily on the collaboration of independent drivers to reduce delivery delays. Delivering late or poor product due to poor truck refrigeration causes a ripple effect as it means FF would have to short its customers, incurring a monetary loss, which consequently results in both 3PL, and tier 2 producers losing revenue. Hence, 3PL ensures that whenever drivers struggle to make delivery, another driver can easily take over the load by hooking the trailer of produce onto their truck. This type of collaboration, which relies heavily on technology through tracking devices and safety equipment, is very effective in mitigating delivery risks and creating a resilient SCN.

Therefore, to examine the impact of collaboration in building a resilient and sustainable SCN fully, a systematic approach was undertaken. Thus, analysis was conducted through seven critical activities, which were established in Chapter 2's literature review as vital components of effective collaboration (Cao & Zhang, 2011; Cao, et al., 2010). These seven factors are, information sharing, goal congruence, decision synchronisation, incentive alignment, resource-sharing, collaborative communication and joint knowledge creation (Cao & Zhang, 2011; Cao, et al., 2010; Simatupang & Sridharan, 2002). The following sub-sections will analyse each concept in relation to the perishable food SCN under investigation.

5.2.1. Information sharing outcomes on resilience and sustainability

5.2.1.1. Information sharing as an enabler of resilience and sustainability

Information sharing within the perishable food SCN was dependent heavily on established trust levels between SCN actor-firms. Supply chain relationships were varied and often differed; thus, they were highly related to the level of transactions between actors. For instance, FF and FC1 have a coopetitive relationship whereby they both cooperate and compete. This creates a nebulous supply chain relationship that is difficult to define and thereby relies on effective and timely information sharing for its sustainability. From the data analysis, this relationship, which is defined by a very high degree of information sharing as outlined in the first level analysis in Chapter 4, increases the reliance of both firms.

Despite FF and FC1 been competitors, share both risk and rewards regarding servicing certain products in the perishable food SCN. Therefore, their exposure to risks is intertwined hence, they must collaborate to minimise it. This allows for strong information sharing on both a dyadic and triad level within the SCN. This allowed for the development of coopetitive relationships. However, beyond the second-tier information sharing becomes purely transactional. For instance, if producers have issues on the farm with their products, they will not convey the information to FF or FB1 depending on whom they are supplying until they are sure beyond any reasonable doubt they cannot make delivery. However, this causes cascading effects as once delivery is late it sets back the production schedule and consequently the delivery of the products to the retailers.

Moreover, the information, which could be perceived to make an actor-firm lose business or leveraged, was least, shared and in most cases, this information would be crucial in the SCN's ability to mitigate risks especially in logistics. Information sharing was found to be crucial and to be the bedrock of all collaborative activities. Information sharing is always the first step and continuous, timely and effective information sharing also proved to be a precursor of trust. Therefore, a high degree of information sharing increases reliance, however, it is clear from the data that actors are reluctant to share any more information than they must especially beyond the second tier.

Dyadic information sharing was the most common for example. R1 provided FF and DC access to their inventory management system which meant that as they were selling product in their stores and the ERP system was updating the internal inventory daily at midnight, a report will be generated and automatically sent to FF and DC to inform them which products are still in stock and which products have been depleted. This allowed timely and critically accurate production planning. This helped overcome the issues of forecasting which at times inaccurately predicted the demand. This meant that FF and DC could end up over or under-supplying.

Oversupplying creates food wastage issues while undersupplying meant the customer's order would not be satisfied. Therefore, the data indicates that information sharing is crucial for building resilience in the SCN, however, due to information trust issues as well data protection concerns, there were mixed levels of sharing which created strong node linkages between certain actor-firms but weak amongst others in the same SCN. SSCM is based on three fundamental principles as established in Chapter 2, economic, environmental and people (TBL). On a deeper level, it aims to keep the supply chain productive without hurting the actors or harming the environment in which it operates. Information sharing was critical for the economic sustainability of the perishable food SCN.

Most actors indicated that it was vital beyond the normal transactional and contractual obligations maintain the economic sustainability of the SCN. Often, regarding issues concerning economic sustainability, most SCN actors expressed eagerness to share information. For instance, R4 and R5 continually communicate with their suppliers' right up to the farmers regarding product specification especially on issues regarding changing consumer tastes. Once retailers obtain information regarding changing consumer demands they immediately share that information with their suppliers. Retailers understand the importance of adapting to consumers changing taste or they will suffer sales losses. Therefore, in the interest of preserving economic sustainability, retailers are quick to share information. This is crucial in building and maintaining economic sustainability.

In terms of environmental sustainability, farmers and food producers mainly drove this as this directly impacts their business productivity and yield outcomes. The issue challenging S1 and S2 was how to convince FF they need to pay a higher price for products that were farmed in a more environmentally sustainable way. Information sharing was critical because if S1 and S2 were able to convey their environmentally sustainable growing initiatives clearly, retailers were able to use this information for marketing purposes thereby increasing their ability to offer farmers higher prices.

However, a major problem expressed in the interviews by both S1 and S2 was that due to the fluctuation of prices, vendors are more reluctant to invest in costly environmental schemes without either governmental support or price guarantees from retailers. This meant that retailers ultimately drove the sustainability agenda, however, this was not mainly for the environment, but it was mostly in response to stakeholder pressure. This disconnect is clear from the disparity in areas of concern, farmers were concerned with water conservation schemes, while retailers were concerned with labour practices (modern day slavery) and organic farming. In relation to people, information sharing was mainly driven by trust. Once trust was lost between actors it was difficult to share any information even information that actors had the discretion to share. Despite possessing crucial information, actors mostly shared information based on trust levels. Thus, information is critical for sustainability however, it is heavily dependent on trust and actor-firm interest.

5.2.2 Joint knowledge creation outcomes on resilience and sustainability

5.2.2.1. Joint knowledge creation as an enabler of resilience and sustainability

From the analysis conducted, joint-knowledge creation was mainly through dyadic relationships in the perishable food SCN. Joint-knowledge creation is critical to responding to the changing market conditions, which alter the business environment. The perishable food industry is dynamic and constantly changing driven by changing customer tastes, fluctuating prices and volatility in demand and supply. Joint knowledge creation by C1 and C4 was critical in countering these challenges. FF and FC1 developed various concepts with a key area of joint knowledge creation focus were product packaging. Packaging has become a major issue in the food industry as it can prevent spoilage, contamination and extend product shelf life. In addition, retailers are demanding packaging that is fully recyclable and is friendly to the environment. FF and FC1 collaborated by creating concepts and packages that reduce the risk of food contamination and product damage in transit. This creates resilience within the perishable food SCN.

Critically, there were a few dyadic joint knowledge creations throughout the SCN. For instance, R5 invested in production lines for FF to make them more efficient and reduce the risk of contamination when processing fruits and vegetables. By understanding how FF process products for them, R5 were able to collaborate with FF to create a better production system. These knowledge creations have resilience implications for the SCN as when knowledge generated by two or more actor-firms, the benefits ripple throughout the entire SCN. However, as with information sharing, joint knowledge creation was limited to the first tier; beyond this tier there was a reluctance to engage in creating knowledge jointly. However, joint knowledge creation proved a critical aspect of acting resilience.

A major concern for actors was how to create knowledge regarding building a SSCM effectively. Critically, the main concern of upstream supply chain actors was joint knowledge creation regarding environmental issues. Water conservation and management were a major issue for farmers in the SCN. However, downstream supply chain actors were more concerned with generating knowledge regarding economic sustainability. Consequently, when there was a dyadic or triadic collaboration, the positive effect of the partnership rippled throughout the SCN. Though as with resilience, most joint knowledge creation is within dyadic and triadic supply chain relationships and though this creates positive ripples in the SCN it is not enough as if this was done on a wider network level. Therefore, joint knowledge creation is useful in generating sustainability synergies but was not sufficiently undertaken within the perishable food SCN under investigation.

5.2.3. Decision synchronisation outcomes on resilience and sustainability

5.2.3.1. Decision synchronisation as a resilience and sustainability enabler

Decision synchronisation proved vital in inventory and replenishment management. FF synchronised its decisions with R1. Using IS, FF had access to R1's inventory log and received daily reports at midnight provided information on the daily sales and current stock levels. This allowed FF and R1 to synchronise their decisions via IS in terms of inventory replenishment. This allows for the mitigation of demand risks as perishable food demand fluctuates on a daily basis dependant on market forces. For instance, they could be slow watermelon sales, but if the weather changes and it becomes hot or sunny, this could increase up sales and diminish stock. Therefore, decisions need to be made in a timely manner and communicated efficiently throughout the SCN. To undertake this effectively, decision synchronisation is crucial as actor-firms make a critical decision in response to market changes to mitigate demand risks. This is particularly important in the perishable food SCN where products have a very short life between the farm and the end-consumer. By synchronising decisions, actor firms can reduce the risks that are inherent form adopting the JIT procurement strategy as it is a lean system that relies on procuring only what is needed in the right amount.

However, inventory must always be where it is needed, when it is needed. This creates unique challenges, as the products are perishable, any delay equates to lost revenue due to reduced quality and product shelf life. Therefore, by synchronising decisions, actor-firms can increase resilience by dealing with issues associated with demand risks. In addition, decision synchronisation is crucial between the focal firms and suppliers. When FF receives product specifications from retailers, they apply decision synchronisation by agreeing with the food broker and farmers on the type of product required in the next season. This allows farmers to plan their farming season and select the right variety dependant on the product specification. Hence, decision synchronisation is a crucial aspect of collaboration that enhances resilience. Decision synchronisation was crucial in reducing food waste within the perishable food SCN. The main issue within the supply side of applying JIT is that if suppliers oversupply they create the risk of food waste. Food wastage is a major issue and unlike with other supply chains, the options to reuse waste are limited. By synchronising their decisions, actors can mitigate the risk of food wastage and create resilience through anticipation and preparation, which creates a form of resistance. Furthermore, by synchronising demand and supply decisions, actor-firms were able to create an economic sustainability model whereby decisions are made for the benefit of the SCN.

This was achieved by creating the ability to detect abnormalities in the SCN and make joint decisions stop and respond to the problem. For instance, when there was a flood that destroyed watermelons and strawberries that were supplied to the focal firm, FF was able to make synchronised decisions with its customers (retailers) and suppliers to supply alternative products to fulfil the orders for a month. In this case, FF found an alternative supply of honeydew and used honeydew as a replacement of watermelon in their fruit trays. Through decision synchronisation, actor-firms can sustain the SCN even in the event of natural disasters that are sudden and cause a lot of disruption. However, by making joint decisions in a timely manner, these shocks are prevented from cascading to the consumers by offering an alternative. This resilience tool creates SCN resilience.

5.2.4. Incentive alignment outcomes on resilience and sustainability

5.2.4.1. Incentive alignment as an enabler of resilience and sustainability

Incentive alignment is directly related to power dynamics as established in section. The analysis established more powerful actors in actors' retailers possess the power which they may use in a negative or positive manner. Incentive alignment is a positive power source whereby actor-firms share, risks, costs and benefits. However, the findings uncover the power of bigger actor-firms by revenue (retailers) to implement incentive alignment. This was one of the few areas in which it could be implemented throughout a huge part of the SCN meaning it went beyond second-tier suppliers. Most incentives implemented in the SCN were centred on the quality and safety of food. Food safety and quality were established in chapter 4 as the main issue most actors were concerned with in their responses. It is an issue that perturbs perishable food supply chains as expressed by actors in their response. Furthermore, it is difficult to trace the point of origin when there has been food contamination that has entered the SCN and affected a consumer. As some perishable food products are consumed directly by consumers without further processing, e.g. cut-fruit, it is paramount that these products were not contaminated and maintained the best level of freshness.

To achieve this outcome, retailers often incentivise food safety and quality management of food products. These incentives may be in the form of price guarantees if fruit and vegetables are grown in a way. In another instance, there are contractual guarantees if suppliers conform to a widely accepted and standardised food safety management system (FSMS) like BRC. This creates resilience in SCN as it reduces the risk of contamination and product damage. The analysis shows incentive alignment reduces risks and allows actor-firms to share risks and benefits.

Incentive alignment was crucial in building sustainability in the perishable food SCN. As established in section 5.1. Retailers used their power to implement sustainability incentives that rippled throughout the SCN. By offering higher prices or better chances of contractual renewal, retailers were able to influence supply chain behaviour. Suppliers to ensure they get supply contracts ensure that products are farmed in a sustainable way with good labour practices. Retailers would communicate their requirements with the focal firm and food contractor, who would, in turn, communicate their requirements to the food brokers and suppliers. This creates sustainable practices, which are crucial for building a SSCM strategy for the entire network.

Therefore, incentive alignment helps build sustainability. However, there is a drawback. Incentive alignment is strongly related to power, therefore in most cases, the actor-firms with the most power could only implement it. As established in the previous analysis, power within perishable food SCN is temporal and in a constant state of flux, though smaller actor-firms may not have power most of the time, when they do attain power it should be used to build interdependencies through incentive alignment.

5.2.5. Resources sharing outcomes on resilience and sustainability

5.2.5.1. Resource sharing as an enabler of resilience and sustainability

Resource sharing within the perishable food SCN was limited to dyadic relationships. No wider resource sharing was observed or noted from the actors in the interviews. The most intensive resource sharing was between FF and its subsidiaries DC and LC. However, there were also resources sharing between FF and FC1 to supply both their customers. This revolved around sharing the cost of acquiring costly production and packaging machinery. By sharing financial resources, FF and FC1 were able to preserve financial resources, which could be redirected or used to mitigate unexpected disruptions. Therefore, resource sharing is crucial in building responsive capabilities as it relieves financial resources and allows for the sharing of cost and benefits.

A major issue in food production is machine breakdowns, by sharing machinery cost, disruptions become less costly for both firms as they absorb and share the risks. However, resource sharing was very limited and in most cases was limited to SCN dyadic relationships. This creates weaknesses in the network as an actor-firm may have the resources to mitigate another's risks and avoid the risk from cascading to the rest of the network. However, as noted by actors in their response, there were two main concerns regarding resource sharing.

First, actors were not convinced about the return on investment (ROI). Second, actors expressed concerns revolving around trust/ as expressed by FC1's manager

It is difficult to invest with another company because you just don't know if they value your money and time as you do

Therefore, resource sharing remains under-utilised as a collaborative strategy within perishable food SCNs. Resource sharing was for suppliers and 3PL mainly undertook SSCM. It was critical to share the logistical cost and coordinate pick-ups and deliveries to ensure supplier made delivery time. However, this was very limited and minimal. Within the perishable food SCN, there is very limited resource sharing.

The study found actor-firms focusing more on their own business continuity plans and protocols and there was a reluctance to share resources as there were reservations regarding ROI and trust.

5.2.6. Goal congruence outcomes on resilience and sustainability

5.2.6.1. Goal congruence as an enabler of resilience and sustainability

Goal congruence was difficult to tease out of the actors as it is concerned with examining how actors believe their own goals are achieved by accomplishing the supply chain objectives. The aim of the perishable food SCN is to get fresh produce from the farm to the consumer through retailers and grocers. The SCN is dynamic and complex and often actors expressed difficulties in relation to goal congruence and thus, did not view the SCN goals beyond their own business interests. However, goal congruence was clearly at play through the co-operative relationships in the SCN. FF and FC1 were competitors yet collaborated to service bigger retailers they could not supply by themselves. By sharing resources and creating goal congruence, they were able to reduce the supply risk issues and ensure the SCN is adequately supplied. This is the essence of goal congruence; it allows actor-firms to view their own goals as been achieved by fulfilling the SCN objectives. As is becoming a major theme within the collaboration, most activities do not go beyond the triad level despite influencing the entire network.

In relation to sustainability, goal congruence was mainly evident in relation to economic sustainability. Actors were able to view how their economic sustainability can be achieved by achieving the SCN objectives. In relation to building, an economic environment that was resilient and sustainable actors clearly expressed an interdependence which was rooted in mutually beneficial outcomes. Beyond economic sustainability, goal congruence was mainly on a dyadic and triadic supply chain level.

5.2.7. Collaborative communication outcomes on resilience and sustainability

Collaborative communication focuses on the frequency, mode and means actors and their respective firms use to communicate within the SCN. Therefore, in the analysis, the following parameters were applied;

i. Frequency – The rate and extent to which actors have four distinct connection types, material flows, information flows, financial flows and contractual flows
ii. Mode and Means – The mode and means actors use to exchange and share information are key in establishing a high degree of connectivity. Information systems (IS) are a key means

While information-sharing analysis is critical in establishing collaboration as analysed in sub-section 5.2.1., collaborative communication goes beneath the information sharing to analyse what is going on at a deeper level. From the analysis, it was established that the frequency of flows between actor-firms was critical in establishing trust. If an actor-firm had high frequency e.g. FF and FC1, FF and 3PL, FC1 and R5, the likelihood of other collaborative activities to develop was high. Therefore, the increased frequency was established as a precursor for deeper and more meaningful collaboration. In addition, the mode and means of communication were crucial factors. This is concerned with the degree of alignment of actor-firms IS.

The more actor-firms IS, the more likely they were to achieve deeper collaborative activities. DC and R1 had a high degree of alignment, which allowed for efficient inventory and food product replenishment. In cases were telephones were used e.g. for spot buys of short products, no further collaborative activities were established. Therefore, to achieve meaningful collaboration, actor-firms frequency, mode and means of collaborative communication is a precursor.

5.3. Information Systems (IS) application in perishable food SCN

Innovative technologies are continually introduced in the perishable food SCN to combat the increasing complexity of sourcing and processing high quantities of perishable products at a fast-moving pace. This constant change of technology increases the risk of human error, which managers stated (see table 24), though infrequent when it occurred it resulted in major loss and disruption. For example, DC lost thousands of US dollars' worth of bananas due to the wrong inventory management systems entry by a warehouse employee, when last-in-first-out (LIFO) was accidentally programmed instead of first-in-first-out (FIFO).

Furthermore, FF experienced inconsistencies in production levels especially of new product lines, which created costing and pricing anomalies. Therefore, continually training and educating users of technology throughout the supply chain network is a risk mitigating strategy that builds resilience and sustainability. Furthermore, IS were critical in facilitating effective food safety and quality management systems. By providing effective food traceability capabilities through LPNs and other various tools like ERPs, IS helps enhance the safety and quality of food products flowing through the SCN. Therefore, it is critical for actor-firms to identify and invest in the right technologies that will allow them to fulfil their core organisational goals. This, in turn, enhances the resilience of the holistic SCN, as the actor-firm will be more capable to anticipate, respond and contain any disruptions.

5.3.1. IS as a power tool

The findings revealed the complexity facing perishable food SCN due to a variety of challenging issues ranging from fresh fruit and vegetable products short lifespan, high probability of product spoilage from farm to fork, retail demand uncertainty and natural disasters. These are some of the issues stated by actors during the interviews as causing major risks and vulnerabilities for firms within the SCN. To circumvent these challenges, actor-firms invested heavily in various technologies with varying capabilities to gain competitive advantage. Thus, from the analysis, the category of

IS in its varied modes e.g. ERPs, email, temperature monitoring devices etc., was constantly emerging from actors' responses. Actors stated that IS was critical in two key areas, first, it provides inter-organisational communication and management tools e.g. forecasting, inventory management etc. and second, it enables external communication and collaboration activities.

The findings further draw out the uniqueness of perishable food SCN, which require constant communication, at times, daily interaction between actors, involved in the SCN is critical. These frequent communications are due to the configuration of most contractual arrangements within the SCN, for instance, it is common for a buyer and supplier to have a 70/30 or 50/50 contract. Which means the supplier is only responsible for supplying 50% or 70% of the buyer's perishable food products, the other 50% or 30% the buyer will source on the open market through food brokers or growers. While this allows for flexibility within the network, it also increases both the mediated and non-mediated power dynamics, which play out on an almost daily basis as buyer-supplier, and buyer-supplier-supplier relationships unfold through the application of IS. Most of these interactions occur over phone and emails, therefore, it is important to delve underneath and expose the power dynamics exerted by actors using IS.

The first capability examined is the use of IS to monitor other actor-firms within the perishable food SCN. Retailers and food manufacturers employed are capabilities to monitor compliance; this is an exertion of power. For instance, FF would monitor FB1's temperature devices and if the temperature fell below an agreed temperature reading, food products could be rejected on delivery even if they visually met the quality standards. Consequently, this application of IS became a deterrent for logistic firms fit their trucks with this type of technology as it could have a negative counter-effect. However, fitting this type of technology also meant trucks that had digitally synchronised temperature checks were more likely to be offered delivery contracts.

5.3.2. IS as a resilience tool

Actors expressed the importance of IS to manage data within the SCN in an efficient and timely manner. This is critical when operating in a perishable good environment. Fourteen actors in their interview expressly stated that their jobs would be impossible without a fully functional and aligned IS capability. IS are critical in risk anticipation as it can apply past supplier or buyer behaviour to forecast inventory and production levels. This is crucial in reducing demand and supply risk. FF operated an Oracle-based IS program which was crucial in inventory and production planning. Due to the nature of the food industry as an FMCG, often, actors must constantly make decisions with incomplete information.

IS plays a crucial risk mitigation role by providing anticipation capabilities, resistance capabilities through inventory management and response and recovery capabilities through providing information sharing and decision-making capabilities. R2's manager stated how IS are crucial for managing the vast amount of data they receive from their customers every hour. By processing and sorting complex information, actors can make better decisions.

To achieve higher capabilities, actor-firms were constantly investing in new technologies. FF installed a multi-million-dollar Oracle based IS to align both intra and inter-organisational information and technological communication capabilities. Within logistics, IS was a crucial resilience tool. IS provided actor-firms visibility over their product in transit? Furthermore, the LPN system ensured that the provenance of food products was preserved throughout the SCN ensuring that in the event contamination is detected, the product could be traced right back to its farm of origin. This enhances food safety and product quality. In addition, the analysis shows IS playing a preventative role by proving checks and redundancies through continuous testing of product, product visibility throughout the SCN and flagging the discrepancies in product paperwork.

For instance, in warehouse management, operatives were completely dependent on IS to store inventory and to pick orders. Due to the vast size of the warehouse, IS capabilities are crucial in undertaking daily operations. However, this over-reliance on technology does pose risk. As outlined in chapter 4, human error is a critical weakness of IS and human interaction. As the adage goes, *garbage in – garbage out* (GIGO), so if the operator puts in incorrect information, they will automatically get an incorrect result. Human error is a major drawback of extensive IS use. IS requires training and development and at times employees with the most experience struggle to adapt to new supply chain technologies. Table 24 provides an excerpt from the analysis conducted highlighting the risk of human error and the critical resilience tool of providing training and development for actors.

Table 24: Excerpt of IS and Human Interaction in perishable food SCN

Meaning Units	Condensed Meaning Units	Code/ Sub-Category	Generic Category	Main Category
"The biggest problem we have is user-error and training issues, if someone starts and they are not trained properly then it becomes a huge problem, when they start working, because we have a lot of redundancies and we do a lot of checks and double checks, so if you look at the screen it will ask you 'are you sure?' well sometimes they are in a hurry or don't understand the consequences and just hit YES and it turns out it's the wrong product, we have lost thousands of dollars' worth of product due to errors" **(DC - Warehouse Manager)**	The biggest problem we have is user-error and training issues	User Errors	Human Error	**Human interaction with technology throughout the supply chain can be a serious risk factor**
	not trained properly then it becomes a huge problem	Training	Training and Development of staff skills	
	well sometimes they are in a hurry or don't understand the consequences and just hit YES	Unaware of implications or consequences of actions	Lack of awareness consequences	
	we have lost thousands of dollars' worth of product due to errors	Financial Implications		
"The problem is they keep changing the tracking systems every so often and my drivers have to try and get used to the new system" **(3PL - Fleet Manager)**	drivers have to try and get used to the new system	Constant		**Continual technological changes are**

"If you look at the production line, on certain shifts it will run faster than others, well that's because certain people can work the machines faster, the costing guys always get annoyed that the figures are inconsistent but what can I do if certain people are faster than others" **(FF - Production Manager)**	that's because certain people can work the machines faster	Change Technological skills and know-how	Adaptability difficulties Unbalanced skill levels	**problematic for actors** **Unbalanced technological skills and understanding yield uneven and inconsistent results**

Table 24 provides an excerpt on the analysis of human in the operations of perishable food SCN. Despite IS being crucial in inspecting and monitoring food safety and quality thereby providing SCN visibility, it can create unintended consequences through drawbacks from human error.

5.3.3. IS as a sustainability tool

The findings also tease out the important underlying role IS plays in facilitating the building and maintenance of resilience in the perishable food SCN. IS ability to provide monitoring capabilities is an important tool for attaining sustainability.   From the study evidence, IS are an important support tool for SSCM within SCNs. However, its uses for sustainable uses remaining limited to monitoring and measurement capabilities. For instance, within the farming side of the SCN, IS can be used for agricultural measurements e.g. water management, soil nutritional measurements etc. However, further down the supply chain, IS was employed as a supporting too; to reduce food wastage.

By applying IS as an inventory management tool, the focal firm was able to mitigate demand risks from retailers and ensure food waste was kept at a minimum. IS are also critical at establishing best practice and standardised operational procedures for actors within the SCN. This helps human development and allows actors to gain new skills and build on current abilities. The ability of actors to develop continually is a sustainability capability as the perishable food SCN is very labour intensive starting with agriculture right up to the food manufacturing and processing stages. Therefore, if there is poor human skill development, it is bound to permeate into supply chain operations and affect the overall performance of the SCN.

5.4. SCN Collaborative Culture

SCN collaborative culture emerged as an important category from the content analysis undertaken. While conducting the analysis, it became evidently clear that decisions undertaken by actors within their responsible roles were driven by intangible knowledge and experiences. This intangible knowledge and experiences were rooted in the actor-firms' culture. SCN collaborative culture in this context refers to actor-firms actively seeking collaboration as a strategy to mitigate risk while building resilience and sustainability. Hence, SCN collaborative culture is underpinned by an actor-firm's resilience and sustainability culture. These will now be analysed in more detail in the following sub-sections.

5.4.1. SCN resilience and sustainability culture

The results showed a varied perception amongst actors as to the level of risks and vulnerabilities in the perishable food SCN they were operating in. There was an emphasis to have contingency plans and resilience tools; especially for issues actors were more familiar with and had experience dealing with. For instance, S1 and S2 managers explained in detail the plans within their respective farms to fight crop diseases and various irrigation schemes to deal with the issues of water management. However, perishable food SCN seems to mostly be relative to risks, especially emerging risks that will be new to SCN actors. Figure 33 illustrates this concept as uncovered from the data analysis. Actors appeared to be more comfortable to discuss known risk and current resilience strategies in place to counter these. So, issue revolving around demand risks, spoiled food produce in transit, natural disasters and food contamination. Figure 33 depicts the three dilemmas actors encounter when dealing with risks and vulnerabilities. Strategizing for what they know, strategizing for what they know they do not know and finally strategizing for what they do not know that they do not know. However, actors also acknowledged the second level, which revolves around issues actors knew they did not know. These tend to be issues regarding demand and supply, including possible natural disasters and are referred to as 'grey swans' by Taleb (Nassim, 2007). However, it is the third level as depicted in Figure 33 that Taleb refers to as the 'black swan' when supply chain managers do not know that they do not know (Nassim, 2007).

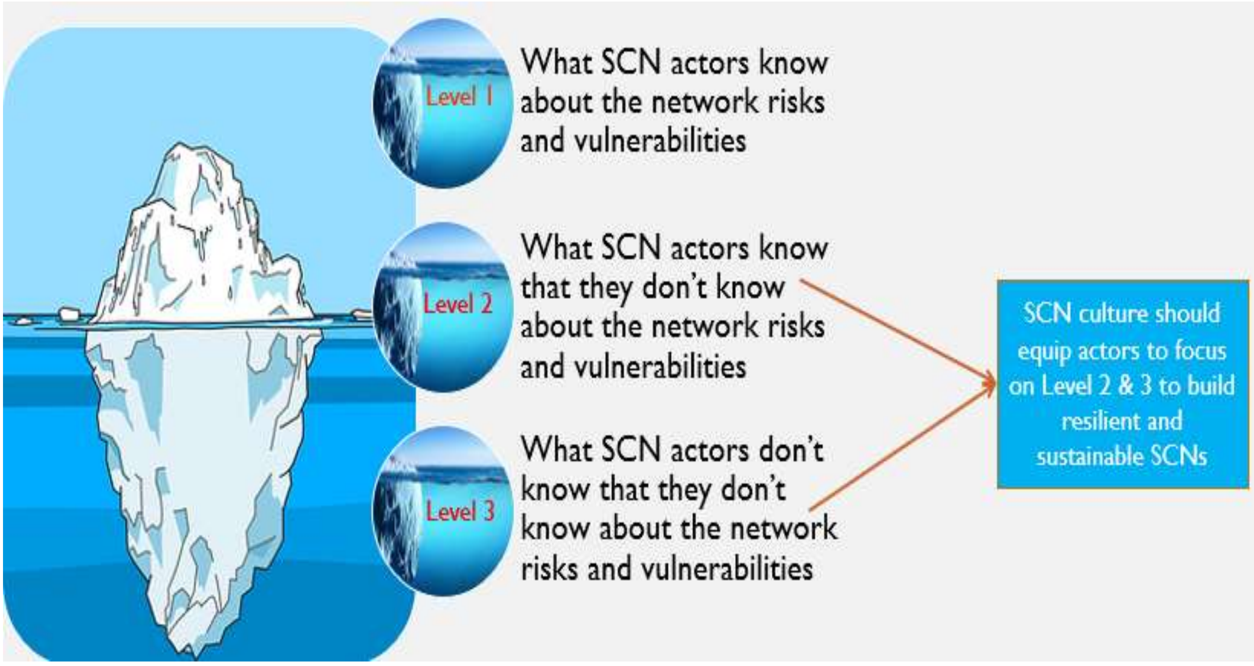


Figure 33: Risk and Resilience perceptions in SCN

These risks which when they appear cause mass disruption to the perishable food SCN, often cause actors to change what they think they know and how they can respond to future challenges. Thus, building a well-grounded risk and resilience culture becomes important. This is evident from FF and FC1's risk and resilience culture within their respective organisations. However, these food firms are competitors, their desire to mitigate risks and build resilience and sustainability was more important than any lost competitive advantage. By combining their resources and collaborating to effectively improve performance and thereby create resilience, FF and FC1 were creating and cementing a risk and resilience culture. The findings show that was a risk and resilience culture is present and thriving, actors deliberately look for synergies through collaboration opportunities to minimise risks and maximise resilience even from competitors. The perishable food SCN was constituted of both negative (competitive) and positive (cooperative) relationships. Some partnerships were long-term e.g. FF and R1 who have been supplier and customer for over 10 years, while FF and R2 were in their second year of business. However, due to the dynamism of the network, hybrid relationships emerged. FF and FC1 are naturally competitors and FC1 is the larger company as it earns an extra US $1, billion in annual turnover.

However, the two firms have a co-opetition and supplier-supplier relationship that has grown and solidified over the last 10 years. This has been possible due to building a risk-averse culture that realises that resilience and sustainability of their businesses are more important than competition. Both FF and FC1 supply R4 and R5 with almost comparable products but FC1 have a larger contract, which it cannot satisfy, so it outsources the excess quantities to FF. This creates a complex negotiating process as FC1 first negotiates with R4 and R5 to secure a lucrative contract and finally negotiates with FF to attain an agreement that safeguards their profits.

These types of co-coopetitive relational dynamics require trust and business rapport supported by tangible mutual benefits to succeed. This is only possible due to the resilience and sustainability of SCN culture. Due to the perishability of the food products within the SCN, demand risk emerged as a major issue. Actors making decisions on forecasting, planning and inventory management with incomplete information mainly drove this. To protect their profitability, tier 2 producers do not state how much it costs them to produce and grow the crops and this sort of information withholding occurs at every level.

This leads to an overreliance on estimations regarding costing, forecasting and production planning. When there is a sudden increase in demand tier 2 producers can demand higher spot prices but equally when demand decreases, there have an excess perishable product which is sold below market value. Therefore, when actors within the network have less information, there are vulnerable to demand risks and price volatility. To overcome this, a culture of collaboration must be fostered which will enhance resilience and sustainability. The issue of balancing diverging interests is a delicate act for all actors in the SCN. The dilemma actors wrestle with is; how can trade-offs between company requirements, customer requirements and other stakeholders be achieved? For FF balancing, inventory with demand risks is a major issue when dealing with perishable food products.

Furthermore, food quality and safety are key issues that cannot be compromised under any circumstances, therefore, too much inventory becomes a food safety and quality risk while too little is a demand risk. Tier 2 producers must balance between environmental concerns e.g. fertilisers, water management etc. against trying to attain maximum yield. Retailers are also attempting to balance inventory and demand. R1 has most of its inventory in transit. By the time inventory is delivered, new orders are placed almost simultaneously. This reduces demand versus inventory dilemma.

Despite actors relying on forecasting techniques and ERP software e.g. JD Edwards, it's often inaccurate due to the volatility of dealing with perishable products in a constantly shifting consumer demand environment. Ultimately, actors rely on their experience, intuition and technology to generate a best guess scenario. However, creating a culture of SCN collaboration can reduce these risks and build resilience and sustainability in the network.

From the analysis conducted, most of the actors were more concerned with economic sustainability and paid little regard to the importance of people and environmental sustainability. While actors did express explicitly the importance of their employees, they did not associate them with resilience or sustainability. However, by teasing out the deeper meaning of the actors' perceptions, it is evident that people are critical in generating resilient and sustainable SCN. Therefore, by having a skewed focus on one pillar of the TBL, actors are creating vulnerability and missing an opportunity to make the SCN more resilient. For instance, the warehouse manager stated that human error was his biggest concern as it had catastrophic consequences and often created cascading disruptions. However, there is also an opportunity to further train and develop operative stop turn their risk factor into a resilience factor. By creating opportunities to fully train and develop staff, actor-firms create an opportunity to build a more sustainable SCN.

5.5. Chapter Conclusion

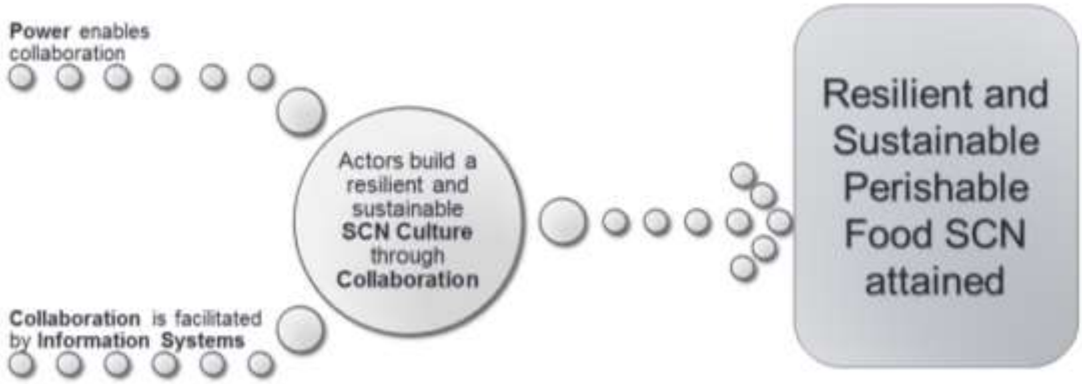


Figure 34: Interplay of main categories in building resilient and sustainable SCN

Figure 34 depicts the interplay of the main categories identified in this chapter, power dynamics, collaboration, IS and SCN culture with collaboration identified as the main enabler of building resilience and sustainability. To mitigate SCN risks effectively, actors must collaborate in implementing SCRES strategies and practices to limit the impact of SCN disruptions and allow the network to return normalcy or exceed the previous level of functionality.

Therefore, this chapter posits that the resilience capabilities of SCN actor-firms to collaborate and mitigate risks are dependent on their degree of collaboration. Figure 35 illustrates how each of the main categories influences the creation of a resilience and sustainability culture. This SCN culture increases the capability to collaborate regarding SCN risks and vulnerabilities and recover in a timely manner from disruptions. Within the perishable food SCN, there are hub firms, which predominately collaborate on a dyadic or triadic level. The higher the degree of collaboration in the supply chain relationship, the more resilient and sustainable it becomes, e.g. focal firm (FF) and FC1 have a buyer-buyer, supplier-supplier and competitor relationship.

This facilitates collaboration through, information sharing, resource sharing, incentive alignment, goal congruence, decision synchronisation and joint-knowledge creation. A key contribution to perishable food SCN sustainability knowledge is the importance of power as a driving force. Actors with the most power e.g. retailers are key in driving and setting the triple bottom line (TBL) sustainability initiatives for the entire network. Various stakeholders, e.g. consumers demanding sustainably sourced food, government setting recycling targets etc, often drive these. Smaller actors in the network oblige to fulfilling goals set by larger more powerful actors driven by their desire to secure and maintain a business from the larger actors this is referred to as incentive alignment.

In conclusion, Figure 34 illustrates how perishable food SCN actors can create a resilience and sustainability culture through collaboration. Collaboration is heavily influenced by power dynamics and facilitated by IS. The following chapter will compile all the findings and outline how the research aim and objectives have been met. Chapter 6 will provide an in-depth discussion of the abovementioned issues by building on SCNT and relate these findings with current literature.

CHAPTER 6: Thesis Contributions

6.0. Chapter Introduction

The main purpose of this thesis has been to explore how actor-firms can build resilience and sustainability in perishable food SCNs. To attain this research goal, an embedded case study was undertaken in a US-based perishable food manufacturer and its supply chain network. This chapter compiles the findings and analysis undertaken to develop sincere, credible and meaningfully coherent propositions that are rich in rigour and qualitative resonance. Thus, the study makes significant contributions to the body of SCM research by advancing knowledge in building resilient and sustainable SCNs. Therefore, Chapter 6 generates propositions underpinned by in-depth discussions, which draw on the tenets of supply chain network theory, pragmatism and current SCM discourse.

6.1. Contribution to Theory

The main purpose of this thesis was to investigate how firms operating in a perishable food SCN can build and sustain resilience and sustainability. To achieve this aim, two fundamental research questions with accompanying probing sub-questions were asked as is shown in Table 25.

Table 25: Thesis Research Questions

1. How can perishable food supply chain networks build and sustain resilience?
a. *What resilience practices do actors operating in a perishable food supply chain network adopt to mitigate risks and manage vulnerabilities?*
b. How can these practices be enhanced to build resilience?

2. How can actor-firms in a perishable food supply chain network build sustainability?

a. *What are the current issues perturbing actor-firms' capability to build sustainability in perishable food supply chain networks?*

b. How can actors effectively build and continually enhance supply chain network sustainability?

Research question 1 (sub-question *a & b*) and research question 2 (sub-question *a*) were answered in the first level analysis conducted in Chapter 4 (zooming in). A second and deeper stage of analysis was then conducted in Chapter 5 to fully answer the research questions from a SCN perspective (zooming out). To build effective supply chain resilience and sustainable strategies, it is critical to understand the risks and vulnerabilities prevalent in the contextual environment under investigation (Brusset & Teller, 2017; Ghadge, et al., 2012). Hence, in Chapter 4, the analysis begins by examining and drawing out the risks and vulnerabilities prevalent in the perishable food SCN under investigation. By applying pragmatic principles using Nicolini (2009)'s ZIZO approach, the risks and vulnerabilities were drawn out to allow for the effective generation of resilient and sustainable supply chain network strategies. Nicolini (2009)'s ZIZO approach allows for the zooming into daily micro-actions conducted by actors and zooming out to see the effect of those actions on the wider network. Three key distinct risk classifications are drawn out from the findings;

i. Deliberately Targeted Attacks
ii. Normal Operations Disruptions
iii. Random and Sudden Disruptions

To mitigate the identified risks and vulnerabilities, four main categories were generated from the analysis conducted, these are

1. **Collaboration,**
2. **Power Dynamics,**
3. **Information Systems (IS) and**
4. **SCN Culture**

Applying supply chain network theory (SCNT) there are several exchange relationships that can be considered; however, this thesis considered the critical connection types identified by Hearnshaw & Wilson (2013) which are, material flows, information flows and financial/monetary flows. Thus, by analysing these three critical connection types in the perishable food SCN under investigation the following propositions were generated to enhance resilience and sustainability.

6.1.1. Proposition 1

1. ***The more actor-firms collaborate, the more resilient and sustainable the perishable food SCN becomes***

a. *An actor-firm's capacity and capability to collaborate within a SCN to achieve resilience and sustainability is driven by intangible capabilities (Power Dynamics, Information Systems (IS) capabilities and Organisational Culture)*

b. *The higher information exchange amongst actors the more SCN can resist disruptions and recover in a timely period from severe disruptions*

This thesis defines and analyses collaboration via the collaborative activities of information-sharing, joint knowledge creation, decision synchronisation, incentive alignment, resource sharing, goal congruence and collaborative communication among supply chain actor-firms. Current literature acknowledges the importance of collaboration especially information sharing, which is often viewed as a strategic viewpoint. Hence, SCM researchers now advocate for the reconceptualization of the supply chain as a network (Yildiz, et al., 2016; Carter, et al., 2015; Hearnshaw & Wilson, 2013; Mena, et al., 2013; Li, et al., 2010; Pathak, et al., 2007). It is important to note that most SCM research centres on the movement of goods/services, information and finances. Hence, the constructed definition attempts to address the new complexity facing 21st century supply chains. Crucially, it notes the importance of coordination and collaboration throughout supply chain activities by all parties involved. These key concepts are critical as research advocating for supply chain collaboration (SCC) to enhance the competitive advantage of a firm's performance is growing (Kumar, et al., 2017; Cao & Zhang, 2011). Furthermore, research argues that collaborative advantage is an intervening factor in enabling supply chain partners to attain synergies and significantly improve performance (Cao & Zhang, 2011). Further justification for inclusion in the definition is drawn from recent. For example, Wakolbinger & Cruz (2012) developed a framework that aims to mitigate risk within SCN through strategic information sharing and risk-sharing contracts. This was evident from the analysis as contractual agreements were used as a resilient strategy. By clearly stipulating risk sharing and reward sharing, actor-firms were able to manage for unforeseen disruptions, as this would ease the cost incurred by any one actor-firm. However, a major problem that emerged was a lack of collaborative symmetry.

This meant there were mixed degrees of collaboration which in-turn yielded mixed results. While many scholars advocate the benefits of collaboration (Stone & Rahimifard, 2018; Cao & Zhang, 2011; Barratt, 2004) within perishable food SCNs, there was better collaboration amongst selective dyadic and triadic relationships. This aligns with contemporary literature, which indicates strong dyadic collaborative relationships especially when trust and dependencies are fostered (Ali, et al., 2018; Ponomarov, 2009). However, past the second tier, collaboration became weak in the SCN. As outlined by Tang & Musa (2011) the origins of risk in supply chains are varied and emanate from both endogenous and exogenous factors, which encompass the TBL principles.

The findings confirm this risk variety, however, the uniqueness of the perishable food SCN creates additional risk complexities. These risks are exacerbated by a lack of coherent collaborative activities throughout the SCN. This enhances the level of damage caused by operational disruptions because actor-firms cannot come together to effectively resist or recover from a disruption. Actor-firms having a mixed degree of collaboration drive this. When zooming out and looking at the impact of this behaviour on the SCN it means some actor-firms can combat certain disruptions e.g. product shortfalls together, while others will penalise each other and look for an alternative supplier.

This lack of collaboration creates vulnerability in the network as there is little information sharing because actors apply *a 'need to know'* information sharing approach. As depicted in Figure 25 (Chapter 4) there were various degrees of collaboration between the actor-firms in the perishable food SCN under investigation. As the study of SCNs is still immature (Braziotis, et al., 2013) more research is needed on the implications of collaboration in building resilience and sustainability in perishable food SCNs. A key issue that emerged was food safety and quality. This was expressed as critical by almost all actor-firms except for the recycling companies.

Various resilient mechanisms were discussed by actors in their interviews which included HACCP, food safety management systems (FSMS) e.g. BRC certification and traceability. Key to achieving this was product visibility throughout the supply chain. Tse and Tan (2011) proposed a framework for product quality risk and visibility assessment. This study concurs with Tse and Tan (2011)'s findings that better visibility of risk in supply tiers can minimise quality risks especially in food production. The dyadic supply chain relationship between FF and FC1 or the triad between FF, DC and R1 indicates that SCC enables the development of synergies among actor-firms, facilitates joint planning and encourages real-time information exchange.

The findings agree with Whipple and Russell (2007)'s study which concluded that SCC was necessary the preparation, response and recovery of supply chains from disruption. Thus, information sharing allows for a deeper and more meaningful collaboration of actor-firms to mitigate SCN risks and vulnerabilities thereby building resilience and sustainability. Hence, Barratt (2004) argues that information sharing along with risk-reward sharing is the cornerstones of collaboration. This is built on by more recent studies (Kamalahmadi & Parast, 2016; Soni, et al., 2014). However, this study goes further and argues that an actor-firm's capacity and capability to collaborate within a SCN to achieve resilience and sustainability is driven by intangible capabilities. These intangible capabilities are, power dynamics, information systems (IS) capabilities and organisational culture.

The analysis revealed that reducing the impact of any disruptions in the perishable food SCN required clear business need and convergence of interests. Nevertheless, issues arose on how to collaborate. A key consideration was a focus on what collaborative activities firms should concentrate their resources and efforts. Thus, IS becomes a critical tool of both knowledge acquisition and power expression by actor-firms in the perishable food SCN. The more IS capacity and capability an actor-firm had; the more effective the firm was at conducting both intra and inter-organisational collaborative activities.

While some literature suggests that JIT and single sourcing increases vulnerability and the possible impact of a disruption (Pettit, et al., 2013; Blome & Henke, 2009; Peck, 2005), perishable food SCNs have no choice but to apply this method as explained by FF's Materials and Replenishment Manager. However, the analysis revealed that, by FF sourcing most of its raw materials from a single source (the food brokerage firm, FB1); this practice increased the levels of collaboration and information sharing. This reflects Skjoett-Larsen *et al.*, (2007)'s findings on managing the complexities of global supply chains. Furthermore, in cases of disruptions, having a major single source supplier allows for faster and more coordinated collaborative response as confirmed by Ergun *et al* (2010) research.

Power dynamics also emerged as a critical factor in determining collaboration. Power was one of the major surprises in this study. Its critical role in fostering collaboration, which is a precursor to resilience and sustainability, was crucial. Powerful actors can initiate collaborative activities much easier especially regarding environmental issues. This confirms Giddens (1984) understanding of power and its use via resources. Furthermore, due to the power dynamics, different actor-firms were able to gain and assert power in moments of disruption e.g. natural disasters. This allowed smaller actor-firms to have the advantage to initiate collaboration. Another key factor, which emerged as crucial, was organisational culture. It was evident from the interviews that how an organisation perceived risk. Resilience and sustainability had a major impact on their collaborative activities.

If organisations had a resilience and sustainability culture, they were able to create nebulous supply chain relationships with their competitors. FF and FC1 and a coopetitive relationship, thus, they were competitors, who had a buyer-supplier relationship. Thus, previous studies show that collaboration is important to improve responsiveness and mitigate effects of disruption, yet there is limited knowledge on how the underlying activities of supply chain collaboration influences supply chain resilience (Ambulkar, et al., 2015; Brusset & Teller, 2017). This study addresses the gap concerning limited knowledge on how the underlying activities of SCC influences supply chain resilience by introducing the importance of intangible factors, power dynamics and organisational culture.

6.1.2. Proposition 2

2. ***Power dynamics can influence actors to conduct collaboration which enables SCN resilience and sustainability***
   a. *Power is not static, therefore, any actor-firm regardless of size can acquire power under certain conditions, however, power should be used effectively to build trust and interdependence which are precursors to collaboration*
   b. *If more powerful and larger actor-firms support and sponsor sustainability initiatives within a SCN the more these initiatives will succeed and attain incentive alignment and goal congruence*

SCNT proffers that SCNs are complex adaptive systems (Carter, et al., 2015; Hearnshaw & Wilson, 2013), thus, the SCN is self-organising and is configured with autonomous actor-firms in control of their own resources for the purposes of profitability, which is a form of power. The autonomous actor-firms operating in the perishable food SCN each have varying levels of resources, which make certain actor-firms more powerful from a resource-based view. Hence, the vast amount of research focusing on power dynamics in SCM is conducted from a resource-based view (Hingley, et al., 2015) and is more focused on investigating specific power actors e.g. intermediaries in supply chains.

However, this study makes an important contribution by exposing the temporal nature of power and the implications this has on building resilience and sustainability. For instance, regarding deliberately targeted attacks, due to the configuration of perishable food SCNs, buyers and sellers are engaged in daily negotiations over sales. Depending on the prevailing conditions, power dynamics are constantly shifting between buyer and seller. This allows conditions for negative power expressions like opportunistic pricing by actors with the most bargaining power.

Despite current literature acknowledging the volatility of FSCNs and the impact this has on price fluctuations (Rezitis, 2018; Sharma & Lote, 2013), the power dynamics at play in the SCN still remain largely underexplored and explained. Thus, a less explored aspect is the impact of actors' power exertions on the long-term supply chain relationships. In particular, what influence this causes regarding building interdependencies, which are critical to undertaking effective collaboration. This study adds knowledge to this aspect by proffering that power dynamics can be used to effectively build interdependencies.

This was exemplified when FF lost a lucrative contract from R2 due to disagreements over contract costs and the quotations presented by FF in the negotiations. R2 was the buyer and therefore, exercised its power to withhold contractual extension. However, R2 encountered various problems with its new supplier and had to come back and negotiate with FF. In this instance, the power dynamics had shifted, and FF now had more leverage. This explains the proposition 2*a'*s submission that power is temporal and in a constant state of flux in perishable food SCN. However, actor-firms operating in a SCN should apply power to build interdependencies, as these are a precursor to collaboration. FF not using its temporal power gain to increase the cost of contract for R2 and opting to renew at the original cost quotation created a state of interdependence. Research conducted by Matopoulos, et al., (2007) over a decade ago identified power as a key factor critical to establishing supply chain collaboration (SCC), underpinned by risk-reward sharing, managing trust and dependence.

This thesis builds on those findings, while Matopoulos, et al., (2007) found power asymmetries to be a hindrance to collaboration due to the weaker companies always attempting to seek alternative alliances with less powerful partners, this study proffers a different approach. By analysing FF and FC1's relationship as competitors using their power to develop an interdependent relationship within the SCN and FF and R2's contractual dispute with FF choosing not exercise negative power through when R2 reopened their previously broken negations; it is clear that power can be applied to build interdependencies. This concurs with power literature in supply chains (Pulles, et al., 2014; Crook & Combs, 2007).

Chapter 5 shows it is much easier for actor-firms to have deeper and more mutually beneficial collaboration if there are interdependencies. Thus, by increasing collaboration, there is a meaningful effect on resilience and sustainability of the perishable food SCN. These findings are supported by the few studies analysing power and its effect on collaboration in FSCNs (Kähkönen, 2014). Over the last two decades, issues regarding sustainability management have moved to the foreground of SCM (Carter & Rogers, 2008). Issues surrounding SSCM affect the food industry to a greater extent as it employs high-human capital and relies directly on natural resources e.g. water, land, natural environment etc. to function. Hence, Maloni & Brown (2006) state how increased pressure for sustainable practices complicates the requirements food companies face from all stakeholders e.g. inputs/raw materials (animal welfare), the environment (energy, water, waste) and social (labour conditions). The analysis revealed that retailers are the face of the perishable food SCN to consumers; hence, pressure for environmental and social issues is exerted to retailers. In response, retailers who are the larger actor-firms in the perishable food SCN by means of financial resources are better situated to incentivise sustainable practices. Issues regarding SSCM have become critical over the last decade (Seuring & Muller, 2008; Pagell & Wu, 2009; Carter & Easton, 2011; Ahi & Searcy, 2013; Pagell & Shevchenko, 2014; Marshall, et al., 2015; Dubey, et al., 2017), thus, end-consumers are now more knowledgeable in issues pertaining to the TBL within SSCM.

Though collaboration has been identified as critical to implementing sustainability, scholars agree that collaboration is difficult to implement due to the complex nature of food supply networks (Aggarwal & Srivastava, 2016; Prima Dania, et al., 2016). Hence, power emerges as a critical factor in navigating the complexity inherent in perishable food SCNs due to a large number of autonomous actor firms involved. Power allows retailers to incentivise sustainability practices in contractual allocations or by simply stating the preferred standard of purchasing. This sustainable purchasing approach forces suppliers to comply with the sustainable standards that have been set.

6.1.3. Proposition 3

3. ***The higher an actor's IS capabilities the higher SCN resilience and sustainability can be achieved through collaboration***
   a. *The higher IS capabilities an actor-firm has, the more collaborative activities it can undertake successfully within its perishable food SCN*
   b. *Continuous IS education and training is a resilience strategy that can reduce gross technological user error and boost user confidence, this enhances social sustainability*

At the turn of the 21st century, IS emerged as a critical factor in managing sourcing activities, production planning, food safety and sales management (Gonzálvez-Gallego, et al., 2015; Gunasekaran & Ngai, 2004). Through intra-organisational IS e.g. ERPs and inter-organisational IS capabilities, actor-firms were able to ensure food safety and quality was achieved through visibility and traceability. Melnyk, et al., (2016) proffer a SCRES cycle that is comprised of six stages which are, Avoidance – Containment – Stabilisation – Return – Review – Avoidance. Therefore, the analysis shows that IS can be effective in implementing this resilient strategy. Thus, IS can be very useful in the avoidance stage through generating LPN for products as soon as they leave the farm to generate traceability. This LPN in the form of a barcode will be on the product until consumption.

This creates a potent form of supply chain visibility, which is considered a SCRES enabler (Busse, et al., 2017). Furthermore, IS was applied to ensure food safety and quality through checks at critical control points like the loading bay, before product goes on to the production line etc. In the event of a food contamination or disease outbreak, the containment procedures are then undertaken. Using IS, food products can be traced via provenance licences (LPN) to first, investigate where the outbreak emanated from and second to contain it. This will then allow the perishable food SCN to stabilise and return to normal. To ensure that risk is understood and adequately mitigated a review will be conducted. This approach is in-line with pragmatic philosophy that states that inquiry only begins after a disruption. When that occurs, actors conduct transactions which create experiences and then become habits.

Hence most scholars agree that the two factors of 'resistance' and 'recovery' underpin most SCRES models and frameworks (Ambulkar, et al., 2015; Kamalahmadi & Parast, 2016; Melnyk, et al., 2016). However, a critical aspect of IS capabilities is the ability to anticipate. Kamalahmadi & Parast (2016) designed a three-phase model that introduces the concept of anticipation. Anticipation ties in with the chosen definition for this thesis, which advocates for a proactive approach (Ponis & Koronis, 2012). This phase advocates for supply chain managers to use all resources available at their disposal to anticipate disruptions and act accordingly (Kamalahmadi & Parast, 2016).

An example of this is R1 allowing FF to access their inventory management system to ensure there is no empty shelf-space in their stores. By allowing access via IS, R1 limits shortfalls arising from unexpected demand increases and supply shortfalls. Thus, supply chain actors should be able to understand the impact of any disturbances, thus, using IS capabilities to calculate the probability of risk and apply appropriate contingency measures.

‘Fragile’ in supply chain vulnerability (SCV) represents both low resistance and recovery capabilities. Thus, when assessing the resilience of a perishable food SCN, it is critical to identify the fragile aspects. For instance, farmers have fragility regarding natural disasters, crop and animal diseases etc. The flooding of the watermelons and the subsequent shortages described in Chapter 4 illustrates this point. On the other spectrum, perishable foods SCN that are ‘hardy’ have high resistance and recovery capabilities. This study has shown that collaboration creates a hardy perishable food SCN underpinned by effective IS. This concurs with other studies that have shown the positive impact of IS on collaborative activities e.g. organisational responsiveness (Cai, et al., 2016), knowledge sharing (Li, et al., 2017; Cai, et al., 2013) and industrial symbiosis (Herczeg, et al., 2018).

A key contribution of this study is building knowledge on the importance of a firm's information processing capability concerning its SCRM, which up-to recently had received very little research attention (Fan, et al., 2016). While information plays a crucial role in the implementation and decisions of many of these collaborative activities, effort has received very little attention in the literature (Fan, et al., 2016). Organisations operate in an increasingly dynamic and uncertain environment, consequently, every business within the supply chain is vulnerable to supply chain disruptions (Ambulkar, et al., 2015).

A major issue that arose from the interviews was the catastrophic cost of human error. This is becoming more prevalent with the proliferation of IS as actor-firms increase IS usage. For example, DC lost thousands of US dollars’ worth of bananas due to the wrong inventory management systems entry by a warehouse employee, when last-in-first-out (LIFO) was accidentally programmed instead of first-in-first-out (FIFO). Furthermore, FF experienced inconsistencies in production levels especially on new product lines e.g. processing new fruit like jicama, which created costing and pricing anomalies. Therefore, continually training and educating users of technology throughout the supply chain network is a risk mitigating strategy that builds resilience and sustainability.

Furthermore, IS were critical in facilitating effective food safety and quality management systems. By providing effective food traceability capabilities through LPNs and other various tools like ERPs, IS helps enhance the safety and quality of food products flowing through the SCN. Therefore, it is critical for actor-firms to identify and invest in the right technologies that will allow them to fulfil their core organisational goals. This, in turn, enhances the resilience of the holistic SCN, as the actor-firm will be more capable to anticipate, respond and contain any disruptions.

6.1.4. Proposition 4

4. ***Collaborative culture towards risks mitigation and network vulnerability management is critical for building SCN resilience and sustainability***
   a. *Actor-firms must develop a resilience and sustainability culture*
   b. *Mitigating risks, attaining resilience and sustainability require a culture of balancing trade-offs*

Collaborative culture emerged as a key factor in actor-firms ability to coordinate towards building a resilient and sustainable SCN. The notion of a collaborative culture has lingered in literature but has never been fully explored. Acknowledging its difficulty in implementation Barratt (2004) noted that the elements that make collaboration were seldom understood, technology, culture and strategic implementation. Hence, Emmett & Crocker (2016) argue for a relationship driven supply chain underpinned by a culture of collaboration. The literature review conducted in Chapter 2 indicates that firms have approached resilience in different ways; some view it in a proactive manner through preplanning and building tolerances (Ponis & Koronis, 2012). On the hand, some firms view it as a reactive capability that is utilised when a disruption or shock occurs (Melnyk, et al., 2016). Thus, this study argues that resilience can be attained when actor-firms have a collaborative culture. Hence, the findings build on Melnyk, et al., (2016)'s work which posits that SCRES is composed of two critical but complementary characteristics: which are the ability to resist and the ability to recover. In the context of perishable food SCN, actor-firms can generate the capability to avoid adverse or negative effects or the ability to contain a disruption thereby minimising the recovery time needed through collaborative culture.

Furthermore, when there is a collaborative culture, the SCN can return promptly to its full operational and functional performance levels after a disruption. At this stage it is critical to point out that contemporary research usually views supply chain risk management as the management of various activities concerning risk identification, assessment, mitigation, and responses (Fan, et al., 2016). However, this study finds that a collaborative culture is an effective method of risk management that creates SCN resilience. Furthermore, the findings uncovered the importance of larger actor-firms in developing a sustainability network culture. More specifically the study found retailers to yield immense power in changing sustainable practices. While more recent research surrounding power mainly focuses on direct effects and mostly dyadic supply chain relationships e.g. supply chain performance in dyads (Huo, et al., 2017), trust (Pulles, et al., 2014; Ireland & Webb, 2007), power asymmetries in dyadic relationships (Nyaga, et al., 2013) this study build on this progress by extending the theoretical lens to the network.

Another key outcome was the importance of carefully trading off the TBL issues surrounding, economic, social (people) and environment. Results indicate that a perfect resilience and sustainability utopia cannot be achieved; however, actor-firms can trade-off various supply chain activities to attain a resilient and sustainable SCN. Hence, Marshall *et al* (2015) found in their study found that when organisations adopt a sustainability culture it had a positive impact on the supply chain. They further argue that this should go beyoond the buyer-suppler dyadic relationship but should permiet the lower tiers. This thesis makes the same argument on the importance of adopting sustainability culture that spreads throughout the network. For instance, FF only recycles its plastic and cardboard waste. Items like glass and protective clothing could be recycled but it would not be profitable for FF so these items are sent to landfill.

Organisations may be fully aware of the negative effect e.g. environmental concerns a particular practice may have, however, if it is not economically viable to rectify the situation then it may be best not to address the matter, this is referred to as balancing trade-offs.

One way to balance the trade-offs is to engage in deeper and more meaningful collaboration. Kumar *et al* (2016) revealed the importance of collabrative culture in strenthening relationships and improving supply chain perfomance. Therefore, this study asserts that actor-firms must develop a resilience and sustainability culture. This will be critical in the ability of the perishable food SCN to effectively mitigate risks while attaining resilience and sustainability. This can be achieved through balancing trade-offs which requires an embedded colaborative culture.

6.2. Research Contributions to Practice

Despite early adaptions of network theory in operations management as stated in Chapter 2 literature review, there are few studies that are applying the latest theoretical developments in the field of management studies especially supply chain research (Hearnshaw & Wilson, 2013). Furthermore, an investigation into supply chain network theory reviews that many studies are skewed towards the 'relational exchange view' (Halldorsson, et al., 2007) and the dyadic/liner view which only focuses on specific firms within a network (Hearnshaw & Wilson, 2013). Therefore, this study is comprehensive and extends knowledge in the configuring of perishable food supply chains as networks defined as a set of 'actor-firms' that constitute independent business units as firms that can make autonomous decisions, and are bound by a set of 'interdependencies' that connect these firms together for the purpose of providing a product or service. This builds on the work of Hearnshaw & Wilson (2013) which set parameters for the SCNT.

These interdependencies' which are represented through connections between actor-firms are determined by numerous factors, however, the most critical is the presence of interaction which was analysed via information flow, financial flow and material flow. This follows the parameters set out for SCNT, which focus on material, information or financial flow as critical in establishing exchange relationships within networks (Hearnshaw & Wilson, 2013). Various research scholars have drawn on different assumptions of the NT in justifying its application to supply chain research. For instance, scholars (Harland, 1996; Wellenbrock, 2013) have identified three key assumptions of the network theory that make it suitable for application in supply chain management research. These three assumptions are:

I. Firms operating within a network are constrained from acting autonomously. Hence, Harland (1996) identifies four key factors important to the formulation of a functioning network, which is, *“the selection of collaborative partners, the establishment of a competitive position, the monitoring of competitors and correct management of relationships”.*

II. Centrality in the network is considered a key competitive advantage

However, the study found out that firms are not always constrained from acting autonomously as suggested by Harland (1996). Instead, the results reveal that there are power dynamics at play which have not always been manifest in SCNT discussions. Power dynamics are crucial as power can be used to influence SCN configuration and collaborative activities.

While Harland (1996) argues that centrality is a competitive advantage, the analysis revealed that centrality is relative and cannot be ascribed to a particular firm unless for research purposes. In reality, any firm given the right circumstances can draw the advantages of centrality in the SCN they operate in. However, a key aspect is the relational aspect of SCNT. Thus, network theory argues that firms rely not only on their relationship with direct partners but with the extended network of relationships with supply chain firms (Chicksand, et al., 2012).

This was evident from the importance of collaboration in building resilience and sustainability. Hence, the focus of network theory is to develop a long-term, trust-based relationship between supply chain firms in supply networks (Chicksand, et al., 2012; Wellenbrock, 2013; Baez, 2016). The results indicate the importance of actions and their outcomes within SCN.

While actors may not always fully understand the impact of their decision on the rest of the network, all actions have consequences. Therefore, drawing on a pragmatic approach, when actors use IS to exert power or collaborate, depending on the outcome it can lead to a collaborative culture. However, when power is applied in a negative manner, e.g. price hikes within the perishable food SCN, there it creates a lack of trust. As established in the analysis, trust and interdependencies are a key prerequisite to effective collaboration. In addition to theoretical contributions, this thesis contributes meaningfully to practice. First, it draws out the temporal power dynamics inherent in perishable food SCNs due to the complexity and dynamism. As depicted in Figure 37, actors operating in the SCN have four possible options along the matrix each with differing effects and consequences.

If SCN actor-firms decide not to collaborate within the perishable food SCN, this will result in a *'WEAK'* SCN that lacks resilience and sustainability. Thus, the network will struggle to recover from disruptions timely and it will be likely more expensive to deal with an interruption to supply chain operations. If smaller actor-firms exercise their power and undertake resilient and sustainable initiatives autonomously, independent of larger actors, it will be an *'an exercise in futility'.* This approach will not yield and meaningful and coherent resilience and sustainability beyond the tiers of actors involved.

If the larger actor-firms use their power and financial muscle to get compliance from the smaller actor-firms this will be *'coercion'.* While this may get the desired results, it will be negative for long-term collaborative activities, as this would have damaged trust levels. Therefore, the ideal position in the matrix is the *'FRUITION'* box as all or at least most of the actor-firms involved in the SCN use their power to engage in collaborative activities thereby enhancing the collaboration culture. This allows for the building of SCN resilience and sustainability as shown in Figure 37.

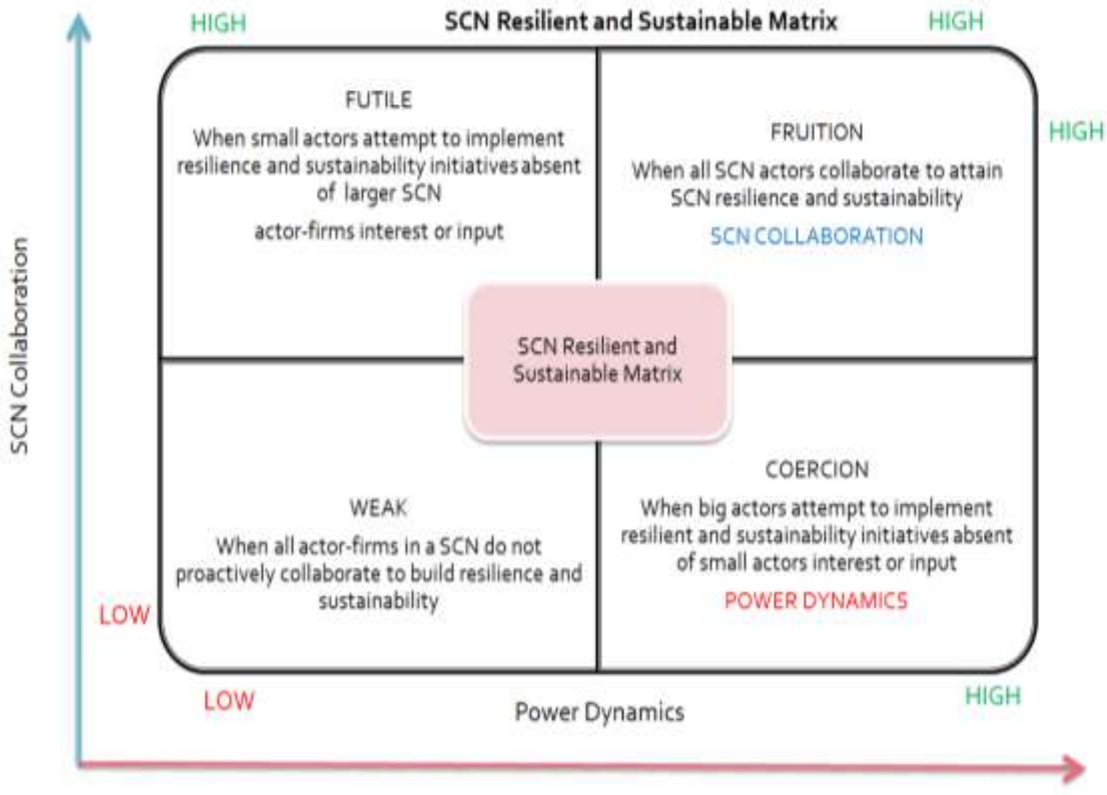


Figure 35: Resilience and Sustainable (RS Matrix) for Supply Chain Network

Figure 37 above present the RS matrix. The matrix is an important contribution to both theory and practice. It draws out the strategy conflicts actor-firms have to contend with when they attempt to set up SCRES and SSCM practices within a SCN. While it may be strategically easier to unilaterally implement resilience and sustainability initiatives, the RS matrix proffers there are various consequences to the four possible strategic choices. Evidently, the researcher strongly advises practitioners and food industry stakeholders to endeavour the attainment of the SCN collaboration approach as it creates a mutually beneficial outcome for all actors involved.

CHAPTER 7: Concluding Remarks and Future Insights

7.1. Thesis Conclusion

The main aim of this thesis has been to investigate how supply chain actors can build resilient and sustainable perishable food SCN. This study applied a cross-sectional, embedded, in-depth, exploratory case study in a food manufacturer and actor-firms across all tiers of its network. Therefore, evidence was mainly drawn from 40 semi-structured interviews and multiple sources, accumulating to the apex of understanding through triangulation, which enhances validity (Yin, 2014). To address the research purpose appropriately, a pragmatist philosophical positioning using an abductive reasoning logical inference has been applied. To begin the analysis, data were first grouped and analysed in tiers. This provided a clear, manifest analysis, which allowed for the generation of meaning units that were then systematically categorised to answer the research questions. First, the focal firm (FF) was analysed as a separate entity followed by all other grouped tiers. This approach followed the within-and-across-case analysis technique. Once this first stage was complete, the identified meaning units were then examined in the context of building resilient and sustainable perishable food SCN. This process was undertaken to answer to the following research questions:

How can perishable food supply chain networks build and sustain resilience?

a. What resilience practices do actors operating in a perishable food supply chain network adopt to mitigate risks and manage vulnerabilities?

b. How can these practices be enhanced to build resilience?

2. How can actor-firms in a perishable food supply chain network build sustainability?

a. What are the current issues perturbing actor-firms' capability to build sustainability in perishable food supply chain networks?

b. How can actors effectively build and continually enhance supply chain network sustainability?

In investigating the prevailing risk and vulnerabilities as the strategies and practices employed, the study answered the sub-questions as displayed in Table 26 below.

Table 26: Summary of sub-questions findings

RISKS AND VULNERABILITIES	RESILIENT PRACTICES	SUSTAINABILITY PRACTICES
I. Deliberate price hiking II. Food fraud III. Mixed degree of collaboration IV. Sourcing strategies V. Demand risks VI. Complexity VII. Transportation issues VIII. Human errors IX. Natural disasters	• Collaboration • Contractual agreements • Trust • Flexibility • Food safety management systems (FSMS) • Information systems (IS) • Planning, production and inventory management • Logistics strategies	• Collaboration • Training and development • Interdependence • Sustainable initiatives

In addition to the research question, the analysis unearthed four main categories, Collaboration, Power Dynamics, SCN Culture, and Information Systems. The interplay between these four main categories provided enhanced collaboration and a collaborative culture. Thus, to mitigate SCN risks effectively, actors must collaborate in implementing SCRES strategies and capabilities to limit the impact of SCN disruptions and allow the perishable food SCN to return to normalcy or exceed the previous level of functionality in a timely manner. Thus, collaboration is heavily influenced by prevailing power dynamics and facilitated by IS.

This thesis analysed collaboration via the collaborative activities of information-sharing, joint knowledge creation, decision synchronisation, incentive alignment, resource sharing, goal congruence and collaborative communication among supply chain actor-firms (Cao & Zhang, 2011). Collaboration proved vital in attaining food safety and quality. This was expressed as critical by almost all actor-firms except for the recycling companies. Various resilient mechanisms were discussed by actors in their interviews which included HACCP, food safety management systems (FSMS) e.g. BRC certification and traceability. Key to achieving this was product visibility throughout the supply chain and this was achieved through IS applications. Depending on the prevailing conditions power dynamics are constantly shifting between buyer and seller. This allows conditions for negative power expressions like opportunistic pricing by actors with the most bargaining power.

Despite current literature acknowledging the volatility of FSCNs and the impact this has on price fluctuations (Rezitis, 2018; Sharma & Lote, 2013), the power dynamics at play in the SCN still remain largely underexplored and explained. Thus, a less explored aspect is the impact of actors' power exertions on the long-term supply chain relationships. Of interest is what impact this causes regarding building interdependencies which are critical to undertaking effective collaboration. This study adds knowledge to this aspect by proffering that power dynamics can be used to effectively build interdependencies. Thus, this study argues that resilience can be attained when actor-firms have a collaborative culture. Hence, the findings build on Melnyk, et al., (2016)'s work which posits that SCRES is composed of two critical but complementary characteristics: which are the ability to resist and the ability to recover. In the context of perishable food SCN, actor-firms can generate the capability to avoid adverse or negative effects or the ability to contain a disruption thereby minimising the recovery time needed through collaborative culture. Furthermore, when there is a collaborative culture, the SCN can return promptly to its full operational and functional performance levels after a disruption.

At this stage it is critical to point out that contemporary research usually views supply chain risk management as the management of various activities concerning risk identification, assessment, mitigation, and responses (Fan, et al., 2016). However, this study finds that a collaborative culture is an effective method of risk management that creates SCN resilience. Table 27 below provides a brief comparison of this thesis results in relation to the extant theory.

Table 27: Comparing select key findings with SCRES and SSCM extant literature

Findings from this Thesis	Existing SCRES and SSCM Literature	Contribution of this Study to Knowledge
Power dynamics are critical in facilitating deeper and meaningful collaboration	Supply chain performance in dyads (Huo, et al., 2017), trust (Pulles, et al., 2014; Ireland & Webb, 2007), power asymmetries in dyadic relationships (Nyaga, et al., 2013)	Most studies focus on direct impact of power e.g. trust, collaboration but lack of power outcomes on wider network as well as SCRES and SSCM. This study contributes in this regard
Information Systems as a tool for collaboration and power expression	Information systems facilitate collaboration in supply chains/networks (Herczeg, et al., 2018; Cai, et al., 2016)	This thesis puts forward that IS can be used as a power tool to facilitate collaborative activities
SCN culture is critical in building resilient and sustainable perishable food SCNs	A collaborative culture is crucial in building supply chain relationships and attaining high levels of performance (Emmett & Crocker, 2016; Kumar, et al., 2016; Barratt, 2004)	The results propose that collaborative culture could be a key factor in building SCRES and SSCM

7.2. Study Limitations and Future Research Avenues

There is no study without limitations and this thesis is no exception. As this study is a qualitative piece of work, it is important to note that the researcher whether knowingly or unknowingly possess biases. While every attempt is made to ensure a non-biased approach, it is likely unavoidable in certain instances as it is influenced, by upbringing, culture, knowledge and experience. Second, this was an exploratory qualitative case study, this means the results cannot be generalised across cases (Yin, 2009). Additionally, this study was conducted in the context of the US food industry. This means the results may not be applicable in other contexts. Moving forward it would be prudent to conduct further quantitative or mixed-methods research applying the identified propositions as testable hypothesis. Another limitation of this study is its cross-sectional nature, this approach limits understanding as perishable food SCN are complex and dynamic, and thus, there are continually changing and adapting to the environmental conditions. This means certain conditions may have changed between the time of data collection and the present day.

The philosophical positioning of the study may be criticised. Criticisms of the pragmatic approach are decades old; Richard Rorty warned of the consequences associated with pragmatism theory on the truth. He argued pragmatism's main weakness emanated in its lack of view on what constitutes truth philosophically (Rorty, 1982). Hence, Elkjaer & Simpson (2011) acknowledge these past criticisms of pragmatism calling them “intellectually naïve” and “philosophically passé”. Thus, critics of pragmatism view it as myopic (Elkjaer & Simpson, 2011; Morgan, 2007; Rorty, 1982). Another drawback is that pragmatism also accepts what ‘might be’ as a plausible outcome and this could turn out to be a flawed approach (Morgan, 2007). However, despite these criticisms, a pragmatist approach remains the best avenue for effectively tackling the thesis aims and objectives.

This study was investigating a phenomenon that is still not fully understood. By undertaking this research in pursuit of a building resilience and sustainability in perishable food SCN, four key categories were unearthed has been critical to attaining SCN resilience and sustainability. These categories can be independently or jointly tested using quantitative methods. By applying predictive modelling techniques, further insights as to their significance towards building resilience and sustainability can be attained. Furthermore, research surrounding new emerging concepts like circular economy, artificial intelligence and block-chain can be investigated in regard to attaining SCN resilience and sustainability.

To conclude this thesis, I propound this statement by a fellow pragmatist scholar,

Sir Karl Popper

"Whenever a theory appears to you as the only possible one, take this as a sign that you have neither understood the theory nor the problem which it was intended to solve."

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Appendices

Appendix 1: Excerpt of Field Observations

Observations and Field notes taken on Wednesday 21st February 2018 at the loading bay of the focal firm between 11:00 and 13:00. A guide of the process was provided by the Quality Manager, then around 12:05, the Materials and Replenishment Manager. We returned upstairs just after 13:00.
Staffs were inspecting pallets of white onion, jicama, grapes and honey-dew. Each vegetable or fruit has very specific inspection guidelines quality control staff must follow. **First, products are inspected on the truck, once it passes this first stage, the produce is then offloaded, and each pallet is assigned a license plate number (LPN). The LPN identifies the product and its place of origin and stays with the product until the retail stage**. When the product is in the loading bay, it then undergoes a second and more rigorous food safety and quality checks; these include sampling for bacteria, fungi, viruses and any other contaminants. Furthermore, there are also checks for any other contaminants e.g. pests or dead insects, any fruit or veg found to be contaminated are removed and the pallet is marked. **As the quality manager explained it is possible for delivery to fail the safety and quality checks after it initially passed, and it was offloaded from the truck. This usually creates problems and is a source of conflict between buyers and suppliers.** If the load initially passed the quality and safety checks and then fails afterwards buyers often feel deceived by that supplier and will often punish them by not ordering from them again. Other quality checks carried out in the bay include visual checks, sugar tests, water content test and slicing the fruit and vegetables open to inspect inside the product. **This stage is considered a critical control point under the Hazard Analysis and Critical Control Point (HACCP).** Once products pass this stage they go on to the production floor, depending on what product it is certain products have to go through a chemical wash e.g. watermelon and honeydew.

Appendix 2: NVivo word frequency

Appendix 3: Buyer Interview Protocol

Research Questions – Buyers

1) *What is your current position?*

Probe: *What duties do you undertake? What are your responsibilities? Years of experience*

2) *What is your typical day like?*

Probe: *Everyday activities, routines. Company processes and procedures*

3) *What are the usual problems that you encounter when you are doing your job?*

Probe: *Routine challenges, where and when do they usually arise?*

4) *How do you usually deal with these challenges/problems?*

Probe: *Is there a routine or procedure to be followed? Do they have autonomy? Are these solutions usually effective?*

5) *Has there been any major incident/s that have arisen in your job role?*

Probe: *What was it? How did you deal with it? Was the solution effective?*

6) *How do you source your raw material/products etc.?*

Probe: *How do they select their suppliers? What are the major contributing factors when selecting suppliers? Contract types? What do they consider to be the most important prerequisites?*

7) *What is the procedure you follow when you are buying your raw materials/products etc?*

Probe: *Do they have autonomy or is the process set out by the company? Are there any issues that you face? How do you deal with them?*

8) *In your own opinion based on your job role and previous experience, is there anything that could be done to improve the process of buying/sourcing your raw materials/products?*

Probe: *If yes, what can be done? Why do they believe it will be effective? If no, why?*

9) *Within your job role, are there any issues that you believe are making the process to buy more difficult or if they are not addressed could make the process more difficult in the future?*

Probe: *If yes, what are there? If no, why?*

10) *What buying system do you use and why?*

Probe: *Just in time? Lean? In your opinion is there a better alternative?*

11) *In your job role, are any of your systems or processes integrated with any of the companies you buy from?*

Probe: *If no, why? If yes, how are there integrated?   In their own opinion, what is the effect of this?*

12) *Do you have a way of identifying potential problems with incoming raw materials/products?*

Probe: *If, yes, what are these procedures? Are they effective? Have they always worked? If no, why?*

13) *If problems arise during your buying process, do you involve other departments/companies in attempting to resolve it?*

Probe: *If yes, who is involved and how does this occur? Is there any process or procedure of dealing with any potential issues that may arise? If they don't work with other companies in their network, why not?*

Probe: *Can you please give examples of these procedures? In your opinion, are they effective?*

14) *Whenever, issues arise within your job role, how quickly and effectively does it take to resolve them?*

Probe: *Please give examples…*

15) *Are your systems (communication, software packages, etc.) integrated with any of the companies you work with?*

Probe: *If yes, which companies? How does this work? What is the impact of this integration? If no. why?*

16) *In your own opinion and based on your experience, do you think your department/area is ready to deal with any problems that may arise at any given point?*

Probe: *If yes, how are they ready? If no, why do they think so?*

17) *In your own opinion what do understand by the term 'sustainability'?*

Probe: *How do you view it? What does it mean to you? What does it involve?*

18) *Based on your understanding, do you believe the company is sustainable?*

Probe: *If yes, why? If no, why?*

19) *In your job role, are you aware of how your organisation processes its waste and by-products from its operations?*

Probe: *If no, move on.   If yes, enquire on processes and procedures. Are these effective? In their opinion, can they be improved?*

20) *Are there any sustainable initiatives your organisation/department undertakes in partnership with other companies you do business with?*

Probe: *If no, enquire why? If yes, enquire on the nature of the partnerships? How do they work together? In your opinion are there effective?*

21) *In your job role, do you work together with any companies you do business with, in terms of gaining access to their company systems or effectively making certain decisions on their behalf?*

Probe: *If yes, which companies? How do you work with them? Probe trust, dependencies, power and sharing rewards*

22) *In your opinion, what has been the effect of working with these companies on your supply chain operations?*

Probe: *What do they believe is the impact of working together? Have they seen any tangible results?*

23) *In your opinion, are there any issues that could arise from working together with companies in you do business with?*

Probe: *If yes, why? If no, why?*

24) *Do you think there is scope to increase cooperation between your firm and the companies in your supply chain?*

Probe: *In your opinion will this be good? What effects do you think it will have your supply chain?*

Appendix 4: Supplier interview protocol

Research Questions – Suppliers

Begin by thanking them for agreeing to participate in the study and break the ice with a relaxed chat on the research and answer any initial queries or reservations they may have.

1) *What is your current position?*

Probe: *What duties do you undertake? What are your responsibilities? Years of experience*

2) *What is your typical day like?*

Probe: *Everyday activities, routines. Company processes and procedures*

3) *What are the usual problems that you encounter when you are undertaking your daily job duties?*

Probe: *Routine challenges, where and when do they usually arise? Do they consider them to be major or minor hinderances?*

4) *How do you usually deal with these frequent challenges/problems?*

Probe: *Is there a routine or procedure to be followed? Do they have autonomy? Are these solutions usually effective?*

5) *Has there been any major incident/s that have arisen in your current or previous job role in the last 5 years?*

Probe: *What was it? How did you deal with it? Was the solution effective?*

6) *Did you work with any companies/departments to resolve the issue?*

Probe: *If yes, which companies did they work with? How did they work together? Was the solution effective? If no, why?*

7) *In relation to your products, how do you sell them and what's the usual procedure?*

Probe: *How do they acquire their customers? What sort of contract types do they have?*

8) *What is the procedure you follow when you are selling your products? In your opinion, is it effective?*

Probe: *How many products are they selling, to whom? Do they find the process straightforward? In their opinion can it be improved?*

9) In your current role or any previous roles in the last 5 years have you had any problems with selling or suppling your products?

***Probe:** If yes, what were there? How did you deal with them? What was the outcome?*

10) Did you work with any other companies to resolve the problem?

***Probe:** If yes, which companies did they work with? Was is it effective? Where there any problems? If no, why?*

11) Within your job role, are there any issues that you believe are important but are sometimes overlooked or not given enough attention?

***Probe:** If yes, what are the issues? If no, why do they believe everything is fine?*

12) Do you have a way of identifying potential problems with your finished products before and after you dispatch them to customers?

***Probe:** What are these procedures? Are they effective? Have they always worked? Can there be improved?*

13) If problems arise with your finished products, how do you deal with them?

***Probe:** Have any problems occurred in the past and how frequent? What were the problems? How did you deal with them? Was the solution effective?*

14) Whenever, issues arise, how quickly and effectively does it take to resolve them?

***Probe:** Please give examples…*

15) Are your systems (communication, software packages, etc.) integrated with any of the companies you work with?

***Probe:** If yes (Go to 16), which companies? How does this work? What is the impact of this integration? If no. why (Skip, 16)?*

16) In your job role, do you work together with any companies you do business with, in terms of gaining access to their company systems or effectively making certain decisions on their behalf?

***Probe:** If yes, which companies? How do you work with them? Probe trust, dependencies, power and sharing rewards*

17) In your own opinion and based on your experience, how ready do you think your department/area is ready to deal with any problems that may arise at any given point?

***Probe:** If yes, why do they think they are ready? If no, why do they think they are not ready?*

18) Based on your job role and experience, what is your understanding of sustainability?

Probe: *How do you view it? What does it mean to you? Establish whether they view it as important or not?*

19) *Based on your understanding, do you believe your supply operations are sustainable?*

Probe: *If yes, why? If no, why? Do they have ideas or different views regarding sustainability?*

20) *How do you deal with waste/by-products generated from your supply operations?*

Probe: *Processes and procedures. Are these effective in your opinion?*

21) *Are there any sustainable initiatives your organisation/department is involved in partnership with other organisations?*

Probe: *What are there? In your opinion are there effective?*

22) *Are your systems (communication, software packages, etc.) integrated with any of the companies you work with?*

Probe: *If yes, which companies? How do you work with them? Probe on issues surrounding trust, dependencies, power and sharing rewards*

23) *In your opinion, what has been the effect of working with these companies on your supply chain operations?*

Probe: *What do they believe is the impact of working together? Have they seen any tangible effects (negative or positive)?*

24) *In your opinion, are there any issues that could arise from working together with companies in your network?*

Probe: *If yes, why? If no, why?*

25) *Do you think there is scope to increase cooperation between your firm and the companies in your supply chain?*

Probe: *In your opinion will this be good? What effects do you think it will have your supply chain?*

26) *Based on the questions I have asked you, is there anything you feel is important and would like to share with me?*

Probe: *Why is that issue/s important to them?*

Check if they have any questions or if they need any clarification regarding the interview. If they do answer and address all their concerns.

Thank them for their time and agreeing to participate in the study.