Capabilities of internal actors to build resilience against supply chain food fraud

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Abstract

Food is an essential part of our global existence, and it is the supply of this [food] that comprises a complex system of suppliers, spread over vast geographic distances. Coupled to this complexity is a increasing demand for food stuffs, with a purported increase in food stuffs of 50% to 2030. However, there is an increasing amount of food fraud occurring, with a recent study citing a European wide increase of 20% fraud with meat products over the preceeding 20 years. Therefore, it is incumbent on supply chain professionals to mitigate risks of food fraud, and look toward existent research to assist. But, there a paucity of research in the area of supply chain food fraud risk and resilience mitigation, with the majority of research being related to scientific testing processes rather than management theory.

Therefore, this research study espouses to address this gap utilising a tri-methodology of systematic literature review, Modified Delphi and semi-structured cross case study analysis. In doing so, it engaged with food supply chain professionals and at latter stages food procurement professionals to gain an appreciated into building internal capabilities against food fraud. Finally, this reasearch compares the outputs of the tri-method approach against existent supply chain resilience literature to build a theoretical framework of capabiltiies of food supply chain resilience, and areas for further research.

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Conference papers & Journal outputs

Fassam, L. (2016) *PhD Trans*, submitted to 15/16 Applied Logistics, Procurement and Supply (STRM064-SPR) _55743_, Transfer Paper 001, University of Northampton

Fassam, L., Dani, S. (2016). Supply chain food crime: can behaviours of supply chain actors affect food integrity?. Logistics Research Network. Conference.

Fassam, L. (2016). Procurement and supply chain resource efficiency. All-party parliamentary sustainable resource group, 1st Feb.

Fassam, L., Dani, S. (2017). A conceptual understanding of criminality and integrity challenges in food supply chains, *British Food Journal*, 119 (1)

Fassam, L., Dani, S. and Hills, M. (2015). Supply chain food crime & fraud: a systematic literature review of food criminality. Paper presented to: 20th International Symposium on Logistics (ISL 2015) : Designing Responsible and Innovative Global Supply Chains, Bologna, Italy, 05-08 July 2015

Fassam, L. (2019). Social value effect of food supply chains and Brexit. DEFRA.

Fassam, L. (2020). The food supply chain must think about post-disaster recovery. The Grocer. 1st April

Fassam, L. (In Presss – 2020). Covid 19: an opportunity to review existent data devoid food supply chains and build resilience against food fraud for SMEs. *Food Security*.

Fassam L., Dani, S. (In Press – 2020) Practitioner led model of building supply chain resilience against food fraud; a Delphi study. *Journal of Purchasing and Supply Management*

Fassam, L., Asefeavazi, S., Dani, S. (2020) Supply chain risk & resilience: literature review of the food challenge. Paper presented to: 6th International Conference on Food & Wine Supply Chain – Italy. (Online 2020)

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1 Chapter One

1.1 Introduction

One of biggest supply chain shocks of the modern era destabilised food supply chains globally in 2020. The shock, Covid 19, has identified how responsive food supply chains are critical in formulating resilience (Hobbs, 2020). In addition, research has identified that inventory and procurement strategies are important for formulating this resilience, to enable a sustained operation as an estimated 82% of organisational spend is allied to these procurement functions (Hobbs, 2020; Sanders, 2020). Managing the food supply chain to become responsive and therefore resilient is shown to improve inventory management by 25% and customer outcomes by 16% (Sanders, 2020). A focus on cost metrics is endemic with research on supply chain resilience. However, elements such as food fraud are missing from this focus. A recent research review on 20 years of meat sector food fraud across Europe identified how 36.4% of all meat fraud cases were related to primary processing, with 95.5% of all cases being related to counterfeiting (Robson et al., 2020). However, there was no mention of management strategies such as the aforementioned building of resilience through inventory or procurement management processes, as well as with continual upholding of retrospective auditing and testing processes. Therefore, this research aims to explore the constructs of building food supply chain resilience, in particular through the lens of food fraud, with a contribution that could inform management about practices to build responsiveness and resilience.

This research is initially conceptualised in the academic area of supply chain risk management. In addition, it is also important to recognise that supply chain management has evolved from a collection of organisations whose sole purpose is to move product flows, to one which is tasked with creating significant organisational value, whilst being agile to consumer demands, flexible to stakeholders needs and cost efficient (Laosirihongthong & Dangayach, 2005; Sweeney et al., 2018). As such, the supply chain is tasked with building competitive advantage, cited as one of the most popular value perceptions within the literature on supply chain management. This need [competitive advantage] is cited by Goh and Pinaikul (1998) as the key driver of strategies that enhances customer satisfaction. However, it could be argued that this view (Goh & Pinaikul, 1998), which is from 22 years ago, may need to be revisited in line with the major upheavals witnessed by business environments throughout this 22 year period, ranging from natural disasters to political fallouts. Therefore, chapter 2 of this research will compare the standard supply chain view with a sector specific approach [food]. This will involve a review

of the degree of fit between traditional supply chain risk management principles and the sector specific view relating to food chains.

Furthermore, despite existent supply chain risk research dating back a number of decades (Goh & Pinaikul, 1998), there remains a paucity of research studies into sector specific elements, such as food supply chain resilience (Fassam & Dani, 2017; Sodhi & Tang, 2012). Additionally, the research that does exist [food supply resilience] takes a very top-level review of resilience management, with little attention paid to the cause-effect relationships (Bacon, 2014; Christopher & Lee, 2004; Punter, 2013). This in itself makes it difficult for practitioners to build robust resilience measures and creates confusion around resilience-building both internal and external to an organisation. Therefore, in order to mitigate risk and build resilience in a food context, the leadership and management teams associated with food supply chains need to review processes and risk management as a holistic process (Diabat et al., 2012; Elliott, 2014; Spink & Moyer, 2011). Furthermore, there are a number of research studies identifying new risk sources within food supply chain research, but specific identification of the risk category or detail along with their effects on performance of food networks is significantly limited (Fearne et al., 2001; Fritz & Schiefer, 2009; Jaffee et al., 2010; Jüttner, 2005; Nakandala et al., 2017; Ruben et al., 2007; Srivastava et al., 2015; Van der Vorst, 2000; Yeboah et al., 2014). Furthermore, while existent management theories exist with resource-based view (Zaridis, A., Vlachos, I., & Bourlakis, M, 2020), network theory (Handfield & Nichols, 2002), stakeholder theory (Sarkis et al, 2010) and theory of constraints (Oglethorpe & Hero, 2013) are all aligned to cost and value based metrics. Also there is no attention being paid to food supply chain resilience building which is driving limited understanding of risk are the scarce comprehension of constructs with resilience building and the actors or stakeholders involved in creating this.

Folke (2006) attempted to bridge this knowledge gap by employing three fundamental concepts of resilience: engineering resilience (building by design resilience measures), ecological resilience (ability to recover quickly and resist damage) and socio-ecological resilience (absorb disruption without need for change). All of these differing resilience measures are relevant to the study of food supply chain resilience, and are areas Manning et al. (2006), Manning (2015) and Manning and Soon (2016) purport as organisational aspirations whether they be quantitative (financial) or qualitative (ecological). However, whilst the research has evolved, it still lacks clarity around the business unit capabilities in building food supply chain

resilience. This lack of clarity is further compounded as 92% of European food supply chains are comprised of SMEs, which are geographically dispersed and involve many actors (Elliott, 2014; Fassam & Dani, 2017), which makes them and the food systems they support vulnerable to shocks. In particular, a critical area of supply chain risk [shock] is food fraud, and there have been numerous high-profile risks associated with fraudulent behaviours recorded in the professional literature at the time of constructing this research study.

With regards to food fraud, Manning and Soon (2016) argue that food fraudsters do not distinguish between various countries and they do not respect borders. In the UK and Ireland, food supply chain foodstuffs originate from an array of countries. They are in the main monitored in an uncoordinated manner, with much of the governance being managed at individual company level, meaning there is a lack of a connected systems view (Johnson, 2014). The international, dynamic, and large-scale supply chain network unfortunately provides greater opportunities for fraudulent activities, leaving food supply chain actors [UK & Ireland] vulnerable. Therefore, in order to build food supply chain resilience and mitigate against increased levels of food fraud, greater understanding is needed of research associated with the constructs of resilience. Consequently, in order to understand the constructs of resilience, a multi-sectoral, cross-functional approach is required. A systems thinking approach is required in which food supply chains are required to collaborate in order to mitigate risk, as no one element in isolation is able to mitigate against all supply chain risks (Spink & Moyer, 2011). However, in pulling together holistic resilience building, there is a paucity of research relating to food supply chain fraud and how this resilience can be achieved with a multi-actor approach.

Nevertheless, the importance of addressing food supply chain resilience and specifically fraud are key as there has been a globally recognised rise in fraudulent activity. In total, 70% of businesses have encountered some form of criminality within their supply chain, with 67% of these events involving persons internal to the affected organisations. This rise of criminality in a supply chain context can be identified within Europe, with 56% of businesses in 2012 reporting some form of fraudulent activity compared to 77% in 2013 (Kroll, 2014 cited by Fassam & Dani, 2017). We could surmise that a rise of fraudulent activity is attributed to better reporting. However, the World Economic Forum asserts that concerns remain over a lack of focus pertaining to resilience in a supply chain context against the continual increase in fraudulent activity (Bowman, 2014; McCarthy, 2014; World Economic Forum, 2013).

Furthermore, studies have been undertaken to review resilience in a business context, with FM Global (2016) citing three fundamental focus areas required to improve overall business resilience, namely economic, quality and supply chain, and within these three thematic areas greater focus is required regarding corruption, infrastructure and suppliers in order to build greater business resilience.

Through a food fraud lens this research will explore the lack of supply chain understanding for the formation of internal resilience by adopting a three-stage process of systematic literature review, Modified Delphi study and semi-structured case study approach to answer the question:

'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'

The remainder of Chapter 1 will describe the aims and objectives of the research, and how this will align to the research question, along with the rationale for focusing on the sector specific approach of food supply chains and resilience to fraud.

1.2 Research Aim

This research employed a continually evolving series of methods, which will be outlined in detail through Chapter 3 reviewing key concepts and views related to building resilience against food fraud in a supply chain context.

The key research aim is:

To explore the capabilities of internal supply chain actors to build supply chain resilience against food fraud. In exploring the research aim, this research has a series of objectives:

Objective 1:
Give the background and context to the research study by critically examining academic literature in the field of food supply chain resilience against food fraud.

Objective 2:
Build an understanding through review of existent food supply chain resilience literature of the metrics needed to build resilience against food fraud in supply chains.

Objective 3:
Against the resilience markers, identify the capabilities for internal resilience building and business units for leading the implementation of the resilience measure/s.

Objective 4:
Conceptualise the ability for business unit level focus to deliver internal resilience building through linking the outputs attained under objectives 1, 2 and 3 to create an understanding for further research into food supply chain resilience building against food fraud.

1.3 Why research food fraud and resilience

The traditional supply chain risk management sphere has received significant attention for the past 15 years. However, despite this noteworthy contribution to knowledge there is very little understanding around the detail about building resilience, with much of the work into the area of risk and resilience being built around top level aggregate driven episodes (Bacon, 2014; Punter, 2013; Sodhi & Tang, 2012). Also, there is little attention paid to the application of risk and resilience building in the food sector, and management processes relatable to resilience building (Elliott, 2014; Fassam & Dani, 2017; Manning, 2015). Therefore, greater understanding of building resilience against fraudulent behaviours in food supply chains is needed, particularly with a reported 50% increase in demand for foodstuffs by 2030 (House of Commons, 2013). In addition, the food sector across Europe is an important industry with 6% GVA attributed from the €1.18 trillion turnover and employing 4.57 million people (European Commission, 2014).

When reviewing corporations and fraud, 70% of businesses cited having been exposed to some form of fraudulent behaviours, with 67% of these events occurring inside the companies (Kroll, 2014). According to the World economic Forum, this lack of understanding on how to build resilience against fraud into supply chain thinking is a challenge (Bownman, 2014; McCarthy, 2014; World Economic Forum, 2013). Specifically, through a food lens, the incidences of food fraud have been on the increase across Europe, with fraudulent behaviours becoming a commonly cited critical issue for modern day food chains (Elliott, 2014; Manning, 2015; Robson et al., 2020).

The academic literature depicts a research gap in creating resilience against food shocks (Hobbs, 2020; Manning & Soon, 2016) and the need for organisational management techniques to incorporate resilience (Elliott, 2014; Fassam & Dani, 2017). Additionally, with recent research citing an increase in food fraud against current demand patterns, the author purports that food supply chains are heading towards a 'perfect storm' with a predicted 50% increase in demand by 2030 (Robson et al., 2020; World Economic Forum, 2013). Therefore, this research will assess the constructs of building food supply chain resilience through the lens of food fraud to inform future research into the management practices for building resilience.

1.4 Contribution to food supply chain resilience research gap

In addressing research relating to resilience building with food supply chains, this thesis takes on board the lack of aforementioned management strategies with existent management theories such as resource-based view (Zaridis, A., Vlachos, I., & Bourlakis, M, 2020), network theory (Handfield & Nichols, 2002), stakeholder theory (Sarkis et al, 2010) and theory of constraints (Oglethorpe & Hero, 2013) that take a purely cost and value driven approach to business research. In doing so, the research study needed to address gaps in these gaps within the food supply chain resilience field. These gaps are noted within the HM Government report into food fraud and denotes a significant lack of systems views within the supply chain arena (Elliott, 2015). In addition, a systematic literature review identified an existent lack of research both academic and practitioner in the area of resilience building with food supply chains (Fassam & Dani, 2017; Manning, 2015). Furthermore, there is an argument that research studies such as this one are needed to counter the abundance of theoretical and quantitative approaches (Eddine, M., Saikouk, T. and Berrado, A., 2019; Randal & Mello, 2012; Stuart et al., 2002).

The objectives of this research provide a suitable process for establishing a rich perspective on the aspects of food supply chains, specifically with a focus on food fraud and supply chain resilience. As such, this thesis contributes to research in two ways, namely theoretically and practically, in the four key ways discussed below.

1.5 Theoretical contribution

While it is noted that prior supply chain management researchers have developed rigorous research, predominately over the past decade, a number of scholars cite this new discipline as

detracting from its original roots within the management field (DeHoratius & Rabinovich, 2011). This has been further compounded by the lack of post-positivist research studies, as identified in Chapter 2 [Literature review] and restricted expansion of a richer field of research approaches, as seen with other fields of managerial research such as finance, marketing or strategy (Boyer & Swink, 2008; Burgess, Singh, & Koroglu, 2006; DeHoratius & Rabinovich, 2011).

Furthermore, the modern extended global food supply chain, as reviewed in Chapter 2 [Literature review], responds to and reflects culture and human behaviours, which can foster subjective decision making. Thus, studies of this nature [human behaviour] require research approaches that can identify linkages with human interactions and the effect these have on supply chain relationships. In addition, supply chains by their very nature are socially linked with a myriad of subjective metrics (Isenberg, 2008; Mello & Flint, 2009). Therefore, this research adopts a Grounded theory approach as researchers can address the human aspects of supply chain management by being able to deploy an inductive method, recognised as an appropriate and peer reviewed process within supply chain management research (Holland, 1992; Sousa-Poza, Kovacic & Keating, 2008).

As such, this research contributes to the academic literature on food supply chains using an exploratory research methodology. In following this method, the research provides a theoretical grounding from an academic and practitioner perspective on food supply chain resilience through a systematic literature review of the existent research. The outputs of this process enable identification of the gaps in food supply chain resilience to fraud in relation to the recommendations contained within the UK Government report into food fraud (Elliott, 2014). The identified gaps associated with key concepts in the area of building food supply chain resilience are authenticity, consumers, data, enforcement, intelligence and risks (Fassam & Dani, 2017). In addition, a broader literature review enhanced the understanding of food supply chain resilience, and develops key themes with three resilience measures (learning and innovation, persistence and robustness, recovery and constancy) and three management metrics (Supply chain dynamics and KPI, strategic leadership, decision leadership) (Edgeman & Wu, 2016; Folke, 2006; Manning & Soon, 2016; Ponomarov & Holcomb, 2009). These identified areas are upheld as essential for building resilience in food supply chains. Therefore, having identified the gaps in academic and practitioner literature linked to the enablers of food supply chain resilience building, this research presents novel directions for future research to the wider

academic community. In doing so, this first element of theoretical underpinning meets the needs of objectives 1 and 2 through understanding the existent literature in the field of food supply chain resilience.

1.6 Practice contribution

The theoretical approach for meeting research objectives identified gaps and enablers, which were revealed as a result of the systematic literature review and wider food supply chain resilience review. This delivered valuable insight into the critical areas missing in food supply chain resilience and identified areas requiring further research. However, in order to meet the needs of building greater empirical works in the area of food supply chain resilience, there was also a need for the research study to engage with industry experts (Dubois & Araujo, 2007), and in doing so deliver greater visibility and context to research outputs, that are understandable and transferable to industry upon conclusion.

Thus, the outputs of the systematic literature review were discussed with an expert focus group of food supply chain stakeholders. These experts were able to validate and confirm the gaps and enablers identified in the first phase of the research [theoretical] and so this is seen as a reliable way to validate findings (Sackman, 1974). While validating the identified gaps from the systematic literature review that were deemed as important and relevant to food supply chain resilience, there was a consensus of opinion across the focus group that a lack of understanding remained in how to build resilience capabilities. Therefore, the second impact of this research involved building a connection between academic research gaps and expert practitioner views through reinforcing research objectives 1 and 2.

To compensate for the aforementioned lack of understanding in the research into food supply chain fraud and resilience building, a Modified Delphi was undertaken to ascertain *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?"*. This direction was taken not only due to a lack of existent literature in this area, but also because existent risk and resilience literature was discursive and did not offer much in the way of understanding the food supply chain context. Also, when reviewing through the lens of food fraud, whilst some existent research was identified in this area, such as the UK Government report into food fraud (Elliott, 2014), it was very biased towards scientific testing and does not align itself well with the business and management aspects of food supply chains. Therefore, the third contribution to research relates to building understanding of the capabilities

of internal actors in building resilience to fraud in a food supply chain, and meets objective 3 of this research thesis.

The next contribution stems from the qualitative engagement with procurement professionals since this function was identified as the business unit for managing resilience building internally. This process, whilst giving some insight into the aspects of food supply chain resilience from a food fraud perspective, also served to build a case study approach to understanding the constructs of resilience capability building that were outputs of the Modified Delphi and their application at different stages of a connected supply chain. In doing this, a cross case study developed themes with the identified internal resilience builder [procurement], compared against aforementioned research methods, to deliver an understanding of the constructs and capabilities of research building. Therefore, while meeting the fourth objective of this research thesis a contribution to research has enabled identification of areas for researchers to carry forward and build more aligned focus on food supply chain resilience, fraud, internal resilience and procurement.

In working with expert practitioners across the three methodological stages the practice based contribution to this research methodology aspired to deliver against all objectives, while adding to the academic knowledge of food supply chain resilience building and food fraud (Kache & Seuring, 2017; Linstone & Turoff, 1975; Randal & Mello, 2012; Rowe, Wright & Bolger, 1992; Stuart et al., 2002).

Additionally, at the time of initiating this research, there was scant academic support for elements relating to social capital, human factors and business unit internal resilience building with relation to food supply chains. Although this is an emerging theme within the academic literature on traditional supply chain risk management, there was limited evidence of this with practitioner need or understanding through a food supply chain lens. This further supports the argument that research studies such as this one are needed to counter the abundance of theoretical and quantitative approaches (Randal & Mello, 2012; Stuart et al., 2002). These gaps not only gave an underpinning direction to this research study, but they further enabled research outputs to be produced for use in academic research in the area of supply chain food fraud (Fassam & Dani, 2017). When concluding this thesis the author notes the studies above have been cited a number of times in peer reviewed works.

Lastly, the scope of this research thesis was not to debate the blockers and challenges associated with building resilience, but rather to foster research around the constructs of resilience building. The concepts and challenges gleaned from the research, while interesting and incredibly relevant to the subject area around issues associated with food supply chain resilience building and fraud, are highlighted as areas for further research in Section 6.4. As such, the research delivers a contribution to practice that counters the abundance of theoretical and quantitative approaches, and delivers a set of metrics against a management theory [Grounded] that permits greater collective understanding from academics and practitioners on areas that address resilience building with clear areas for further research (Eddine, M., Saikouk, T. and Berrado, A., 2019; Randal & Mello, 2012; Stuart et al., 2002).

1.7 Research methodology outline

With a specific focus on the field of Supply chain management research, social science has always had a broad set of theories associated with the sector which brings about greater understanding of the subject area through varying means of social research data gathering, thus researchers in the field of supply chain risk management find it hard to define singular theories to support studies (Defee et al., 2010; Lambert & Garcia-Dastague, 2006; Mentzer et al., 2001). Much of this lack of cohesion in supply chain management theory is in part due to the complex nature of supply chains, with the multi-actor approach and intertwined human elements across large and extended globalised chains (Mentzer et al., 2001). In addition, methodologies within supply chain management research have been discussed for a number of years (Davis & Flint, 2012; Golicic & Davis, 2012; Sarmiento, Whelan & Sprenger, 2018).

However, despite this geographical divide in addition to differing opinions over methodologies and reported over-dependence on quantitative modelling and differing academic opinion, there remains the need for research studies that close the 'academic and practitioner' gap and deliver greater understanding of tangible research outcomes (Carter, 2008; Sarmiento, Whelan & Sprenger, 2018).

Therefore, this research methodology set out to utilise a multi-methods approach to mitigate against development of singular theories. In light of this, a three-stage methodology was designed to engage industry experts to bridge the divide in existent knowledge [academic-practitioner] to answer the research question *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*.

1.7.1 Literature review and expert focus group

The first step in the methodological process was reviewing existent research in the areas of food supply chain resilience and food fraud. This was undertaken in order to set the scene and give direction to the overall research design process as well as to offer outputs of 'gaps' and 'enablers' in relation to food supply chain resilience and food fraud. A systematic literature review delivered a set of 'gaps' with existent food supply chain food fraud literature, with a wider literature review of food supply chain resilience proffering a set of 'enablers'. An expert focus group of supply chain experts confirmed the gaps and enablers identified in the first phase of the research, a methodological process seen as reliable in order to validate findings (Ogden et al., 2005; Sackman, 1974). While giving empirical context to an unknown area of supply chain research [resilience & fraud], outputs gave rise to a need to deploy a methodology that can lead to more research understanding whilst meeting the needs of the objectives 1 and 2 with this research.

1.7.2 Modified Delphi

With much of the existent food supply chain resilience literature identified in the aforementioned quantitative works, there is a need for greater understanding of social science elements and management research related to the human decision aspects of food supply chain resilience building (Randal & Mello, 2012; Stuart et al., 2002).

However, in attempting to review research approaches in the supply chain field, there is an identified lack of post-positivist approaches which this study aspired to address (Boyer & Swink, 2008; Burgess, Singh, & Koroglu, 2006; DeHoratius & Rabinovich, 2011). In support of this post-positivist deficit, the research approach identified an over-reliance on mathematical modelling linked to the over use of survey methods in relation to supply chain management review, which meant the majority of existent research is wedded to a positivist (objective-quantitative) research approach (Burgess, Singh, & Koroglu 2006; Carter, 2008).

Therefore, a Modified Delphi was chosen as it enables researchers opportunities to elicit opinions around a subject area where minimal data is available, such as with food supply chain fraud, as outlined by the systematic literature review (Kache & Seuring, 2017; Linstoner &

Turoff, 1975; Rowe, Wright & Bolger, 1992). This process engaged with food supply chain professionals (discussed in more detail in Chapter 3) and continued the theme of experts being key to delivering robust research outcomes. This process enabled a set of outputs to permit understanding of capabilities required to build resilience against food fraud in a supply chain, along with the internal actors for managing this. Furthermore, the Modified Delphi enabled the creation of metrics to bring understanding of objective 3 of this research study.

The first process [Pre-phase] posed the question 'What are the internal constructs to building resilience against food fraud in supply chains?' to the twenty participants and in particular, aimed to establish from their extensive professional experience what are the 'top 10 challenges associated with building food supply chain resilience against food fraud'. Utilising this expert panel in this manner enables differing views to be collated, fostering high quality responses that can be aggregated into reliable research outputs (Gupta & Clarke, 1996), which during the first phase [Pre-Phase] elicited a total of 200 answers. On return of data, the researcher then spent a significant period of time reviewing the 200 initial responses, initially removing duplication and aggregating into groups using qualitative cluster analysis (Revelle, 1979), which reduced the amount to 46.

The next step [Phase I], the second round of the process, involved sending out the 46 aggregated topics to the 20 Modified Delphi participants, where each was scored against a LIKERT scale 1-5 (1 strongly disagree – 5 strongly agree), assessing the degree of fit with supply chain resilience and food criminality. The Modified Delphi results were returned and analysed by the research team and ranked in order of highest LIKERT score attained.

$$CV = \sigma / \mu$$

Across the three rounds, a mean value (x) was calculated for each thematic area to permit a mean value to be achieved for each question, with the final round checked against a coefficient of variation to review whether responses would change with further rounds (Dajani, 1979; English & Kernan, 1976). The coefficient of variation was chosen over other statistical methods associated with Delphi research such as Pearseon (r) or F-Test (F) due to the coefficient of variation displaying lower skewness of results (Shah & Kalaian, 2009).

1.7.3 Semi-structured case study interviews

Following on from the previous two stages of research data collation the study adopted a semi-structured interview process with procurement professionals. The outputs of the Modified Delphi identified procurement as being closely connected with building resilience in the top 10 round 3 Modified Delphi outputs. Therefore, a sector specific [procurement] approach through adopting a 'selective' case study was needed in order to review in more detail, and to create a robust research validation process (Dubois & Araujo, 2007; Hakim, 1987). The case studies were chosen as they had an existing transactional relationship, as food processor, food logistics, food retailer and food consulting. The cases chosen for this research had 5 participants per organisation, which addresses concerns of Creswell (2009) and Eisenhardt (1989), who stated that cases of over 10 per case study deliver an over saturation and cause challenges for over reliability of results. However, across the wider participant group a total of 20 participants were gained, which addresses sample sizing with similar triangulated studies (Masood, Dani, Burns & Backhouse, 2006; Mason, 2010; Munhall, 2012). Therefore, this study into the challenges associated with food supply chain resilience adopted a process of engaging with 5 participants from each case study selection across the businesses within the European food sector, all of which are active in the global food supply chain, with hypothetical saturation of results achieved with this sample size and discussed in more detail in Chapter 3 (Eisenhardt & Gtaebner, 2007).

Furthermore, 80% of PhD research studies have been found to contain 15 participants for qualitative research study purposes (Mason, 2010). Therefore, it is argued that saturation can be achieved with relatively small sample sizes (Mason, 2010). To further validate the research approach sample sizing, it is recommended to have a maximum of 10 participants per case study to deliver appropriate and robust results (Creswell, 2009). Thus, this study into the challenges associated with food supply chain resilience adopted a process of engaging with 5 participants from each case study selection across the businesses within the UK and Irish food sector. All participants were active in the global food supply chain, with hypothetical saturation of results achieved with this sample size (Eisenhardt & Gtaebner, 2007). Therefore, by having 20 participants across all case studies this research met the needs of sample size recommendations with PhD research (Mason, 2010), while addressing saturation and sample size challenges at individual case study level with 5 participants each (Creswell, 2009; Mason, 2010).

1.7.4 Triangulation

Triangulation was adopted making the study able to gain a more detailed appraisal of conclusions and credibility around the research question (Maxwell, 1996). In taking a 'critical realism' abductive grounded theory approach, following the qualitative multi-methods approach [triangulation], connection and validation of outputs could be achieved (Bloor et al., 2015). This abductive approach mitigates against the recognised drawbacks associated with mixed methods approaches, positing itself well with deductive and inductive approaches (Johnson & Onwuegbuzie, 2004; Morse, 2005; O'Cathain, 2010; Parry-Langdon et al., 2003). Furthermore, by utilising as part of the study process a Modified Delphi study with mixed methods, 'member validation' with research outputs was achieved, further mitigating against drawbacks of triangulated mixed methods (Denzin, 1970; Emerson & Pollner, 1988; Tashakkori &Teddie, 2003). In addition, Modified Delphi methods have proven to be an efficient survey method when only a limited amount of data on a topic is available (Linston & Turoff, 1975; Rowe, Wright & Bolger, 1992). They were chosen for this study due to the limited academic research available in the arena of food supply chain food fraud and food supply chain food crime and so that a practitioner approach to research validation could be taken (Fassam & Dani, 2016; Kache & Seuring, 2017).

1.7.5 Reliability

Lastly, research reliability is reinforced by eliciting the opinions of experts, allowing each expert to review the opinions of other participants with an assurance of anonymity which avoids issues of bias or coercion that may be presented during focus group or discussion scenarios (Sackman, 1974). This was achieved through developed concepts and theories (Gummesson, 2000) from the Modified Delphi outputs with case study research. A sector specific procurement approach adopting a 'selective' case study was employed in order to review the research thesis desires of resilience building with food fraud, a method supported as a robust research validation process (Dubois & Araujo, 2007; Hakim, 1987).

Despite this study having noted three research limitations, it is the belief of the author that outputs pertaining to methodical processes are well grounded in academic theory, aligned with a robust set of governed flows and suitable for delivering the necessary credibility and

reliability for a PhD study. Furthermore, in building upon the much-required reliability, the research ethics were deployed in full alignment with the host institution, backed up by noted academic authors in the area.

1.7.6 Research methodology conclusion

This research study had identified a lack of research literature in academic and practitioner repositories (Chapter 2), and given the complex and social nature of supply chain management, the research required a process that would begin to review the aforementioned research gaps whilst understanding the existent research methods in Supply chain management (Defee et al., 2010; Lambert & Garcia-Dastague, 2006; Mentzer et al, 2001). Therefore, the research process engaged with industry experts to minimise the divide [academic-practitioner] in understanding the research question [*'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*] and contribute to academic knowledge, a method well recognised for deriving applicable theory (Alvesson & Kärreman, 2007; Colquitt & Zapata-Phelan, 2007; Van Maanen, Sorensen, & Mitchell, 2007). During a review of the research processes an identified lack of post-positivist approaches was noted (Boyer & Swink, 2008; Burgess, Singh, & Koroglu, 2006; DeHoratius & Rabinovich, 2011), with an over-reliance on mathematical modelling and overuse of survey methods portraying supply chain management research as wedded to a positivist (objective-quantitative) research approach (Burgess et al, 2006; Carter, 2008).

Therefore, this study sets out to address the suggestion by scholars that there needed to be greater use of case study approaches within supply chain management research studies (Kahkonen, 2011; Seuring, 2009), by occupying the space between positivism and constructivism, which is ontologically positioned to the thinking of 'critical realism', a philosophical approach which sits as the interface between the natural and social worlds i.e. the ability to bridge the divide that exists with positivism (objective) and constructivism (subjective) (Bhaskar, 2014; Danemark et al., 2002; Losch, 2017). Having reviewed deductive versus inductive, the research took a blended approach of deductive-inductive study (Saunders et al., 2009; Saunders et al., 2012), systematically reviewing literature in the fields of supply chain food crime and supply chain food fraud to highlight existent gaps and give direction regarding research questions and data methods. Subsequently, the research followed an inductive approach deploying a Delphi study, semi-structured interviews and case study

examination to reach concensous on the research question of: *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*.

Furthermore, by utilising as part of the study process a Delphi process, 'member validation' with research outputs was achieved, further mitigating against the drawbacks of triangulated mixed methods (Denzin, 1970; Emerson & Pollner, 1988; Tashakkori and Teddie, 2003). Furthermore, Delphi methods have proven to be an efficient survey method when only a limited amount of data on a topic is available (Linston & Turoff, 1975; Riggs, 1983; Rowe, Wright & Bolger, 1992). It was therefore chosen for this study due to limited academic research available in the arena of food supply chain food fraud and food supply chain food crime and in order to take a practitioner approach to research validation (Fassam & Dani, 2016; Kache & Seuring, 2017). Furthermore, Triangulation methods were adopted to permit a more detailed appraisal of conclusions and credibility around the research question (Maxwell, 1996). As such, taking a 'critical realism' abductive grounded theory approach, validation of outputs could be achieved while mitigating against recognised drawbacks associated with mixed methods approaches (Bloor et al., 2015; Johnson & Onwuegbuzie, 2004; Morse, 2005; O'Cathain, 2010; Parry-Langdon et al., 2003).

Lastly, research reliability is reinforced by eliciting the opinions of the experts, allowing each expert to review the opinions of other participants with an assurance of anonymity, which avoids issues of bias or coercion that may be presented during focus group or discussion scenarios (Ogden et al., 2005; Sackman, 1974). This was achieved through developing concepts and theories (Gummesson, 2000) from the Delphi outputs with case study research. Therefore, a sector specific [procurement] approach adopting a 'selective' case study was employed in order to review in more detail, and detailed as a robust research validation process (Dubois & Araujo, 2007; Hakim, 1987).

1.8 Research thesis overview

Chapter 1 – introduces the topic area with a short synopsis of the literature outlining the problem statement and potential gaps. It furthermore summarises the aims, objectives and research questions, along with a short review of the methodological approach employed.

Chapter 2 – this chapter presents the literature review, which looks at traditional supply chain risk management and the auspices of current research within the food supply chain resilience sphere. It then moves to look specifically at fraud in a supply chain context, and review specific sectors to give an understanding of the issue this research hopes to understand. Lastly, the research process undertook a systematic literature review with a specific focus of understanding the existing literature in the topic area of food supply chain fraud, comparing and contrasting this against the UK Government paper into resilience building [food fraud] to identify gaps.

Chapter 3 – reviews the differing methods, philosophical approaches in delivering research. It outlines the three key stages of the research process, namely the systematic literature review, Modified Delphi study and semi-structured case study. It concludes with reviewing ethical issues and any challenges related to repeatability.

Chapter 4 – this chapter presents and discusses the aforementioned research outputs in a serial manner, correlating where needed against existent knowledge, which concludes with an overview coded against existent resilience measures to give a theoretical model for discussion

Chapter 5 – this chapter discusses the empirical aspects of the research, comparing against the literature identified in the area of food supply chain resilience, proffering a correlation across the Modified Delphi expert constructs of resilience building against fraud and the views of procurement professionals on achieving supply chain resilience.

Chapter 6 – looks towards the novel contribution this research has made in relation to food supply chain fraud, some practical implications for the research, along with recommendations for future research and any gaps or challenges this research may have encountered.

2 Chapter 2 - Literature review

2.1 Literature review introduction

The literature review for this research reviews the key concepts and approaches associated with supply chain management and their relation to food supply chain management, aligned with the research aim of reviewing *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'.* The study is particularly interested in the areas of risk and resilience in a traditional supply chain context and in reviewing the current body of knowledge associated with food supply chain resilience.

The key themes in this literature review pertain to food supply chain risk, food supply chain resilience and fraudulent behaviours within the food supply chain. This literature review begins with an appraisal of the supply chain, examination of the existent supply chain risk and resilience literature, and then assesses the current academic knowledge pertaining to food supply resilience.

2.2 Supply chain management

The supply chain has moved from a collection of organisations who just managed a product through a series of logistics nodes or manufacturing processes to a systematic grouping of flows which come together to manage the global management of product streams that create significant organisational competitive value, all whilst being agile to consumer demands, flexible to stakeholders' needs and cost efficient (Laosirihongthong & Dangayach, 2005; Sweeney et al. 2018). This competitive advantage is one of the most popular perceptions of the supply chain, with Goh and Pinaikul (1998) citing the need for it [competitive advantage] to drive strategies that enhance customer satisfaction. Since conducting this research, some may argue these views are out of date (Goh & Pinaikul, 1998) being some 22 years of age, but they remain central and true to the supply chain strategies today, and are therefore relevant for consideration.

Not only is supply chain management a tool for satisfying the customer (both internal and external), it is a multi-faceted cross functional business management function that delivers economic advantage for all stakeholders in the chain whilst meeting customer needs (Gunasekaran et al., 2004; Sweeney et al. 2018; Waller, 2003). Much of the composition relating to these espoused benefits according to Waller (2003) have been grounded in

manufacturing operations and lack a wider sectoral view. Therefore, the researcher purports a need to review the auspices of traditional supply chain management through the lens of food supply chain management.

The traditional supply chain comprises a number of tiered suppliers that move products through a series of different nodes, from raw material to finished product, in an effective and efficient manner that permits the correct amount of products to be in the right place, at the right time for a minimal cost (Mentzer et al., 2001; Saad et al., 2002). In order to ensure the achievement of effective supply chain execution, performance measures or key performance indicators (KPI) are utilised. However, given the globally dispersed nature of supply chains, differing cultures and perceptions, working practices, and even management styles come in to play which means having one set of coherent measurements across a multi-actor supply chain is at times difficult (Gunaekaran et al., 2004; Hervani & Helms, 2005; Pavlov et al., 2019). In creating the aforementioned differentiation, performance measurement is critical to overall organisational and supply chain success (Bhagwat & Sharma, 2007), however, much of this is unachievable due to a lack of connected data infrastructure (Kache & Seuring, 2017), a critical metric needed in today's modern supply chain operation.

In addition to differentiation, measurement and data, the supply chain needs collaboration across the differing tiers, an aspect the researcher upholds as the most critical aspect of supply chain management. In order to have collaboration, there must be an alignment of process measurements, which often fail to manifest themselves due to fragmented processes and cultures (Angerhofer & Angelides, 2006; Kache & Seuring, 2017; Sweeney et al., 2018). However, whilst these areas have been well researched in the areas of supply chain management, there is very little attention paid to how they [differentiation, measurement, data and collaboration] come together to proffer business tools for effective supply chain management (Chan and Qi, 2003; Lin et al., 2010; O'Conner et al., 2018;).

Yet, when we review the modern day supply chain, despite the basic underpinning measures still being relevant (competitive advantage and differentiation), much has changed since the early days, particularly in relation to the global marketplace that we now have, which has created both opportunities and threats for the trading lanes (Chopra & Meindl, 2013; Pavlov et al., 2019). The operations within the globalised supply chains are no longer managed in a silo manner and they need to interact as part of a collaborative process driven approach. Much of

this collaboration and change of business operation has happened at pace, with the first industrial revolution of the 1800's through to the present day fourth industrial revolution. During its evolution of just over two hundred years this aggressive change in management has expanded and become more complex, with the latter portion we now find ourselves in fraught with different skill sets requiring management of complex datasets in order to pull together varying product streams (Chen, 2017).

Due to globalisation, the present day supply chain is incredibly complex, with products being constructed with materials from potentially thousands of suppliers, from hundreds of countries all completed under the right place, right time and right quantity premise, and comprising the three key flows of 'cash, information and logistics' (Cragg & McNamara, 2018; Juttner, 2005; Trappey et al., 2016). It is these three flows that need to be managed in a synchronous manner, as any lack of alignment causes risks within the supply chain that will negate delivery of the service proposition and stifle customer satisfaction.

In pulling this all together, and managing the complexity, in line with the three key aspects of supply chain management (cash, information, logistics), the wider chain needs to work to gain competitive advantage (Bourlakis & Weightman, 2004; Hung, 2011). However, with the complexity of the supply chain comes risk, particularly in terms of the tiers that operate within the extended operations. Often, supply chains are not comprised of single supplier relationships, meaning organisations are forced to build relationships with their competition's suppliers, which in itself gives rise to risks of anti-competitive behaviours. However, Kwak et al. (2018) cite the ability for supply chain actors to have an influence on all dimensions of risk when working together, regardless of their position. This therefore suggests that positive competitive advantage can be achieved while managing risks across the collaborative supply chain.

Nevertheless, it is argued that supply chains are exposed to disturbance or shock when they become too efficient or lean, leaving them open to risk of anti-competitive behaviours (Dhingra et al., 2014; Christopher et al., 2011). This over efficient and overly lean risk to supply chains is caused due to lack of leadership and management understanding of the risks posed to their wider holistic supply chain operations (Huang et al., 2020; Roh et al., 2014). However, Chen (2019) argues that these risks and vulnerabilities can be mitigated against by embracing better IT integration across wider supply chain stakeholders. This, therefore, enables the supply chain

to operate in a more agile manner, while being able to be cognisant of risks and giving that much needed visibility to leadership and management teams.

In summary, there has been much development in relation to the supply chain, with its roots firmly cemented in history. Many of the step changes have happened over the preceding 200 years across the varying industrial revolutions, with swifter change gathering pace in its latter stages and in the present day. There are, as the literature purports, many challenges to the supply chain, but overriding agreement is reached that collaboration and use of data can create competitive advantage by breeding agility and mitigating risk.

2.3 Traditional supply chain risk management

The purpose of traditional supply chain risk management is to understand and mitigate against risks that may occur. Key to the better use of risk management is understanding that not all risks can be avoided, but moreover how we build in processes for when and if they occur (Wiengarten et al., 2016; Yang & Fan, 2016). Furthermore, the network of differing suppliers is more effective when this review and process management of risk is undertaken in a co-ordinated manner (Vedel & Ellegaard, 2013; Wiengarten et al., 2016). However, the literature does not detail whether this should be at department level across all organisations, or if one organisation should take the lead under direction of a particular business unit. Therefore, the researcher believes a disconnect exists with the existent supply chain management risk literature, and this is an area the current study will review in the context of food supply chains.

In addition, many supply chain risks that lead to supply shocks can have a longer term effect on brand and/ or operational performance, therefore it is crucial to embrace this risk management as an embedded process in our organisations (Christopher & Lee, 2004; Ho et al., 2015; Tang & Tomlin, 2008). To this end, there is now an emergence of research that supports the building of supply chain risk management processes when they are constructed (Nooraie & Mellat Parast, 2015; Pearson et al., 2014). However, there is little understanding about the inclusion of supply chain actors once the process has been designed. This is supported by Ritchie & Brindley (2000), who support the belief that organisations need to be agile when implementing risk management, as many SMEs are struggling to achieve this in larger more extended supply chain networks. This is an incredibly important consideration for this research, as 92% of European food businesses are classified as SMEs, which therefore questions the ability for traditional supply chain risk model translation in a food context.

The significance of greater holistic supply chain focus associated with risk and resilience is supported by the European Commission and OECD (European Commission, 2014), who explain that traditional supply chain risk is measured against key themes such as criminality, disease (epidemic), natural disasters, technological (cyber crime) and terrorist events. These fundamental thematic areas are determinants of aggregate event-driven episodes, which cultivate ambiguity in the wider supply chain understanding of risk management. Allianz (2014) undertook to understand the constructs of supply chain risk, and attempted to categorise supply chain events that comprise episodes of business risk. However, although these risks highlight a top-level appreciation of the differing business risk, there is no correlation with sector type, node or global location permitting a better understanding of holistic value chain risk management.

In reviewing the holistic supply chain risks of criminality, there is a globally accepted rise in fraudulent activity within the business domain. In total, 70% of globally positioned businesses have encountered some form of criminality within their supply chain, with 67% of these events involving an insider from within the organisation. This rise of criminality in a supply chain context can be identified within Europe, with 56% of businesses in 2012 reporting some form of fraudulent activity compared to 77% in 2013 (Kroll, 2014). We could surmise that perhaps this rise of fraudulent activity is attributed to better reporting, however, the World Economic Forum asserts that concerns remain over a lack of focus pertaining to resilience in a supply chain context against a continual increase in fraudulent behaviour (Bowman, 2014; McCarthy, 2014; World Economic Forum, 2013). Furthermore, studies have been undertaken to review resilience in a business context, with FM Global (2016) citing three fundamental focus areas required to improve overall business resilience, namely economic, quality and supply chain. Within these three thematic areas greater focus is required on corruption, infrastructure and suppliers to build greater business resilience.

When considering dynamics relating to uncertain market and business environments, the importance of achieving competitive advantage in a global trade marketplace that has complex relationships amongst supply chain network actors (i.e. suppliers, producers, logistics providers, service providers, customers, etc.) is important to achieve. However, as discussed previously, supply chains are more susceptible to a myriad of different types of risks, both man-made and non-man-made. Thus, academics such as Manuj and Mentzer (2008) argue that

risk management methods incorporate three essential phases: i. identifying risk, ii. risk evaluation, and iii. mitigating risk. However, this research and its author asserts this approach is not necessarily applicable to all supply chains, which is what this section of the literature review will explore in more detail, and specifically in relation to the food sector and fraudulent behaviours.

The empirical examination of supply chain risk management is broadly defined in academic research (Lockamy, 2011; Punniyamoorthy et al., 2013; Svensson, 2000; Zsidisin et al., 2004). In being able to address better risk perception in the field of supply chain, Rao and Goldsby (2009) provide a systemic classification of risks, which Tummala and Schoenherr (2011) developed into a broad method to govern potential risks in a supply chain by adopting risk management procedures. According to these management approaches, risk identification is considered as the first stage in risk analysis processes, followed by risk assessment, and risk monitoring stages (Rao & Goldsby, 2009; Tummala & Schoenherr, 2011). The process of risk assessment is identifying the most appropriate mitigation and proactive strategy based on identified risks, along with their impacts on the supply chain and measurement techniques hinge on the architectural assessment "impact area" of various risks (Chopra & Sodhi, 2004). Therefore, supply chain risk management (SCRM) encompasses the processes of risk recognition, risk measurement, risk handling, risk analysis, risk monitoring across the risk management principle (Jüttner et al., 2003; Neiger et al., 2009; Norrman & Jansson, 2004). However, despite the research and published articles post-2006 has shown a growing focus on supply chain risks and vulnerability while the academic concentration on risks specifically related to the food supply chain field has been limited.

2.4 Existent food supply chain management theories

Supply chain management research has undertaken a number of studies in the area of management research. One such area aligned to the approaches of this research thesis is the resource-based view (RBV), a strategy upheld by scholars as permitting maximum organisational value being extracted from a businesses own resource pool (Carter, Kosmol and Kaufmann, 2017; Hunt & Davis, 2012). Whilst this approach [RBV] is grounded in research as being able to leverage information flows to build greater competitive advantage (Arya & Lin, 2007; Popli, Ladkani & Gaur, 2017; Zaridis, A., Vlachos, I., & Bourlakis, M, 2020), there is scant academic evidence that RBV can leveraged to build resilience, specifically in a food supply chain context, with the majority of the academic literature

focussing on the cost and profit aspects of value generation, rather than that of hidden more social capital aspects. However, there are elements of scholarly work that supports RBV as being able to increase brand value and reputation, which could arguably be linked to mitigating issues in the food supply chain such as fraudulent behaviours (Lii & Kuo, 2016). However, this element is misunderstood, with this research having the potential to link this research gap with practitioner view.

In addition to RBV, network theory, and stakeholder theory has been upheld as a way to connect activities of different supply chain actors to build greater outcomes and controls around behaviours (Handfield & Nichols, 2002; Thorelli, 1986). Alike the benefits espoused with resource-based view, the network theory and stakeholder theory permits integration of stakeholder information flows, but is more relevant to resilience building as it looks to internal and external views of the stakeholder (Sarkis et al, 2010). While scholars have utilised network and stakeholder theory as a way to build greater stakeholder connectivity within food supply chains (Manders et al,2016), there is little evidence of it being utilised to build a resilience culture.

That said, there have been some scholars who have deployed management theories to build resilience in food supply chain. Oglethorpe & Hero (2013) utilised Theory of constraints (TOC) to review UK local food supply chains. Whilst their work identified how restraints within the system were holding back locally connected food chains, it was focused on the shorter food supply chain. In addition, while TOC was deployed to review the food supply chain, there was no explicit connectivity to resilience and food fraud, with the majority of the research being connected to the traditional aspects of management theory and cost based relationships.

Therefore, while there is a clear connection between building greater information flow with resource-based view, network theory, stakeholder theory and theory of constraints, with all four contributing value based benefits to a supply chain. There is scant evidence of these management views being used in building food supply chain resilience, thus supporting the purported research gaps of this thesis with more works required in understanding the underpinning aspects of building greater food supply chain resilience.

2.5 Food chains: an introduction

While there has been significant attention paid to traditional supply chain risk management in conventional management circles, there is a lack of attention paid specifically to the food industry (Diabat et al., 2012; Fassam & Dani, 2017). The research author purports this as a gap that needs addressing as there is a 'perfect storm' of food security on the horizon, with current predictions that demand may outstrip supply by 2030 (Elliot, 2014; House of Commons, 2013). In addition, food authenticity and safety are completely different legislative processes and considerations than that of standard supply product flows. Therefore, in order to mitigate risk and build resilience in a food context, the leadership and management teams associated with food supply chains need to review processes and risk management as a holistic process (Diabat et al., 2012; Elliott, 2014; Spink & Moyer, 2011). In order to build this much needed resilience into food supply chains, operators need to be flexible to market needs, while being resilient to disasters such as man-made and non-man-made disaster (e.g. flood, earthquakes, fraud, market changes) (Folke, 2006; Manning & Soon, 2016). However, food supply chain leaders do not need to discount prior research into traditional supply chain management risk and resilience building. It is here that this research aims to bridge the gap, and the remainder of this chapter will review the literature around food supply risk, food supply chain fraud and food supply chain procurement, drawing together a comparison for review in the latter stages of this research.

2.6 Food supply chain resilience

There are significant risks that affect the food supply chain, and in the main these do not differ from those within traditional supply chain risk management spheres. However, there are a number of food specific risks that will be discussed later in this chapter, and which need to be understood by supply chain strategists in order to build resilience into food chains (Manning & Soon, 2016). Nonetheless, despite many of the risks emanating from outside the organisation, there is a significant portion of risks that are internal to an organisation, which cause significant disruptive events for food organisations and can cause business level fragility (Christopher & Peck, 2004; Viswanadham & Kameshwaran, 2013; Waters, 2007). Polyviou et al. (2019) support the view that resilience within food supply chains can be achieved through greater use of social capital. This means that by having a more bottom-up strategic approach enabling all employees to work closer together, coupled with smaller geographic distances between actors and fewer hierarchies, the food business will build innate resilience and be agile to risks when they occur. This view supports the research author's earlier view that while

traditional supply chain risk management is relevant, reviewing through a food lens is required in order to appreciate the nuances that exist in sector specific areas when building resilience.

In addition, Keessen et al. (2013) question the focus of socio-ecological approaches to building food supply chain resilience, and whether there should be a more holistic approach. This would therefore intimate that the view of Polyviou et al. (2019) of internal social capital has to be embedded into each organisation if they are to work together in a resilient manner across the complete food chain. However, Edgeman and Wu (2016) suggest there is a need for the food supply chain to embrace sustainable enterprise excellence, resilience and robustness (SEER2). This [SEER2] embraces the areas of governance, data, intelligence sharing, supply chain management and socio-ecological resilience building in a food supply chain. They (Edgeman & Wu, 2016) go on to explain how SEER2 can act tactically and work strategically across the wider supply chain, taking into account the competing and complementary interests of varying stakeholders. Therefore, this research author supports the need for more understanding to be placed around the use of social capital and SEER2 in a food supply chain context to compliment traditional supply chain resilience measures.

In order to understand how social-capital and SEER2 could dovetail with existent food supply chain resilience building, it is important to review the three concepts of food chain resilience (Folke, 2006). These, Folke (2006) notes, are the three fundamental concepts of resilience: engineering resilience (building by design resilience measures), ecological resilience (ability to recover quickly and resist damage) and socio-ecological resilience (absorb disruption without need for change). All of these differing resilience measures are relevant to the study of food chain resilience, and are areas Manning et al. (2006) and Manning (2015) purport as organisational aspirations whether they be quantitative (financial) or qualitative (ecological). In pulling together the existent research into strategic resilience building in food chains, Manning and Soon (2016) provide a model of resilience measures. This model 'Triple-R' comprises 'Ready', 'Respond' and 'Recovery' areas for business units to build into their strategic operational plans. When this is viewed in relation to the aforementioned works of Folke (2006), a clear correlation of management focus and resilience builder can be obtained. However, while this study aspires to be an 'enabler' of resilience it lacks context around the internal business unit for achieving the same. Therefore, aspects of this representation of food supply chain resilience and management factors will be utilised later in this research through chapters 4 and 5 to build on the existent 'enablers' with food supply chain resilience research.

2.7 Food supply chain risk

Most research studies in the arena of risk related to food supply chains have focused on a singular or two issue approach such as but not limited to environmental concerns, without considering wider connectivity ramifications of the food supply chain (e.g. Manning & Baines, 2007; Vasileiou & Morris, 2006) or food safety issues (e.g. Roth et al., 2008). Therefore, historic food supply chain risk and resilience management is not truly looking to cause-effect relationships in dealing with each issue as a succinct and silo event.

Directly related to food supply chains, Peck (2006) investigates the potential capability of using diversified retailers, and manufacturing organisations within food supply chains. Her results show that in the main, retailers are interested in transferring and sharing possible risks upstream in the chain, giving authority and responsibility to their suppliers for managing entire disruptions. The significance of Peck's (2006) report is the essential requirement for adopting appropriate risk management across the food supply chain network. This research also explains that actors in the food supply chain tend to concentrate on internal risk elements rather than the comprehensive approach to considering both internal and external factors in the environment. Furthermore, this research, whilst identifying the need to review risk across a wider set of supply chain actors, is not deemed by the author as collaborative, an area as previously mentioned, which is needed within supply chain management.

Given the food supply chain's specific characteristics and the perishable nature of its commodities across extended and geographically dispersed networks, food chains are often more complex than other supply chains such as automotive manufacturing (Mithun ali & Nakade, 2014; Singh et al., 2018). However, there is a number of research studies identifying new risk sources within food supply chain research, but specific identification of the risk category or detail along with their effects on performance of food networks is significantly limited (Fearne et al., 2001; Fritz & Schiefer, 2009; Jaffee et al., 2010; Jüttner, 2005; Nakandala et al., 2017; Ruben et al., 2007; Srivastava et al., 2015; Van der Vorst, 2000; Yeboah et al., 2014). Also, food supply chains have encountered continual threats from numerous internal and external elements such as price vulnerability, climate volatility, food losses, nutrition security, and regulation and governance issues (Fredriksson & Liljestrand, 2015; Gokarn & Kuthambalayan, 2017). However, it is worth noting the most cited and adopted supply chain risk classification across differing academic research studies relates to Tang (2006). Tang

(2006) analysed more than 200 quantitative articles between 1964 and 2005, and classified supply chain risk into two major risk types including disruption and operational risks. The disruption risks recorded are affected by man-made and non-man-made natural failure (i.e. terrorist violations, hurricanes, earthquakes, storm, economic disaster (Diabat et al., 2012; Nakandala et al., 2017). Operational risks emerge during the business procedure execution or different supply chain practices (Xiaoping, 2016). Taking this a step further, Heckmann et al. (2015) debate that operational risks in food supply chains include supply failure, demand fluctuation and uncertainty, price variance in the market, and increasing cost due to machine/ equipment failure or management failure. Therefore, there still remains a disconnect between the identification of specific risks, the complication of the food supply chain networks and research to assist stakeholders in mitigating risk and building resilience.

When it comes to risk classification and typology within the supply chain, authors such as Christopher and Peck (2004), Mentzer (2008), and Olson and Dash (2010) claim that for simplification of categorising supply chain risks, they should be classified into three main groups including internal to firm, external to the firm but internal to the supply chain network, and external to the network, which are further broken down into five sub-categories: internal process, internal control, demand and supply in supply chain network, and environmental risks. These areas define processes as sequences of value-adding activities adopted by the various firms and the internal process risks that can disrupt these processes at firm level. They collectively argue that significant internal control risks arise from misapplication of policies, rules, and procedures for controlling processes in the firms. In terms of supply chain demand risks, they argue that it is related to potential disruptions that have negative effects on the downstream flows in supply chains such as materials, cash, and information. In addition, Goh et al. (2007) agree that most risks are categorised based on their sources which are simply supply networks and external environment, with no mention of the internal environment. However, many recent studies represent an increasing occurrence of supply chain risk concertation due to disruptive occurrences from human-made (man-made) and natural origin (non-man-made) (Ali et al., 2018; Govindan, 2018).

Therefore, in order to appreciate the current academic body of knowledge of risk associated with the food supply chain a review was undertaken across the literature of emergent risks in the agri-food supply chain (Table 1). Within this exploration of food supply chain risk there was an abundance of literature supporting sources of risk such as weather-related risk, natural

disaster risks, biological and environmental-related risks, market-related risks, logistical and infrastructure risks, political, public policy and institutional risks, and management and operational risks (Table 1) (Fitzgerald, 2005; Jaffee et al., 2010; Meuwissen et al., 2001; Yeboah et al., 2014). However, within the agri-food supply literature there was very little research to support internal actors as a risk, which is a divergence from traditional supply chain risk management, and an area for review within this research project.

Risk Typology	Description
Weather-related risk	Result of hail and wind catastrophe as well as immense humidity or extreme rain that can increase the possibility of pests and diseases.
Natural disaster risks	Extensive typhoons, droughts, cyclones, hurricanes, earthquakes, floods, and volcanic activity.
Biological and environmental related risks	The biological risk can be from various sources such as bacteria, plants, insects, viruses, birds, animals, and humans. Some of these risks frequently have negative impacts on the quantity of production and postharvest, but some of these may have an effect on the quality of products as well. Environmental-related risks are caused by environmental degradation such as soil erosion or factory pesticides or sewerage flow into water sources.
Market-related risks	Mainly, market risks are caused by reasons such as demand fluctuation, price change, change in quality standards, short in supply and access to various desirable products and services.
Logistical and infrastructure risks	Lack of reliable and affordable transport, inappropriate communication management and information sharing, high energy consumption due to improper route planning and transportation of food selections can cause logistics and infrastructure risks.
Political risks	Political risks are related to politico-social vulnerability inside or outside of a country, trade disruptions due to contention with other neighbouring countries or traders, seizure of the assets due to disputes or regulation changes by foreign countries and investors.
Public policy and institutional risks	Changing monetary, uncertain financial policies (e.g., credit, savings, insurance) and tax policies; changing regulatory and legal procedures are major causes of public policy and institutional risks.
Management and operational risks	Weak system management regarding making decisions about capital and asset allocation, source selection, quality control, planning, and forecasting, using the high capacity of machines and equipment and maintaining those, and communication and leading labour and employees are the main sources of management and operational risks.

Table 1 Main typologies of risks in agri-food chains (Fassam, L., Asefeavazi, S., Dani, S., 2020)

However, when reviewing the literature relating specifically to food safety there is a body of knowledge that reviews risk across six metrics, namely internal, external, logistics, market forces, information and cooperation (Aramyan et al., 2006; Aramyan et al., 2007; Xiaoping, 2016). There is a high incidence of internal threats identified within this body of knowledge, however, much of this pertains to the scientific side of food safety, with again little attention given to the supply chain aspects of food resilience. This therefore strengthens the points made in the latter stages of this chapter 2 that there is an abundance of scientific understanding with mitigating food supply chains risks, but little in the business and management arena (Fassam & Dani, 2017).

Note: Internal: 1; External: 2; Logistics: 3; Market: 4; Information: 5; Cooperation: 6							
Risk Assessment Indexes	1	2	3	4	5	6	Citation
Supply delay or provide the inappropriate quality materials	※						Guan et al. (2011); Mithun Ali et al. (2019); Xiaoping (2016)
Insufficient inventory management	※						Diabat et al. 2012; Liu and Fan (2011); Mithun Ali et al. (2019)
Sanitising problem	※						Xiaoping (2016); Mithun Ali et al. (2019)
Unqualified human resources	※						Govindan (2017); Xiaoping (2016); Mithun Ali et al. (2019)
Inappropriate customer relationship management	※						Assefa et al. (2017); Mithun Ali et al. (2019)
Unqualified quality and unsafe products	※						Shirani and Demichela (2015); Sun (2014); Mithun Ali et al. (2019)
Inadequate capacity	※						Xiao et al. (2009); Orgut et al. (2016); Sun (2014)
Equipment and machine failures	※						Xiao et al. (2009); Shirani and Demichela (2015)
Poor leadership	※						Dani and Deep (2010); Mithun Ali et al. (2019)
Epidemic and contagious diseases		※					Assefa et al. (2017); Xiaoping (2016); Mithun Ali et al. (2019)

Change quality standards		※					Xiaoping (2016); Mithun Ali et al. (2019)
Inflationary pressures on costs		※					Xiaoping (2016); Mithun Ali et al. (2019)
Regulatory and legal changes		※					Xiao et al. (2009); Sun (2014); Mithun Ali et al. (2019)
Disruption from human-made and natural catastrophes		※					Govindan (2017); Xiaoping (2016); Mithun Ali et al. (2019)
Environmental risks		※					Dobler et al. (2014); Freise and Seuring (2015)
Food defection and spoilage in transit duration, machining processes, and sales processes			※				Xiaoping (2016); Mithun Ali et al. (2019)
Delay and interrupt logistics			※				Xiaoping (2016); Mithun Ali et al. (2019)
Demand fluctuation and vulnerabilities				※			Guan et al. (2011); Xiaoping (2016); Mithun Ali et al. (2019)
Price fluctuations				※			Xiaoping (2016); Mithun Ali et al. (2019)
Unsteady marketing channel				※			Xiaoping (2016); Mithun Ali et al. (2019)
Destructive competition				※			Xiaoping (2016); Mithun Ali et al. (2019)
Change of consumers' taste and expectations				※			Diabat et al. (2012); Mithun Ali et al. (2019)
IT failure					※		Diabat et al. (2012); Mithun Ali et al. (2019)
Bullwhip effect					※		Xiaoping (2016); Mithun Ali et al. (2019)
Supplier communication failure						※	Diabat et al. (2012); Mithun Ali et al. (2019)
Suppliers and partner selection						※	Xiaoping (2016); Mithun Ali et al. (2019)

Collaboration failures						※	Xiaoping (2016); Mithun Ali et al. (2019)

Table 2 Food typologies of safety risk (Fassam, L., Asefeavazi, S., Dani, S., 2020)

Of significant interest to academic research with regard food supply chain resilience building is performance measurement, with many scholars considering risks as major sources for compromising performance the supply chain (e.g. Aramyan et al., 2007; Yeboah et al., 2014). It is suggested that in order to provide greater insight into supply chains, as well as integration of the supply chains actors and generation of useful information for decision making, performance management is considered a powerful tool (Benson and Clay, 1998; Chan and Qi, 2003). The most significant performance measurement suggested across the research studies pertains to financial, and in particular total cost of ownership, which the authors purport affects the level of responsiveness to customer, flexibility, food safety and quality time, particularly lead time and process (Aramyan et al., 2007; Bigliardi & Bottani, 2010; Vorst, 2006). The level of risk and associated challenge posed to actors within the supply chain is detailed in Table 3 against the characteristics contained within the research. However, as with the previous food supply chain risk and resilience literature, there is no mention of internal actors with this [measurement], with many of the studies looking externally across supply chains.

Product Characteristic		
Characteristic	Definition	Authors
Perishability & shelf life	Due to the natural perishability of various food products, it is essential to protect them from spoilage across different stages such as preparation, storage, and distribution to extend shelf-life. Temperature, packaging techniques (e.g. modified atmosphere), and transportation methods are important for perishable foods. Give them the desired shelf-life.	(Dreyer et al., 2014); (Holley & Patel, 2005); (Romsdal, 2014)
Complexity	The level of complexity is varied among different food products based on their divergent structure. It can increase as a result of product differentiation, the packaging structure, and delivering options.	(Dreyer et al., 2014); (Romsdal, 2014)

PLC, NPD, innovation	Food products have short PLC and a high probability of failure for a new range of products.	(Romsdal, 2014)
Volume variability	Food products are mainly produced in high volume and generally have high uncertainty and variability in downstream flow in their supply chains.	(Romsdal, 2014)
Market Characteristic		
Characteristic	Definition	Authors
Lead time variability	In FSCs, retailers commonly order and receive high deliveries in the short response time.	(Dreyer et al., 2014); (Romsdal, 2014)
Demand uncertainty	Due to immensely promotional activities, and a strong probability of bullwhip effects, demands in FSCs are highly uncertain.	(Romsdal, 2014)
Inventory management	The availability of keeping inventory is limited in FSCs. Reputational damage is a common consequence and cost of lost sales because of stock-out in this network.	(Romsdal, 2014)
Production System Characteristics		
Characteristic	Definition	Authors
Make-to-order lead time and production	As a result of a growing variety of food products with different logistic specifications and production demand (e.g. set-up essential, high capacity) for distinguishing market segments, food supply chain firms intend to adopt more MTO production methods as a basic production method in their company. Generally, the possibility of postponement for food production is low.	(Romsdal, 2014); (Soman et al., 2004)
Plant, process and technology	FSCs mainly adopted integrated or continuous production techniques. The requirement for high capital investment to provide equipment and machines in initiating phase, low flexibility for moving machines, the low variable cost, no need for skilled labours, the high volume of products, long set up time with a high cost for set up are major characteristics of this production method in FSCs.	(Romsdal, 2014); (Soman et al., 2004)

Supply uncertainty	Generally, supply of raw materials for FCS has significant reliability, but some reasons such as seasonality, need of attention to the economy of scale, and demand fluctuation can bring some uncertainty in FSCs.	(Romsdal, 2014); (Soman et al., 2004)

Table 3 Typologies of food supply chain risk (Fassam, L., Asefeavazi, S., Dani, S., 2020)

Focussing specifically on the food supply chain, a review of the key supply chain risks was undertaken (Table 4). Eight key themes arose: demand, supply, inventory, quality, logistics and market. Considering previous research and in particular the need for measurement in the food supply chain to build resilience and manage risk it is essential that companies select some risks that have significant impacts on their supply chain performance. However, considering the consequences that risks can cause in various businesses is important when selecting the relevant risks (Sheffi, 2005). This therefore means before an organisation can achieve the benefits espoused in building resilience by building a set of risk focussed performance measures, an organisation first needs to be cognisant of the risks it currently has. Furthermore, if organisations as prior research suggests look toward finance as the biggest risk to their business, there is significant potential this internal review of 'what is actually happening' will not happen, meaning areas as identified in Table 4 will not be placed within a measurement process to build resilience. In addition, within all this research, no matter the risk mechanism or resilience measure, there is no mention of the business unit that is responsible for correlating all of these processes to build resilience.

No	Risk	Index	Causes	Citation
1	Demand	Demand volatility; demand uncertainty; demand mix; customer migration; develop new market; inappropriate information sharing; inaccurate forecast; over or under specification	Losses performance; opportunity cost in terms of lost sales; impose unnecessary cost in terms of disposing or storing	Guan & Philpott, 2011; Mithun Ali et al., 2019; Xiaoping, 2016; Nakandala et al., 2017; Srivastava et al., 2015; Sun & Tang, 2014; Rosales et al., 2012; Mirzapour Al-E-Hashem et al., 2011;
2	Supply	Supplier reliability; ICT infrastructure; supply quality;	Failure through product quality, delays, product reputation, lost demand	

		supplier capability; shortage in raw materials		Qiao et al., 2012; Paksoy et al., 2012; Prakash et al., 2017; Ali et al., 2018
3	Inventory	Failure in inventory planning; control failures; high or too low inventory level	Increasing holding costs; increasing lead-time and setting time; obsolescence; stock-out	Diabat et al., 2012; Liu and Fan 2011; Mithun Ali et al., 2019
5	Quality	Hazard in food features; lack of standards; perishability; low quality of raw materials; disruption in processing	Adverse effect on financial viability; lack of trust among partners; brand damage; reputations and business loss	Liu & Fan, 2011; Krížová et al., 2016; Bai et al., 2018; Wang et al., 2008; Kleindorfer and Saad 2005; Peck & Helen, 2006;
7	Logistics	Increasing energy consumption and cost; lack of labour; port congestion and closures; inappropriate logistics infrastructure; accessibility to reliable logistics channels; lack of communications and information technology	Possibility of customer dissatisfaction; decreasing market share; inefficiency in operational performance; adverse effect on financial viability of the organisation	Hauser, 2003; LaLonde, 2004; Jaffee et al., 2010; Joshi et al., 2009; Aramyan et al., 2007; Rosales et al., 2012
8	Market	Destructive or low market competitiveness; price fluctuations, unsteady market channels, rate of exchange	Adverse effect on financial viability of the organisation; brand damage; loss of reputations and businesses; market share decreasing	Xiaoping, 2016; Mithun Ali et al., 2019; Peck & Helen, 2006

Table 4 Food supply chain risk consequence (Fassam, L., Asefeavazi, S., Dani, S., 2020)

In synthesizing different perspectives from the aforementioned literature about varying risk typologies and their consequences in food supply chain networks (Table 4), this research study

moves to reviewing categories of supply chain risks which include demand, macro and operational risks, and particularly supply risk, demand risks, food safety and quality risks identified as important in building supply chain resilience (Nakandala et al., 2017; Tang, 2006).

Macro risks are related to negative and infrequent and historically external situations that can impose negative pressures on the food industry. These macro risks include natural risks (non-man-made) and human-made risks (man-made). The main sources of the macro level risks in food supply chains include natural catastrophe, epidemic and contagious diseases (e.g. bird flu), changing policy (e.g. Brexit), and political risk (e.g. a terrorist assault, regulatory and legal changes, unqualified human resources) (Diabat et al., 2012). The second form is operational risk, which can occur due to a supplier's failure as a significant entity in the food supply chain. These failures can emerge as a result of a wide range of issues including poor quality of raw materials, long lead time and delay for supplying raw materials, loss of reputation and incapable suppliers, stock-out and shortage of raw materials, and inappropriate communication with suppliers (Diabat et al., 2012; Prakash et al., 2017). Demand risks can arise from uncertain volatile customer demand patterns in terms of volume and demand mix, consumer tastes, inadequate information from customers, inaccurate demand forecasting, and requirement changes in terms of food safety (Diabat et al., 2012; Jaffee et al., 2010; Tang & Tomlin, 2008; Yeboah et al., 2014). Lastly, food safety and quality risk are elements that threaten the entire supply chain's operation, and arise through a set of hazards pertaining to specific food characteristics (Liu & Fan, 2011). The lack of ability to achieve safe foodstuffs because of the high level of uncertainty is also defined as food insecurity and can be examined as a risk level related to food quality, although it is historically related to food availability (Wang et al., 2008). In summary, the measurement focus for food supply chain quality risks can be summarised into five main classifications: supplied raw materials risk (Bai et al., 2018); manufacturing and processing risk (Marucheck et al., 2011; Matuszek, 2012); logistics (i.e. packaging, warehousing, and transportation) risk (Biranjia-Hurdoyal & Latouche, 2016); sales and marketing risk (Yeung & Morris, 2001); and political and legal risk (Sun, 2014). However, again, as in the earlier discussion, there is little to support the internality of risk with regards to these three top level risk areas, with a focus on external resilience building.

2.8 Review of supply chain risk appraisal approach

The risk assessment and resilience building is well-defined as an explicit systematic process that is both complex and evolving, and adopts comprehensive quantitative risk assessments.

However, various firms, specifically small and medium-size organisations, of which the European food supply chain comprises 92% (Fassam & Dani, 2017), encounter many difficulties within their quantitative risk assessment implementations. The predominate reasons for these difficulties include lack of proficiency, knowledge, scheduling, time management, motivation, engagement and capital. In addition, due to the lack of access to quantitative data and structuring an applicable model with appropriate parameters, the quantitative risk assessments are not always usable (Rathore et al., 2017). This gives rise to challenges and arguments that the food supply chain SME is not properly connected into the wider food chain, which not only gives rise to risk, but precludes them for inclusion in the wider food supply with larger retailers.

According to Coleman & Marks (1999), when risk managers struggle with the above-mentioned problems, they can adopt qualitative risk assessment for prioritising risks, setting appropriate strategies and policies, and risk resource allocation. The assessment is usually associated with inaccurate and inadequate data for quantitative risk evaluation (CAC, 1999). In order to make a bridge, the gap between two different approaches (i.e. qualitative and fully quantitative), various semi-quantitative scoring systems and other techniques such as decision trees have also been introduced (Davidson et al., 2006; Huss et al., 2000; Marks et al., 1998; Ross & Sumner, 2002). However, much of these mechanisms and knowledge will be out of reach to the average food supply chain SME, which will lack resource and expertise in this area.

Author(s)	Aim	Risks involve	Method
Ali et al., (2018)	To evaluate the impact of possible demand disruptions in FSCs	Demand disruption	Game theory
Behzadi et al., (2018)	Review the mathematical models generated in agricultural business	Seasonality Supply Lead-times Perishability	Review Paper
Nakandala et al. (2017)	Risk assessment with two different approach and creating novel approach for assessment	Macro level risks Operational risks external to the firm Internal risks	Hierarchical holographic modelling and FL
Song and Zhuang (2017)	To model a government-manufacturer-farmer game for FSCs risk management	Society health risks from chemical additive	Game theory
Xiaoping (2016)	Reduce the occurrence of the food safety issues and ensure the quality of the people's life	Safety risk	Fuzzy AHP
Dong & Cooper, (2016)	Develop a model by adopting AHP approach for supply chain risk assessment	Earthquake Financial Crisis Supply interruptions Inaccurate demand forecasts Technology upgrades Machine breakdowns	Orders-of magnitude and AHP
(Heckmann et al., 2015)	A critical review of supply chain risk	Network risk Process risk	Review Paper

(Ho et al., 2015)	A literature review regarding supply chain risk management	Macro risk factors Micro risk factors Demand risk factors Manufacturing risk Factors Supply risk	Review Paper
(Sun & Tang, 2014)	Examine the research literature related to food supply chain risk assessment for realising progress in this area	Planning Quality of raw materials Resource allocation Production Specification change Delay Defects Reputation Contract risks Supply	Review Paper and survey
(Cai et al., 2013)	Propose an incentive scheme include two contracts (i.e. wholesale-market-clearance and wholesale-price-discount sharing) for eliminating ‘‘double marginalization’’ in three-tier supply chain	Poor logistics contracts	SIM
Diabat et al. (2012)	Managing and mitigating risks in food supply chain	Macro level risks Demand management risks Supply management risks Product/service management risks	ISM Modelling
Sanchez-Rodrigues	Qualitatively examine the various types of uncertainty effecting on	Delays Delivery constraints Lack of coordination	Review Paper

et al., (2010)	transport operations instead of evaluating the each involve risk	Variable demand Poor information	
Liu & Fan (2011)	To examine risks in FSCs	The quality risks The logistics and inventory control risks The structural risks The information risks The cooperation risks The market risks The environmental risks	System dynamics
Rao and Goldsby (2009)	SCRM review	Environmental factors Industry factors Organisational factors Problem-specific factors and Decision-maker related factors	Review Paper
Joshi et al., (2009)	Identify the relationship between cold chain and developing economies in India	Information Communications technology	Fuzzy Interpretive Structure Modelling (FISM) approach
Tang (2006)	Perspectives in supply chain risk management	Operational risk Uncertain cost Disruption risk Natural and man-made disasters Economic crises	Review Paper
(Wu et al., 2006)	Model for inbound supply risk	Internal risk Quality, cost, engineering capability, production flexibility, continuity of supply external risk	AHP

		Demand, economical stability, market characteristics, natural or man-made disaster, security	
Gaudenzi & Borghesi, (2006)	Proposed a method to assess supply chain risks according to supply chain objectives	Transport/distribution Manufacturing Order cycle Warehousing Procurement	AHP/ F/T
Jüttner, (2005)	To understand the business needs for (SCRM) from a practitioner overview.	Loss of IT Fire Loss of site Employee health and safety Customer health and product safety Industrial action Loss of suppliers Terrorist damage Pressure group	Exploratory quantitative survey and qualitative focus group discussions
Chopra and Sodhi (2004)	Managing risk to avoid supply chain breakdown	Supply risk Strategic risk Regulatory risk Customer risk Operations risk Impairment asset risk Competitive risk Financial risk Reputation risk	Supply chain risk tool
Allen & Schuster, (2004)	Managing complex problems associating with both operational and supply chain risk for minimising the costs	Length of harvest season Crop size under climatic variations	SP

(Yeung & Morris, 2001)	Consumer perception of food risk in chicken meat	Microbiological risk Chemical risk Technological risk	Pilot study

Table 5: Summary of food supply chain risk management assessment literature (Fassam, L., Asefeavazi, S., Dani, S., 2020)

In the past decade, a growing number of studies have concentrated on supply chain risk and resilience, such as:

Gaudenzi & Borghesi (2006) aim to assess supply chain risks and suggest an AHP-based framework. Chang et al. (2015) provide an exploratory model to develop optimum decisions for decreasing risk in food supply chains. In order to present a comprehensive system thinking approach in the supply chain risk management field, Ghadge et al. (2012) provided a detailed literature review. In addition, Nikou & Selamat (2013) presented a literature review on supply chain risk management to evaluate the potential risks across the Malaysian food supply chains, with Manning & Soon (2016) citing agility and stability as being required across various organisations designed to build food supply chain resilience model. Fearne et al. (2001) aspired to mitigate the different risks regarding fresh beef and concentrate on quality security systems, whilst Srivastava et al. (2015) evaluated the relationship between potential risks and organisational performance in food supply chains, particularly for fresh food retail networks. Ding et al. (2014) measure the indicators of quality performance in the FSCs in the Australian beef processing business, and the various risk effects on food processing performance was undertaken by Chaudhuri et al. (2016). Finally, in order to set the policy of reacting to various risks, Dani & Deep (2010) highlight issues involved with food supply chain risk and resilience by developing a research review in the different literature.

What this section of analysis of literature into research around food supply chain risk and resilience has identified is that while there has been a rise in generic studies on supply chain risk since 2006 and a significant rise in outputs [research] in the preceding decade, there is still much to do. There is little or no research into the internal aspects of resilience building with food supply chain actors, predominately around the SME sector, with the majority of existent research looking at more cross-functional external business risks. This therefore is a significant

gap in the current body of knowledge that this research will review and discuss in the latter chapters (4 & 5).

2.9 Food supply chain fraud

The term food fraud can be defined as an illegal intentional deception for economic gain using food that could impact consumer health (Spink et al., 2017). Food fraud activities include, for example, counterfeiting, tampering, diversion, tax evasion, overrun, grey market products, smuggling, unauthorised products, unauthorised re-filling, adulteration, misleading indications/ labelling and misrepresentation of packaging size (Manning & Soon 2014; Spink et al., 2017). Instances of food fraud events can occur at all stages in a food supply chain and can often easily cross international borders, often without trace (Everstine et al., 2013). Globally, fraudulent behaviours associated to food supply chains comprised of instances such as the Eurovet scandal (Smith, 2013), the horsemeat scandal that occurred in 2013 in Europe (Rob Smith et al., 2017), the blackfish fraud (Robert Smith, 2015), a Brazilian meat scandal in 2017 (Manning et al., 2017), and the 2017 fipronil eggs contamination scandal that occurred in Europe and Asia (Kowalska et al., 2018), as well as the Halal meat fraud (Smith, 2004), all of which are contemporary instances of distinguished complex food fraud.

As such Food fraud events can have dramatic economic and consumer impacts, with consumer confidence in products falling, resulting in widespread product recalls and expensive authenticity testing (Spink et al., 2017). Charlebois et al. (2016) reported on the growing concerns of consumers regarding food safety, accuracy of labels, and increased levels of mistrust in food systems following increased amounts of reports of food fraud events such as mislabelling of kosher, halal or other food products. These food fraud events also highlight the weaknesses in current food safety and food defence measures which enable vulnerability and opportunities for food fraud behaviour in food supply chains, and further reinforce the research author's aforementioned view that not all risk and resilience measures are similar across differing supply chains.

Due to globalisation, an complex distribution systems are more frequently having challenges around fraudulent behaviours and can have significant effect on consumer safety and health (Manning & Smith, 2015; Quested et al., 2010). There is evidence showing that the more complex the supply chain, the more consumers detach from their purchased food and the detail of where it was produced (Scally, 2013; Smith 2004). According to the National Audit Office

(NAO) report in 2013 concerning food fraud factors since 2003, the following factors were identified as the most significant elements that increased the probability of food fraud:

- As a result of increasing food supply chain complexity, tracing food fraud is more difficult
- Considering the growing volume of importing food products from international points rather than local suppliers in the EU, the vulnerability likelihood regarding the effective controls have increased
- Owing to restricted household budgets and the need to decrease financial pressure, additional cost pressures are imposed on suppliers
- Due to the high demand for food availability, the ingredients and food costs are increased

The research into food fraud is connected to the aforementioned research as it is predominately related to issues around cost (Table 1). Reinforcing this view, DEFRA identified price factors (i.e. the value of money) as the highest influencing factor on selecting food products by the consumer during 2012 to 2016 (Table 6). Consequently, it appears there is little attention paid to the provenance of food in terms of consumer priorities, and with this stakeholder [consumer] driving overall food supply chain decisions, focus is on cost over other factors (Pustjens et al., 2016; Spink & Moyer, 2011).

	(DEFRA, 2012)	(Carr et al., 2013)	(DEFRA, 2014)	(DEFRA, 2015)	(Brown et al., 2016)
Price	41%	39%	41%	36%	36%
Quality	14%	16%	16%	18%	18%
Taste or smell	11%	14%	12%	13%	13%
Healthy option	8%	9%	9%	10%	10%
Familiar	9%	7%	7%	7%	7%
Promotions	7%	7%	6%	6%	6%

Table 6 Factors influencing consumers' choice

Ruth et al. (2017) divided the elements which make food supply chains vulnerable to food fraud into three subsections: opportunities, motivations, and control measures. Importantly, it should be noted that food fraud incidents can originate from both internal and external aspects of the supply chain, giving rise to earlier challenges with traditional supply chain risk mitigation measures being devoid in internal resilience building. This means actors in the supply chain must be receptive to external vulnerabilities but also must actively consider internal vulnerabilities (Manning, 2016; Ruth et al., 2017). Opportunities for food fraud can relate to the very mechanisms there to protect against them such as scientific testing. For example, complexity of advanced analytical testing can increase the susceptibility to fraudulent behaviours due to their reactive, random approach and often destructive nature [process], which can differ in governance dependant on geography (Moyer DeVries & Spink, 2017). Food supply chains with increasingly complex and larger networks have reduced transparency, particularly if different actors are located geographically further away and with minimal physical safeguards (Sarpong, 2014).

In addition, a number of academic studies have identified motivations behind food fraud, which include economic drivers, supply shifts and pricing metrics (Manning & Soon, 2014), value added product attributes (Grunert & Aachmann 2016), competition levels (Huisman, 2016), previous criminal activities (Baucus & Near 1991), and unethical business strategies (Huisman 2016). In some instances, the appeal of combating rising commodity prices, scarcity of raw ingredients, increased competition, pressure to reduce costs, maximising profits and consumer preference may tempt food supply chain actors into undertaking fraudulent activities (Elliot, 2014). As such, for some, undertaking food fraud may be seen as a necessary measure to ensure that they can sustain their place in the food market (Elliot, 2014).

The final aspect of supply chain food fraud vulnerability relates to current control measures across geographically dispersed food supply chains, which come in two forms, the technical [scientific] and managerial {process]. Technical [scientific] control measures are aimed at detecting fraud by generating data on the prevalence of adulterated products, such as fraud monitoring systems, utilising readily available data to pinpoint and detect fraudulent foodstuffs (Ruth et al., 2017). Managerial control measures ascribe to be more preventative by establishing ethical codes of conduct, integrity screening and whistle blowing systems. As a result, the process [managerial controls] requires food supply chains to adopt contractual

processes that can mitigate fraudulent behaviours, which work according to regional and national laws (Ruth et al., 2017).

In the UK and Ireland, food supply chains source ingredients and products from an array of other countries, which are in the main monitored and traced through individual food companies or foreign owned entities within a larger transnational corporation (Johnson, 2014). This dynamic and large-scale supply chain network allows for greater opportunities for fraudulent activities and leaves actors in UK and Irish food supply chains more vulnerable owing to their fragmented nature and aforementioned lack of global alignment with governance processes. Therefore, in order to build food supply chain resilience and mitigate against increased levels of food fraud, more stringent control measures must be implemented and strategically enforced.

There is, however, research that cites procurement functions' role in mitigating against fraud in the food supply chains by identifying risks through undertaking vulnerability assessments at each node in the supply chain. Furthermore, this process of node vulnerability review often follows the complete farm to fork process associated with a specific product (Manning & Soon, 2016). However, there is little empirical support of how a procurement department can perform this function both internally and externally (Elliott, 2014; Fassam & Dani, 2017).

That said, Motarjemi and Wallace (2014) demonstrated the significance of utilising a vulnerability assessment tool when developing mitigation measures through root cause analysis to determine supply chain food fraud causes in relation to internal employees and external perpetrators. They further found a proactive approach aimed at improving supply chain practices and reducing intentional food fraud activities in conjunction with the utilisation of a vulnerability assessment tool essential for mitigating risk in food supply chains. However, despite this support of vulnerability assessment to mitigate food supply chain food fraud there is little acknowledgement of the responsibility of managing this metric within the supply chain. Furthermore, Manning and Soon (2014) expanded upon this vulnerability assessment by identifying types of criminality, magnitude of risk and typical countermeasures in place to develop informed mitigation measures, which is discussed in more detail later in this literature review.

2.10 Categories of food fraud

In the evaluation of the fraud report in the Rapid Alert System for Food and Feed (RASFF), six main fraud classifications are noted (Bouzembrak & Marvin, 2016). As shown in the RASFF report, issues regarding labelling, health certificates, and import documentation are the most frequent food fraud occurrences (Tähkäpää et al., 2015).

Another categorisation of food fraud incidence is provided by Spink and Moyer (2011a, 2011b). Their categorisation of seven groups of food fraud have been determined as adulteration, counterfeiting product, diversion, over-run, simulation, bribing, and theft (Table 6) (Manning & Soon, 2016; Manning et al., 2016).

LITERATURE	FOOD FRAUD TYPES
RASFF (BOUZEMBRAK & MARVIN, 2016)	False, missing, deceptive, inappropriate health certificates
	Illicit import
	Bribing
	False, missing, deceptive, expired documents related to importing food products or ingredients
	Labelling issues
	Expiry date
(SPINK & MOYER, 2011A); (SPINK & MOYER, 2011B); (WEESEPOEL & VAN RUTH, 2015)	Adulteration
	Counterfeiting product
	Diversion
	Over-run
	Simulation
	Tampering
	Theft
(PUSTJENS ET AL., 2016)	Substitution
	Concealment
	Mislabelling
	Grey market production/ Diversion/ Theft
	Unapproved enhancement

LITERATURE	FOOD FRAUD TYPES
	Counterfeiting
	Dilution
(MOORE ET AL., 2012)	Replacement[1]
	Incorrect statement of origin to avoid paying taxes or tariff
	Incorrect statement of location, breed, or varietal sources
	Incorrect statement of production process
	Addition[2]
	Removal[3]
(Georgiou & Danezis, 2017)	Selling harmful food
	Intentionally false statement food

Table 7 Key authors citing significant food fraud and risk occurrences

Manning and Smith (2015) argued that food fraudsters do not distinguish between various countries and they do not have specific boundaries. In addition, they debated that it is not possible to estimate the exact and accurate cost of these food fraud classifications. Some of these food frauds may occur unintentionally. For instance, mislabelling can arise without the suppliers' awareness due to complex commercial intercommunication earlier defined. However, often suppliers may be involved in theses fraud actions and know the wrong origin of the food product (Shears, 2010). According to product labelling law, the food products should not mislead about the following aspects:

- Size
- Price
- Ingredients
- Process, geographical origin, expiry and production date
- Endorsing organisation or people

Spink and Moyer (2011) provide a matrix that identifies the food fraud position among other extensive pre- required policies (i.e. food quality, food safety, food defence) for mitigating risks in the food supply chain. Despite the fact that these aspects may not always match accurately with these classifications and may overlap with other groups, this matrix presents an effective scheme for discriminating among these food safety ranges.

	Intentional	Unintentional	Economic Gain	Harm (i.e. public health, economic, terror)
Food quality		*	*	
Food Safety		*		*
Food Fraud	*		*	
Food defence	*			*

Table 8 Food protection risks matrix adapted from (Spink & Moyer, 2011)

Spink and Moyer (2011) believe that food fraud always has an economic motivation, whilst food defence motivations are exposing harm or danger to consumers' health and economics. Food fraud commonly is inflicted by the food chain actors that have considerable access to food ingredients or products such as wholesalers or manufacturers. However, the converse is said forfood defence, with the most common perpetrator residing outside of the food supply chain, with terrorism. Table 9 illustrates the various groups of mentioned food risks, the main motivation of each of those, and their effects.

Risk classification	Motivation	Effect
Food quality	Mismanage	Decline brand equity and reputation
Food Fraud	Economic gain	Margin profit, public frightening
Food Safety	Harm	Industry damage, public frightening, margin profit, recall costs
Food defence	Harm	Industry damage, public frightening, adulterated products, recall costs

Table 9 Food protection risk – root cause analysis adapted from Spink and Moyer (2011)

Adulteration has negative effects on the consumer, industries, partners, and regulatory bodies' trust across the food supply chain. It also can cause various disruptions in trading activities in target markets. Even unintentional adulteration as a result of food quality risks can also happen because of environmental elements, and issues related to packaging, warehousing, and logistics problems, among other elements (Johnson, 2014).

Pustjens et al. (2016) suggest in order to develop understanding around food supply chain fraud, use of the food fraud triangle (Fig 1) is needed for interpreting vulnerability in food fraud, including three main aspects: rationalisation/control measure, opportunity, and motivation.

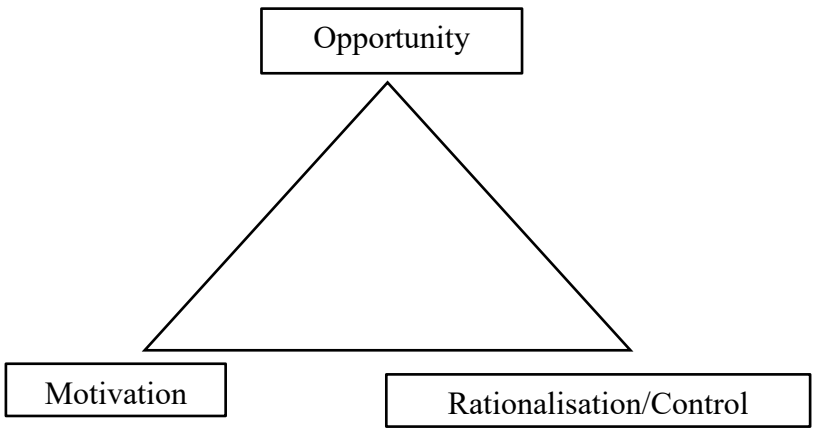

Figure 1 Food Fraud Triangle (Pustjens et al., 2016)

Opportunities for fraud are created through uncertain internal management, weak control supervision, and because of the misuse of people's authority. Opportunities and motivations emerge from either the internal and external organisation's environment Van Ruth et al.,

(2018). In terms of food fraud, any food chain performer poses a likely opportunity for the incidence of food fraud. The motivation is drives, desire or a demand perceived by individuals who participate in fraud. In terms of food fraud, the main motivation is achieving profit margin and economic gain. Rationalisation involves an individual adjusting his/ her attitude to the frequently approved approach of trust (Rodgers, 2012). The possible risk extract from two aspects of motivation and opportunity can improve or impose higher risks depending on the use of control measure tools on the third side of the triangle. If organisations focus on adopting effective control measure tools, they may proactively detect and prevent potential risks caused by two other sides of the fraud triangle (i.e. motivation and opportunity). When the probability of gaining profit is more than the likelihood of getting caught, the vulnerability of food fraud in the supply chain can carry on (Everstine et al., 2013).

Spink and Moyer (2011) have also identified another categorisation for food fraud risk that has direct effects on public health. There are three key types in this classification including direct, technical, and indirect risks. The main points in this classification are that Spink and Moyer (2011) focus on the consequences of risk for proposing that motivation is not considered in this case.

Direct food fraud risk arises when the consumer is met with immediate or unavoidable risks, such as the addition of extremely toxic or dangerous contaminants. In this case, the hazard can create negative impacts on the entire population or part of a population. Indirect food fraud risk arises when the consumer is threatened through long-term vulnerability, for instance, creation of a chronic toxicity contaminant in the individual body, as a result of the uptake of low doses. Technical food fraud risk is immaterial in essence, for instance, missing, deceptive, expired documents of importing food products or lack of stating process, geographical origin, expiry and production date in food product label (Esteki et al., 2019; Spink & Moyer, 2011; Spink et al., 2017).

2.11 Food integrity elements

2.11.1 Product integrity fraud

According to previous literature reviews, the main examples of fraud in product areas are involved with products such as cereals (Pegels et al., 2015), dairy products (Deelstra et al., 2014), seafood (D'Amico et al., 2014; Pardo et al., 2016), fruits (Marieschi et al., 2016), meat

(Cawthorn et al., 2013; Kane & Hellberg, 2016), potatoes (Lopez-Vizcón & Ortega, 2012), saffron (Nenadis et al., 2016), and organic foods (Johnson, 2014). There are various techniques for verifying product integrity such as accurate and reliable sensors, rapid and on-line analysis such as spectroscopic and chromatographic methods, or deriving data from multivariate chemical-related information in food products by chemometric techniques. In order to verify product integrity, companies have to spend lots of money on product tests. In addition, in some cases, the turnover times take a long time due to specific requirements in sampling processes and this can have negative impacts on lead times across the food supply chain systems. Due to the high costs of verification tests and some destructive tests regarding product integrity, supply chain decision-makers commonly prefer process integrity verification instead of product integrity (Borràs et al., 2015; BSI, 2014).

2.11.2 Process integrity fraud

The food labelling system with its current features and characteristics cannot ensure food supply chain networks regarding food quality and safety (Aung & Chang, 2014). Extraneous features of process integrity such as manufacturing techniques, organic and vegan products, adopted standards for employees and animal welfare, security standards' compliance, product origin (geographically) indicated as 'value descriptors' are all employed instead of innate, substantial features of food ingredients or products. Therefore, these types of products are not reliable to process integrity fraud (Bigot et al., 2015, Müller & Gaus, 2015). Origin fraud has been identified at different levels including incorrect identification of geographic origin, by country or region.

By taking advantage of spectrometric on-line chemical analysis that can be examined via multivariate statistical techniques, food products can be recognised concerning their country of origin, class, species, and possible adulteration (Riedl et al., 2015). However, because of the lack of consistent worldwide standards for assuring product validity and adopting various multivariate screening techniques throughout the world, the success of measurement methods can be affected regarding the food fraud mitigation (López et al., 2014).

2.11.3 Data integrity fraud

Mol and Oosterveer (2015) have proposed four main categories of traceability based on an integrity system, as shown in Table 10.

Type	Feature
Book and claim	Certificate base
Identity safety	Track and trace base
Segregation	Separation base
Mass-balance	Volume base

Table 10 Traceability classification based on integrity system adapted from (Mol & Oosterveer, 2015)

The major problem of traceability systems includes the inability to integrate documents and data across the food supply chain, the mistakes and inaccuracies of information and documents, and lack of real-time data and reports (Badia-Melis et al., 2015).

Some technical approaches such as radio frequency identification (RFID), Internet of Things (IoT), smartphone technologies, and hologram features in the packaging of food products can help food supply chain networks to have immediate access to information and improve the traceability of information and data that are necessary for verifying integrity in both product and process (Mitenius et al., 2014).

2.12 Drivers of supply chain fraud

Manning et al. (2016) argue that market competition is considered as a significant driver for food supply chain fraud. The reason lies in the fact that companies have high intentions to gain higher economies of scale and profit margin. Some state that bad intent is not supported by European law concerning food safety (van der Meulen, 2015), while others debate that food safety in terms of creating regulations for food fraud has a low value. However, safety is concentrated on unintentional food contamination while food fraud includes misleading and intentional actions (Manning & Soon, 2016). Even local and niche foods are not guaranteed to be protected from fraud threats, and there is a growing demand to show product and process validity (Gbegi & Adebisi, 2013; Manning & Smith, 2015). Furthermore, increasing

complexity in food supply chains because of globalisation and various regulatory parameters can make traceability of food products difficult and enhance the possibility of food fraud (Manning et al., 2016).

Other factors such as lack of visibility and trust regarding food market and employee, lack of employee commitment, and poor supply chain governance, can increase the likelihood of food fraud and fraudulent behaviour (Huck et al., 2016 ; Kennedy, 2012; Sarpong, 2014). Supply chain elements that may mitigate against food fraud include: rules and legislation, adopting novel and appropriate technologies, storage management, appropriate demand planning and procurement associated with an effective relationship with trusted suppliers (Fassam & Dani, 2017).

2.13 Fraud vulnerability assessments and food fraud mitigation

Food fraud vulnerability assessment (FFVA) is adopted to clear the mistakes that can create opportunities for unwanted incidents (Spink et al., 2017). There are different FFVA tools such as CARVER + Shock method (Catlin, Michelle & Kautter, 2007), NSF Fraud Protection Model (NSF, 2017), SSAFE FFVA tool (Van Ruth et al., 2018), Guidance for Food Fraud Mitigation (The United States Pharmacopeia Convention, 2016), and Model for Food Fraud Initial Screening (Spink et al., 2016). These have been adopted to support organisation and regulatory bodies to predict the probability of fraud throughout the food chain.

As an example, the following points have been proposed by Food Drink Europe (2016) in order to mitigate food fraud risk and implement effective action plans:

- Adopt a suitable food fraud risk system in line with food safety and food quality management in various organisations.

- Implement Food Fraud Vulnerability Assessments using data collected from ingredients, packaging, distribution, supplier’s details and examining these data in order to locate food fraud activities across the food supply chain.

- Generate prevention processes for food fraud according to existent effective guidance.

The U.S. Pharmacopeia Convention (USP, 2017) proposed a system for a food fraud management system that is initiated with an assessment stage for identifying food fraud vulnerabilities. In the next stage making a decision about the proper structure and evaluation process is essential for mitigating potential food fraud. For continuous improvement in this system, all stages should be performed like an iteration cycle to enhance efficiency in the various food supply chain networks.

2.14 Sector specific view of food supply chain fraud

However, in order to truly understand the extent of UK and Irish food supply chain food fraud and mitigation measures in place, this research will now move to review the existent literature in meat, dairy and agriculture sectors.

2.14.1 Meat supply chains

Brooks et al. (2017) demonstrated the complexity of meat supply chains in the UK, in particular in the beef industry. From processing, importing/ exporting, storage facilities and the multiple traders involved in sourcing and supplying, the nature of beef supply chains is intricate. Consumer preference for certain cuts means that much beef is sourced from outside domestic supply chains, which can make it more challenging to monitor and can leave supply chains exposed to vulnerabilities (Brooks et al., 2017).

Following the horsemeat scandal in 2013, eight mitigation measures were recommended after a government review into the integrity and assurance of food supply networks, and this led to the formation of a national food crime prevention framework (Elliot, 2014). The main objectives of this framework were to reduce the likelihood of such a large-scale food fraud event happening again and to rebuild consumer trust in processed meat products. The eight recommended mitigation measures for suppliers to employ were: consumer first, zero tolerance, intelligence gathering, laboratory service, audit, government support, leadership and crisis management (Elliot, 2014). Importantly, these measures were aimed at actors at all nodes in the supply chain from producers and processors to government enforcement bodies, but again did not move to deliver key actors for resilience building either internally or externally across all connected actors.

Consumer first initiatives were recommended as the highest priority with the need to 'always put the needs of consumers above all other considerations and this means giving food safety and food crime prevention an absolute priority over other objectives' (Elliot, 2014). In order to secure this, many food retailers have significantly increased the transparency of information available to consumers. Tesco annually releases reports on their website regarding their meat testing framework and its findings. For example, in 2016/ 2017 480 DNA tests were conducted on meat and since January 2013, 9383 tests have been undertaken (Tesco, 2020). The review strongly recommends that suppliers, processors and others implement annual targeted testing programmes based on horizon scanning and intelligence, data collection and well-structured surveys (Elliot, 2014). This all makes food crime difficult to commit and deters potential perpetrators, thus mitigating the risk of food fraud. However, it is a reactive process, utilising historic data, which permits much of the fraud to continue undetected for significant periods of time.

The second recommendation on zero tolerance means that the response to major dishonesties must be 'deliberately punitive' (Elliot, 2014). Procurement deals which are suspiciously inexpensive and 'too good to be true' should be questioned by industry players (Brooks, 2017). To support this, government must work with industry to ensure active mitigation is included in company risk registers and in the supporting of whistleblowing and reporting of food crime (Elliot, 2014). A whistleblowing hotline was set up by the National Food Crime Unit (Elliot, 2014). Furthermore, industry incentives should actively reward those with responsible procurement practice as food crime prevention is more viable when all stakeholders in the supply chain are involved. Stakeholders should agree upon food specification, adhere to transport and handling, check conformity through sampling and decide whether the adequacy of systems is sufficient (Elliot, 2014).

Intelligence gathering and the development of a safe haven has led to the development of the Food industry intelligence network (Creswell, 2015). This allows organisations to share anonymised data and test results with legal support, thus ensuring no financial gains can be made through competitors' knowledge (Creswell, 2015). This network, however, remains unshared with regulators and government departments such as the food standards agency (FSA) due to fear of implication and confidentiality (Brooks, 2017). In order to mitigate against risk at a national level, industry and regulators must share information with each other (Elliot, 2014). Through the advances in surveillance programmes and targeted sampling programmes,

this mitigation measure utilised by procurement has significantly increased the number of companies (retailers, processors etc.) providing meat testing services (Brooks, 2017), however, it requires greater connectivity and 'real-time' adoption across food supply chains. This process also lacks the management focus required to embed within extended and globally dispersed food supply chains.

The Elliot also recommended in order to better mitigate against food fraud in UK supply chains changes needed to be made to audit. Following the review, the British Retail Consortium (BRC) food safety standard adopted a new mandatory framework including vulnerability assessments (Brooks, 2017). Under this, food manufacturing sites are expected to perform risk assessments of their products by undertaking vulnerability assessments on raw materials from manufacturers or via agents and subsequently, establish mitigating strategies to reduce any identified risks (BRC, 2017). Where raw materials are obtained via an agent, the site where they are obtained from must be assessed for its suitability as a supplier. These clauses apply to all food sectors, not just meat supply chains (BRC, 2017). In particular, traders and agents are areas of vulnerability in supply chains. To mitigate the threats here, the BRC developed a standard for agents and brokers which ensures processes are in place to manage their supply systems, focusing on food fraud prevention (Brooks, 2017).

Moreover, specifically for meat traders the International Meat Traders association (IMTA) developed a Good Trading Practice Guide in 2015 relating to food fraud prevention, which sought practical steps for companies to implement to strengthen resilience to fraud (IMTA, 2016; Brooks, 2017). The IMTA also introduced a meat scam tracker where its members can report suspected scams across the meat industry (Brooks, 2017; IMTA, 2016). This has provided further awareness and industry knowledge enabling members of the IMTA to implement preventative measures in their organisations.

Furthermore, the British Meat processors association, BRC Global Standard and members of the food industry have produced a Meat Supply Chain Assurance module (BRC, 2016). This module enables companies to demonstrate to consumers increased transparency and visibility levels in UK meat supply chains and provide information on how organisations manage species-species contamination. The Elliot also recommended the use of unannounced audits to mitigate against food fraud. In relation to this, 99.9% of suppliers have committed to unannounced audits (Elliot, 2014). As of July 2014, under the Safe Quality Food plan, institutes

sites are required to receive an unannounced re-certification audit in every three -recertification cycles. These audits must occur in all aspects of the supply chain from storage to meat commodity markets, to transport and to retailers (Elliot, 2014).

To be successful mitigation measures need the support of government and clear leadership. Clearer defining of the role and responsibilities of agencies and organisations by the government and the establishment of the National Food Crime Unit have supported mitigation measures deployed in supply chains (Brooks, 2017). However, further collaboration between industry and government in line with intelligence sharing and resource allocation is required to eliminate food fraud from UK meat supply chains.

2.14.2 Dairy supply chains

Moore et al. (2012) identified milk as the second most adulterated food ingredient in scholarly records between 1980 to 2010. In particular, milk producers can increase financial margins through dilution, extraction of valuable components such as milk fat, addition of cheap bulking additives such as flour to increase the value of solids, and the addition of ice and some chemicals such as sodium bicarbonate to increase shelf-life (Handford et al., 2016). In addition, Hanford et al. (2016) noted that the addition of adulterated substances in milk can have chronic impacts on human health ranging from hypotension, cancer, kidney damage and impaired vision.

To mitigate against this, Handford et al. (2016) suggested implementation of whistle blower policies and the collection and analysis of milk samples taken by auditors to validate suppliers' products. The UK diary industry often has shorter supply chains due to the fact that most UK milk is processed in the UK. 50% of the milk produced in the UK is sold as fresh liquid milk (which meets most of the domestic demand), 25% is used in cheese and the other 25% is used in yoghurts, desserts and other dairy products (HM Government, 2013). The supply chain follows six nodes from feed production, milk production, cooling and storage, processing, retail and the consumer (food integrity), which is significantly less than most globally dispersed food chains. However, there are still instances of food fraud, which negates earlier shorter supply chains to build resilience.

VanRuth et al. (2018) utilised a food fraud vulnerability assessment whereby food fraud factors in relation to opportunities, motivations and control measures were identified. For the milk supply chain the highest ranking food fraud factors in the opportunity sector related to availability of technology and knowledge to adulterate raw material, fraud detectability in raw materials, fraud detectability in final products and access to production lines. This suggests that in order to mitigate against these food fraud factors, supply chains must have rigorous testing measures implemented at the production and processing stages. When it comes to motivation, the valuable components of attributes and the level of competition of industry and price asymmetries were the highest scoring. Furthermore, Van Ruth et al. (2018) found that in regard to control measures in milk supply chains the highest food fraud factors were lack of integrity screening of own employees and not implementing the national food policy.

Currently, the two main mitigation measures deployed during the processing of milk are reception and pasteurization used to reduce the microbial load (Flari et al., 2014). In line with these two hazard analysis critical control points (HACCP), the efficiency of these two measures is certified and evaluated on a periodic basis via laboratory samples (food integrity). These two measures are utilised to ensure the safety of food for consumption, yet they also serve a purpose to minimise the risk of food fraud events. Specific controls test the fat content and the rapid automation system tests the protein content and ingredient content in dairy products (Pei et al., 2011).

A further challenge for the dairy industry lies in producing organic milk. For a UK Farm to be organic it must meet EU standards such as ensuring crop rotation and other forms of husbandry to maintain soil fertility (Sanders, 2013). Furthermore, all stakeholders in the supply chain must be certified as organic. However, organic milk is a premium product, which means the financial costs at each stage in the supply chain are much higher than that of a non-organic supply chain, thus leaving food fraud through replacement of inorganic milk as a viable option (Sander, 2013). In Europe, there have been notable organic food scandals implemented by employees of certification bodies who were involved in counterfeiting certificates and documents regarding the certification process trade documents (Sanders, 2013).

To mitigate against food fraud, the UK dairy industry utilises labelling measures such as The Red Tractor Assurance Scheme. The Red Tractor established in 2000 is the UK's biggest farm and food standards scheme covering food safety and traceability. Dairy standards include

parlour plant cleaning protocol, contingency plans and annual veterinary reviews. More specifically, the dairy standards include measures, such as: 'Dairy and milk storage access points must be kept secure at night and when unattended' and 'chemicals …used within the milk production area must be suitable' (Dairy Standards, 2019). Removal from this scheme can have significant commercial impacts, and this can serve as a deterrent for farmers to abide by regulations and to not partake in food fraud activities (HM Government, 2013). Furthermore, in the UK there are high tariffs to import dairy into the EU which makes it expensive and not cost effective, further limiting the financial gain of committing food fraud (HM Government, 2013).

2.14.3 Agriculture supply chains

Cereal grains such as barley, rye, oats maize, rice and wheat are very common ingredients in food and feed production supply chains (Pegels et al., 2015). For food safety and food fraud purposes grains are tested for authenticity to comply with labelling rules as well as to avoid unfair competition advantages and protect vulnerable consumers such as those suffering with coeliac disease from eating inflammatory proteins (Mafra et al., 2008). It is important to identify which cereal species are used in a given product for food safety and to avoid economic fraud.

In the UK any product sold as organic must have a certification symbol or number on display (Shears, 2008). This ensures that it complies with minimum government standards. In the UK, The Soil Association organic symbol is the UK's main certification marker, which appears on 70% of organic food products in the UK. Controls on organic arable systems include soil fertility, crop rotation, crop protection, and crop storage (Shears, 2008). In the agriculture sector one of the biggest food fraud challenges is mitigating against the selling of products that are labelled as organic which are in fact non-organic. It is very difficult to distinguish scientifically which crops have been grown organically and which have not. For example, synthetic fertilisers are almost indistinguishable to natural fertilisers (Brereton, 2006). The challenge of mitigating against this is heightened by the fact that in the UK 'for every £100 spent on food by consumers, less than one penny is spent by local authorities on testing' (Novak, 2006).

One way to mitigate against food fraud across all UK supply chains is the use of traceability systems (Morin & Lees, 2015). Successful traceability systems include the grouping of ingredients and raw materials into units with defined properties referred to as traceable resource units, with unique identifiers assigned to these units, and recording of product and process properties linked to identifiers as well as a mechanism implemented to facilitate access to recorded properties (Morin & Lees, 2015). Most food organisations have internal traceability systems, with sufficient software generating reports relating to internal processes in the company. The issue with supply chains is that implementing traceability systems from producer to retailer or raw material to consumer product requires a large amount of communication and willingness for organisations to share information (Morin & Lees, 2015). Sarpong (2014) purported that if companies improved their ability to trace products, they could also expect to increase supply chain confidence of consumers and see the potential to expand their markets.

The UK wheat-flour-bread supply chain consists of over 10,000 farmers, grain handlers, millers, bakers, food caterers, retailers and separate small export chains (Barling et al., 2009). This industry has a relatively small amount of food fraud compared to the meat and dairy sectors. This is because testing and certification of schemes are required at each node in the supply chain, resulting in increased transparency. For example, at the first node seeds must be certified in agreement with the National List under the Agriculture and Horticulture Development Board and the use of pesticides by farmers requires a detailed pesticide registration process (ADHB, 2020). All wheat harvested in the UK for human consumption is covered under farm assurance schemes such as the Red Tractor Farm Assurance – Combinable Crops & Sugar Beet Scheme (Red Tractor, 2017). These schemes are grounded on current standards of good agricultural practice. Farmers involved are inspected annually by third-party agencies to verify practice and record keeping in regard to storage, utilisation of agrochemicals and pest control (Red Tractor, 2017).

In the milling stage assured grain must be accompanied with a ‘Post Harvest Declaration’ and a unique farm identification number (Red Tractor, 2017). The grain is also tested at the mill to assess quality and conformance with specifications of protein content, moisture content and specific weight under the National Association of British and Irish Millers (Nabim, 2019). In a given year, 172,000 lorry loads of wheat are tested by millers, which equates to over 1.5 million data entries (Nabim, 2019). Assured sources of good standards to crop production and

food safety are measured by independent inspections. NABIM certifies that UK millers only purchase wheat which has been 'assured' by inspection (Nabim, 2017). At the baking stage audits are performed and traceability is required on additional ingredients added to flour (Barling et al., 2009). UK retailers then use labelling regulations to demonstrate to consumers that products have followed specific standards.

However, there are some challenges in the agriculture industry in regard to mitigating against food fraud activities. Barling et al. (2009) found that many workers stressed the difficulty in traceability due to the standard practice of blending wheat in storage and at mills. Although traceability was identified in most nodes of the wheat chain, the information was not gathered systematically and was not transmitted throughout. To increase transparency and to reduce any food fraud behaviour, Barling et al. (2009) highlighted the need for more inclusive processes of communication for more transparency in facilitating transmission of information.

Supply chains also need adequate leadership with one organisation assuming the role of leadership (Lambert et al., 1998). In UK supply chains major retailers like Tesco and Aldi have begun reviewing their supply chains (Sarpong, 2014). Retailers should ask searching and detailed questions of suppliers to ensure suppliers are as credible as they make out to be (Sarpong, 2014). In order to support this, Sarpong (2014) argues that appropriate supplier due diligence must be conducted prior to contract formation between retailer and supplier. This due diligence must ensure a supplier has contingency plans, and systems in place to promote compliance with legislation as well as to clarify any potential areas of concern in regard to practice and fraudulent activities (Sarpong, 2014).

2.15 Supply chain food fraud summary

It is clear that, following large food fraud events such as the Horse Meat Scandal in 2013 consumers have become more aware of the vulnerability of food supply chains in the UK. Following this increased awareness, the importance of transparency and traceability throughout supply chains and the demand for consumers to be able to source where there food products have come from has placed pressure on agriculture, dairy, and meat sectors to enhance their mitigation measures and to reduce the risk of food fraud events. The Elliot provides detailed mitigation measures to combat food fraud, and in particular the review signifies the importance of authenticity testing and surveillance programmes (Elliot, 2014). This measure is used in all

three industries to garner the quality of food products and to ensure fat and protein contents are at the required amounts (Nabim, 2020; Pei et al., 2011).

The second mitigation measure on zero tolerance recommended the use of whistleblowing systems and risk registers (Elliot, 2014). The meat sector has substantial initiatives in place enabling industry members to reveal potential food fraud behaviours such as the National Food Crime Unit (Elliot, 2014). The dairy and agriculture industry meanwhile have limited resources and measures in place in regard to informing others about food fraud in supply chains. Similarly, the meat sector utilises intelligence gathering to form a food industry intelligence network (Creswell, 2015). However, there are issues with the sharing of information with government bodies (Brooks, 2017). A challenge for all three supply chains is overcoming competitive advantages when sharing information so that food fraud measures can be implemented successfully. There is a need for greater communication between suppliers and retailers and government bodies (Brooks, 2017).

Changes to auditing have improved mitigation in the UK meat and agriculture supply chain. The adoption of The British Retail Consortium provides a safety standard which is utilised across all three supply chains in the UK (BRC, 2017; Brooks, 2017). In addition, the adoption of an agent and broker food safety standard is useful for providing traceability and mitigating food fraud in more complex systems (Brooks, 2017). The use of unannounced audits and spontaneous testing is a well-established way of assuring high food quality and safety and reducing the likelihood and appeal of committing food fraud (Brooks 2017; Flari et al., 2014).

Furthermore, the use of assured standards such as the Red Tractor Assurance Scheme enables agriculture and dairy practices are maintained at higher standards (Dairy Standards, 2019; Red Tractor, 2017). The commercial advantage of being a member of this scheme provides a strong incentive to abide by which in turn mitigates against food fraud (HM Government, 2013). Although advances have been made in mitigating against food fraud in UK supply chains there are still significant vulnerabilities which make food fraud a viable option. Future initiatives should aim to enhance supplier and retailers' relationships, ensure supply chains have adequate leadership, encourage adequate authenticity through connected data interchange and more inclusive opportunities for open and secure communication between stakeholders acting at different nodes in supply chains. These measures would enhance transparency and reduce the opportunities and vulnerabilities to food fraud events in UK supply chains.

2.16 Systematic literature review of food fraud and crime research

In order to bring greater focus to the research study's desires of building resilience in food supply chains against food fraud and criminality, an understanding of current academic knowledge was required. Therefore, a systematic review was undertaken utilising the keywords 'Food crime' and 'Food fraud' suffixed by 'supply chain', with the methodological process discussed later in Chapter 3.

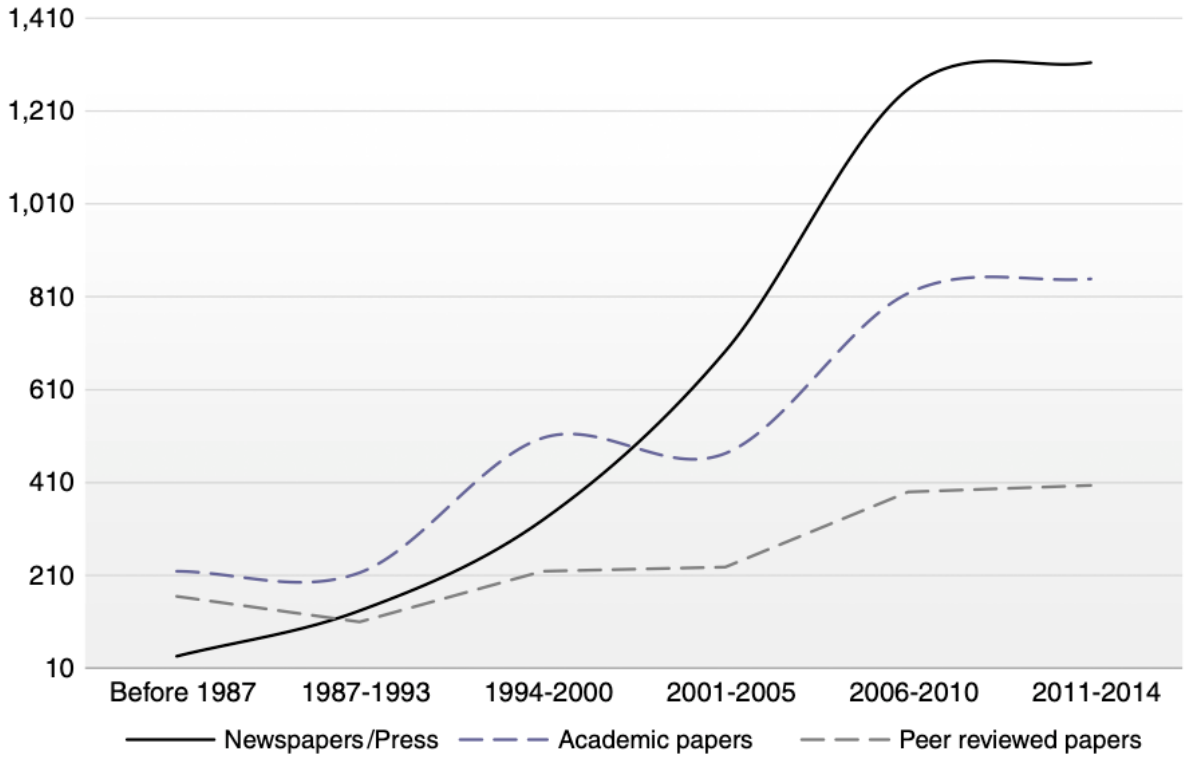

Figure 2 Academic and practitioner press

The cross-sectional analysis of the literature highlights a tendency within academia and practitioner-led publications to centre risk and resilience research around cumulative event-driven thematic areas that attempt to review cause and effect relationships in an aggregate manner. Recent events within global food supply chains have evidenced a detachment between thematic areas of research and the direction of practitioner-led interest (Figure 2). This disconnect between practitioner need and academic research is further supporting the aforementioned "perfect storm" of risk and resilience within food supply chains across Europe. Taking, for example, the UK food manufacturing sector which comprises 310,000 businesses, engaging 3.8 million workers across a net worth of £96 million (European Commission, 2014),

any risk or resilience issue in this sector could have drastic consequences to a nation's health and country's GDP. It is therefore of no surprise that DEFRA (2013) purports the need for organisations to foster environments of collaborative practice that enhance nutrition, quality and safety of food stuffs through the generation of innovative programmes supported by research that develop tools and databases to mitigate risk in a food supply chain context. This need for innovation is also supported by recent UK Government reports with both Professor Elliott and Food Standards Agency supporting the need for greater collaborative sharing of information to permit holistic food supply chain actors to benefit from greater food product authenticity and traceability (Elliott, 2014; FSA, 2016).

The linkages between authenticity and traceability are highlighted by Nelleman et al. (2009), who assert that there are annual global food supply chain losses of 1.3 billion tonnes, with no awareness or appreciation of where this product is leaking from. Although in itself this raises questions regarding traceability in the food supply chain, it further supports the need to recognise and understand that if supply chain actors are unable to trace foodstuffs leaving the food chain, how are they (food supply chains) in a position to identify elements coming into food supply chains (authenticity)? In order to mitigate these issues associated with authenticity and traceability against that of disappearing foodstuffs, Nelleman et al. (2009) suggest examples of legislative efforts to curb risk associated with criminality, building greater resilience into food chains. However, studies by the Africa Research Bulletin (2013) have discovered that over legislation of food chains cultivates a black-market community, driving food losses higher and exacerbating the challenges of "invisible" and "traceable" supply chains. This lack of "traceability" creating the "invisible supply chain" strengthens the authors' views that food supply chain resilience is a cross-functional process and cannot be mitigated by legislation alone. However, in predicting food supply chain criminality it is crucial that organisations understand the causative factors that influence occurrences of risk, such as criminal factions being able to circumvent existing scientific testing processes, and supply chain actors of complex extended food supply chains needing to navigate the differing cross-border regulations in place (Manning & Soon, 2014).

2.17 Literature chapter conclusion

This literature review chapter commenced with a basic introduction to supply chain, traditional supply chain risk management and food supply chains. It then took a deeper look into the areas

of food supply chain risk, food supply chain fraud and areas of industry specific food supply chain fraud (Agriculture, Dairy and Meat), which identified existent gaps in academic knowledge. Lastly, having reviewed the current body of knowledge regarding food supply chain risk and resilience, a systematic literature review was undertaken to align with the outputs the research study aims to review, namely establishing a degree of fit with building food supply chain resilience (method discussed in Chapter 3). All of these elements fed into the overall research methodology and process of answering the research question *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*.

It was found that whilst there is a significant amount of existent knowledge about traditional supply chain risk, there is a lack of attention paid specifically to the food industry (Diabat et al., 2012; Fassam & Dani, 2017). As such, the author purports this is of great importance as often food supply chains are complex, with larger networks fostering reduced transparency, particularly as actors are located geographically further away, thus permitting minimal physical safeguards (Sarpong, 2014). The complexity and geographic dispersion increase the probability of profit being gained in comparison to the likelihood of getting caught, and thus the vulnerability of food fraud in the supply chain continues (Everstine et al., 2013). This further supports the gaps in existent research around the systems views, particularly with inventory and procurement (Elliott, 2014).

In addition, a number of academic studies have identified motivations behind food fraud, which include economic drivers, supply shifts and pricing metrics (Manning & Soon, 2016), value added product attributes (Grunert & Aachmann 2016), competition levels (Huisman, 2016), previous criminal activities (Baucus & Near 1991), and unethical business strategies (Huisman 2016). Linked to this, the most significant performance measurement suggested pertains to the financial, and in particular to the total cost of ownership, which the author suggests can affect the level of responsiveness to customer, flexibility, food safety and quality time, particularly lead time and process (Aramyan et al., 2007; Bigliardi & Bottani, 2010; Vorst, 2006). Consequently, it appears there is little attention paid to the provenance of food due to consumer priorities, which drive overall food supply chain decisions to focus on cost over other factors (Pustjens et al., 2016; Spink & Moyer, 2011). This cost focus drives uncertain internal management and weak control supervision permitting opportunities and motivations to emerge around fraudulent behaviours (Rodgers, 2012; Van Ruth et al., 2018). However, while there

are a significant number of existent management theories used within food supply chain research circles such as resource based view, network theory, resource theory and theory of constraints, none address the challenges that reside with addressing the research gap around building food supply chain resilience.

The literature review process became the construction of a base theoretical model of existent literature within the food supply chain that go towards building resilience (Table 11). This theoretical representation delivers the 'gaps' within the existent food supply chain fraud literature (Fassam & Dani, 2017). It then sets out 'enablers' with a resilience measure (Manning & Soon, 2016) and management focus (Folke, 2006), which then compare against research of food supply chain resilience building and the 'Triple R' model of resilience building (Manning, 2015; Manning & Soon, 2016). As such, this literature review has delivered on the needs of objectives 1 and 2, by identifying existent gaps in food supply chain food fraud and food supply chain resilience literature.

How the literature meets the gaps:

- The aforementioned challenges around geographic dispertion (Sarpong, 2014) strengthens the argument that gaps in existent research around the systems views, particularly with inventory and procurement (Elliott, 2014).

- Cost driven management decisions (Pustjens et al., 2016; Spink & Moyer, 2011) drive weak control supervision and management which permit behaviours of individuals and organisations to go unnoticed (Rodgers, 2012; Van Ruth et al., 2018). This lack of management focus on the wider systems view, further strengthens the outputs of the UK Government report (Elliott, 2014) and the need to address greater understanding of building resilience in this area.

- Manning, (2015) and (Manning & Soon, 2016) have built the Triple-R model of resilience. However, gaps reside with an over abundance of quantitative and theoretical approaches (Burgess et al, 2006; Carter, 2008), therefore, adopting greater use of practitioner engagement with this research study will permit greater context to be gained.

- Existent management theorties of resource-based view (Zaridis, A., Vlachos, I., & Bourlakis, M, 2020), network theory (Handfield & Nichols, 2002), stakeholder theory (Sarkis et al, 2010) and theory of constraints (Oglethorpe & Hero, 2013) are all aligned to cost and value based metrics, with no attention being paid to food supply chain resilience building. This strengthens the afformentioned gaps with management literature and food supply chain resilience, that was identified within the systematic literature review and the UK Government report (Elliott, 2014).

- Finally, the systematic literature review (Fassam & Dani, 2017), has identified the paucity of existent knowledge in building resilience understanding for food supply chains. Therefore, underpins the afformetioned identifiable gaps already identified, and build upon the research methodologies utilised in this research study (Delphi & Case study).

Academic view on Food supply chain resilience			Triple R food resilience model		
Academic Literature ***(Gaps)***	**Management focus** ***(Enablers)***	**Resilience measure** ***(Enablers)***	**Ready**	**Respond**	**Recover**
Data, Intelligence, Risk	Learning and Innovation	Supply chain dynamics / KPI	Forecasting & Demand supply	Forecasting & Managing SC shocks	Systems feedback
Enforcement, Data, Intelligence	Persistence and robustness	Strategic leadership	Continuous review & Organisational objectives	Decision support & Organisation objectives	Continuous improvement
Authenticity, Enforcement, Risk	Recovery & constancy	Decision leadership	Management support & Evidence based assessment	Management decisions matrix	Continuous improvement

Table 11 Adapted from Fassam & Dani (2017); Folke (2006); Manning & Soon (2016)

Furthermore, these output ‘gaps’ and ‘enablers’ have given a grounding and direction for this research thesis. They will be utilised later in the presentation and discussion of research data [Chapter 4 & 5], to draw direct correlation between research outputs and existent literature in the field of food supply chain risk and resilience.

In summary, the lack of a consistent approach to research into food supply chains coupled with confusion in understanding the difference between “food crime” and “food fraud” is oppressing accountability, authenticity and traceability, thus is a significant area for academia and practitioners alike to collaboratively facilitate resilient food chains. It is clear from the current research that no one solution alone can mitigate risk in a food supply chain; therefore, the research author argues that it is incumbent on business, government and research communities to support and underpin the auspices of scientific testing and legislation by bringing together a triangulated approach (Science, Legislation and Operational) to food supply chain resilience through a collaborative approach to security of supply.

However, this can only be fully addressed by undertaking a more detailed piece of research, which this thesis aspires to do, in order to address the gaps with understanding around building internal resilience against food fraud and the business unit responsible for driving this through the internal and external stakeholders.

3 – Chapter 3 – Methodology

3.1 Objectives

This chapter will detail the methodology and research design, outlining ways in which the approach to inquiry evolved into a research study that met the auspices of contributing to the food supply chain resilience academic body of knowledge. There were many choices to be made regarding methodological approach and which methods to adopt in order to make the study relevant, rigorous and repeatable, whilst ensuring a positive contribution to academic and practitioner knowledge was achieved. Social science research has been underpinned by an epistemological position, permitting an understanding of the process knowledge attainment and validation. Yeung (1997, p. 52) explains how "Philosophy deals with the ontological and epistemological aspects of the social sciences (i.e., what is the social world and why do we do need to research it?), whereas substantive social sciences themselves address the theoretical and methodological issues (i.e., why do social phenomena occur the way they do and how do we research on them?)."

With a specific focus on the field of supply chain management research, social science has always had a broad set of theories associated with the sector [supply chain], which brings about greater understanding of the subject area through the varying means of social research data gathering, and as a result, researchers in the field of supply chain risk management find it hard to define singular theories to support studies (Defee et al, 2010; Lambert & Garcia-Dastague, 2006; Mentzer et al, 2001). Much of this lack of cohesion in supply chain management theory is in part due to the complex nature of supply chains, with the multi-actor approach and intertwined human elements across large and extended globalised chains. Therefore, selecting methodologies is intrinsically associated with challenges of knowledge production and understanding. In addition, while taking into account the aforementioned issues around human elements in differing supply chain actors meant design and methods were critically important for this research study.

3.2 Overview of supply chain management and multiple paradigms

This issue with methodologies and their associated methods within the supply chain management sphere has raged between academics for a number of years, with internationally revered Chartered Association of Business schools publishing papers on this topic (Golicic & Davis, 2012; Sarmiento, Whelan & Sprenger, 2018). To compound the complex issues

associated with social research and supply chain management, a prevalence of studies in the US emphasises statistical modelling over that of empirical methods, with European research promoting greater use of empirical research with supply chain management. This divergence of view creates a clear geographical divide over how supply chain management research should be undertaken, which in itself causes discontent between research academics and creates a greater divide for the practitioners and their understanding. However, despite this geographical divide, there remains a need for research studies that close the 'academic and practitioner' gap to bring about greater understanding of tangible research outcomes (Sarmiento, Whelan & Sprenger, 2018). Therefore, this research study will set out to engage with industry experts to craft a bridge between the divide [academic – practitioner] by striving to meet the research aim: *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*. Through making a contribution to academic and practitioner knowledge, this is a method well recognised for deriving applicable and relevant theory (Alvesson & Kärreman, 2007; Colquitt & Zapata-Phelan, 2007; Van Maanen, Sorensen, & Mitchell, 2007).

The modern extended global food supply chain, as reviewed in Chapter 2 [Literature review], responds to and reflects culture and human behaviours, which can foster subjective decision making. Thus, studies of this nature [human behaviour] require research methodologies that can identify linkages with human interactions and the effect these have on supply chain relationships. Additionally, supply chains in their nature are social and linked with a predominance of subjective [softer] cross – cultural metrics, areas understood to be problematic with supply chain management strategy, for example, the buyer-supplier relationships and anti-competitive behaviours, which are noted as being heavily associated with fraudulent activities within business (Isenberg, 2008; Mello & Flint, 2009). Grounded theory is an approach a researcher can adopt to address the human aspects of supply chain management by being able to deploy an inductive method, recognised as an appropriate and peer reviewed process within supply chain management research (Holland, 1992; Sousa-Poza, Kovacic & Keating, 2008).

Previous supply chain management researchers have developed rigorous research, predominately over the past decade, which has given rise to the supply chain as a legitimate discipline in its own right. However, a number of scholars cite this new discipline as detracting from its original roots within the management field (DeHoratius & Rabinovich, 2011). This has been further compounded by the lack of post-positivist research studies, as identified in Chapter 2 [Literature review] and restricted expansion of a richer field of research approaches,

as seen with other fields of managerial research such as finance, marketing or strategy (Boyer & Swink, 2008; Burgess, Singh, & Koroglu, 2006; DeHoratius & Rabinovich, 2011).

The lack of empirical and qualitative research has been addressed by some scholars utilising surveys, a commonly seen method and approach within supply chain management research (Boyer & Swink, 2008). Furthermore, the over-reliance of mathematical modelling connected to the overuse of survey methods means that supply chain management research is still wedded to positivist (objective) research approaches (Burgess et al, 2006). A detailed literature review (Burgess et al., 2006) posited the need for greater paradigm diversity to develop more comprehensive understanding of the challenges associated with supply chain management. For the development of the field of supply chain management resilience and avoiding staleness permeating within academic research, it is argued that greater depth and breadth be achieved with methodological approaches (Alvesson & Kärreman, 2007; Boyer & Swink, 2008). This is what this research aims to address by taking a more balanced approach to epistemologies through a mixed objective-subjective 'critical realism' approach, detailed later in this chapter.

3.3 Research strategy, philosophy and approach

3.3.1 Research strategy

A research design framework or research strategy can consist of areas such as action research, case studies, experimental or grounded theory (Saunders et al., 2009). The aforementioned abundance in the field of supply chain management of research strategies in the positivist deductive research areas [quantitative] along with computer modelling and simulation had to be considered with this research study. As such, careful consideration was needed for the chosen research strategy direction, as it [research strategy] can be influenced partly by the research questions and extent of existent knowledge in the chosen field of study. which is underpinned by the researcher's chosen philosophical stand point (Saunders et al., 2009; Saunders et al., 2012). The outputs from chapter 2 [literature review] identify a lack of existent knowledge and application in the field of supply chain management, and in particular 'supply chain fraud' and 'supply chain criminality'. Not only is there is a lack of knowledge, the empirical work undertaken is limited, giving rise to a partial understanding as to why the subject of supply chain resilience and fraudulent behaviours gets lost in practice. Therefore, more work is needed in the area as purported by scholars in bringing about greater empirical work in the areas of purchasing and supply chain management, and bridging the

aforementioned geographical divide with academic supply chain management research (Dubois & Araujo, 2007). However, the intersection of varying actor interests within a supply chain means that research strategies should encapsulate the system of systems theory of supply chain management and not confine the research to one actor or organisation (Gorod et al, 2008).

Therefore, the majority of supply chain management research strategies (e.g. modelling and simulation) are arguably not fit for purpose in gaining an appreciation of the 'softer' human side of food supply chain resilience building (Randal & Mello, 2012; Stuart et al., 2002). In order to bridge the challenges of heavily quantitative works, scholars have suggested the need for greater use of case study approaches within supply chain management research studies (Kahkonen, 2011). Therefore, this research will employ a mixed methods approach to include cross case studies in order to answer the research question pertaining to food supply chain resilience building, for which the research strategy will be detailed later within this chapter.

3.3.2 Research philosophy

It may be at times daunting to explore and review one's own stance with regards research and the philosophical positioning that underpins the process of governance to deliver ethically aligned outputs. However, it is a 'must do', being grounded in research and originally conceptualised in 1690 by John Locke, who espoused the importance of researcher abilities to reflect and discuss philosophical ideas (Guba & Lincoln, 2005; Schultz & Hatch, 1996). Nevertheless, it has been suggested that good philosophy is not always a precursor to the production of good research, so one must caution viewing philosophy in isolation when constructing research (Patton, 2002). Thus, researchers should appreciate the holistic research paradigms of which most share three primary elements: epistemology, ontology and methodology (Creswell, 2003; Guba, 1990). Many scholars have argued that a blend of these elements can be utilised to develop good research, with both epistemological and ontological aspects being crucial for good social science (Easterby-Smith et al., 2012).

Despite this ability to blend together primary elements of research, there exists an ongoing debate with scholars over the most appropriate philosophical paradigm for social science and therefore, supply chain management research. There are two extremes of the philosophical paradigm with positivism and social constructivism within social science and management research. The positivist view assumes a socially geared existence which can be assessed

through objective [quantitative] methods (Creswell, 2009; Easterby-Smith et al., 2012). Conversely, social constructivism takes the subjective [qualitative] assumption, gaining knowledge through the interaction of humans with each other (Creswell, 2009). This is due in part to the domain of supply chain management where ontological constructs are centred around inter-organisational relationships (positivist), ignoring the wider holistic social aspects of connected supply chains.

When reviewing the relationship between supply chain actors, there has further been assumptions in the field [supply chain management] that all activities within a chain can be controlled by one actor or focal company (Aastrup & Halldorsson, 2008). Furthermore, some scholars have asserted that supply chain risk, in which fraudulent behaviour is embedded, is dependent on global perceptions and organisation culture (Carter et al., 2015). In addition, it has been suggested that differing cultures and organisations interpret supply chain resilience differently, and at times to suit their own operational environment (Walker et al., 2004). These views have been driven by methodological deductive mathematical methods (Adamies, Papachristos & Pomonis, 2012; Sachan & Datta, 2005), which like the inter-organisation relationship approach is positivist (objective) in approach and once again ignores the social (subjective) interaction of supply chain actors. Many scholars have argued against the dominant deductive positivist (objective) approach of supply chain research, and call for a more balanced paradigm to recognise the subjective nature that resides within the field of supply chain management (Aastrup & Halldorsson; Boyer and Swink, 2008). Therefore, as this research study occupies the space between positivism and constructivism, it can be argued that the ontological positioning should be aligned with the thinking of 'critical realism', a philosophical approach which sits as the interface between the natural and social worlds, and which has the ability to bridge the divide that exists between positivism (objective) and constructivism (subjective). With this direction of research application [critical realism], the use of case studies has been promoted as being able to deliver abductive reasoning outputs within a supply chain context (Aastrup & Halldorsson, 2008; Boyer and Swink, 2008; Sachan & Datta, 2005).

However, 'critical realism', despite having identified benefits in understanding the objective [quantitative] and subjective [qualitative] aspects of supply chain management research, suffers at the hand of being seen as 'at war' with the varying research paradigms (e.g. epistemology, methodology and ontology). Therefore, in order to benefit from a mixed

philosophical approach that recognises the objective aspects of existing theoretical aspects [positivism] allied to the socio-cultural characteristics of human behaviours [constructivism] within global supply chains, one scholarly view argues a pragmatist view can be adopted (Creswell, 2009). While reviewing aspects of research relating to historical, political and social metrics, pragmatism ignores the historical top-down approach of philosophy (i.e. epistemology, methodology and ontology) (Guba & Lincoln, 1994). The central argument for pragmatism lies with the research question and its ability to permit researchers freedom to study a topic in a manner they deem suitable (Johnson & Onwuegbuzie, 2004; Saunders et al., 2009; Tashakkori & Teddlie, 2003).

As outlined above, scholars have explained the need for a balanced approach to research design and output, leveraging both positivist and constructivist approaches and following the primary elements of research paradigms (epistemology, ontology and methodology) that blend together to develop good social science research (Creswell, 2003; Easterby-Smith et al., 2012; Guba, 1990). Therefore, this research will adopt a 'critical realism' approach to address both the objective (positivist) and subjective (constructivist) complexities residing within supply chains (Adamies, Papachristos & Pomonis, 2012), whilst permitting flexibility in research direction, as this study into food supply chain fraudulent behaviours involves different methods of data collection such as case studies, Delphi studies and interviews (Creswell, 2009).

3.3.3 Research methods & methodology

The research design is important for creating justification of the data types, method of collection, analysis method, interpretation and presentation, permitting satisfactory conclusions to be drawn to research questions (Yin, 2009). There is a myriad of frameworks developed across business management theory to facilitate research design, such as the three components of research constructs, namely philosophical positioning, strategic enquiry and methods deployed (Creswell, 2009; Yin, 2009). In order to appreciate the three approaches purported by Creswell (2009) and Yin (2009), researchers must understand the difference between a method and a methodology.

They [method and methodology] have been described as "concerned with the analysis of how research should be undertaken or how it can proceed, in other words, the study of the means of

attaining knowledge of the world, rather than the practice themselves" (Ramsay, 1998, p. 163). Therefore, research methods are often based on researcher assumptions, described as:

> Ontology – "the claims or assumptions that a particular approach to social enquiry makes about the nature of social reality" (Blaikie, 1995, p. 6).

> Epistemology – "the claims or assumptions made about the ways in which it is possible to gain knowledge of this reality, whatever it is understood to be; claims about how what exists may be known" (Blaikie, 1995, p. 6).

Despite these discussions around methodologies, the majority of social research in the area of supply chain management is devoid of philosophical positioning. Instead, much of the research in this field leverages the research gap in existent knowledge to justify the research positioning and approach. In addition, rather than adopting the traditional epistemological approach, research should be underpinned around the theory that went before it (Edmondson & McManus, 2007). Furthermore, Edmondson & McManus (2007) support the use of research methods based on methodological fit against emerging, intermediate or mature theories. However, specifically relating to the area of supply chain management research, it is argued that elitism allied to the methodological debate leads to an unhelpful divide and potentially dilutes overall research aims, with an argument that qualitative and quantitative analysis is required (Koch, 1991).

Therefore, embryonic and under-explored topics such as supply chain food criminality, the focus of this study, should adopt more open-ended and exploratory methodologies in order to create a qualitative base for quantitative techniques to be applied as the research matures. In other words, research gaps and new areas of supply chain management research are better reviewed using a qualitative approach, with quantitative methods coming at a later stage for theory testing.

This research has drawn on grounded theory methods (Glaser & Strauss, 1967), as the limited research undertaken in the area of supply chain food fraud and its evolving nature meant an exploratory approach was needed, especially with the desire to engage with practitioner sector specific experts.

3.4 Research approach and design

Before research studies can begin, it is crucial that the research approach is clearly defined in conjunction with the concepts, methodologies and theories (Edmondson & McManus, 2007; Silverman, 2000). Within these varying approaches there are two recognised routes for a research data approach, quantitative and qualitative. Quantitative research approaches place the emphasis on collecting and analysing numerical data, concentrating on measuring scale, range and frequency. This type of research is harder to design and develop in the initial stages. However, the results attained through quantitative research are usually highly detailed and structured, and the results are often demonstrated using statistical diagrams. Qualitative research approaches, on the other hand, are more subjective in nature than quantitative research, and qualitative methods are synonymous with any data collection technique that generates or uses non-numerical data. Qualitative research usually includes examining and reflecting on the less tangible aspects of a research subject, for example, values, attitudes and perceptions.

The advantage of qualitative research is that it may be easier to initiate data collection than in quantitative studies. However, interpreting the results and the presentation of the findings can often be more difficult than in quantitative research (Edmondson & McManus, 2007; Silverman, 2000). Another downside to this type of research is that the findings, which have an element of subjectivity, can easily be challenged. For the purposes of this empirical study, the researcher decided on a multiple research method approach to minimize the errors caused by single data collection methods. Furthermore, a combination of the data collection methods enabled the researcher to generate further research questions as the study progressed, through the various stages as outlined later in this chapter.

Furthermore, a research approach refers to its alignment to being either deductive or inductive (Table 12), with some studies having benefited greatly from a combination of both approaches (Saunders et al., 2009; Saunders et al., 2012).The former [deductive] relates to the development of a theory and/ or hypothesis, and requires the design of a suitable research strategy to test that theory/ hypothesis. Deductive research starts with reviewing theoretical frameworks attained from a body of previous knowledge (i.e. research studies) that can then be empirically tested (Kovacs & Spens, 2005). Whilst an inductive approach is taken when a theory is unknown at the outset, but is then developed as a result of the analyses of the data collected. Collis and Hussey (2009) also describe deductive research as a study, where a conceptual

structure is developed and then tested by empirical observation. On the other hand, inductive research is a process where a phenomenon is first observed and certain conclusions are subsequently drawn (Cavana, 2001), or, as Collis and Hussey (2009) put it, the inductive approach relates to research where the theory is developed from the observation of empirical reality.

Deduction (Quantitative) Emphasises	Induction (Qualitative) Emphasises
Scientific principles	Gaining an understanding of the meanings humans attach to events
Moving from theory to data	A close understanding of the research context
The need to explain causal relationships between variables	The collection of qualitative data
The collection of quantitative data	A more flexible structure to permit changes of research emphasis as the research progresses
The application of controls to ensure validity of data	A realisation that the researcher is part of the research process
The operationalization of concepts to ensure validity of data	Less concern with the need to generalise
A highly-structured approach	Gaining an understanding of the meanings humans attach to events
Researcher independence of what is being researched	
The necessity to select samples of sufficient size to generalize conclusions	

Table 12 Deductive versus Inductive approaches to research (Eisenhardt, 1989; Kovacs & Spens, 2005; Saunders et al., 2009; Saunders, 2012; Yin, 2009)

There are scholars who debate the former (deductive) approach with the potential to limit data collation due to pre-conceived theoretical positions and potential bias associated with the same (Eisenhardt, 1989; Koulikoff-Souviron, 2005; Yin, 2009). However, despite there being an

argument to begin with a 'zero theory' approach (inductive), a body of scholars suggest flexibility is needed with the research approach in order to build bridges between robust theoretical approaches allied to the agility of inductive design (Koulikoff-Souviron, 2005).

This research, having reviewed the positive and negative connotations of deductive versus inductive, took the blended approach to a deductive-inductive study as purported by Saunders et al. (2009) and Saunders et al. (2012), by systematically reviewing literature in the fields of supply chain food crime and supply chain food fraud, to ascertain firstly the principles in the current body of academic and practitioner knowledge that exist, and secondly to recognise any gaps that exist in order to guide the direction of the research questions and data methods. Subsequently, the study undertook an inductive approach deploying semi-structured interviews, Delphi study and case study examination to reach the research aim: *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'.* There are scholars who suggest the combination of deductive and inductive approaches makes an abductive approach to research (Dubois & Gadde, 2002; Saudners et al., 2009), which is the approach this research study into supply chain food fraud resilience will take.

In the latter stages of the research studies and once the deductive approach was completed through a systematic literature review, the study takes the aforementioned inductive approach commonly associated with grounded theory. To understand grounded theory and its significance for this study, it is important to appreciate it can be applied to academic research across many philosophical paradigms from the positivist to interpretivist (Meredith et al., 1989). However, there can be a direct correlation and leaning towards the positivist paradigm with grounded theory (Campbell & Stanley, 1963; Hair et al., 2010). This leaning towards the positivist paradigm with classical grounded theory does not blend well with this study and its desires for a blended 'critical realism' approach. However, Rahmani and Leifels (2018) suggest the need for a shift in epistemological view with grounded theory to a more pragmatist view, thus making grounded theory more applicable to the researcher's aim to review research gaps ahead of robust theory creation. This is further strengthened by scholars who claim wholly deductive approaches restrict the development of theory (Bell & Bryman, 2007; Green et al., 2009). Therefore, to leverage the inductive approach and embrace the abductive process of understanding objective and subjective aspects of food supply chain management resilience

building, this study will adopt an abductive grounded theory process (Rahmani & Leifels, 2018).

However, there are drawbacks to classical grounded theory (Dubois & Gadde, 2002; Saudners et al., 2009), as it has the potential for bias due to arguments associated with other interpretations that can arise from the data. In order to eradicate as much bias as possible from results, this research study deployed a Delphi study to compare and contrast the research questions with a separate set of participants. The results of this were then triangulated with a semi-structured interview process, meaning the deductive approach of gap analysis in identifying the current gaps in research can be ratified with the inductive approach of industry practitioner expertise in building theoretical outputs.

3.5 Triangulation

Triangulation generally has been considered a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation (Stake, 2008).

It [triangulation] assists in identifying the realities that are either similar or dissimilar, using differing methods to achieve this (Stake, 2008). One of the aforementioned challenges with the quantitative research endemic within supply chain management studies is their rather siloed approach to research conclusions, that can at times reflect only systematic bias or limitations. With many of the gaps identified within the literature pertaining to the 'softer' human side of supply chain management, it can be argued that humans are the element that need engaging with in order to gain a deeper appreciation of the challenges associated with the research topic of food supply chain resilience (Fontana & Frey, 2005).

Furthermore, triangulation also enables researchers to gain a more detailed appraisal of the study's conclusions and credibility (Maxwell, 1996). Thus, research studies that adopt triangulated methods are seen to have greater levels of trustworthiness in the interpretations of results and therefore outcomes than singular methodological research approaches.

Therefore, to align rigour with research and permit credibility with results, and to be able to begin to bridge the gaps between the subjective human nature side of food supply chain resilience and the objective quantitative elements, this study will adopt the multi-methods triangulation approach of Decrop (1999). This approach is a frequently utilised method of

triangulation deploying interviews and secondary data analysis to permit robust and reliable research outcomes.

3.6 Research design: A cross-cultural, comparative case study approach

This research employs a 'critical realism' abductive grounded theory approach, following the qualitative stance used in a multi-methods approach, a method supported by extensive research into the connection and validation of outputs (Bloor et al., 2015). In order to bring together the much-needed aforementioned empirical mixed methods approach discussed in the research strategy portion of this chapter, it is suggested that a case study be used as an empirical investigation process that permits realisation of actual events (Robson, 1993). This case study meets the needs of the chosen philosophical approach of this study, and in particular, the inductive and subjective understanding of the human aspects of food supply chain management and resilience building. A case study exploration is normally deployed to gain this 'real world' appreciation, and in the relation to this research study will be reviewed across food supply chain actors (Yin, 1994) to explore the degree of fit with empirical views through semi-structured interviews and predicting change through a Delphi study, both of which will be detailed later in this chapter. Use of case studies permits the establishment of models, frameworks and theories from the outputs, particularly in diverse and under-researched areas (Stake, 2008).

There is, however, a prominent debate between scholars over the use of case studies versus surveys, which is not prevalent in the supply chain management field due to its positivist approach to methods permitting generalist approaches to creep in (Boyer & Swink, 2008). There are scholars who argue against this theory, citing the use of case studies as positing theoretical positions (Stuart et al., 2002; Yin, 2009). Nonetheless, in keeping with the earlier discussions around research strategy and positioning, this study positions itself in favour of the latter view, by deploying positivist and constructivist approaches through the abductive grounded theory. This abductive approach mitigates against recognised drawbacks associated with mixed methods approaches, aligning itself well with deductive and inductive approaches (Johnson & Onwuegbuzie, 2004; Morse, 2005; O'Cathain, 2010; Parry-Langdon et al., 2003). Furthermore, using a Delphi study with mixed methods approaches is seen as creating 'member validation' with research outputs, further mitigating against the drawbacks of triangulated mixed methods (Denzin, 1970; Emerson & Pollner, 1988; Tashakkori & Teddie, 2003).

Therefore, in attempting to bridge the academic-practitioner gap that exists within food supply chain management resilience, this research will leverage the mixed-method abductive grounded theory approach to reach the research aim: *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'.*

3.7 Systematic literature review

The research process followed in this study consisted of three steps. First, at the initial stage of the research, problems were identified from a preliminary review of the literature. This research employs a systematic literature review (SLR), which affords a well-defined and coordinated facilitation of research gap analysis for researchers, across areas of literature which are often contradictory and subjective in approach (Denyer & Tranfield, 2006; Tranfield et al., 2003). As such, a systematic cataloguing of current research was undertaken through an iterative method to identify, explicate and refine across research databases to ascertain the significance of the reviewed research (Clark & Oxman, 2001; Tranfield et al., 2003). To ensure appropriate rigour and objectivity in the overall process, the authors conducted the analysis individually using a common framework to give validity to the research outputs, as suggested in the systematic literature review processes supported by Duriau et al. (2007), Rousseau et al. (2008) and Tranfield et al. (2003).

In the initial review of food supply chain risk literature and considering recent events affecting food chain actors e.g. the Horsemeat case, the emerging nature of food supply chain criminality and food fraud was identified. This created the focus for the study and a multi-stage search process was adopted. This enabled an inclusive search criterion at the outset, setting the scene for the wider context of food supply chain food crime and fraud (including but not limited to academic journals, books, news articles, practitioner journals and government articles). This initial search utilised the keywords "Food crime", "Food fraud", "Authenticity", "Procurement", "Risk & Resilience" and "Traceability" all prefixed by "Supply chain", presenting 97, 220 results. The researchers then re-examined this body of knowledge within the supply chain risk and resilience sector and applied a concentrated search for "food fraud" and "food crime" areas that were prevalent in the Food Standards Agency and UK Government reports (Elliott, 2014; FSA, 2016), which offered 7, 623 (1, 456 peer reviewed) and 9, 839 (1, 150 peer reviewed) articles respectively, with a high concentration of findings pertaining to scientific approaches to food criminality (Figure 3). Therefore, in order to meet the outcomes of governmental research and gain insight into the cross-functional understanding (DEFRA,

2013; Elliott, 2014; FSA, 2016), the research process further examined journals to assess relevance in the field of business [supply chain], with the authors selecting a detailed review of the subject area using only the search criteria "supply chain food fraud" and "supply chain food crime" against an inclusion criteria of peer reviewed academic journals, which delivered a return of 91 and 42 respectively. The authors then applied the additional criteria against the Chartered Association of Business Schools (CABS) research catalogue due to its international acknowledgement and impact in the sector of business research, yielding 5 peer reviewed papers under the aforementioned search criteria.

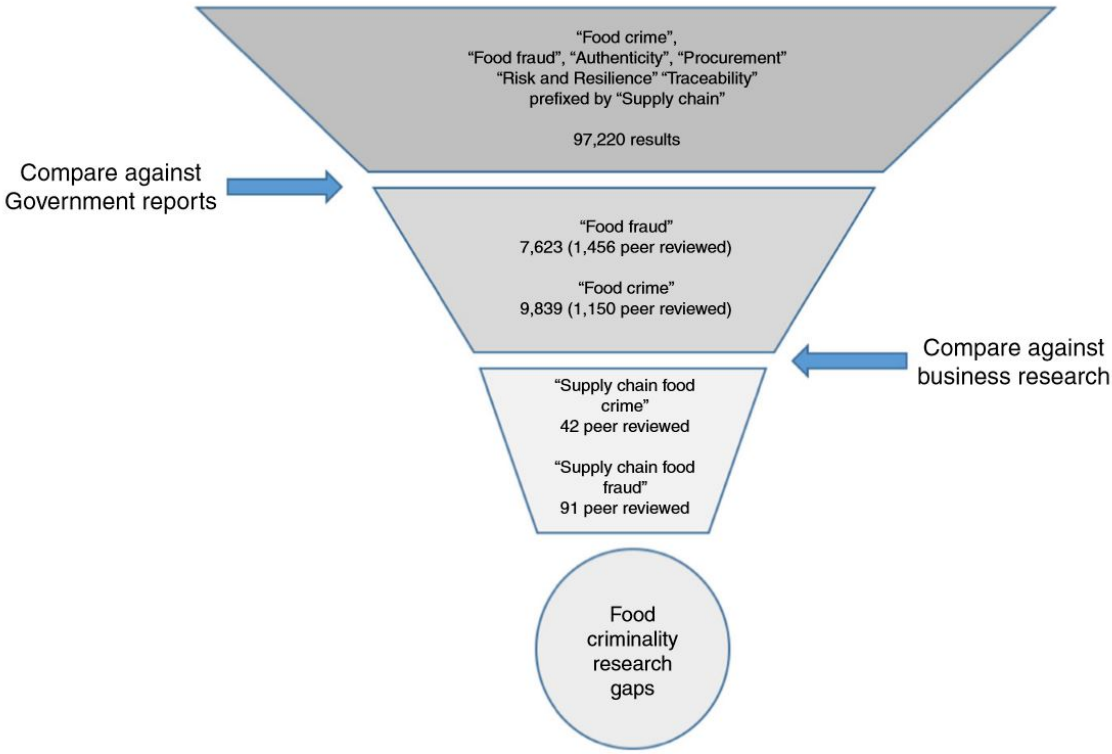

Figure 3 Systematic literature review process

The concluding phase of assessment analysed the UK Government report into Supply Chain Food criminality, particularly the eight pillars of food supply chain criminality prevention: "Consumers, zero tolerance, intelligence gathering, laboratory testing, audit, government support, leadership and crisis management" (Elliott, 2014, p. 15). A comparison was made of the eight pillars set against the focussed peer reviewed papers to assess the relevance of existing thinking within academic and practitioner circles, to achieve insight into the research gaps across thematic areas.

This process involved stages of revision of the original ideas until gaps were identified within the area of research interest. Several potential research questions were generated from the research problems. The literature was thoroughly checked to determine whether those questions had been answered. The research aim was then identified based on the final selection of research questions, and the research objectives were derived from the main aim, being refined several times in the process. Then, to answer the research aim, literature was further studied to establish an appropriate theory. Key concepts or variables involved in the subject of research were also identified.

3.7.1 Expert panel focus group

Qualitative research usually supports the resolve and ability of the researcher in developing representative samples from their chosen area and due to their in-depth approach to research with a good understanding of what is needed to achieve good probability sampling (Malhotra & Birks, 2007). Given the lack of research into the area of food supply chain criminality and fraud, as identified in this study's systematic literature review, it was clear that an approach embracing theoretical sampling of groups into a case study was needed. Therefore, participants for the semi-structured interviews were chosen based on their relevance to the industry, adding theoretical relevance (Dubois & Araujo, 2007; Eisenhardt, 1989; Stuart et al., 2002).

As the study was underpinned by the UK Government report into food fraud, the criteria for inclusion in the research were three-fold:

- Participants must be a UK business with global reach in a food supply chain context.
- All participants must have been at a minimum middle management within the food industry for 5+ years.
- Participants must be involved with creation of supply chain strategy.

Initially, access was given to the Musgrave Food Group Ireland, where the researcher had previously worked as Head of Supply Chain, and had encountered numerous challenges with integrity within the food supply chain. Access to this group (Musgrave) gave a valuable insight into the correlation with the literature and practitioners' view. It became soon apparent, given the breadth of the topic, that a focus group to undertake pilot research was needed, and through the many industry contacts a group of 30 food supply chain industry professionals were formed

and aligned to the auspices of good abductive theory research (Binder & Edwards, 2010; Curtis et al., 2015; Rahmani & Leifels, 2018).

	Food processor	Food logistics	Food retail	Food Policy
Director	3	5	3	1
Senior Manager	4	4	4	4
Policy Advisor	0	0	0	2
	7	9	7	7

Table 13 Focus group participants

The members of the focus group were chosen based on the aforementioned criteria, and came from a variety of industry sectors, with a vast array of experience within the food supply chain process (Table 13), and chosen for their role within the food supply chain and encapsulating a farm to fork approach to include processor, logistics provider (including warehousing), retail operator (including convenience retail) and policy advisors (including DEFRA and members of the National Food Crime Unit). This panel for the focus group was an expert panel for reviewing the literature from both academic and practitioner perspectives prior to the Modified Delphi, giving the basis of a cross-functional food supply chain strategic leadership team to give direction for the study (McKenna, 1994; Skulmoski, Harman & Krahn, 2007). This initial focus group was tasked with reviewing the current literature against their own experiences, and that of the research aim: *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*. In addition, outputs from the focus group were analysed for key themes, and to give alignment for use later on with the Modified Delphi study and case study involving semi-structured interviews, a process aligned with semi-structured research that utilises triangulation as a method of validation (Binder & Edwards, 2010; Bloor et al., 2015; Curtis et al., 2015; Rahmani & Leifels, 2018).

3.8 Delphi study

3.8.1 Applicability of methodology to support research question

The research study undertook a Delphi study as part of its methodological process in reviewing resilience building in food supply chains against criminality, in order to meet objective 3 of this research for identifying the capabilities for internal resilience building and business unit for leading the implementation of the resilience measures. This [Delphi] has been upheld as a proven and efficient method to elicit opinion around a subject area where little data is available, such as with food supply chain fraud, as outlined by the systematic literature review in this research study (Fassam & Dani, 2017; Kache & Seuring, 2017; Linston & Turoff, 1975; Riggs, 1983; Rowe, Wright & Bolger, 1992). Furthermore, prior research in the field of supply chain risk management has upheld the Delphi process as a way to get experts in their chosen field to form panels of expertise that permit horizon scanning of future business events. These events are purported as repeatable in likelihood of recurrence; therefore, assumptions can be formed that Delphi research responses converge towards a mid-range dispersal (Johnston, 1976; Ng, 1984).

3.8.2 Different types of Delphi techniques

In order to deliver outcomes for the research process that were robust and aligned with need, a review of the differing Delphi techniques is needed to appreciate alignment of fit. In reviewing, five of the most popular Delphi processes were considered (Table 14).

	Classic	Modified	Policy	Decision	Real-time
Participants	Expert (any)	Expert (any)	Expert (Politician)	Expert (Any)	Expert (Any)
Key outcome	Future events	Future events	Decision policy	Decision topic related	Future events
Potential bias	No	No	No	No	Yes
Comments	Face to face, lengthy	Flexible to research needs, i.e. e-surveys	Only suitable for policy driven research where metrics are known	Only suitable for research where outcomes are now inputs for consensus decision	Mitigates drop out rates, but permits peer pressure issues to arise

Table 14 Types of Delphi study

Classical Delphi (Original)

The classic Delphi was developed to remove any bias associated with peer pressure in some more traditional research methods. By eliciting anonymity in the process, expert engagement is more connected to the topic in hand, rather than being concerned with issues around confrontation of answers with peers in open groups. This direct confrontation can involve hurried answers, or a tendency for opinion to be swayed by others (Dalkey & Helmer, 1963, p. 458). However, the anonymity can pose challenges in some circumstances, with an argument residing that anonymity can result in a lack of being accountable for one's responses (Sackman, 1974). In order to avoid this issue, it is important that experts are chosen with care, ensuring a good mix of organisations and experience is achieved (Kache & Seuring, 2017; Ng, 1984).

The Classic Delphi is an iterative process that solicits outputs over a number of differing rounds. Within all the Delphi processes, there is no prescribed number of rounds required,

however, the standard number of rounds is three (detailed below). The first stage of the Delhi involves the use of an 'open' question. In order to maintain a process where no bias exists, research leads need to be wary of steering results within this initial stage. A way to avoid this research bias creeping in to initial stages of the Delphi is to adopt an open-ended question based on a literature review (Hsu & Sandford, 2010).

> Round 1 - The initial open-ended questionnaire is critical as it serves as the foundation for everything that follows. As this is such a key element, researchers need to be careful not to slant or bias this initial questionnaire in order to direct the outcome desired by the researcher inadvertently. As noted by Hsu and Sandford (2010), as an alternative to an open-ended question from the researcher, some researchers will base the initial literature on the current literature.
>
> Round 2 – Within the classic Delphi participants are given a summation of the answers from the first round. In accordance with anonymity, this round [two] delivers this consolidated answer sent back out to participants in order to rank these outcomes in order of importance.
>
> Round 3 – Participants get the set of answers from round 2 once again, are asked to score once again in order of ranked importance and to identify a top set of critical metrics overall.

Modified Delphi

A modified Delphi is a classic Delphi that has been modified in some way to suit the needs of the research study. One of the most common modified Delphi methods is one which utilises a focus group to elicit answers and utilises some form of quantitative process to determine whether further rounds are needed (McKenna, 1994; Skulmoski, Harman & Krahn, 2007). As with the classic Delphi, in order to remain bias free, the anonymity of participants must be upheld. Therefore, care must be exercised with use of focus groups, with the preference being that these groups be undertaken on a one to one basis to avoid bias and peer pressure (Dalkey & Helmer, 1963, p. 458).

Policy Delphi

The third Delphi for consideration relates to policy [Policy Delphi], which has the overriding aim of making a decision from the collective Delphi expert participants. Participants usually comprise members of lobby groups or politicians, and like the classic Delphi, it maintains anonymity throughout the research process (Crisp et al., 1997, p. 117; Rauch, 1979, p. 162).

Decision Delphi

A decision Delphi brings together experts to deliver an overarching decision at the end of the process, much like the aforementioned Policy Delphi, however, using industry experts rather than politicians. This [Decision Delphi] differs from the Classic Delphi in that it reaches a consensus on decision, rather than on fact (Rauch, 1979). In being decision-focussed, it is suited to outcomes where inputs are already clear and understood, opposed to research areas that are little explored.

Real Time Delphi

A Real-time Delphi differs significantly from that of the Classic Delphi in that it garners consensus in an open manner, with all participants able to see the responses of others, often discussed as the 'consensus conference' (Gnatzy et al., 2011). Despite this method [Real-time] being better at mitigating against drop-out rates, it does not deal with the issues of anonymity, therefore, it can be open to potential bias or coercion creeping in.

Overall, whichever type of Delphi that a researcher deploys, the reliability of the study is enforced and underpinned by the experts involved. In order to maintain the best results and remove bias, anonymity is of paramount importance (Ogden et al., 2005). Although drop-out rates with the Delphi are important to mitigate, the adoption of a 'Live Delphi' could be argued as permitting bias and coercion in the study. Furthermore, by having a more considered approach to Delphi, and not being live, this gives participants time to consider their answers, which strengthens the outputs of Delphi research studies.

Therefore, in order for the study to remain closely allied to the Classic Delphi, while adding in the flexibility of using an e-platform to collate data, the study is validated with a focus group and employs a quantitative method to ensure the correct amount of rounds are used, meaning this research employs the 'Modified Delphi'.

3.8.3 Applicability of methodology to support research question

This research employed the Modified Delphi technique to compose a list of food supply chain issues with a particular focus on building resilience against criminality into food supply chains. Delphi methods have proven to be an efficient survey method when only a limited amount of data on a topic is available (Linston & Turoff, 1975; Riggs, 1983; Rowe, Wright & Bolger, 1992), and therefore they were chosen for this study due to limited academic research available in the arena of food supply chain food fraud and food supply chain food crime, as well as to take a practitioner approach to research validation (Fassam & Dani, 2016; Kache & Seuring, 2017). Previous Delphi research has utilised experts to form judgement panels about the likelihood of future events and recurrence of similar instances occurring, therefore, building an assumption that the wide range of responses would be distilled and converge toward a mid-range distribution (Johnston, 1976; Ng, 1984). Furthermore, Delphi study research is recognised as a process flow for collecting expert opinion permitting researchers access to previously unexplored issues, which was deemed by the researcher here as important given the lack of perceived understanding on the subject of criminality and fraud within the food supply chain sectors (Garrod & Fyall, 2005; Green et al., 1990; Padel & Midmore, 2005).

Research reliability is reinforced by eliciting the opinions of the experts, allowing each expert to review the opinions of other participants with an assurance of anonymity, which avoids issues of bias or coercion that may be presented during focus group or discussion scenarios (Ogden et al., 2005; Sackman, 1974). Furthermore, to increase the validity of data received, reduce research fatigue and mitigate against respondents dropping out of the research study, the authors deployed a 'live' Delphi approach which facilitates an almost immediate feedback loop (Geist, 2010; Gnatzy et al., 2011). However, rather than adopting the 'live Delphi' approach whereby all experts are in the room together, this study allowed all respondents to see all answers in an anonymised fashion, to protect against elements of peer pressure bias (Ogden et al., 2005). Each expert member provided individual recommendations or opinions on the central research question: *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*. These were then circulated to the other participating members so that a consensus could be formed through collaborative review. Owing to its quantitative, expert-based nature, the Delphi technique is useful in situations where statistical options are not practical, such as under-researched areas like supply chain

food criminality and fraud. The technique also allows respondents time to reflect and provides them equal opportunity to contribute.

3.8.4 Selecting Delphi experts

For Delphi studies to be a success, the selection and engagement of the experts is critical (Kache & Seuring, 2017; Ng, 1984; Rowe et al., 1991). The expert panel for this study comprised expert practitioners for the Modified Delphi that were drawn from a variety of positions within food supply chains, including:

- Representatives from leading logistics and supply chain bodies (i.e. Chartered Institute of Logistics and Transport, Chartered Institute of Procurement and Supply)
- Members of the UK Food & Drink Federation
- Members of European Commission food supply chain projects
- Employees of the top 100 FTSE food supply chain firms

In total, 20 global supply chain experts, like in the focus group, were from strategically relevant positions (Table 15) and engaged in the Modified Delphi process delivering a sample size accepted as robust and relevant to delivering appropriate outcomes (Kache & Seuring, 2017).

Job title	Number of participants
Manager Finance	2
Manager HR	1
Director, Operations	2
Director, Finance	2
Director, Procurement	3
Plant manager	2
Director Supply chain	3
Director logistics	3
Manager Supply chain	2
	20

Table 15 Modified Delphi participant role

Delphi expert participants not only represented differing roles within food supply chain organisations (Table 15), they also belonged to different sectors within the food supply chain. The study chose to have a mixed representation from different food supply chain nodes (Table 16) in order to get a representative holistic view of challenges with food fraud and supply chain integrity pertaining to the research question of *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*.

Industry	Number of participants
Food manufacturer	5
Food retailer	4
Food distributor	5
Food service	3
Food processor	3
	20

Table 16 Modified Delphi participant sector

The academic literature suggests that potential challenges are seen with the larger organisations and the buyer-supplier conundrum and associated risk sharing issues with contract management across extended supply chain (Ghadge et al., 2017; Nyaga et al., 2010). Therefore, engagement with Delphi participants was undertaken with food supply chain experts from varying business sizes from SMEs through to global blue-chip corporates. The participants from these were validated through the selection process experience of risk sharing and contract challenges with food supply chain management (Table 17).

Organisational annual turn over	Number of participants
< £1M	2
£1-£5M	4
£5 - £10M	1
£10-£20M	5
£20M+	8
	20

Table17 Modified Delphi participant organisational turnover

3.8.5 Data collection process and response rate

The Modified Delphi study data collection was conducted across the period of January 2018 (Round 1), March 2018 (Round 2) and April 2018 (Round 3), with the turnaround time for responses from participants being within one week of instigating each round. Round 1 of the process saw an email be sent to all 20 respondents asking for their view on the research question of 'the challenges associated with food supply chain resilience from a food criminality perspective'. Prior to each round the integrity of the questions were checked for consistency and that they were comprehensive in approach by pre-testing with an independent academic expert of food supply chain management, an approach [pre-testing] that is suitable for ensuring reliability of the research approach (Von der Gracht & Darkow, 2010). All 20 experts involved from Round 1 of the study through to Round 3 gave a response rate of 100 percent at each stage, therefore, the study suffered from zero response dropout rate.

3.8.6 Delphi process

To address the study research question of *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?',* a standard three-phase Modified Delphi research methodology was developed, in line with the thinking that greater differentiation of results is not seen by adding further rounds of questioning but it is proven to permit expert feedback from participants to mitigate against research fatigue and foster greater reliability (Kauko & Palmroos, 2014; Okoli & Pawlowski, 2004). Across the three rounds

individual frequency distribution was evaluated to gain understanding of expert views to thematic relevance. Additionally, a mean value (x) was calculated for each thematic area to permit a mean value to be achieved for each question, with the final round checked against a coefficient of variation to review whether responses would change with further rounds (Dajani, 1979; English & Kernan, 1976). The coefficient of variation was chosen over other statistical methods associated with Delphi research such as Pearseon (r) or F-Test (F) due to the coefficient of variation displaying lower skewness of results (Shah & Kalaian, 2009).

In order to get a starting point for perceptions of building resilience against food fraud in supply chains, this research undertook an initial phase [Pre-phase] of the Modified Delphi study as there was limited academic knowledge in the area of food supply chain fraud resilience building (Fassam & Dani, 2017). The first process [Pre-phase] posed the question 'What are the internal constructs to building resilience against food fraud in supply chains?' to the twenty participants and in particular, aimed to establish from their extensive professional experience what are the 'top 10 challenges associated with building food supply chain resilience against food fraud'. Utilising this expert panel in this manner enables differing views to be collated, fostering high quality responses that can be aggregated into reliable research outputs (Gupta & Clarke, 1996), which during the first phase [Pre-Phase] elicited a total of 200 answers. On return of data, the researcher then spent a significant period of time reviewing the 200 initial responses, initially removing duplication and aggregating into groups using qualitative cluster analysis (Revelle, 1979), which reduced the amount to 46.

The next step [Phase I], the second round of the process, involved sending out the 46 aggregated topics to the 20 Modified Delphi participants, where each was scored against a LIKERT scale 1-5 (1 strongly disagree – 5 strongly agree), assessing the degree of fit with supply chain resilience and food criminality. The Modified Delphi results were returned and analysed by the research team and ranked in order of highest LIKERT score attained.

The next steps, rounds 3 [Phase II] and rounds 4 [Phase III], were undertaken in a similar fashion to Phase I, with the 46 aggregated answers being sent back to respondents to re-score. During this phase, participants could not see their original scoring or that of any other participants in order to remove any potential bias.

To utilise the process of understanding when to cease further rounds of the study, known as the stopping rule, the research used a Coefficient of variation (CV), a recognised statistical test to ensure completeness and robustness of outcomes, while indicating the end point of a survey (English and Kernan, 1976; Yang, 2003). Furthermore, the coefficient of variation is the measure of standard deviation (σ) to its corresponding mean (μ), noted as the most reliable tool for ensuring statistical relevance with a Delphi study (Shah & Kalaian, 2009), and using the formula:

$$CV = \sigma / \mu$$

In the majority of cases, the coefficient of variation was below <0.2 (26 responses in total), which, according to Dajani (1979), is a minor difference and therefore concludes that stability was reached in the research outputs with no further rounds of a Modified Delphi being required. However, towards the lower end of the scale (responses >26), a coefficient of variation was noted as registering just above 0.2, suggesting any further rounds would require these statements to be reworded (Kernan, 1976), therefore 20 items were precluded. Furthermore, in order to reach a consensus with the outputs of the Modified Delphi that are rigorous for further exploration, the Modified Delphi included only outputs with values of CV <0.01. This limits the variation of response between experts, meaning that outputs are more robust and statistically relevant to the research question (Kalaian & Kasim, 2012). Therefore, for the purposes of statistical rigour, the research study only reviewed the responses with a coefficient of variation of less than <0.1, as the Modified Delphi process was designed within the confines of this research thesis to review and deliver a focussed set of meaningful measures for utilisation by academics and practitioners alike.

When reviewing the process of statistical relevance, this research, once having deployed the 'stopping rule' to the Modified Delphi ,utilised the process of the coefficient of variation and the MEAN to determine degree of importance with ranking results (Hasson, Keeney, & McKenna, 2000; Hsu, 2007), which ensures research is repeatable and aligned with the robust methods that match with an understanding of ceasing to repeat the process and outputs that are identified in order of importance.

In addition to the three-phase Modified Delphi, and following engagement with the expert focus group (Table 13), a further process was added to assess factors associated with

quantitative data analysis across multi-stakeholder approaches to permit strategies around decision making to develop a process upheld as relevant and rigorous in research (Rice & Spayd, 2005). This additional approach resolved to review stakeholders that the UK Government report into food fraud (Elliott, 2014) identified as relevant to building resilience, as this [stakeholder] had been a clear gap in the business academic literature. The top 10 from the final round 3 Modified Delphi were returned to participants electronically, who were requested to rank in order of importance the elements from the Delphi top 10 that pertained to the departments responsible for Finance, Government, HR, IT, Marketing, Operations (logistics), Procurement and Quality. This was done in order to gain an appreciation of the experts' views on responsibility, and to ascertain any themes or gaps in the perceptions of supply chain resilience and food criminality.

3.9 Semi-structured interview process

As outlined earlier in the methodology, this study uses abductive approaches where no hypothesis is required. As such, this type of research relies on patterns forming to develop concepts and theories (Gummesson, 2000). Therefore, following on from the previous two stages of research data collation [Focus group & Modified Delphi], the study adopted a case study review comprising of semi-structured interviews with procurement professionals. The outputs of the Modified Delphi identified procurement as being closely linked to building resilience with the top 10 round 3 Modified Delphi outputs, and therefore, a food sector specific [procurement] approach through adopting a 'selective' case study was needed in order to review in more detail, and as part of a robust research validation process (Dubois & Araujo, 2007; Hakim, 1987).

3.9.1 Selection of interview subjects

The process for inclusion for semi-structured interviews was similar to that of the focus group, whereby participants were chosen for their relevance within industry (Dubois & Araujo, 2007; Eisenhardt, 1989; Stuart et al., 2002). In doing so [selection], a key area for consideration is purposeful sampling, which is a process of selecting respondents deliberately and associated with a specific group or demographic, and which is well suited to research using smaller sample sets (Ritchie et al., 2003). Being purposeful with participant selection [purposeful sampling], this study uses judgement that was gleaned from the outputs of the Modified Delphi and Focus group to deliberately select cases for inclusion related to procurement (Babbie, 1998; Merriam,

1998). In adopting this approach, the study addresses the two key aims of purposeful sampling (Ritchie et al., 2003), which will be explained below.

Firstly, diversity is achieved within the sample, with the research study engaging with participants who hold differing roles from varying industries at different stages of the food supply chain. While the research attempted to address gender bias, it was not possible given the current make up of organisational employees. Based on the need to review procurement professionals within the food industry, the semi-structured purposeful sample of case study participants followed the selection methods seen with the Modified Delphi. In doing so, participants were approached from differing sections of the food supply chain (Table 18), which not only gave diverse views across the food supply chain, but also addressed the diversity requirement needed in similar studies (Ritchie et al., 2003). Furthermore, to ensure balance was achieved with each node of the food supply chain, this study had a balanced approach to role inclusion, meaning each case study included was similar in number and position within the organisation, ensuring subject matter was balanced and relevant (Ritchie et al., 2003).

	Food processor	Food logistics	Food retail	Food consulting
Director	1	1	1	1
Senior Manager	2	2	2	2
Buyer	2	2	2	2
	5	5	5	5

Table 18 Semi-structured interview case study participants

While it was important to have case study participants from a procurement function and at differing levels within the organisation, the need for the complete food supply chain view was important to capture within the semi-structured interview process. This was deemed important as outputs of this study had identified food supply chain fraud mitigation to be under-researched in the literature, with a theme in the Modified Delphi arising in relation to the

procurements link to food fraud mitigation in supply chains. Therefore, case study organisations were chosen in a 'selective' manner, an approach upheld by Hakim (1987) as being relevant with studies where case study approaches need to focus on a particular area, in this case, procurement. Therefore, due to the significant experience of this PhD study's researcher in the supply chain context, it was felt that having organisations involved with case studies that have a business relationship would enrich the research results. Furthermore, in order to get a connected supply chain view, organisations were chosen that had a transactional relationship. This was undertaken to garner outputs across connected multi-organisational connections, analysing and reviewing themes between the differing supply chain actors connected to procurement and food supply chain resilience building. Furthermore, although the organisations were connected through business tractions, the participants in each organisation were anonymised and not aware of the cross-supply chain semi-structured interview process in order to mitigate against issues of peer pressure and bias.

The organisations approached and included in this study were chosen due to their transactional relationship with each organisation. This gave a grouping of organisations and a view of representative food chain actors. However, a potential drawback was the lack of upstream growers (farmer). Due to the complex nature of ingredients sourcing within the food supply chain, particularly at SKU level, and after consultation with the focus group concatenate reviewing academic literature in the field of food supply chain resilience, it was deemed out of scope for this particular research study. Specific detail on case study organisation will be discussed in the next section [3.9] of this thesis.

	Food processor	Food logistics	Food retail	Food consulting
Turnover	> 1 Billion	> 0.5 Billion	> 3 Billion	> 3 Million
Employees	>500	>500	>500	>50
Location	Northampton, UK	Northampton, UK	Dublin, Ireland	Cork, Ireland

Table 19 Case study participant breakdown

In addition, qualitative studies are usually small in size, and while Ritchie et al. (2003) claim there is no relevant size or scale to determine statistical relevance, there are differing views in academia on sample size. In order to gain the diversity needed with case studies and statistical relevance with case study research, there are two arguments, as explained below.

Firstly, it is suggested circa twenty cases be utilised when studies are wanting to undertake triangulation as a method of review (Lewis, 1998). Others, such as Eisenhardt (1989), espouse anywhere up to 10 cases can deliver robust results. It is therefore important to understand an approach which will deliver an appropriate number of cases while remaining statistically relevant. A more recent approach is one where studies review the saturation point of data collation, ceasing when results remain static [no change], rather than focussing on case study numbers and the contra-arguments relating to the same (Idrees et al., 2011; Kaufmann & Denk 2011; Manuj & Pohlen, 2012; Mason, 2010). Furthermore, 80% of PhD research studies have been found to contain 15 participants for qualitative research study (Mason, 2010). Therefore, it is argued that saturation can be achieved with relatively small sample sizes (Mason, 2010). To further validate the research approach sample sizing, it is recommended to have a maximum of 10 participants per case study to deliver appropriate and robust results (Creswell, 2009). Thus, this study into the challenges associated with food supply chain resilience adopted a process of engaging with 5 participants from each case study selection across the businesses within the UK and Irish food sector. All participants were active in the global food supply chain, with hypothetical saturation of results achieved with this sample size (Eisenhardt & Gtaebner, 2007). Therefore, by having 20 participants across all case studies this research met the needs of sample size recommendations with PhD research (Mason, 2010), while addressing saturation and sample size challenges at individual case study level with 5 participants each (Creswell, 2009; Mason, 2010).

3.9.2 Case study organisations

This section of the thesis will outline the four case study organisations who participated in the semi-structured case study analysis. An overview will be given of the industry, market size, regional coverage and link to the food supply industry. The process for inclusion for semi-structured interview case study organisation was similar to that of the focus group. Participants were chosen for their relevance within industry, while the process [case study] was well suited to smaller sample sets (Dubois & Araujo, 2007; Eisenhardt, 1989; Ritchie et al., 2003; Stuart

et al., 2002). Lastly, this process was chosen as a way of eliciting a purposeful sampling method to meet the research object 4 of understanding the internal constructs of resilience building against food fraud (Ritchie et al., 2003).

3.9.2.1 Food producer (FP)

The food producer involved with this research study ranked in the top 200 Fortune 500 companies and encapsulates 37 food brands back to 1906. It has a global turnover of £21 billion, with 39% of this taking place within the case study catchment area of Europe. Within the region of Europe the case study organisation employs 12, 000 people across its network, which are dispersed across 20 countries. Across this organisational make up there are 9 manufacturing sites that are linked to 3 research and development centres. It has circa 14, 500 stock-keeping units (SKUs) across the categories of beverages, grocery retail and snacks, with key lines making up 38% of the market share within Europe. To support its food supply chain the case study participant utilises on average 3, 500 trucks per day to support distribution of food stuffs to circa 6, 000 customers. The inclusion of this stakeholder into the case study process means an organisation with significant reach in the food supply chain sector across Europe is included.

3.9.2.2 Food logistics (FL)

The second case study participant company has its roots in the agriculture industry and was founded in 1940. It is a leading player in the European logistics sector, turning over £843 million annually, and utilising circa 2, 700 vehicles located across 43 operating centres. It employs 6, 600 employees who are dispersed across its network, which includes 8.8 million sqm of warehousing. Its business activities are spread across Europe, with overland road operations, rail operations, port operations, airline ACMI operations and warehousing facilities. Much of its present-day operations underpin the movement of foodstuffs across differing nodes of the supply chain. It has a bespoke unit that operates third party logistics and overland transport for food retail sectors. Therefore, representation of this company in the case study was complimentary to other selected organisations as a transactional player.

3.9.2.3 Food retailer (FR)

The third case study participant was a food retailer, encapsulating traditional large store footprint environments, smaller convenience retail operations and operating food service operations. It has operations in Ireland, Spain and UK across these sectors, and has a 140-year

heritage. The organisation employs circa 41, 000 people, across its 1, 400 stores, some 15 logistics facilities and circa 750 vehicles. All of this supports a £5.4 billion annualised turnover, with a business that is still very family-orientated in its approach and values. This organisation was chosen, firstly due to the author's prior connections of having worked within the company but also because it is a leading retailer in the food sector, and has a transactional relationship with the other case study organisations.

3.9.2.4 Food consulting (FC)

The fourth case study is a significant player in the consulting sector, formed in 1854, operating in 157 countries, employing 276, 000 and turning over £34 billion. Specifically, the food consulting arm in Europe turns over £35.5 million, and has 12, 000 employees across 21 locations. Their reach in terms of food supply chains is incredibly extensive, having projects post and live with all the major players at every stage of the food value chain. This made them a valuable participant in the research study, giving a holistic view of procurement, while having a transactional relationship with the other three case study organisations.

3.9.2.5 Case study participant summary

In summary, the four case studies were chosen due to their transactional relationship, which made them representative in terms of a modern-day food supply chain. The case study organisations collectively have reach in 23 of the 27 European Union countries, turn over £27.6 Billion (Europe), employ 71, 600, and operate circa 6, 950 vehicles daily, from 91 locations (plus 1,400 stores), with 14.8 million square metres of food grade warehousing space. In addition, the European food industry contributes 6% GVE, has intra Europe exports of £273 billion (3/4 of which are destined for single market use) with a total of £191 billion in food manufacturing (Eurostat, 201; Food & Drink Europe, 2018). This therefore makes the composition of case study organisations significant in terms of market share as it comprises 25% of the intra-European movement of foodstuff activity, 11% of food manufacturing, 4% of food retail interest and 1.5% of the total European Commission GVA.

3.9.3 Conducting the case study

The approach of case study research traditionally involves interview questions, encapsulating experience, recorded evidence and in some cases observation that permits new research themes

to emerge from results (Manuj & Pohlen, 2012; Yin, 2003). There are four predominant ways to conduct interviews: group interviews, semi-structured interviews, structured interviews and unstructured interview processes (May, 2001). Adopting a structured interview process is deemed as appropriate for reducing bias, however, it is less flexible with results as it is very prescriptive in nature, and at times can narrow the focus and discussion associated with case study participants (Sarantakos, 2001). An unstructured approach delivers varied results due to its very open approach, which can at times mean results differ in direction from the research study's original hypothesis or direction. Therefore, in order to review the outputs of the Delphi study and the finding that procurement was predominately noted as being related to food supply chain risk mitigation, it was felt that semi-structured interviews would be the most appropriate method. This method permits the flexibility needed in giving participants the ability to answer freely and permits new themes to be discovered, while maintaining a structure aligned to the needs of the research study (Bryman, 2004; King, 1994). The outputs of semi-structured collated data responses were in a qualitative manner to review the case study within each of the four organisations.

3.9.4 Semi-structured interview process

The semi-structured interview process began in July of 2018 and took a period of four months to engage with all case study participants (Table 19), with this portion [interviews] of the study concluding in October 2018. Due to the companies all being based within the UK (2 sites) and Ireland (2 sites), site visits were made during this time to the four organisations to capture data in face-to-face interviews. As outlined before, the organisations were selected by the researcher due to their transactional nature in business and connection to procurement, therefore being deemed as subject matter [procurement] proficient and willing to participate in the research study. All participants were issued via email an ethics form, outlining their participation, details of the study, the anonymity of companies and participants, alongside their right to withdraw from the research study. Once this had been agreed by each case study participant and organisation, a series of meetings were arranged between July and October 2018.

The semi-structured interview process was undertaken in the participants' workplace, partly due to the familiarity permitting ease for respondents, but also so the researcher could view the behaviours first hand within the workplace. Before each interview, an open discussion was had with each participant to explain the research process, gain an understanding of the persons'

detailed experience and their personal objectives outside the workplace. This was done to put participants at ease, build a rapport and create trust in the process, while putting the researcher and participant on the same level (Ritchie et al., 2003). All participants were given the semi-structured interview questions a week ahead of the interviews, to permit them time to review ahead of the process and mitigate against rushed and not thought through answers on the day (Patton, 1990). During the interviews, which lasted from 1.5 to 3 hours in duration, data was transcribed digitally on an iPad and also recorded for review after, with all outputs being placed onto a secure cloud-based server.

3.9.5 Data analysis

As discussed, this research study uses abductive grounded theory (mix of deductive and inductive approaches). This approach is recognised as relevant to new areas of study, permitting development of outputs to be relevant and robust, with the creation of theory in new areas of supply chain research such as food chain criminality (Glaser & Strauss, 1967; Randal & Mello, 2012; Walker & Myrick, 2006). The principles of grounded theory were followed with data analysis, initial literature review undertaking a deductive review and latter stages with inductive approaches through use of focus group, Modified Delphi and 'Selective' case studies with semi-structured interviews.

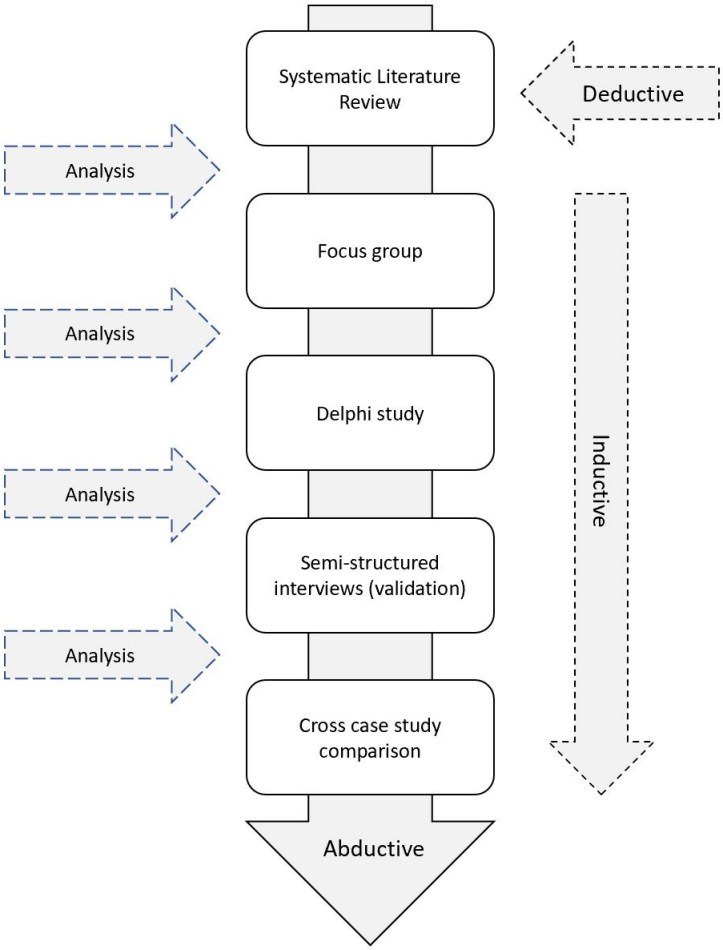

Figure 4 Data analysis steps

In the varying steps of analysis (Figure 4), patterns of data and categories were collated, which informed the next steps of the research process and permitted this study to be approached in an open manner and not be constrained by a theoretical process, which allowed the data to build theoretical outputs (Easterby-Smit, 2008; Kaufmann & Denk 2011; Ketokivi & Choi, 2014). In the latter stages of the research data process, from Modified Delphi and 'Selective' case study semi-structured interviews, data was coded in order to build a picture of themes arising from the qualitative data (Miles et al., 2014).

The data was split into three differing levels in order to evaluate effectively. This was done as follows:

1. Literature (Deductive approach) was reviewed to gain an appreciation of the existent body of knowledge in both academic and practitioner fields, a step that is upheld as critical with any kind of grounded theory research study (Charmaz,

2012; Mello & Flint, 2009). The outputs were categorised into eight key themes from the UK Government report into Food supply chain fraud (Elliott, 2014). Research where available was coded into these areas to build a picture of research against these coded areas. What became apparent at this early stage was a limited amount of knowledge in the area of supply chain food fraud mitigation, which was crucial in building the methodology of the study based on research need rather than following a process (Glaser & Strauss, 1967; Randal & Mello, 2012; Walker & Myrick, 2006).

2. The Modified Delphi (Inductive approach) compared the differing sources of data with similar or same outputs, coding into categories at each stage to remove duplication (Strauss & Corbin, 2011). Final round (4) top ten results were coded with sub-themes by the participants against the 6 areas deemed as responsible for building resilience in food supply chains according to the UK Government report into Supply chain food fraud (Elliott, 2014). This stage delivered a view that the expert panel of Modified Delphi participants viewed procurement as the most crucial element of business in building resilience.

3. The third and final set of coding was with the 'Selective' case study semi-structured interviews (Inductive approach), which was done after the data had been merged to build a consistent data set (Miles et al., 2014). This stage took data sets from the Modified Delphi with results being coded to build a set of data against 10 questions across 6 specific themes for building food supply chain resilience with a procurement view.

The outputs of the data process (Figure 4) built a data set that has been reviewed for repeated results, leaving a consistent data set for review with regard to the research desires of reviewing the research approach to answering *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*, which will be discussed in more detail in Chapter 5 of this research study thesis.

3.10 Validity and reliability

As outlined earlier in this chapter, abductive grounded theory studies are predominately qualitative in its approach. There are, however, challenges with qualitative research

approaches, with some authors reporting issues with validity (Silverman, 1993; Silverman, 2000). The subject of reliability comes down to two metrics (Easterby-Smith et al., 2002):

- Are data sources transparent?
- Can outputs be replicated, and similar results achieved by other researchers?

This study adopted clarity in its approach, detailing all data sources along with the approaches that were utilised. In addition, it adopted trusted methods of research that have been advocated as reliable and valid by peer-reviewed science research in the field of supply chain management, which addresses the subject of reliability (Easterby-Smith et al., 2002).

However, reliability with qualitative research offers an additional potential challenge, as quantitative approaches using data sets are driven by the numbers. Qualitative approaches instead are left to the interpretation of the researcher and how they would for example ask questions, interpret research outputs or code data (Silverman, 2005). Therefore, in order to reduce reliability issues, this study adopted an inter-rater reliability test, a process where another independent person checks the codes and duplication to improve reliability (Ryan & Bernard 2000; Voss et al., 2002). Thus, with this study, all coding and removal of duplication was reviewed by another university academic to check and agree with the process and its outcomes.

In addition, and to further mitigate against the aforementioned issues associated with reliability and validity, Silverman (2000) recommends the use of triangulation. This use of triangulation, as mentioned earlier in Chapter 4, uses data from differing sources in order for researchers to build robust outcomes based on comparing and contrasting outputs from different research methods. This use of multiple sources of data in triangulation makes research studies more dependable (Decrop, 2004), which was one of the key reasons why this research study employed triangulation as a method of data validation.

Another manner in which the reliability of research methods that deploy case studies can be used is expert intervention. Use of experts to validate research outputs is a method that underpins better judgement, as often experts have a ‘lived’ experience of the research topic, therefore bringing a validation step to the process (Churchill, 1979). This study into food supply chain fraud and resilience included experts in the focus group in order to firstly validate

the literature review findings, give direction to the lack of underpinning academic research in this topic area and to act as a the ‘sounding board’ and governance structure of the research study process.

3.11 Research limitations

This research study followed an iterative process of research design, which was in line with well-grounded research examples. However, despite the process design and alignment with a peer-reviewed process, there were four main limitations of this study.

Firstly, there was a limited amount of academic and practitioner research, particularly within the business focussed arena related to supply chain food fraud mitigation. This of course was mitigated against by adopting the abductive grounded theory and Modified Delphi, methods specifically designed for such instances and relevant because of the under-researched area of supply chain management (Randal & Mello, 2012; Stuart et al., 2002). However, it would have been more advantageous from a triangulation perspective to have had more literature to bring into the comparison, even though a mitigation measure against this was the use of the UK Government report into food fraud (Elliott, 2014), employed as a benchmark of excellence in the field of supply chain food fraud and as a comparison tool.

Secondly, the study aimed to embrace a secondary cross case analysis to bring in a final validation method of the link between procurement and mitigation of food fraud in a supply chain context. However, there was a lack of detailed case study literature available in the open source libraries, which made secondary case study use of little value. Despite this, the scant secondary case study detail was collated by the researcher and added in Chapter 5 to develop the theoretical outputs from the abductive grounded theory research into food supply chain food fraud and future research suggestions.

The third research limitation pertained to financial resource. This study was undertaken with expenses that were self-funded. The researcher would have included case study analysis in a global context with selective case study semi-structured interviews had more funding been available. It is felt that this would have added a richness to the study with a high percentage of food supply chains being of global nature. However, this was not possible, so instead there are plans detailed in Chapter 5 in further research suggestions that expand on this area.

Lastly, the research aimed to engage with a true food value chain approach and have representative actors contained within the food supply chain. While the study managed to garner a connected chain of Processor, Food 3PL Logisticians, Food Retailer and Food Consulting, there was no inclusion of upstream farmer (grower). This was due to the complexity of ingredients contained within each SKU, and it was deemed by the researcher and focus group to be too complex and out of scope for this particular research study.

3.12 Research ethics

The issues associated with ethics are of concern to researchers and institutions alike, and embody the code of conduct and principles of investigators involved with research studies. This research study used the research ethics process of the home institution (University of Huddersfield), alongside detailed reading of known researchers in the field of ethical research consideration (Israel & Hay, 2006; Stake, 2008).

Although the study follows university research guidelines, it was worth understanding and refreshing one's approach to research, particularly around qualitative research studies that can fall foul of subjective views (Stake, 2008). Therefore, this study deployed a peer review process as already detailed, to ensure where possible researcher subjectivity and associated challenges were mitigated against (Easterby-Smith et al., 2002; Ryan & Bernard 2000; Voss et al., 2002).

Furthermore, the aspects of participant and organisational risk need to be taken into account, as it is cited as a critical consideration for studies by Kimmel (1998) and Stake (2008). In meeting the needs of stakeholder participation, this study undertook a Modified Delphi process (Strauss & Corbin, 2011), whereby participants were anonymised, did not meet others within the sample group and were given the right to withdraw if they felt their position, organisation or any other matter were compromised, a process cited as critical in removing research bias in qualitative studies (Christians, 2005; Strauss & Corbin, 2011). It was made clear that any and all data would not be connected to person or organisation and used only for research purposes, with this being agreed at the ethics process prior to inclusion in the study. In addition, semi-structured interviews with the case study experts gave voluntary consent to be considered in the research study, an area that is seen as the norm within research circles (Kimmel, 1988). However, despite the voluntary implied consent, this study undertook a written ethics process, which included a statement of inclusion with the right to withdraw being present for all parties, along with the anonymity afforded to other research study participants.

3.13 Methodologies fit with addressing the research gap

As discussed, there is an argument that research studies such as this one are needed to counter the abundance of theoretical and quantitative approaches within the food supply chain resilience sphere (Eddine, M., Saikouk, T. and Berrado, A., 2019; Randal & Mello, 2012; Stuart et al., 2002). As such, this research employs a 'critical realism' abductive grounded theory approach, following the qualitative stance used in a multi-methods approach, a method supported by extensive research into the connection and validation of outputs (Bloor et al., 2015).

Having ascertained there has been little attention paid to risk and resilience in food supply chain management (Elliott, 2014; Manning, 2015), alongside resilience building being undertaken at an aggregate top level (Bacon, 2014; Punter, 2013; Sodhi & Tang, 2012) and with a lack of business management theories connected to the research subject area (Arya & Lin, 2007; Carter, Kosmol & Kaufmann, 2017; Hunt & Davis, 2012; Popli, Ladkani & Gaur, 2017; Zaridis, A., Vlachos, I., & Bourlakis, M, 2020), a robust understanding of research process and design was needed. Therefore, in addressing the challenges within the field of resilience related to food supply chain management, the approaches connect and build on each other by using differing social science methods to build greater knowledge base (Defee et al., 2010; Lambert & Garcia-Dastague, 2006; Mentzer et al., 2001) as follows:

Systematic literature review – the research process deployed a systematic literature review (SLR), a well-defined process for research gap analysis (Denyer & Tranfield, 2006; Tranfield et al., 2003). The process systematically catalogued relevant research, ensuring appropriate rigour with the systematic literature review processes supported by Duriau et al. (2007), Rousseau et al. (2008) and Tranfield et al. (2003). The findings of the process found scant evidence of academic research in the area, and delivered a set of gaps for review against the UK Government report into food supply chain fraud (Elliott, 2014). Therefore, as food supply chain resilience (fraud & crime) is a relatively new subject area, a review of the outputs was required to underpin good probability sampling (Malhotra & Birks, 2007), therefore, outputs of the review were fed into an expert panel focus group.

Expert panel focus group - given the afformentioned lack of research into the area of food supply chain resilience, it was clear that an approach embracing theoretical sampling of groups into a case study was needed. Therefore, participants for the semi-structured interviews were chosen based on their relevance to the industry, adding theoretical relevance (Dubois & Araujo, 2007; Eisenhardt, 1989; Stuart et al., 2002). The focus group reviewed the outputs of the systematic literature review which were analysed for key themes. This process enabled greater alignment of systematic literature review outputs for use with the Modified Delphi, a process aligned with semi-structured research that utilises triangulation as a method of validation (Binder & Edwards, 2010; Bloor et al., 2015; Curtis et al., 2015; Rahmani & Leifels, 2018), and permits greater robustness of research outputs.

Delphi –using a Delphi study with mixed methods approaches is seen as creating 'member validation' with research outputs, particularly in areas of research where variables or ouputs are little understood (Denzin, 1970; Emerson & Pollner, 1988; Tashakkori & Teddie, 2003). Utilising the outputs from the systematic literature review, which was compared against the UK Government report into food fraud (Elliott, 2014) and validated through the expert panel focus group, a set of key themes were crafted for use with the Modified Delphi study. As the Modified Delphi was eliciting expert opinion against the factors that build greater resilience in food supply chains, a requirement was that events and outputs must be repeatable in likelihood of recurrence; therefore, assumptions can be formed that Delphi research responses converge towards a mid-range dispersal (Johnston, 1976; Ng, 1984). Whilst the outputs of the Modified Delphi are noted as events in their own right, in order for the research to develop concepts and theories, a selective case study was utilised (Dubois & Araujo, 2007; Gummesson, 2000; Hakim, 1987).

Case study – the use of case studies permits the establishment of models, frameworks and theories from the outputs, particularly in diverse and under-researched areas (Stake, 2008). It was chosen to review the outputs of Modified Delphi resilience metrics, and create a robust research validation process (Dubois & Araujo, 2007; Hakim, 1987). The case study participants were chosen as they have a transactional relationship with each other, therefore enabling an understanding of understanding the internal constructs of resilience building against food fraud (Ritchie et al., 2003).

Triangulation & analysis – in bringing all of the methods together, triangulation a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation was used (Stake, 2008). This method is noted as working well with abductive grounded theory approaches, such as with this research, and using mixed method approaches enables the creation of new theory in relatively under researched areas, as with food supply chain resilience (Glaser & Strauss, 1967; Randal & Mello, 2012; Walker & Myrick, 2006). In the varying steps of the methodologies, data was collated from each process, analysed (as per Chapter 3) and fed into the next stage, a process held up as relevant for research studies not wanting to build robust theoretical outputs (Easterby-Smit, 2008; Kaufmann & Denk 2011; Ketokivi & Choi, 2014). In closing, the research chose to utilise experts with commercial experience with the data and analysis section to give the research a "lived" experience and give direction to the overall process (Churchill, 1979).

3.14 Methodology conclusion

This research study had identified a lack of research literature in academic and practitioner repositories (Chapter 2), and given the complex nature of supply chain management, it needed to select a research process that would be able to bridge this gap while understanding the existing landscape of research methods in Operations management [Supply chain] (Defee et al., 2010; Lambert & Garcia-Dastague, 2006; Mentzer et al, 2001). Therefore, this study set out to engage with industry experts to minimise the divide [academic-practitioner] in understanding the research question [*'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*] and contribute to academic knowledge, a method well recognised for deriving applicable theory (Alvesson & Kärreman, 2007; Colquitt & Zapata-Phelan, 2007; Van Maanen, Sorensen, & Mitchell, 2007). However, in attempting to review research approaches in the supply chain field, there is an identified lack of post-positivist approaches which this study needed to address (Boyer & Swink, 2008; Burgess, Singh, & Koroglu, 2006; DeHoratius & Rabinovich, 2011). In support of this post-positivist deficit, the study identified an over-reliance on mathematical modelling and overuse of survey methods portraying supply chain management research as wedded to a positivist (objective-quantitative) research approach (Burgess et al, 2006; Carter, 2008).

Therefore, this study firstly set out to address the suggestion by scholars that there needed to be greater use of case study approaches within supply chain management research studies (Kahkonen, 2011; Seuring, 2009). In this way the research study occupies the space between

positivism and constructivism, which is ontologically positioned to the thinking of 'critical realism', a philosophical approach which sits as the interface between the natural and social worlds i.e. the ability to bridge the divide that exists with positivism (objective) and constructivism (subjective) (Bhaskar, 2014; Danemark et al., 2002; Losch, 2017). In addition, having reviewed the positive and negative connotations of deductive versus inductive, this study took the blended approach to a deductive-inductive study (Saunders et al., 2009; Saunders et al., 2012), systematically reviewing literature in the fields of supply chain food crime and supply chain food fraud to ascertain from first principles the current body of academic and practitioner knowledge that remains, as well as highlighting any gaps that exist and forming direction regarding research questions and data methods. Subsequently, the study undertook an inductive approach using semi-structured interviews, and a Delphi study and case study examination to reach concensous on the research question of: *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*. There are scholars who suggest the combination of deductive and inductive approaches refers to abductive approaches to research (Dubois & Gadde, 2002; Saudners et al., 2009), which is the approach this research study into building resilience into food supply chains will take. In the latter stages of the research, once the deductive approach had been completed [systematic literature review], the study takes the aforementioned inductive approach commonly associated with grounded theory, an approach applied to academic research across many philosophical paradigms from the positivist to interpretivist (Hunt, 1992; Meredith et al., 1989). Therefore, to leverage the inductive approach and embrace the abductive process of understanding objective and subjective aspects of food supply chain management resilience building, this study adopted an abductive grounded theory process (Rahmani & Leifels, 2018).

Triangulation was adopted to give the study the ability to gain a more detailed appraisal of conclusions and credibility around the research question (Maxwell, 1996). In taking a 'critical realism' abductive grounded theory approach, following the qualitative multi-methods approach (Triangulation), connection and validation of outputs could be achieved (Bloor et al., 2015). This [abductive] approach mitigates against the recognised drawbacks associated with mixed methods approaches, positing itself well with deductive and inductive approaches (Johnson & Onwuegbuzie, 2004; Morse, 2005; O'Cathain, 2010; Parry-Langdon et al., 2003). Furthermore, by utilising as part of the study process a Delphi study with mixed methods, 'member validation' with research outputs was achieved, further mitigating against the drawbacks of triangulated mixed methods (Denzin, 1970; Emerson & Pollner, 1988;

Tashakkori and Teddie, 2003). Furthermore, Delphi methods have proven to be an efficient survey method when only a limited amount of data on a topic is available (Linston & Turoff, 1975; Riggs, 1983; Rowe, Wright & Bolger, 1992). It was therefore chosen for this study due to limited academic research available in the arena of food supply chain food fraud and food supply chain food crime and in order to take a practitioner approach to research validation (Fassam & Dani, 2016; Kache & Seuring, 2017).

Lastly, research reliability is reinforced by eliciting the opinions of the experts, allowing each expert to review the opinions of other participants with an assurance of anonymity, which avoids issues of bias or coercion that may be presented during focus group or discussion scenarios (Ogden et al., 2005; Sackman, 1974). This was achieved through developing concepts and theories (Gummesson, 2000) from the Delphi outputs with case study research. Therefore, a sector specific [procurement] approach adopting a 'selective' case study was employed in order to review in more detail, and detailed as a robust research validation process (Dubois & Araujo, 2007; Hakim, 1987).

Despite this study having noted three research limitations, it is the belief of the study author that outputs pertaining to the methodical processes are well grounded in academic theory, aligned to a robust set of governed flows and suitable for delivering the necessary credibility and reliability of PhD forms of study. Moreover, in building upon the much-required reliability, research ethics were employed in agreement with the host institution, and backed up by noted academic authors in the area.

4 Chapter 4 – Presentation and analysis of the data

4.1 Analysis of data introduction

As discussed in Chapter 3, the majority of supply chain management research strategies (e.g. modelling and simulation) lack appreciation of the 'softer' human side of food supply chain resilience building (Randal & Mello, 2012; Stuart et al, 2002). Therefore, in order to mitigate against the challenges of heavily quantitative works, there is a need for greater use of case study approaches within supply chain management research studies (Kahkonen, 2011; Seuring, 2009). Thus, this chapter [4] will present a mixed methods approach to include a systematic literature review, Modified Delphi study and semi-structured cross case studies in order to answer the research question *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*

The data contained within this thesis was collected over an 18-month period between November 2017 and May 2019. This chapter reviews the differing data constructs emanating from the systematic literature review, modified Delphi study and semi-structured interviews [case studies], collating findings for discussion within Chapter 5 of this thesis.

The chapter begins by displaying data from the three research strands [systematic literature review, modified Delphi and semi-structured interviews] in their raw and unanalysed form. The latter stages of the chapter then develops key themes from each of the research methods used, and in particular looks for cross-cutting themes across the differing methodological processes.

In doing this, it is important to recognise that qualitative data management, as per the processes utilised within this research thesis, do not have a standardised process map to adhere to (Saunders et al., 2012). Therefore, there are no defined process flows that need adhering to, on the proviso that outputs from qualitative methodologies present data in a fair and equitable manner (Bryman, 2006; Yin, 2009). Despite this non-standard approach being contained within qualitative analysis, this research aimed to follow the classical analytical approaches of Miles and Huberman (1994) by categorising data by use of codes, linking comments and forming bridges between generalisations in order to give a coherent output from differing qualitative methodologies, thus enabling one view of developing themes to be achieved.

4.2 Systematic literature review data outputs and discussion

4.2.1 Step 1 - Holistic view of supply chain food criminality literature

The researched literature on supply chain risk management adequately covers areas such as inventory, procurement and risk, but has been found to be lacking in thematic areas pertaining to food supply chain risk management (Table 20). Given the rise of food criminality and continuing demand for food, this lack of food chain risk management understanding is of concern, particularly given inventory and procurement strategies deployed across the holistic supply chain are well understood as a risk mitigation strategy (Sodhi & Tang, 2012).

Topic	Count
Logistics	10,520
Supply chain	8,321
Transportation management	6,203
Theoretical treatment	5,435
Management research	4,505
Risk management	3,622
Operations research	3,416
Demand management	3,221
Inventory control	2,622
Purchasing	1,522

Table 20 Top 10 peer reviewed papers' thematic 'supply chain risk management' areas

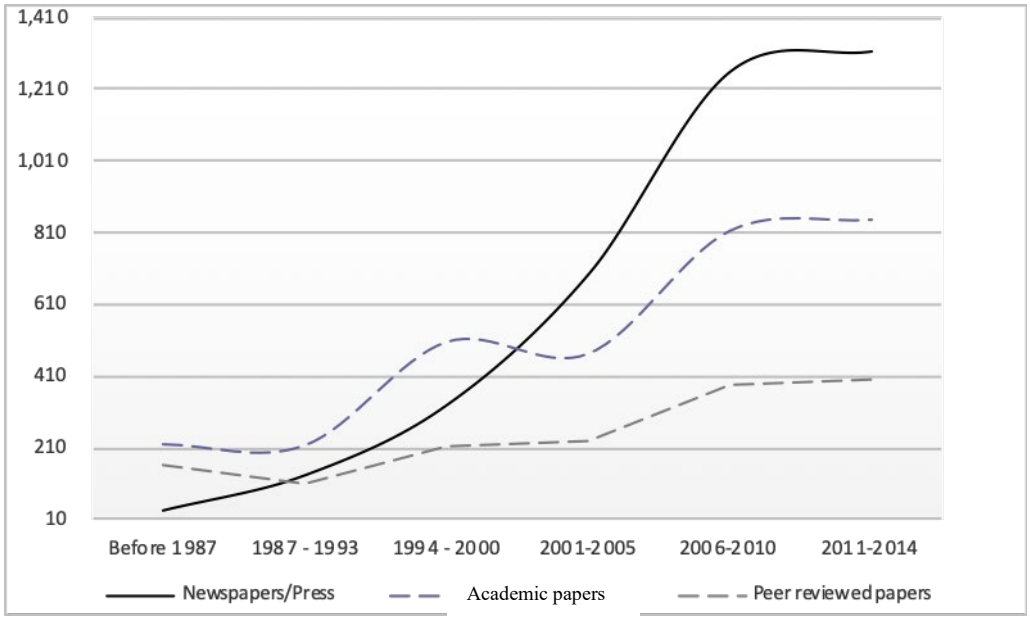

Figure 5 'Food crime' publications [Academic & Practitioner] (Fassam & Dani, 2017)

Additionally, taking the wider view of all articles published in the area of 'food crime' and 'food fraud', due to the relatively new-found status of the topic in supply chain related research, there is a distinct difference between the amount of academic articles published in comparison to those published in professional literature and newspapers (Figure 5). There is a clear divergence amongst the two streams of publishing [industry/ news and academia], albeit there was a spike in news press activity post 'horse meat 2013'. However, this still suggests a need for academia to research further into this thematic area supporting governmental and practitioner initiatives in the areas of food criminality to create a body of knowledge to support resilient food supply chain strategies.

Topic	Count
Crime & offence	155
Social anthropology	128
Health & wellbeing	80
Economics	73
Food & ingredients	71
Obesity	61
Food supply chains	39
Criminology	34
Diet & nutrition	33
Hostility	33

Table 21 Top 10 peer reviewed papers thematic ‘Food crime’

Despite the clear divergence between business/ news articles and academic research, the existing body of academic knowledge has a highly scientific concentration on the areas of public health and diet within the ‘supply chain food crime’ research. This literature depicts how ‘public health’ and ‘diet’ have developed as compelling thematic areas against other food supply chain challenges, and supports the view that consumers are more concerned with diet and security of supply than that of criminality (DEFRA, 2013).

Possibly the most surprising gap in food supply chain risk management literature when compared to SCRM sources is a lack of focus pertaining to softer management challenges and risks associated with fraudulent activity (Table 21). The Chartered Institute of Procurement and Supply suggests the need for greater transparency in relation to trading practices and the engagement of supply chain partners to facilitate eradication of fraudulent behaviour across holistic supply chains (CIPS, 2013). The lack of topics such as bribery, corruption and fraud in food supply chain risk management are accordingly areas that need addressing by academic research, in addition to the aforementioned areas.

4.2.2 Step 2 - Focused Chartered Association of Business School data

In order to probe deeper into the two topics within the academic literature on supply chains, the authors focused on the key words 'Supply chain food fraud' and 'Supply chain food crime', which complement the terminology utilised in key literature and governmental reports (DEFRA, 2013; Elliott, 2015; Spink & Moyer, 2011). This focussed search returned ninety-one 'Supply chain food fraud' and forty-two 'Supply chain food crime', peer-reviewed journal papers.

Author	Date	Methodology type
Van Dorp	2003	Qualitative case study
Manning & Soon	2014	Qualitative case study
Jamal & Shariffudin	2014	Interviews
Uriocoli, Paulraj & Naslun	2013	Semi-structured interviews
Sarpong	2014	Media case studies

Table 22 CABS Supply chain food crime and fraud methodologies

In order to align with the outputs and recommendations of the Government reports (DEFRA, 2013; Elliott, 2014; FSA, 2016) and draw parallels across research in the area of business and management, the authors utilised the Chartered Institute of Business School (CABS, 2015) listings for the literature analysis. This returned 5 papers in the areas of 'supply chain food crime' and 'supply chain food fraud', identifying an immediate lack of peer-reviewed business and management literature in the area of food supply chain risk management, and thus supporting the findings in the wider supply chain first stage systematic review (step 1). The research focus and methodology across the peer-reviewed CABS journal papers was principally qualitative in its approach, with a split between reviews of existent literature, case studies and semi-structured interviews (Table 22), across a range of countries with the preponderance of European origin (Table 23).

Author	Date	Research area
Netherlands	2003	Beef labelling: the emergence of transparency
Malaysia & UK	2014	Developing systems to control food adulteration
Malaysia & UK	2014	Perceived value and usefulness of halal labelling: The role of religion and culture
Denmark, Sweden, Switzerland & US	2013	The role of law enforcement agencies in transport security, survey with Swedish operators
Ghana	2014	Traceability and supply chain complexity: confronting the issues and concerns

Table 23 Countries of supply chain food crime and fraud CABS journals

4.2.3 Thematic comparison of detailed literature review

A detailed examination of peer-reviewed 'food supply chain crime' and 'food supply chain fraud' CABS papers was undertaken identifying key thematic areas (Table 23), which were compared alongside existent government research into food supply chain resilience by Prof Elliott (Elliott, 2014) and the non-CABS food supply chain risk papers (Table 24).

Country.	Date	Title
Bowman	2014	Companies are failing to detect financial fraud in supply chains
Elliott	2014	Elliott Review into the Integrity and Assurance of Food Supply Networks – Final Report
European Commission	2015	Food fraud network report 2015
FM Global	2016	Resilience index annual report 2016
Food Today	2013	European Union action plan to tackle food fraud
Food Standards Authority	2016	Food crime annual strategic assessment
Food Safety Authority Ireland	2015	What is food fraud
Johnson	2014	Food fraud and "economically motivated adulteration" of food and food ingredients
McCarthy	2014	Has Globalization made corruption worse
National audit office	2013	Food safety and authenticity in the processed meat supply chain
NSF	2014	The 'new' phenomenon of criminal fraud in the supply chain
Which consumer report	2013	The future of food – giving consumers a say

Table 24 Key non-academic supply chain food crime and fraud related publications

The key thematic areas (Table 25) indicate an inconsistent approach to the academic literature, from both the peer-reviewed CABS outputs and non-CABS literature and that of the Government's report produced by Prof. Elliott. Critical areas such as authenticity, authorities, enforcement and intelligence are heavily discussed by Prof. Elliott, however, these areas are not apparent in the academic research. Nonetheless, there are thematic areas where an

alignment can be identified such as business, fraud, health and information. This suggests that despite there being gaps in current academic thinking, a partial alignment does exist in the existent literature within the field of business research.

	ALL	CABS	Elliott
adulteration	x	X	
analysis	x	X	
authenticity			x
authorities			x
business	x	X	x
consumers			x
control	x	X	
crime	x		x
data	x	X	
dna	x		
enforcement			x
fraud	x	X	x
government			x
health	x	X	x
industry			x
information	x	X	x
intelligence			x
management		X	x
method	x	X	
production	x	X	x
products	x	X	x
quality	x	X	
risk			x
safety	x	X	x
sample	x	X	x
species	x	X	
standards/systems	x	X	x
testing			x
traceability	x	X	

Table 25 Thematic areas across CABS journals, Elliott review and non-CABS journals

4.2.4 Conceptual understanding of thematic areas

Prof. Elliott's report for the government study identified 8 pillars of food supply chain resilience. These pillars as identified are not just important as bases of resilience but are the concepts to utilise to counter food fraud and crime in the supply chain. The following section creates an understanding of the 8 concepts from the perspective of themes and information identified through the focused literature sources and wider literature.

4.2.4.1 The approach to stakeholder perception

Across the existent Chartered Association of Business Schools (CABS) and non-CABS peer reviewed journals, little attention has been given to the aspects of consumer interaction with food criminality. When reviewing available literature, there is no evidence of a connect between food supply chain criminality and consumers, which is potentially driven by retail shoppers being more concerned with price and nutrition rather than that of authenticity (DEFRA, 2013). Rarely do retail shoppers realise they have been a victim of food fraud or crime, particularly due to their busy lifestyles being far removed from understanding the authenticity and originality of their food stuffs, thus reporting levels are low, which stifle profile raising of this prolific supply chain crime (FSA, 2016). Yet, despite this lack of cohesive consumer approach to food chain criminality by academics, business and consumers, the theme of a nation's health is prevalent across all three streams (Table 25), which suggests, albeit not explicitly, the consumer is affected by food criminality, but the extent, and longer term health and wellbeing aspects are yet to be fully understood. Therefore, in order to align research with government and practitioner activities, and develop processes and legislation to mitigate food risk and underpin Prof. Elliott's eight pillars of food resilience, a greater appreciation is needed of consumer perceptions of food chains.

It is not just academic research that is grappling to understand the landscape of food criminality, the European Commission explains how differing perceptions of food crime and food fraud are understood across its member states, with no clear 'European' definition of the problem (European Commission, 2014). Morling, Head of the UK Food Crime Unit, attempts to redress the confusion in the sector by defining food fraud and crime as simply "dishonesty relating to food production or supply, which is either complex or results in detriment to consumers, businesses or overall public interest" (FSA, 2016, p. 9), supporting one view of this food supply chain resilience issue. Nonetheless, 'dishonesty' in a food supply chain sense is quite often seen as a victimless crime, with the majority of food criminality resulting in limited health risks, with the noteworthy exception of the Chinese milk powder melamine case, Peanut Corporation of America case and Sudanese spice dyes public health issues (FSA, 2016; Gossner et al., 2009; Stiborova et al., 2002).

In spite of this, the authors suggest that there is a potential long term health and wellbeing aspect to food criminality that is yet to be understood, predominately due to the contaminates or impurities not being detected ahead of consumer consumption (Everstine et al., 2013; Moore

et al, 2012; Wheatley & Spink, 2013). Therefore, with consumers having 'busy' lives which impact on their understanding of authenticity and a focus on pricing, coupled with a lack of true understanding over the health and wellbeing aspects of food criminality, caution should be placed around labelling this a 'victimless crime'. The authors assert greater focus should be placed on a collaborative business, government and academic approach to understanding the true extent of food criminality and its impact on consumers from a health and wellbeing perspective, as well as the longer-term effects of ingestion of economically motivated adulterated food stuffs.

4.2.4.2 Zero tolerance - the process environment

The suggestion of zero tolerance is an interesting concept, particularly when we have aforementioned consumer focus based around availability and price, and the impetus of food criminality episodes not being addressed by traditional food defence, quality or safety processes (Spink, 2014). However, the 'horse meat scandal' of 2013 hit the headlines with an identifiable spike in publishing activity (Figure 5), shaking consumer confidence in the market and strengthening the need for a 'zero tolerance' approach to food authenticity. Nonetheless, research in the field has not followed the trend in developing a culture of zero tolerance, with none of the reviewed CABS journals recognising the link between consumers and food criminality. Therefore, the author suggests that business and academia are still endeavouring to understand the auspices of 'supply chain food crime' and 'supply chain food fraud' with a need for greater understanding of these two areas in order to have one view of 'food supply chain resilience' and 'food chain integrity'.

Furthermore, food criminality, whether accidental or intentional, is incredibly complex, in part due to the globally extending supply chains that encompass a myriad of actors, quite often within the SME sector (90% SMEs in Europe) that prescribe to a compliance process rather than prevention (Spink et al., 2014). This compliance is quite often a precursor to greater food supply chain challenges, with organisations both commercial and governmental looking to legislate the risk out of supply chains and build resilience through greater detection. However, according to Spink et al. (2014), this cannot happen due to the need for entire supply chains to holistically reduce the opportunity of fraud occurring, and the reduction of food criminality must become a preventative process rather than reactive (European Commission, 2014), therefore arguably leading to the need for a triangulated approach of business (operations), testing and legislation to be complimentary.

4.2.4.3 Intelligence led approach to food chain resilience

Holistic supply chains must understand that those seeking to exploit food chains for criminal and financial gain will quite often do so in a stealth like manner, making resilience building akin to 'fighting an invisible enemy' (Spink, 2011). In order to combat this invisible threat, Manning & Soon (2014) support the auspices of intelligence gathering, an area advocated as crucial to the defence and mitigation of risks in a food supply chain context (Elliott, 2014). However, the creation of a data rich 'shared' environment quite often comes at a cost, with commercial and government organisations not seeing the return on investment, predominately due to the aforementioned lack of understanding into the extent of fraudulent activities across the holistic supply chains, with each case being viewed in isolation. Despite this, the intelligence led approach to preventing criminality in a food supply chain context can reduce overall costs with prosecutions and investigative processes that come about in a reactive governance construct (Spink et al., 2014). In addition, Spink (2014) supports the need to bring about greater detection of contaminants within adulterated food stuffs with a need for supply chain actors to understand the value that prevention brings. This 'value contribution to prevention', however, gives commercial organisations 'an out', offering extended retail supply chains the opportunity to pass on risk to upstream partners and moving away from the '8 pillar' framework of viewing food criminality as a holistic supply chain problem, rather than in isolation.

The current professional literature suggests that the UK government has adopted an intelligence led approach to fighting food criminality with the creation of the Food Crime Unit (FCU), which is also a step towards the 'zero tolerance' network required to bring about greater food supply chain resilience. Nevertheless, an intelligence led approach relies on the sharing of information and with little focus on the softer aspects of this area coupled with a lack of industry specific focus and trepidation over holistic supply chain resilience (Sodhi & Tang, 2012), it is not a solution that can be expedited. However, research within the CABS papers provides a distinct prevalence of data, information and analysis for combating food supply chain criminality (Manning & Soon, 2014; Sarpong, 2014). The 'big data' approach to criminality management is currently lacking within the existent literature and requires a more detailed holistic supply chain view to become meaningful to businesses.

4.2.5 Supply chain risk management and food chains – the literature

This cross-sectional analysis of the literature highlights a tendency within academia and practitioner led publications to centre risk and resilience research around cumulative event-driven thematic areas that attempt to review cause and effect relationships in an aggregate manner. Recent events within global food supply chains have evidenced a detachment between thematic areas of research and the direction of practitioner led interest. This disconnect between practitioner need and academic research is further supporting the aforementioned 'perfect storm' of risk and resilience within food supply chains across Europe. Taking for example the UK food manufacturing sector which comprises 310, 000 businesses, engaging 3.8 million workers across a net worth of £96 million (European Commission, 2014), any risk or resilience issue in this sector could have drastic consequences to a nation's health and country's GDP. It is therefore of no surprise that DEFRA (2013) purport the need for organisations to foster environments of collaborative practice, that enhance nutrition, quality and safety of food stuffs through the generation of innovative programs that leverage off of research that develop tools and databases to mitigate risk in a food supply chain context. This need for innovation is also supported by recent UK Government reports with both Professor Elliott and the Food Standards Agency supporting the need for greater collaborative sharing of information to permit holistic food supply chain actors to benefit from greater food product authenticity and traceability (Elliott, 2014; FSA, 2016).

The linkages between authenticity and traceability are highlighted by Nelleman et al. (2009), asserting annual global food supply chain losses of 1.3 billion tonnes with no awareness or appreciation of where this product is leaking from. Although in itself this raises questions regarding traceability in the food supply chain, it further supports the need to recognise and understand that if supply chain actors are unable to trace foodstuffs leaving the food chain, how are they in a position to identify elements coming into the food supply chains (authenticity)? In order to mitigate against these issues associated with authenticity and traceability and that of disappearing foodstuffs, Nelleman et al. (2009) suggest examples of legislative efforts to curb risk associated with criminality, building greater resilience into food chains. However, studies by the Africa Research Bulletin (2013) have discovered that over-legislation of food chains cultivates a black-market community, driving food losses higher and exacerbating the challenges of 'invisible' and 'traceable' supply chains. This lack of 'traceability' creating the 'invisible supply chain' strengthens the author's views that food supply chain resilience is a

cross-functional process and cannot be mitigated by legislation alone. However, in predicting food supply chain criminality it is crucial that organisations understand the causative factors that influence occurrences of risk, such as criminal factions being able to circumvent existing scientific testing processes, and supply chain actors of complex extended food supply chains needing to navigate the differing cross-border regulations in place (Manning & Soon, 2014).

Academic view on Food supply chain resilience			**Triple R food resilience model**		
Academic Literature ***(Gaps)***	**Management focus** ***(Enablers)***	**Resilience measure** ***(Enablers)***	**Ready**	**Respond**	**Recover**
Data, Intelligence, Risk	Learning and Innovation	Supply chain dynamics / KPI	Forecasting & Demand supply	Forecasting & Managing SC shocks	Systems feedback
Enforcement, Data, Intelligence	Persistence and robustness	Strategic leadership	Continuous review & Organisational objectives	Decision support & Organisation objectives	Continuous improvement
Authenticity, Enforcement, Risk	Recovery & constancy	Decision leadership	Management support & Evidence based assessment	Management decisions matrix	Continuous improvement

Table 26 Food supply chain resilience coding – adapted from Fassam and Dani (2017); Folke (2006); Manning and Soon (2016), and Ponomarov and Holcomb (2009)

Lastly, in order to give context to the latter portions of this research (the Delphi) and against the existent body of knowledge contained within the food supply chain resilience sphere, the areas of management and resilience concepts along with their actions were coded against leading food resilience authors (Fassam & Dani, 2017; Folke, 2006; Manning & Soon, 2016; Ponomarov & Holcomb, 2009) (Table 26). This enabled the outputs from the literature review to be coded against existent research relating to food supply chain food fraud and food supply

chain resilience building. This not only enabled alignment with the existent literature, but further developed a clear correlation with the outputs against resilience measures. Codes were thus created by reviewing the supply chain literature for measures of building supply chain resilience in food chains (Table 26), 'Gaps' (column 1). These were then coded against 'Enablers' of 'Management focus' (column 2) and the resilience concept (column 3) that go with building resilience within supply chains. Lastly, the supporting action of 'triple-R' model of food supply chain resilience building (column 4) was used so as to produce a model that is meaningful to academics and practitioners in understanding the link between existent supply chain resilience literature and food chains. This food supply chain resilience coding was then utilised with the Delphi results, as discussed later in chapter 4 and 5.

4.2.6 Systematic literature review conclusion

In summary, the lack of a consistent approach to research into food supply chains coupled with the confusion in understanding the difference between 'food crime' and 'food fraud' have been found to be oppressing accountability, authenticity and traceability. Thus, they are significant areas for academia and practitioners alike to collaboratively investigate to facilitate resilient food chains. Additionally, there is a divergence between the areas of academia and practitioners' views, which in itself can be an issue. Quite often practitioner journals are paid to conduct research or there are the latest trends to follow, which can often cause issues pertaining to relevance and do not necessarily relate to it being a specific issue.

There was much across the differing literature sources reviewing generic supply chain risk and areas pertaining to business, fraud, health and information interchange need. However, it has been identified when comparing to the UK Government report into supply chain food fraud (Elliott, 2014) that there are gaps pertaining to authenticity, consumers, data, enforcement, intelligence sharing and risk mitigation (Table 25). In addition, it is clear from current research that no one solution alone can mitigate risk in a food supply chain, therefore, this research thesis seeks to review the link between business, government and research communities to support and underpin the auspices of scientific testing and legislation, by bringing together a triangulated approach (Science, Legislation & Operational) to food supply chain resilience through a collaborative approach to security of supply, an area that will be explored further in the remainder of chapter 4 and through chapter 5 with the overall results discussion. In doing

so, this thesis will focus specifically on the research gaps identified in the literature of data, intelligence sharing and risk mitigation.

In short, the literature is building towards a triangle of stakeholders (people), zero tolerance (process) and intelligence led (systems) approaches, all of which are underpinned by traditional supply chain risk management governance. However, there is a lack of cohesion between supply chain actors whether they be business, consumer or government, which will be explored later in this chapter [4] and chapter 5.

4.3 Delphi study data outputs and discussion

4.3.1 Delphi study introduction

This section of the research findings chapter relates to outputs of the Modified Delphi. The thesis takes into account the criticism of Delphi research regarding associated review stages having too much data, making understanding of results difficult (Landeta, 2006; Mitroff & Turroff, 2002). In light of this, the research thesis aspires to combat this by breaking down the results and discussions into a series of different headings.

The research study undertook a Modified Delphi study as part of its methodological process in reviewing resilience building in food supply chains against criminality. This Modified Delphi has been upheld as a proven and efficient method to elicit opinion around a subject area where little data is available, such as with food supply chain fraud as outlined by the systematic literature review contained within this research study (Fassam & Dani, 2016; Kache & Seuring, 2017; Linston & Turoff, 1975; Riggs, 1983; Rowe, Wright & Bolger, 1992). Furthermore, prior research in the field of supply chain risk management has upheld the Modified Delphi process as a way to elicit experts in their chosen field to form panels of expertise that permit horizon scanning of future business events that may be currently unknown. These events are purported as repeatable in the likelihood of recurrence; therefore, assumptions can be formed that Delphi research responses converge towards a mid-range dispersal (Johnston, 1976; Ng, 1984).

The Modified Delphi study set out to explore key elements of building supply chain resilience and the connection to food criminality, in particular against the research question *'What are the capabilities of internal supply chain actors to build supply chain resilience against food*

fraud?'. This exploration of the research question was undertaken with 20 industry experts, as outlined in Chapter 3, across a number of differing food supply chain actors at strategic levels.

In order to get a starting point for perceptions of building resilience against food fraud in supply chains, this research undertook an initial phase [Pre-phase] of the Modified Delphi study as there was limited academic knowledge in the area of food supply chain fraud resilience building (Fassam & Dani, 2017). The first process [Pre-phase] posed the question *'What are the top 10 capabilities for building internal resilience against food fraud?'* to the twenty participants and in order to harness their extensive professional experience. Utilising these expert participants in this manner enables differing views to be collated, fostering high quality responses that can be aggregated into reliable research outputs (Gupta & Clarke, 1996), which during the first phase [Pre-Phase] elicited a total of 200 answers. On return of the data, the researcher then spent a significant period of time reviewing the 200 initial responses, initially removing duplication and aggregating into groups using qualitative cluster analysis (Revelle, 1979), which reduced the amount to 46.

The next step, [Phase I] the second round of the process, involved sending out the 46 aggregated topics to the 20 Modified Delphi participants, where each was scored against a LIKERT scale 1-5 (1 strongly disagree – 5 strongly agree), assessing the degree of fit with supply chain resilience and food criminality. The Modified Delphi results were returned and analysed by the research team and ranked in order of highest LIKERT score attained.

The next steps, rounds 3 [Phase II] and rounds 4 [Phase III], were undertaken in a similar fashion to Phase I, with the 46 aggregated answers being sent back to respondents to re-score. During this phase, participants could not see their original scoring or that of any other participants in order to remove any potential bias.

To utilise the process of understanding when to cease further rounds of the study, known as the stopping rule, the research used a coefficient of variation (CV), a recognised statistical test to ensure completeness and robustness of outcomes, while indicating the end point of a survey (English and Kernan, 1976; Yang, 2003). Furthermore, the coefficient of variation is the output of standard deviation (σ) to its corresponding mean (μ), noted as the most reliable tool for ensuring statistical relevance with a Delphi study (Shah & Kalaian, 2009), by using the formula:

$$CV = \sigma / \mu$$

In the majority of cases, the coefficient of variation was below 0.2 (26 responses in total), which according to Dajani (1979) is a minor difference and therefore concludes that stability was reached in the research outputs, with no further rounds of a Modified Delphi being required. However, in order to reach a consensus with the outputs of the Modified Delphi that are rigorous for further exploration, the Modified Delphi aimed to only include outputs with values of CV <0.01, as this limits the variation of response between experts, meaning outputs are more robust and statistically relevant to the research question (Kalaian & Kasim, 2012). Therefore, 26 responses that noted a coefficient of variation that was registering above 0.2 were removed in line with aforementioned rigour challenges (Kernan, 1976). However, for the purposes of statistical rigour, the research study only reviewed responses with a coefficient of variation of <0.1, as the Modified Delphi process was designed within the confines of this research thesis to review and deliver a focussed set of meaningful measures for utilisation by academics and practitioners alike.

Due to there being time available within the research process with the 20 experts, a further process was added to assess factors associated with quantitative data analysis across multi-stakeholder approaches to permit strategies around decision making to develop a process upheld as relevant and rigorous in research (Rice & Spayd, 2005). This additional approach resolved to review stakeholders that the UK Government report into supply chain food fraud (Elliott, 2014) identified as relevant to building resilience, as this stakeholder had been a clear gap in the business academic literature. The top 10 from the final round 3 Modified Delphi was returned to participants electronically, who were requested to rank in order of importance the elements from the Delphi top 10 that pertained to the departments responsible for Finance, Government, HR, IT, Marketing, Operations (logistics), Procurement and Quality. This was done in order to gain insight into the experts' views on responsibility, and to ascertain any themes or gaps in the perceptions against supply chain resilience and food criminality.

All of the data elements from the Modified Delphi were coded against key themes from food supply chain resilience literature, a process noted as relevant and which enables common themes to be identified with Delphi research processes (Oxborrow & Brindley, 2012).

4.3.2 Modified Delphi responses

Once the 20 experts' responses had been through the three stage Modified Delphi process, a notable static mean and coefficient of variation of <0.2 was identified across the 26 answers consolidated through the process across all three stages (Table 27), leading to the view that a general consensus had been reached at all stages of the Modified Delphi. Further strengthening this position was the coefficient of variation being below 2 in all cases, meaning the research process [Delphi] had reached the 'stopping point'.

Food supply chain characteristics	Ph 1 Mean	Ph 2 Mean	Ph 3 Mean	STD DEV	MEAN	Coefficient variation
Holistic procurement collaboration	4.8	5	5	0.12	4.93	0.02
Collaborative information with trading partners	5	4.5	5	0.29	4.83	0.06
Internal communications	4.9	4.5	4.9	0.23	4.77	0.05
Holistic information flow	4.6	4.8	4.5	0.15	4.63	0.03
Holistic forecasting customer requirements	4.5	4.8	4.5	0.17	4.60	0.04
Intelligence sharing across departments	4.2	5	4.6	0.40	4.60	0.09
Inventory visibility	4.5	4.6	4.5	0.06	4.53	0.01
Flexible supply chain partners	4.5	4	4.8	0.40	4.43	0.09
Visibility of customer demand	4.2	4.8	4.2	0.35	4.40	0.08
Traceability standards aligned	4.3	4.8	4	0.40	4.37	0.09
Real time data	3.3	4.6	4.1	0.66	4.00	0.16
Training & learning	4.6	3.8	4.5	0.44	4.30	0.10
Risk management	3.8	4.6	4	0.42	4.13	0.10
Sourcing agility	3.8	4.5	3.8	0.40	4.03	0.10
Supplier collaboration	3.8	4.3	3.2	0.55	3.77	0.15
Standardised systems	3.5	4	4.4	0.45	3.97	0.11
Flexible inventory and buffering strategies	3.6	4.4	3.8	0.42	3.93	0.11
Shorter supply chains	3.8	4	3	0.53	3.60	0.15
Better supply chain analysis	3.5	4.5	3.5	0.58	3.83	0.15
All partner supply chain surplus benefit	3.5	3.5	4.2	0.40	3.73	0.11
Enforcement	3.5	4	3	0.50	3.50	0.14
Lead time reduction	3.5	3.9	3	0.45	3.47	0.13
Quality departments involvement with procurement	3.8	3.2	4	0.42	3.67	0.11
Government intervention	3	4	3.2	0.53	3.40	0.16
Overall supply chain response – speed	3	4	3	0.58	3.33	0.17
Flexible planning systems	4	3	3	0.58	3.33	0.17

Key – **GREEN** = Highest MEAN, **AMBER** = Medium MEAN and **RED** = Lowest MEAN

Table 27 Respondents with coefficient of variation <.0.2

When reviewing responses, those outside of the top 10 had significant differences of opinion and changes between differing phases of the Delphi. Of note are the changes of attitude and

lower ranking historic supply chain management techniques to mitigate resilience such as agility, flexibility, lead time reduction and management of supplier constraints. This leads the researcher to surmise that despite their historic importance to supply chain management, these traditional aspects of supply chain resilience building are being replaced by more connected ICT solutions to combat the ever-rising issues of supply chain resilience and food criminality. It would further strengthen the points pertaining to over complex and expensive traditional supply chain mitigation strategies that have a high failure rate (Barratt, 2004; Delbufalo, 2012). In relation to food supply chains, the researcher proposes that traditional methods are still valid, but they will have greater effect when supported by ICT solutions. This supports a view that suggests traditional supply chain resilience methods are understood, but strategic thinkers are looking to other innovative methods to enhance historic methods.

4.3.3 Top 10 responses

In order to focus the results of the Modified Delphi, the research thesis concentrates on the top 10 responses (Table.28) chosen as they align to the methodology associated with a Delphi of being predominately based on the highest rated MEAN average and having a coefficient variation of <0.1 meaning outputs are more statistically robust (Kalaian & Kasim, 2012). Thus, on review of the 30 Delphi responses (Table.27), it can be clearly identified that the MEAN average for the majority of answers is of 4.0 or above, so the researcher chose to focus on the top 10 responses, as these were a final MEAN of 4.0 and above with a relevant coefficient of variation (<0.1).

Of these responses there is an identifiable and predominant relation to Information and Communication Technologies (ICT), and associated elements of data sharing, explicitly with information flow, visibility, intelligence sharing, real time data, collaborative flow with partners and internal communications. There are tacit connections to ICT and data sharing with inventory visibility, customer demand visibility, and forecasting demand, as arguably these are well embedded and aligned to modern day supply chain activities with ICT and data sharing. This leads the researcher to purport a need for connected and robust supply chain connectivity with data sharing being of paramount importance for building food supply chain resilience. This further reinforces the need for food supply chain actors to be collectively looking for ICT solutions to solve challenges associated with food supply chain resilience. The ability for food supply chains to deploy technology to visibly link up inventory and consumer demand means

that traditional supply chain management theories, such as managed inventory and obsolescence mitigation, can be deployed to much greater effect, while enabling the holistic systems view to permeate across supply chain actors in building resilience (Fawcett et al., 2012; Hines, 2004).

Food supply chain characteristics	Ph 1 Mean	Ph 2 Mean	Ph III Mean	STD DEV	MEAN	Coefficient variation
Holistic procurement collaboration	4.8	5	5	0.12	4.93	0.02
Collaborative information with trading partners	5	4.5	5	0.29	4.83	0.06
Internal communications	4.9	4.5	4.9	0.23	4.77	0.05
Holistic information flow	4.6	4.8	4.5	0.15	4.63	0.03
Holistic forecasting customer requirements	4.5	4.8	4.5	0.17	4.60	0.04
Intelligence sharing across departments	4.2	5	4.6	0.40	4.60	0.09
Inventory visibility	4.5	4.6	4.5	0.06	4.53	0.01
Flexible supply chain partners	4.5	4	4.8	0.40	4.43	0.09
Visibility of customer demand	4.2	4.8	4.2	0.35	4.40	0.08
Traceability standards aligned	4.3	4.8	4	0.40	4.37	0.09

Key – **GREEN** = Highest MEAN, **AMBER** = Medium MEAN and **RED** = Lowest MEAN

Table 28 Modified Delphi factors with coefficient variation of <0.1

Furthermore, the ability to forecast consumer demands appeared to factor highly across the expert focus groups' desires to build resilience into food supply chains. Historically, forecasting has been seen as crucial in mitigating cost control and risk in supply chain management, which is interesting as despite there being no direct correlation with food criminality and supply chain profitability, one could assume a link given the need to forecast demands. However, the link between forecasting and food criminality goes deeper than simple cost control, being more allied to abilities to maintain greater control of stock across an extended supply chain, therefore mitigating the ability for products to be substituted out whilst in storage.

Outside of the traditional elements of supply chain management, such as forecasting and deployment of ICT, there appears a need to foster greater internal communication across an organisation. It could be argued that the aforementioned auspices of holistic food supply chain

integration with ICT and the need to forecast demand requires the absolute connected communication culture internally within an organisation in order to mitigate food supply chain risk. This would support the need to utilise better data sets across food supply chain actors to build resilience against criminality (Elliott, 2014; Fassam & Dani, 2017; FSA, 2016), with shared data and forecasting methods permitting tighter control of stock movement and storage across the global food supply chain networks.

Academic Literature 'Gaps' **Outputs from Systematic literature review** **(Fassam & Dani, 2017)**	**Resilience measure 'Enablers'** **Outputs from supply chain resilience literature review** **(Bourlakis et al, 2014; Edgeman & Wu, 2016)**	**Management focus 'Enablers'** **Outputs from supply chain resilience literature review** **(Elliott, 2014; Manning & Soon, 2016)**	**Food supply chain characteristics** **Outputs from Modified Delphi**
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Holistic procurement collaboration
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Collaborative information with trading partners

Enforcement, Data, Intelligence	Strategic leadership	Persistence & Robustness	Internal communications
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Holistic information flow
Data, Intelligence, Risk	KPI	Learning & innovation	Inventory visibility
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Holistic forecasting customer requirements
Data, Intelligence, Risk	KPI	Learning & innovation	Flexible supply chain partners
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Visibility of customer demand
Authenticity, Enforcement, Risk	Decision leadership	Recovery & Constancy	Intelligence sharing across departments
Authenticity, Enforcement, Risk	Value based dynamics	Recovery & Constancy	Traceability standards aligned

Table 29 Top 10 Modified Delphi results coded to food supply chain resilience and management focal point outputs from systematic literature review (Bourlakis et al, 2014; Edgeman & Wu, 2016; Elliott, 2014; Folke, 2006; Manning & Soon, 2016, Ponomarov & Holcomd, 2009)

The next step of the research data was a review of the connection between outputs from the systematic literature review (Column 1, 2 & 3 of Table.29) and the Modified Delhi outputs

(column 4 of Table.29). Here, the top 10 food supply chain resilience factors from the Modified Delphi (Column 4, Table.29) were coded against the 'gaps' with 'Academic literature gaps' (Column 1, Table.29) and 'enablers' with 'management focal point' (Column 2, Table.29) and 'resilience measures' (Column 3, Table.29). These 'gaps' and 'enablers' with resilience measures were coded through the aforementioned systematic review and by using QSR NVivo 12®, by coding keywords relating to the resilience measures in nodes to portray correlation between the themes (Column 2 & 3, Table.29) contained within the literature (Bourlakis et al., 2014; Edgeman & Wu, 2016; Folke, 2006; Manning & Soon, 2016; Ponomarov & Holcomb, 2009). From the coding exercise, a clear pattern around learning and innovation can be identified, and this supports the much needed establishment of strategies that develop connected data interchange at board level, an area identified as lacking in the literature review [Chapter 2]. Also noteworthy is the predominance of areas linked to the need for dynamic supply chains and strategic leadership. There is much literature pertaining to supply chain resilience and agility, but only a small academic body of knowledge to support the food supply chain sector and resilience to food fraud. All of the findings of the Modified Delphi are linked to the gaps that the systematic literature review had highlighted with regards authenticity, consumers, data, enforcement, and intelligence and risk, but more was needed to gain insight into business functions connected to these resilience building areas, an area discussed in the latter portion of Chapter 4.

4.3.4 Delphi ranked against area of interest in building food resilience

Within the top 10 themes of the Modified Delphi, the coefficient variable was stable and at a level where no further rounds were needed or changes to statements in order to draw conclusions around the research question outputs. Therefore, the researcher utilised the additional time with industry experts to build a model of the department or organisational involvement and relevance for building resilience against a particular Modified Delphi metric. The departments utilised were taken from the UK Government report into building supply chain resilience into food chains (Elliott, 2014), and the areas identified as crucial to building food supply chain resilience were:

Finance, Government, HR, IT, Marketing, Operations (including logistics), Procurement, Quality.

Academic Literature 'Gaps' **Outputs from Systematic literature review** **(Fassam & Dani, 2017)**	**Resilience measure 'Enablers'** **Outputs from supply chain resilience literature review** **(Bourlakis et al, 2014; Edgeman & Wu, 2016)**	**Management focus 'Enablers'** **Outputs from supply chain resilience literature review** **(Elliott, 2014; Manning & Soon, 2016)**	**Food supply chain characteristics** **Outputs from modified Delphi**	**Lead internal actor** **Outputs from the Modified Delphi interview process**	**Internal support units** **Outputs from the Modified Delphi interview process**
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Holistic procurement collaboration	Procurement	Finance, IT, Operations
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Collaborative information with trading partners	Procurement	Finance, IT
Enforcement, Data, Intelligence	Strategic leadership	Persistence & Robustness	Internal communications	HR	Operations, Procurement, Finance

Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Holistic information flow	Procurement	IT, Operations, Finance
Data, Intelligence, Risk	KPI	Learning & innovation	Inventory visibility	Procurement	IT, Operations
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Holistic forecasting customer requirements	Procurement	Marketing, Finance
Data, Intelligence, Risk	KPI	Learning & innovation	Flexible supply chain partners	Procurement	Marketing, Finance
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Visibility of customer demand	Procurement	Marketing, Finance
Authenticity, Enforcement, Risk	Decision leadership	Recovery & Constancy	Intelligence sharing across departments	Procurement	Finance, Operations
Authenticity, Enforcement, Risk	Value based dynamics	Recovery & Constancy	Traceability standards aligned	Procurement	Government, Quality

Table 30 Ranked responsibility of top 10 Modified Delphi factors of supply chain resilience, against the identified business unit resilience builder (Bourlakis et al, 2014; Edgeman & Wu, 2016; Elliott, 2014; Folke, 2006; Manning & Soon, 2016, Ponomarov & Holcomd, 2009)

To continue from the correlation analysis (Table.29), whereby the literature review gaps, along with the enablers of resilience were mapped against the Modified Delphi, a further element of research review and correlation was required. This is noted in Table.30, whereby the data as

presented in Table.29 has been built upon with the internal business departments responsible for building resilience (Column 5 & 6, Table.30). As noted in the methods section (Chapter 3) this process was part of the Modified Delphi, and used as an exploratorty process to identify resilience creation unit.

When analysed (Table 30), it can be clearly noted that procurement is put forward by the expert panel as the leading factor responsible for building supply chain resilience against food criminality, as it was the lead function in 90% of cases, with 10% attributing it to HR with procurement as a supporting function. When Modified Delphi experts were engaged with to determine the stakeholders involved with building internal resilience, they were afforded free text, and some pertinent comments were made, as follows:

> "Procurements are a central function, with reach and connectivity beyond a normal business functions ability"

> "They [procurement] are the connection to the outside world, enabling a view to be attained that is objective"

> "It is a function that sits between all actors, therefore should be the driver for change, both internal and external"

> "It is only right that those who manage the specifications and supplier selection process, be the gatekeepers of ensuring contracts and therefore provenance is achieved"

> "I do not think procurement are the leading light with regards building resilience, but they can certainly act as a central conduit to change"

> "The ability to garner reach outside an organisation and drive the strategic need for alignment starts with procurement"

There is a definite view from the Modified Delphi experts that procurement has an objective outward facing role, one that is seen to be in charge of specifications, contract negotiation and provenance management. However, this needs more detail and understanding in order to draw

conclusions, which will be reviewed and discussed later in Chapter 4 within the case study semi-structured interviews with procurement experts.

Of further interest are the elements of finance, which are held as second highest importance, and in normal business operations these two functions [finance and procurement] are closely linked and even contained within the same business units. Furthermore, when the Modified Delphi experts were asked to expand upon the procurement functions role, there was no mention or correlation made to finance and its role with procurement teams. This therefore was deemed as another area that required deeper exploration within the semi-structured interviews, to gain an appreciation of the differing perspectives and role of both procurement and finance in relation to food supply chain resilience building.

Additional significant factors to note are the areas of Government, HR, Marketing and Quality in building resilience within the supply chain context. These areas are not as prevalent as others, and despite this, they still clearly play an important role in building much-needed food supply chain resilience, with the researcher suggesting that these functions should interface with procurement to bring about true holistic connectivity (Table 30). Some of the comments relating to this area are:

> "Government is a function of policy, and often stifles much needed innovation for the food sector"

> "It is not just rule making that Governments need to undertake, greater understanding of sector is needed to ensure it [sector] can move forward"

> "Marketing functions are not interested in how differing processes come together to bring products to life, which often is a precursor to failure with food supply chains"

> "The marketing teams are more interested in glossy outcomes than food provenance and security"

> "The quality departments are critical in aligning standards, but lack cross supply chain collaboration"

> "There is a lack of forward thinking within quality teams, much of the work undertaken is reactive or box ticking and leads to blame cultures"

> "Skills are important to the sector, however, Human resources team lack the sector specific knowledge to bridge clear gaps"

The secondary views of the Modified Delphi expert panel seem to view the functions of Government, HR, Marketing and Quality as outside the 'trusted' circle and lacking sector specific knowledge and not being innovative enough to support the overall functions. This would support the stakeholder mapping that was undertaken with HR not featuring as a stakeholder to build resilience, despite Learning and innovation featuring high in the management focal point of building resilience. Government, Marketing and Quality only feature once each in the matrix, which would lead one to support the view that historic management have viewed these stakeholders as extra to the supply chain operation.

However, the areas of IT and Operations fair better as being a resilience builder, which is hardly surprising given the aforementioned desires to build greater ICT solutions into the food supply chain, with Operations having considerable touch points over the physical product, where arguably much of the activity pertaining to the food supply chain takes place. Like previous iterations of stakeholder review the free text aspect relating to areas of internal resilience builder in relation to IT and Operations with key aspects are as follows:

> "Operations are critical for successful mitigation of risk, but lack the buy in of wider business functions"

> "The Operations functions are always viewed as the poor cousin, they have so much to offer, but lack a seat at the table"

> "Operations teams are key to delivering resilience in food supply chains, and need closer working ties with buyer-supplier relationships"

> "IT are often seen as the silver bullet to building supply chain resilience, but lack innovation and sector understanding"

> "Operations and their IT systems are critical to the success of food supply chain risk and resilience building"

> "Too much is being placed around IT systems such as Blockchain in being the gatekeeper to food supply chain resilience"

> "Skills are the biggest challenge to successful Operations implementation of risk mitigation"

As with other elements of the stakeholder assignment, there were emerging gaps when reviewing the alignment to food supply chain resilience building. Skills, perceptions and systems design involvement appear to be drivers of exclusion for Operations and IT involvement. These areas would further support the need for 'Learning and Innovation' to be key for Management focus when looking to build resilience into food supply chains. These areas were carried forward to the semi-structured interviews in order to gain an appreciation of these metrics with procurement experts, and like aforementioned areas, will be discussed in the latter stages of Chapter 4.

One could assume therefore a bias exists towards the procurement and finance functions being noted as externally facing, with the potential for other areas to be deemed as lacking importance in building resilience with regards to food supply chain resilience. Therefore, like the procurement and finance aspects, these areas need to be explored in greater detail within the semi-structured interviews.

Whilst the Modified Delphi experts gave some clarity and insight into their decision-making processes over stakeholder assignment, the thesis researcher felt it important to marry up the outputs of the Modified Delphi with the aspects of food supply chain resilience building discussed in the literature review in Chapter 2.

This has enabled a matrix to be constructed (Table 30) which depicts academic research outputs pertaining to food supply chain resilience, alongside the outputs of the Modified Delphi and a list of stakeholders. This shows there is a clear need for dynamic supply chains and key performance indicators (KPI) to be implemented. Procurement as a function is clearly well

aligned to the supply chain dynamics elements, with IT and Operations being more allied to KPI usage. Learning and Innovation make up 70% of the need for food supply chain resilience building, which dovetails with the experts' views around skills gaps in the sector, and is a theme across all the differing stakeholders that is identified as crucial. These findings were carried forward into the semi-structured interviews to elicit opinion from procurement professionals, in order to build an understanding of these elements in a supply chain context.

4.3.5 Key areas of responsibility in developing food fraud mitigation in supply chains

Holistic procurement collaboration and flexible inventory buffering strategies are upheld as key according to the experts. This aligns well with the auspices of traditional supply chain risk management processes. However, the interesting aspect pertains to expert evaluation of procurement and IT being departments driving the building of resilience allied to this metric, with operations, whilst acknowledged, not being considered a key consideration.

The adoption of shorter supply chains was seen to be in the domain of the operations department, which goes against traditional operational models. This is perhaps because little of the sourcing strategy can be controlled by operational teams, leading the researcher to believe that while the coefficient of variation was stable, further exploration is needed in the case studies to explore the meanings behind this area.

Holistic forecasting of customer demands was again scored highest with procurement departments. However, of interest is the inclusion of Operations departments high in the scoring. This was noted down to the Information Technology systems management of operations departments within food supply chains.

As a result, a mapping of the food resilience characteristics from the Modified Delphi (Table 30) was carried out. This was coded against the 'gaps' from the systematic literature review, and the 'enablers' from the 'management focus' and 'resilience measure' from the literature review, which were then coded against the 'capabilities of resilience building' with the Modified Delhi against an identified set of stakeholders responsible for internal resilience building. In itself this gave an interesting output, with 7 of the 10 metrics being firmly aligned to the management focus of learning and innovation, with the resilience measure predominantly being supply chain dynamics and one metric [inventory visibility] allied to use

of key performance indicators (KPI). This is not discounting the other management and resilience strategies, but does deliver the beginnings of a focus and framework towards the research question of *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*.

4.4 Case study process

The case study's semi-structured interviews were proposed as an empirical study method to develop a way to match patterns in order to analyse outputs of the Modified Delphi responses. In doing this, the fourth objective of this research thesis could be reached by collating outputs attained under objectives 1, 2 and 3 and permitting an understanding for further research into food supply chain resilience building against food fraud. As such, the case study set to utilise semi-structured interview questions based on outputs of the top Modified Delphi to elicit opinions from procurement professionals in response to the research aim of *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*.

In order to permit greater data analysis and interpretation of sector specific challenges in the semi-structured interviews, the participants and their respective businesses were given a code (Table 31). This enabled outputs to be correlated to an industry or level within an organisation, giving greater richness to the data and an ability to compare against the systematic literature review and Modified Delphi outputs.

As discussed in the methodology section [Chapter 3], the four case studies were chosen due to their transactional relationship, which made them representative in terms of a modern-day food supply chain. The case study organisations collectively have reach in 23 of the 27 European Union countries, turn over £27.6 billion (Europe), employ 71, 600 people, operate circa 6, 950 vehicles daily from 91 locations (plus 1, 400 stores), and have 14.8 million square metres of food grade warehousing space. In addition, the European food industry contributes 6% GVE, has intra Europe exports of £273 billion (3/4 of which are destined for single market use) with a total of £191 billion worth of food manufacturing (Eurostat, 2014; Food & Drink Europe, 2018).This therefore makes the composition of case study organisations significant in terms of market share as it comprises 25% of the intra-European movement of foodstuff activity, 11%

of food manufacturing, 4% of food retail interest and 1.5% of the total European Commission GVA.

	Food processor	Food logistics	Food retail	Food consulting
Director	FPD1	FLD1	FRD1	FCD1
Director	FPD2	FLD2	FRD2	FCD2
Senior Manager	FPM1	FLM1	FRM1	FCM1
Buyer	FPB1	FLB1	FRB1	FCB1
Buyer	FPB2	FLB2	FRB2	FCB2
	5	5	5	5

Table 31 Semi-structured interview participants coded

The questions were split into three thematic areas, which were aligned with the outputs of the Modified Delphi inputs and areas of known food supply chain resilience. This enabled the researcher to identify themes from participants that were clearly connected with the emerging conceptual framework relating to the research question *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*.

The research utilised QSR NVivo 12® software to create a sortation process of phrases contained within the responses gleaned from participants, which were in the form of word frequency, text search and content analysis. The terms were then utilised to build an understanding of the link between food supply chain resilience building, outputs from the Modified Delphi study and the perception of procurement professionals, particularly as they had been identified as critical for managing this metric by the food supply chain experts contained within the Modified Delphi.

4.4.1 Semi-structured question rationale

The questions outlined below (Table 32) were broken down into thematic areas built from the literature review outputs based on current resilience and management focus in existent academic literature. Furthermore, the questions themselves were based on the outputs of the Modified Delphi in order to elicit responses from procurement professionals as to the degree of fit both in actual practice in the 'as-is' state and the desired practice in the best class 'to-be' status.

Section one, relating to 'Leaning and innovation' and supply chain dynamics, is specifically related to the Modified Delphi outputs of collaboration, information flow (both internal and external) and the adoption of agile and flexible supply chain strategies to build food supply chain resilience. This section is directly linked to the areas of consumers, data, intelligence and risk identified as gaps in existent academic literature.

The second section relates to 'Persistence and robustness' and 'Strategic leadership' and specifically looks to the internal communication metrics that reside within an organisation, to again review existing process flows relating to this, or a desired state in order to foster resilience building. Like the former section, this connects well with meeting the academic research gap pertaining to enforcement, data and intelligence.

Lastly, 'Persistence and constancy' relating to 'Decision leadership' were reviewed against the ability of an organisation to adhere to governance and traceability standards. This links to the areas of academic research gaps in food supply chain resilience, specifically regarding authenticity, enforcement and risk.

This gave rise to a set of questions which were aligned with the systematic literature review and published gaps around this area (Fassan & Dani, 2017), alongside the constructs of historic food supply chain resilience building through a 'resilience measure' and 'management focus' against the outputs of the Modified Delphi, bringing context to a sector specific focus in the procurement sector.

Academic Literature Gaps	Resilience measure	Management focus	Questions
Consumers, Data, Intelligence, Risk	Learning and Innovation	Supply chain dynamics / KPI	1.Does your organisation use holistic procurement collaboration across its supply chain?
			2. Do you share information with trading partners up and downstream?
			3.Is there a seamless and holistic information flow across your supply chains?
			4. Do you have visibility of inventory, and how far across your supply chain can you see this?
			5.Is there any collaborative forecasting undertaken within your supply chain?
			6. Does your business adopt flexible supply chain strategies?
			7. Have you got visibility of consumer demand?
Enforcement, Data, Intelligence	Persistence and robustness	Strategic leadership	8. Are your organisational internal communications supporting good supply chain practice?
Authenticity, Enforcement, Risk	Recovery & constancy	Decision leadership	9. Is there intelligence sharing across your departments, both internal and external?
			10. Do you believe that traceability standards are aligned across your supply chain?

Table 32 Semi-structured interview questions

4.4.2 Thematic resilience measure – Learning and innovation

The first set of questions relating to the thematic resilience measures of learning innovation was put to the procurement executives of the four differing organisations. The table below (Table 33) sets out the summary response detail against the thematic area that emerged from the semi-structured interview process (Column 1), the number of overall participants involved (including percentage) and a breakdown by case study organisation to collective response rate.

Thematic area	Participant number	%	Food processor	Food logistics	Food retail	Food consulting
Business collaboration	15	75	4	2	5	4
Systems view	14	70	4	5	1	4
Tiered Supplier visibility	9	45	0	2	4	2
Forecasting	9	45	4	4	1	0

Table 33 Key themes from the first set of semi-structured questions

4.4.2.1 Business collaboration

The first key theme identified in relation to the first set of semi-structured questions related to a need for greater collaboration. This was the most agreed upon metric, with 75% of the participants having elicited a response in this area. When a review is done in terms of the sector, greater agreement is seen in retail (5), with food processor and consulting (4) showing significant levels of agreement and the food logistics being less in agreement.

Within retail, participant FRD1 cited how their organisational procurement departments were "investing significant amounts of money with suppliers in order to build greater provenance", which is seen in much of the literature with retailers investing heavily in technology to gain

greater visibility. However, both FPD1 and FPB1 had somewhat differing views, with the former citing “more needs to be done to link the retailer with the processor” and within the buying section of this organisation “visibility is only needed around price and lead time, have never been asked about integrity of ingredients”. In addition, FCD2 explained how “a perceived investment of technology is happening across the food sector, much of which is focussed around greater efficiency (cost), with little attention being paid to the crucial role data connected chains make in contributing to greater nutrition, reduced waste and lessening fraud”. These comments from the producer would intimate that despite the desires to invest in technology, it is not reaching far enough upstream, and there is perhaps a need for more data, visibility and intelligence as suggested by the academic literature. When pushed, the three members of Food Logistics seemed reticent to offer any opinion on this subject.

4.4.2.2 Systems view

The second theme arising from the first set of questions was a lack of systems view, with 14 of the 20 participants (70%) having been connected to this thematic area. Leading in this area was food logistics (5), food consulting and food processor (4) equal but significantly contributing and food retailer eliciting a lower contribution (1).

Logistics by its nature of historically being reactive to the demands of markets due to a lack of data visibility would explain the higher score, specifically as FLD2 states that with “a disparate need for others to share information, we invest in technology to track loads and driver behaviours, but this data never gets used”. When pushed further on the subject of systems view, FLD2 felt “there is little attention paid to the movement of goods between facilities, and any data capture would not be acted upon”. This therefore is well aligned once again to the gaps in academic literature around risk and intelligence sharing, but poses questions around the validity of such processes with a lack of systems view. This view was reinforced by retail teams as FRM1 explained: “our department looks to the availability, price and lead time of goods, we do not currently do this in terms of all systems within the supply chain” and FRB2 stated “a fully connected view of the systems would assist greatly indecision making, but with so many products one would argue we would be in data overload”. This retailer view therefore reinforces benefits associated with a systems view but raises questions over the resource to interpret this, which is felt by the logistics business in gathering data that is not being utilised, which leads researchers to highlight concerns around potential ‘data fatigue’.

4.4.2.3 Tiered supplier visibility

The third thematic area was 'No view past 2nd tier of supplier' with 9 (45%) participants being involved or relating to this area, consisting of food retail (4) as the highest, food processor and food consulting (2) equal but at the lower end, and food logistics (0) having no participants. This is hardly surprising given the historical perceptions of tiers working in one direction only, and much driven in the direction of downstream to upstream. Therefore, given the importance of data, and risk mitigation as per academic research gaps, the researcher pushed for more detail with food logistics, food consulting and food processor. FLD2 said, "margins are incredibly short in logistics, meaning investment in flashing technology is simply not possible, more is needed for the bigger players to assist smaller more margin constrained players". FLB2 explained, "we use very manual systems, which continually need to be updated into larger organisations systems, meaning increased time and higher margin for error". Furthermore, when engaging with food processors ,FPD1 stated, "the data is a two-way system between us and the distributors, but it is very last minute with changes to systems. This makes it very hard to make sustainable and resilient processes as continual changes create issues with data integrity". In addition, FPM1 cited "much of my week is pulling together differing formats of data, from lots of suppliers, which is not only a laborious task, but fraught with errors and costs". This drew the researcher to believe there is a need to engage further with food logistics and food processing organisations around connected data in terms of cost (both capital expenditure and resource) and system errors, as the auspices of a systems view to build resilience into food chains cannot happen without full connectivity.

4.4.2.4 Forecasting

The fourth thematic area to emerge pertains to 'forecasting end-end supply chains' and was referred to by 9 (45%) participants, including food processor and food logistics (4), food retail (1) and food consulting (0).

Forecasting end to end supply chains in a collaborative manner is well aligned to the research gaps relating to this thematic area of data and intelligence, and arguably, as noted by academic research in Chapter 2, goes towards reducing risk. This can be supported by the views of the two directors in both the food processor and food logistics areas with FPD1 citing, "having connected forecasting would greatly reduce waste and absolutely build better resilience into the food supply chain" and FLD2 stating, "my procurement team are well placed to coordinate

with others in the food chain to bring about better operational efficiency and resilience". These two views support not only the need to foster great connectivity across food chains, but procurement can be the vehicle for change in building food supply chain resilience. In addition, a buyer in food retail, FRB1, talks of "abilities for me to connect across the wider chain would greatly benefit confidence to our senior leadership teams around provenance and price", whilst a buyer in the food producer sphere, FBP2, espouses, "being able to forecast collectively means we would be able to react to consumer demands quicker, and potentially permit retailers to engage with their consumers over product origin, surely this is a great marketing piece?". Members of the Food consultancy case study group did not ally themselves with this metric, however, FCB2, a specialist buyer within food consulting, did state, "forecasting would enable vested interests to be achieved and collective profitability, which in itself builds resilience". This fourth metric has some interesting supporting comments, with the majority of players in the case study agreeing that forecasting is a good way forward for all participants, with everything from cost control, visibility, waste reduction and resilience being mentioned, which all matched with the metrics of consumer, data, intelligence and risk.

4.4.2.5 Learning and innovation summary

In summary, the themes from the first series of questions, whilst being rather narrow in terms of the questions being asked, were rich and did align well to the gaps identified within the systematic literature review, resilience metric and management methods. In particular, there were some differing views on use of technology, such as the perception that the supply chain was already connected by retailers, opposed to the view that more needed to be undertaken by food processors and food logistics operators. In addition, food logistics operators seem to be feeling that data is not being utilised in the correct manner, therefore resilience is being missed. Food consultants were the only participants to support the view that better profitability through sharing data would lead to greater trust and therefore resilience. Finally, it was noted by a Logistics Director that the procurement team was well placed to manage the wider supply chain process of resilience building through data management.

4.4.3 Thematic resilience measure – Persistence and robustness

The second set of questions relating to the thematic resilience measures of persistence and robustness was put to the procurement executives of the four different organisations. The table below (Table 34) sets out the summary response detail against the thematic areas arising from

the semi-structured interviews (Column 1), the number of overall participants involved (including percentage) and a breakdown by case study organisation to collective response rate.

Thematic area	Participant number	%	Food processor	Food logistics	Food retail	Food consulting
Cost	18	90	5	5	4	4
Blame culture	16	80	5	5	4	2
Training	15	75	4	2	4	5
Governance	15	75	4	4	4	3

Table 34 Key themes from the first set of semi-structured questions

4.4.3.1 Cost

The first theme identified (by most respondents) 'Increased cost'had 18 of 20 participants relating to this metric, with food processor and food logistics operators with highest participation (5), and food retailer and food consultant equal (4) but still eliciting high response rates across participants.

Cost metrics are often cited within the logistics and supply chain industry as the most prevalent metric, with little attention paid to the more intangible aspects such as people behaviours, which was supported by much of the participants.

As this section of questions was closely linked to completing the academic research gap on strategy, the research decided to portray this section of research firstly with a 'top down' approach director, followed by a 'bottom up' operative approach.

Leadership and Management Team (Top down):

FRD1 (Retail): “There is a real need for those across the wider organisation to understand the importance of behavioural science, particularly when we are talking building resilience, there is too much focus on cost”.

FPD2 (Food production): “The majority of my team are measured on throughput and cost, very little attention is placed on internal communication. You ask of resilience, we struggle to maintain our own business unit resilience with the cost culture driving through organisational behaviour”.

FLD2 (Food logistics): “We try to instil cross functional communication teams through meetings, much of this is related to managing risk and resilience in our business. This does seem to have more of a focus on the back office functions such as finance and procurement, and often lacks inclusion of operational facing teams”.

FCD1 (Food consulting): “Much of our work relates to change management, and more often the brief is about head count and cost. When we attempt to bring in the softer skills of comms or culture, it is often shunned over the priority of quick wins”.

Operators view (Bottom up):

FBP1 (Food buyer production): “…..with little attention being paid to culture, our organisation just reviews cost, nothing about people, product integrity, value, which is at times frustrating”.

FLB1 (Food buyer logistics): “We have a keen eye on cost, and monitor this against the market, as that is a great way to alert us to issues, such as the too good to be true deals. But, quite often targets take over the need to be vigilant and this can slip through the net, and is often something picked up through experience and not a KPI”.

FRB1 (Food buyer retail): “If only more would be done to eradicate this focus on cost, procurement is more than just this”.

FCB2 (Food buyer consultant): “Often engaged with food organisations looking to reduce cost, and quite often they miss the benefits of culture in building a more cost-conscious environment. It is cost that is causing issues around resilience, which is why we push this [culture] so hard”.

With this section of semi-structured case study questions relating to ‘Strategy’ one would question the food sector’s ability to embrace the benefits seen with bottom up operations strategy in engaging internally to foster greater collegiate communications. This is an area supported by academic literature as building resilience, and is arguably key in meeting the needs of research gap closure in enabling enforcement and data transfer. When reviewing the operator level, it is noted that many are attempting to build resilience by embracing cultural change or perceptions around procurement departments, but this is being hampered by an overly top down focus on cost control.

4.4.3.2 Blame culture

‘Blame culture’ was the next highest theme with 16 (80%) respondents eliciting a response related to this metric, with food processor and food logistics the highest (5), food retail showing significant connection (4) and food consulting identifying the least (2).

In keeping with the previous metric (increased cost) with culture being intrinsically linked to operations and supply chain management, the analysis of data will review the participants through a ‘top down’ ‘bottom up’ lens.

Leadership and Management Team (Top Down):

FPD1 (Food production): “Organisationally we work hard to remove the culture of blame, trying to just review cause – effect of issues rather than people. This is where procurement sits well, quite often the A-political department, we are well placed to attempt mitigation of this [blame]”.

FRD1 (Food retail): “Often blame is laid at the door of procurement for not meeting cost or specification metrics. However, as an organisation we try and shy away from this as it is not helpful to stakeholders either internal or external”.

FLD2 (Food logistics): “I always feel we are to blame for all failures in the food chain, and this permeates quickly down through the ranks, meaning morale is low, equates to lack of innovation and certainly engagement. We do try and counter this, but it just results in tit for tat email exchange”.

DCS2 (Food consulting): “Culture, it is the one thing we continually push, no matter what we are working on with clients. When you talk of resilience, and particularly food fraud, it is easy to pass blame with multi-tiered supply chains”.

Operators view (Bottom up):

FBP1 (Food processor): “I despise the blame culture, it doesn’t foster an environment of trust, which is crucial for us procurement folk”.

FLB2 (Food logistics): “This [blame culture] starts from within, when you have a senior leadership team that supports you and decisions, it helps with this”.

FRB1 (Food retail): “I often am at the receiving end of blame, it always perceived the retailer is the bad guy, always looking to screw the next one in the chain. Nothing is farther from this, but internally, it is hard at times, especially to maintain governance when it easy for some to hide”.

FCB2 (Food consulting): “Internal communication is often overlooked with siloed business units, in favour of expensive data engines, with a flawed perspective data is the silver bullet for risk and resilience building”.

There was much discussion to suggest that both sides of the operation strategy are aligned on the aspects of internal communication. There seems to be a desire for the procurement teams to garner more trust both internally and externally, with a sense of saying they are in this together, opposed to historic top down dynamics. This was a surprise to the researcher, as when the metric of blame culture surfaced, it was assumed in a negative manner. In the majority of cases it is seen as a negative, something to get away from, and certainly a metric that needs to be eradicated, seen as connected with the auspices of internal communications.

4.4.3.3 Training

The first theme identified (most respondents) in the section relating to persistence and robustness was related to 'Increased cost' with 18 of 20 participants referring to this metric. When broken down, it can be seen that food processor and food logistics operators had the highest participation (5), and food retailer and food consultant were equal (4) but still eliciting high response rates across participants.

Leadership and Management Team (Top Down):

> FPD1 (Food processor): "……with training being a major part of keeping staff engaged and current on the best ways to develop cultures that embrace communication, silos simply don't work for us, and leave us exposed as an organisation to all kinds of risk".
>
> FPM1 (Food processor): "There are clear advantages of having robust training practices in place, but this is rarely understood by the Senior Leadership teams, with a focus on throughput rather than retention and prevention".
>
> FLD2 (Food logistics): "Communication is key in our business, without it we're operating blind, but I often find there are organisational gaps with understanding over procurement functions, and addressing this would enable us to perform better for the organisation".
>
> FLM1 (Food logistics): "We are constantly fighting tight budgets, with little or no focus placed on the benefits of training within our procurement departments. Quite often it is left to the individual to engage with self-study, and an expectation that continued professional development is their responsibility".
>
> FRD2 (Food retail): "Our organisation spends a significant amount on training, but, in relation to your questions initially on fraudulent behaviours, there is nothing currently focussing on the links between ethics [fraud] and communication. This is something I would endorse and would suggest this needs to go outside the organisation too".
>
> FCD1 (Food consulting): "Our business model is built partially around inter team communication and building better supply chain operation through better culture. It is

difficult to measure any successes and would be hard pressed to offer examples where the feedback has permitted measurement of this, an area to work on with before and after scenarios".

Operators view (Bottom up):

FBP1 (Food processor): "Continually we look to upskill, and this well received in terms keeping our teams ahead of the curve with issues occurring in the food chain. Recently saw a spike in mislabelled product coming in from a European supplier, which was only spotted by the monthly short trainings we undertake".

FBP2 (Food processor): "…….being engaged with training makes us more aligned to company objectives….."

FLB2 (Logistics): "There is very little training undertaken without our company, and this I feel makes us exposed to threats, and it also makes me feel undervalued…..".

FRB1 (Food retail): "……ensuring that training is not just for our own procurement teams, but we try to reach out suppliers to collaborate, which is not always very successful. Much of the response relates to being too busy or lack of value proposition".

FRB2 (Food retail): "There a constant battle between the changing threats and the ability to identify them, at times feels like we are months behind what has been identified and actually happening in real time".

FCB1 (Food consulting): "Continually, I am operating training sessions, but it is really hard to get procurement professionals to engage, as they are simply too busy firefighting operational issues. Feels like a continual struggle between managing the short versus longer term objectives".

Much of the focus with training resulted on inward approaches to training, with few examples being cited of how training related to building food supply chain resilience was cross-functional and multi-disciplinary. There were times when differences of opinion occurred, especially with the expectation that employees were expected to take a self-study approach to

keeping updated. This has issues around retention and engagement of staff, which creates questions around ability to maintain true resilience building with disenfranchised staff. However, there was a resounding positive opinion toward use of training to build resilience, with agreement arising that this needs to go beyond the traditional silo based approach and towards a more holistic approach.

4.4.3.4 Governance

'Governance' was one of the lowest scoring metrics across the participants but was still significantly represented by participants, with 15 participants (75%) referring to it and responses being equally spread (4 participants per sector) across food Processor, food logistics and food retail, with food consulting seeing a slightly lower participation (3 participants).

In keeping with the previous metric (increased cost) with governance being intrinsically linked to operation and supply chain management, the analysis of data will also be reviewed through a 'top down' 'bottom up' lens.

Leadership and Management Team (Top Down):

> FDP1 (Food processor): "This is a good point, as governance is arguably the most important part of the food chain, much of our work is aligned with this and we spend a lot of time undertaking process review and audits to achieve this".
>
> FDP2 (Food processor): "There are times where this [Governance] is an Achilles heel to the industry. We seem to continually seem to be chasing our tails with adherence, and the over auditing and lack of alignment of standards is mind blowing".
>
> FLD2 (Food logistics): "The food supply chain is potentially the most over regulated industry. Of course we need Governance, but at times it comes across as a blocker to building creative and innovative processes in the procurement sphere".
>
> FRD2 (Food retail): "Governance is often seen as a swear word by Operational teams, they are so focussed on getting boxes out the door, whenever we [Procurement] talk of this [Governance] the eyes go sky ward. Perhaps the training we discussed earlier needs to go beyond back office and permeate out to the wider organisation".

FCM1 (Food consulting): “This is a subjective word [Governance], differing departments at different stages of the food supply chain have their own interpretation of Governance. From what I seem the further upstream you go, the less likely stakeholders will see it as a benefit, with downstream retailers loving it, it’s marketable”.

Operator view (Bottom up):

FBP1 (Food processor): “Probably the most over used work in procurement teams. At times even I get lost in its true meaning in building food chain resilience”.

FBP2 (Food processor): “It is obvious we need it within procurement, but it is very hard to get this cascaded out across suppliers and operational teams. I spend much of my time chasing lack of adherence to standards simply because cost or time corners are being cut, the system seems to focused on cost and lead time”.

FLB2 (Food logistics): “Governance doesn’t seem to match up with the operational processes, almost like we are putting the cart before the horse, and not engaging together to see if the two can be achieved’.

FRB1 (Food retail): “Is it financial, food safety, consumer law governance, the list goes on. Does at times feel like we [procurement] are the only ones in the food supply chain concerned with and responsible for managing this process, not officially of course”.

FCB2 (Food consulting): “Procurement teams are well placed to be managing this, I have seen very good examples, normally downstream, that are managed by procurement teams”.

All procurement teams across all of the case study organisations were in agreement that governance was incredibly important for building food supply chain resilience. However, there was significant agreement that there are differing opinions across the food chain relating to this [Governance]. This would indicate that more needed to be done in order to give clarity around

the use of governance, with a clear theme arising that this should be managed by procurement teams.

4.4.3.5 Thematic resilience measure – Persistence and robustness summary

In summary, the main two elements of the procurement teams [Leadership and management, and Operations] seemed to agree with the metrics coming out of the analysis of the semi-structured interviews in this section of analysis. The only divergence was with training, with somewhat more push back and lack of uptake being seen within the food logistics sector compared to others, and an evolving theme that training related to food resilience needs to go beyond the confines of procurement teams. Also, the word 'Governance' seems to take on many meanings and is often lost in translation, while being embraced in different manners dependant on where you sit in the food chain. Furthermore, there is agreement arising that procurement can be the gate keeper to managing this governance, with some examples cited, whilst, however, training, culture and perception needs to be aligned across the wider food supply chain. This needs further review (Chapter 5) into whether this is a silo approach to procurement department managing governance, or a more holistic approach to more co-opetitive approaches.

4.4.4 Thematic resilience measures – Recovery and constancy

The final set of questions (x2) relates to the thematic resilience measures of recovery and constancy. The table below (Table 35) sets out the summary response detail against the thematic area arising from the semi-structured interviews (column 1), the number of overall participants involved (including percentage) and a breakdown by case study organisation to collective response rate.

Thematic area	Participant number	%	Food processor	Food logistics	Food retail	Food consulting
Data integrity	18	90	5	4	5	4
Visibility	18	90	4	5	5	4
Supplier co-opetition	17	85	5	5	4	3
Audit fatigue	16	80	5	2	5	4
Alignment	16	80	3	3	5	5
Anti-competitive behaviour	16	80	5	5	2	4

Table 35 Key themes from resilience measure – Recovery and constancy

4.4.4.1 **Data integrity**

The highest-ranking thematic area arising from the final section of semi-structured case study questions related to data integrity across stakeholders, both internal and external. With 90% of respondents taking part, food processor and food retailer equally engaged (5), along with food logistics and food consulting being slightly lower (4), but equally engaged.

Lack of data integrity was endemic across all of the sectors in the case study example, with food processors (FPD1) explaining, "….the lack of resilience in our organisation is undisputedly driven by data integrity. There is a continual challenge around data coming in that is either in different formats or incorrect. Much of our times is spent data cleansing, which means interpretation is key, and leaves us open to risks if we manage this wrong". In addition,

FPB1 and FLB2 both alluded to the opportunity within supply chain resilience to build and create innovation within food logistics, and when pushed, FPB1 stated, “there is a lack of innovation within the industry and we are quite often viewed as a necessary evil. Having procurement lead innovation in the areas of data integrity would for sure build resilience while changing perceptions”. This area of innovation was also supported by FRD2, FCD2, FRM1 and FCB1, with FCD1 supporting the view of industry perception with “a need to change perceptions in the industry, and data will permit us to achieve this”. Therefore, an agreement was reached across all participants that innovation is needed to build resilience, it should be managed with procurement teams, and in doing so there is a potential to change perceived and historic practices.

4.4.4.2 Visibility

Also, the highest-ranking thematic area and arguably connected to the aforementioned thematic area of ‘data integrity’ showed no visibility was referred to by 90% of respondents taking part, with food logistics and food retail the highest (5), and food processor and food consulting (4) with a slightly lower participation.

Visibility was a hot topic across the case study participants, with all those answering citing this as an issue. Interestingly, there were elements of blame coming from some different sectors with FPD2 citing, “Retail as a major problem when it comes to visibility of data and forecasts, which make it almost impossible to build resilient and sustainable operations”. Conversely, FRD2 stated, “If food processors engaged earlier in the process and were more open book about their operations, we would reduce areas such as wastage in our systems”. This was interesting as in earlier portions of the case study semi-structured questions, all stakeholders cited blame culture as a blocker to building resilience, yet it exists within their own thinking when pushed on food supply chain resilience.

Specifically, in managing the visibility metric, FPM1, FLM1 and FCD2 alluded to procurement operations being able to manage a systems view of developing greater visibility both internal and external. In particular, FPM1 stated, “Procurement by its very function is central to the movement of data with ordering, managing, financing and closing the process”, and FCD2 said, “there is an opportunity to develop connectivity between procurement functions to enable greater visibility, this will benefit all from swifter payments, lessened waste, real-time visibility of logistics operations and deliver better more resilient food lines for consumers”.

4.4.4.3 Supplier co-opetition

Supplier co-opetition metric was participated in by 17 (85%) of the case study actors, with food processor and food logistics the most active (5), food retail (4) and food consulting (3) the next.

Despite the former questions eliciting responses about blame with visibility (at Senior Management level) in the processing and retail participants, there was an agreement amongst the majority that use of others resources (co-opetition strategies) would build greater resilience. FPD1 stated, "Quite often food procurement departments are replicating work being done elsewhere in the chain. This is not only time consuming and carries a cost, but the repetition often means other more important areas get missed". This view was supported by both FRM1 and FCD2, with a collective view that a collaborative approach to using each other's resources would definitely build greater resilience. FRD1 suggested, "If we as food chain businesses collectively shared audit detail and supplier performance through our procurement departments, the overall food business would be more transparent". When pushed for more detail around this, FRD1 stated, "The reason this doesn't happen relates to a lack of data sharing internally, we cannot even get our own operational teams to relay correct and detailed information, the ability to do this wider is limited, although needed".

However, there was one critical negative with sharing of resources, with FCD2 espousing the anti-competitive behaviours that have manifested themselves within the food business arena, citing "traditional methods of Senior Leadership education such as the MBA have taught them to create differentiation. As such, we may know collaborating with other resources can deliver a sustained benefit and therefore resilience, the differentiation monster kicks in, and stops this from happening, thus the silo approaches food supply chain strategies". When pressed further on this topic for solutions, FCD2 stated, "It's simple, culture change, starts at the top, and needs agreement across the board. But, with some suppliers having multiple masters and fear of data getting into wrong hands, fear of reprisal stifles true resilience building, someone needs to take the lead, and why not procurement as a wider profession?"

4.4.4.4 Audit fatigue

This metric [Audit fatigue] had a participant rate of 80% (16), with food processor and food retailer most active (5), food consulting (4) and food logistics least engaged (2).

Much of the discussions with the case study participants mentioned the continual auditing process as a problem for the wider food supply chain. FRD1 cites, “This links to the collaboration I mentioned before, if we could collectively share data across varying procurement departments we would be able to automate this process, releasing time and cash”. This point of collaborating on audits was supported by the majority of participants, with FLM1 stating, “……they just cause us a never ending headache, as soon as one [audit] is complete, we start preparing for another”, and FRB2 explaining, “There is a greater need for procurement teams to share detail and good practice on audits. I get the feeling some organisations are just ticking a box, which makes the whole process worthy of nothing, especially with the resilience we are discussing today”.

4.4.4.5 Alignment

The metric of alignment had 16 (80%) participants’ involvement, including food retailer and food consulting as most engaged (5) and food processor and food logistics (3) equally lesser involved.

Most interesting was the differing views regarding alignment. The majority of food processor participants saw alignment as a process of smoothing the flow of products through a supply chain (efficiency). Food logistics were predominantly concerned with the alignment of resource with capacity, understandably given their 3PL operation works throughout (cost). Food retail mainly reviewed alignment with consumer forecasting and ensuring product as available at store level (demand), and food consultancy was the only sector to see alignment of systems as a way of building resilience in food chains (systems). Therefore, despite it being a key theme, and as valid as that is, it is important to review the differing opinions case study stakeholders had, and how these were wedded to sector specific challenges.

In particular, FPD2 was very concerned with “…..a lack of alignment with forecasted data, which makes the whole process of supply difficult to manage. This in itself leads to arguments between internal stakeholders, which arguably creates friction and moves focus away from critical areas such as resilience”. There was similar discourse in culture [internal] with food logistics, and in particular FLM1 was surprised with “….the way our operatives get treat by others, such as drivers, not seen as part of the solution and often left waiting for hour at retail

DCs [distribution centres]. This lack of aligned thinking causes a very unsustainable solution to be operationalised daily".

4.4.4.6 Anti-competitive behaviour

Anti-competitive behaviour was the last of the key themes emerging from the case study semi-structured interviews, with 80% (16) participation, and with food processor and food logistics most prevalent (5), food consulting (4) and least active food retail (2).

It is of no surprise given the comments made to question responses that the procurement professionals would cite anti-competitive behaviour as a challenge to building food supply chain resilience. Yet, surprisingly, the majority did not see it as a negative across their existent relationships, and in the main saw this as a non-issue for their own operations. FRD1 supports this, stating, "our negotiated contracts are built around ensuring gain shares are built in for all, with a hope that won't have one person in our chains making excessive profits. We also attempt to spread the risk where able". The ability to mitigate such behaviours was seen by both food processor and food logistics, with FPM1 stating, "Our extended relationships are managed by the procurement team, this eradicates any subjective comments muddying the waters with suppliers and customers. We have had issues in the past where relationships were ruined by an off the cuff comment, we now manage this messaging through our team [procurement] to give one voice". Despite the majority of participants being relatively positive about anti-competitive behaviours within their own operations, FCM1 did cite issues with new suppliers being closed out: "Quite often relationships have been built in these chains, and risk of anti-competitive behaviours and risk of these relationships failing stop external or new suppliers coming into the food chains. This in itself needs to be managed better by procurement teams, as it is not a design process that is built on resilience, but rather than comfort".

4.4.4.7 Thematic resilience measure – Recovery and constancy summary

In summary, the key areas from the academic literature on building resilience in food supply chains aligned to the areas of recovery and constancy. Much was discussed about systems and lack of data or visibility across all participants and sectors, which dovetails directly with constancy, and especially the repetitive nature of data input and potential of errors leading to resilience issues. There was much discussion around audit fatigue and utilising co-opetition strategies as a way of fostering more resilience, with the beginnings of agreement that

procurement functions should be the gatekeeper to managing these processes and messages both internally and externally. Of concern, despite agreement that collaboration is needed and anti-competitive behaviours need to be eradicated, support of the former [collaboration] is at times missing, with elements of blame culture creeping in. Also, anti-competitive behaviours are not within the realms of these organisations, but the comfort approach to supplier management is precluding the potential to build greater resilience in the process with new suppliers.

4.5 Chapter conclusion

This chapter began by justifying the use of chosen data analysis methods and the interview questions chosen alongside the case study semi-structured interview participants. It also, through an analysis method using QSR NVivo 12®, broke down the chapter into thematic areas aligned with the systematic literature review coding, and focussed on the key themes arising that had significant mention amongst the participants. There were of course many themes that developed throughout the various conversations. However, it was decided to focus on thematic areas that were directly related to the coding of the research themes and resilience areas. Therefore, what was presented is a set of thematic areas, in line with peer-reviewed food supply chain resilience measures, and outputs from a Modified Delphi of food supply chain experts to connect the degree of fit with food supply chain procurement experts, which will be discussed in more detail in Chapter 5.

The systematic literature review analysed existent research contained within Chartered Association of Business Schools (CABS) listed journals that were associated with ‘Food supply chain food fraud’ and ‘Food supply chain food crime’, chosen as much of the gaps associated with this sector [food supply chain resilience] pertain to business research, with much research conducted into the science of areas such as destructive scientific testing. There was also significant confusion surrounding the understanding of accountability, authenticity and traceability, alongside interchanging terminologies on ‘food crime’ and ‘food fraud’. Additionally, there was a divergence noted between areas of academia and practitioner view, which in itself can be an issue. However, quite often practitioner journals are in line with paid research or latest trends which can often cause issues pertaining to relevance and do not necessarily relate to it being a specific issue.

There was much in the literature reviewing generic supply chain risk and areas pertaining to business, fraud, health and information interchange need. However, it has been identified when comparing to the UK Government report into supply chain food fraud (Elliott, 2014) that there are gaps pertaining to authenticity, consumers, data, enforcement, intelligence sharing and risk mitigation. In addition, it is clear from current research that no one solution alone can mitigate risk in a food supply chain, therefore, this research thesis seeks to review the link between business, government and research communities to support and underpin the auspices of scientific testing and legislation, by bringing together a triangulated approach (Science, Legislation & Operational) to food supply chain resilience through a collaborative approach to security of supply, an area that will be explored further in the remainder of Chapter 4 and through Chapter 5 with the overall results discussion. This thesis will thus focus specifically on the research gaps identified in the literature of data, intelligence sharing and risk mitigation.

Once the systematic literature review had been completed, and a review was undertaken with the focus group to ensure degree of fit with the wider food supply chain industry, a Modified Delphi was undertaken with a group of food supply chain experts. In order to focus the results of the Modified Delphi, the research thesis concentrated on the top 10 responses, chosen as they aligned with the methodology associated with a Delphi and being predominately based on the highest rated MEAN average, whilst delivering robust coefficient of variation results. Thus, on review of the 30 Delphi responses, it can be clearly identified that the MEAN average for the majority of answers was 4.0 or above, therefore the researcher chose to focus on the top 10 responses, as these were a final MENA of 4.0 and above with a relevant coefficient of variation.

From these responses there was an identifiable and predominant relation to Information and Communication Technologies (ICT), and associated elements of data sharing, explicitly with information flow, visibility, intelligence sharing, real time data, collaborative flow with partners and internal communications. There are tacit connections to ICT and data sharing with inventory visibility, customer demand visibility, forecasting demand, as arguably these are well embedded and aligned to modern day supply chain activities with ICT and data sharing. This leads the researcher to purport a need for connected and robust supply chain connectivity through data sharing, which is seen as paramount for building food supply chain resilience. This further reinforces the idea that food supply chain actors are collectively looking for ICT solutions to solve challenges associated with food supply chain resilience. The ability for food supply chains to deploy technology to link up visibly with inventory and consumer demand

means that traditional supply chain management theories such as managed inventory and obsolescence mitigation can be deployed to much greater effect, while enabling the holistic systems view to permeate across supply chain actors in building resilience (Fawcett et al., 2012; Hines, 2004, p. 76).

Furthermore, the ability to forecast consumer demands appeared to factor highly amongst the expert focus groups' desires to build resilience into food supply chains. Historically, forecasting has been seen as crucial in mitigating cost control and risk in supply chain management, which is interesting as despite there being no direct correlation to food criminality and supply chain profitability, one could assume a link given the need to forecast demands. However, the link between forecasting and food criminality goes deeper than simple cost control, being more associated with abilities to maintain greater control of stock across an extended supply chain, therefore mitigating the ability for products to be substituted out whilst in storage.

Outside of the traditional elements of supply chain management such as forecasting and deployment of ICT, there appears to be a need to foster greater internal communication across an organisation. It could be argued that the aforementioned auspices of holistic food supply chain integration with ICT and the need to forecast demand requires the absolute connected communication culture internally within an organisation in order to mitigate food supply chain risk. This would support the need to utilise better data sets across food supply chain actors to build resilience against criminality (Elliott, 2014; Fassam & Dani, 2016; FSA, 2016), with shared data and forecasting methods permitting tighter control of stock movement and storage across the global food supply chain networks.

Within the top 10 themes of the Modified Delphi, the coefficient of variable was stable and at a level where no further rounds were needed or changes to statements in order to draw conclusions around the research question outputs. Therefore, the researcher utilised the additional time with industry experts to build a model of the department or organisational involvement and relevance for building resilience against a particular Modified Delphi metric. The departments utilised were taken from the UK Government report into building supply chain resilience into food chains (Elliott, 2014), and areas upheld as crucial to building food supply chain resilience.

When analysed, it can be noted that procurement is put forward by the expert panel as the leading element responsible for building supply chain resilience against food criminality, as it is the lead function in 90% of cases and only in 10% of cases was it seen as second. Thus, there was a need to address this emerging theme that procurement is heavily involved with the majority of resilience building in a food supply chain. As a response, a case study semi-structure interview process was undertaken with food supply chain procurement experts.

The case study semi-structured interview questions were coded against the literature review outputs in Chapter 2, and aligned to the Modified Delphi outputs of Chapter 4, as follows:

> Learning & Innovation – the themes from the first series of questions, whilst being rather narrow in terms of the questions being asked, were rich and did align well to the gaps identified within the systematic literature review, resilience metric and management methods. In particular, there were some differing views on use of technology, such as the perception that the supply chain was already connected by retailers, opposed to the view that more needed to be done by food processors and food logistics operators. In addition, food logistics operators seemed to be feeling that data was not being utilised in the correct manner, therefore resilience was being missed. Food consultants were the only participants to support the view that better profitability through sharing data would lead to greater trust and therefore resilience. Finally, it was noted by a Logistics Director that the procurement team was well placed to manage the wider supply chain process of resilience building through data management.
>
> Persistence & Robustness – the main two elements of the procurement teams [Leadership and management, and Operations] seemed to agree with the metrics coming out of the analysis of the semi-structured interviews in this section of analysis. The only divergence was with training, with somewhat more push back and lack of uptake being seen within the Food Logistics sector compared to others, and an evolving theme that training related to food resilience needs to go beyond the confines of procurement teams. Also, the word ‘Governance’ seems to take on many meanings and is often lost in translation, while being embraced in different manners dependant on where you sit in the food chain. Furthermore, there is agreement arising that procurement can be the gate keeper to managing this [Governance], with some examples cited. However, training, culture and perception need to be aligned across the

wider food supply chain. This does though need further review (Chapter 5) into whether this is a silo approach to a procurement department managing governance, or a more holistic approach to more co-opetitive approaches.

Recovery & Constancy – the key areas from the academic literature on building resilience in food supply chains aligned to the areas of recovery and constancy. Much was discussed about systems and lack of data or visibility across all participants and sectors, which dovetails directly with constancy, especially the repetitive nature of data input and potential of errors leading to resilience issues. There was much discussion around audit fatigue and utilising co-opetition strategies as a way of fostering more resilience, with the beginnings of agreement that procurement functions should be the gatekeeper to managing these processes and messages both internally and externally. Of concern, despite agreement that collaboration is needed and anti-competitive behaviours need to be eradicated, support of the former [collaboration] is at times missing, with elements of blame culture creeping in. Also, anti-competitive behaviours are not within the realms of these organisations, but the comfort approach to supplier management precludes the potential to build greater resilience in the process with new suppliers.

Systematic literature review (academic review)			Modified Delphi Study (practitioner engagement)			Cross case study analysis (practitioner engagement)				
Academic Literature Gaps	**Resilience measure**	**Management focus**	**Food supply chain characteristics**	**Lead internal actor**	**Support units**	**Thematic area Semi-structured**	**FP**	**FL**	**FR**	**FC**
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Holistic procurement collaboration	Procurement	Finance, IT, Operations	Business collaboration	4	2	5	4
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Collaborative information with trading partners	Procurement	Finance, IT	Systems view	4	5	1	4
Enforcement, Data, Intelligence	Strategic leadership	Persistence & Robustness	Internal communications	HR	Operations, Procurement, Finance	Blame culture	5	5	4	2
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Holistic information flow	Procurement	IT, Operations, Finance	Systems view	4	5	1	4
Data, Intelligence, Risk	KPI	Learning & innovation	Inventory visibility	Procurement	IT, Operations	Supplier co-opetition	5	5	4	3
Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Holistic forecasting customer requirements	Procurement	Marketing, Finance	Data integrity	5	4	5	4
Data, Intelligence, Risk	KPI	Learning & innovation	Flexible supply chain partners	Procurement	Marketing, Finance	Business collaboration	4	2	5	4

Data, Intelligence, Risk	Supply chain dynamics	Learning & innovation	Visibility of customer demand	Procurement	Marketing, Finance	Alignment	3	3	5	5
Authenticity, Enforcement, Risk	Decision leadership	Recovery & Constancy	Intelligence sharing across departments	Procurement	Finance, Operations	Visibility	4	5	5	4
Authenticity, Enforcement, Risk	Value based dynamics	Recovery & Constancy	Traceability standards aligned	Procurement	Government, Quality	Data integrity	5	4	5	4

Key – **GREEN** = Highest agreement, **AMBER** = Medium agreement and **RED** = Lowest agreement

Legend – FP (Food processor), FL (Food logistics), FR (Food retailer) & FC (Food consulting)

Table 36 Summary of the research approach with methods, outputs and research gaps – 'constructs of food supply chain resilience' (CFSR)

These themes from the varying methods utilised within this research are summarised in Table 36. Column 1 is the 'gaps' identified within the systematic literature review. These were coded across through the linear process against column 2 resilience measure and column 3 management focus, both identified in the wider literature review as resilience builders in food supply chains. Column 4 relates to the capability of building internal resilience against food fraud, an output from the Modified Delphi, which consequently delivered an internal lead [column 5] and support functions [column 6], thus closing the research gap in understanding internal resilience builder. Finally, the semi-structured case studies gave key themes which were coded against the aforementioned ones that specifically relate to the procurement role in building internal resilience [column 7], with columns 9 through 11 being the weighting for each respective case study company participant. The relationship between these outputs and the literature into supply chain resilience building will be discussed in more detail through Chapter 5. This mapping shows how the methodological process of the research has gone through the varying stages of systematic literature review, Modified Delphi and Cross case study. Furthermore, it identifies how each step outputs fed across to the next step, in crafting the connection to the research gaps (colum 1) with practitioner expertise. This approach addresses the identified supply chain resilience gaps with heavily quantitative approaches

(Eddine, M., Saikouk, T. and Berrado, A., 2019; Randal & Mello, 2012; Stuart et al., 2002), with a ‘critical realism’ abductive grounded theory approach (Bloor et al., 2015).

5 Chapter 5 – Discussion

This research set out to review the capabilities of food supply chain actors [internally] to build resilience against food fraud, and in doing so undertook a three step triangulated process of systematic literature review, Modified Delphi study and semi-structured case study questionnaire, outputs of which will be utilised in this chapter to discuss findings, comparing against the literature reviewed into food supply chain resilience [chapter 2]. In particular, this thesis chapter will focus specifically on the research gaps identified in the systematic literature review of data (Fassam & Dani, 2017), doing so under three thematic areas of 'learning and innovation', 'persistence and robustness' and 'recovery and constancy'.

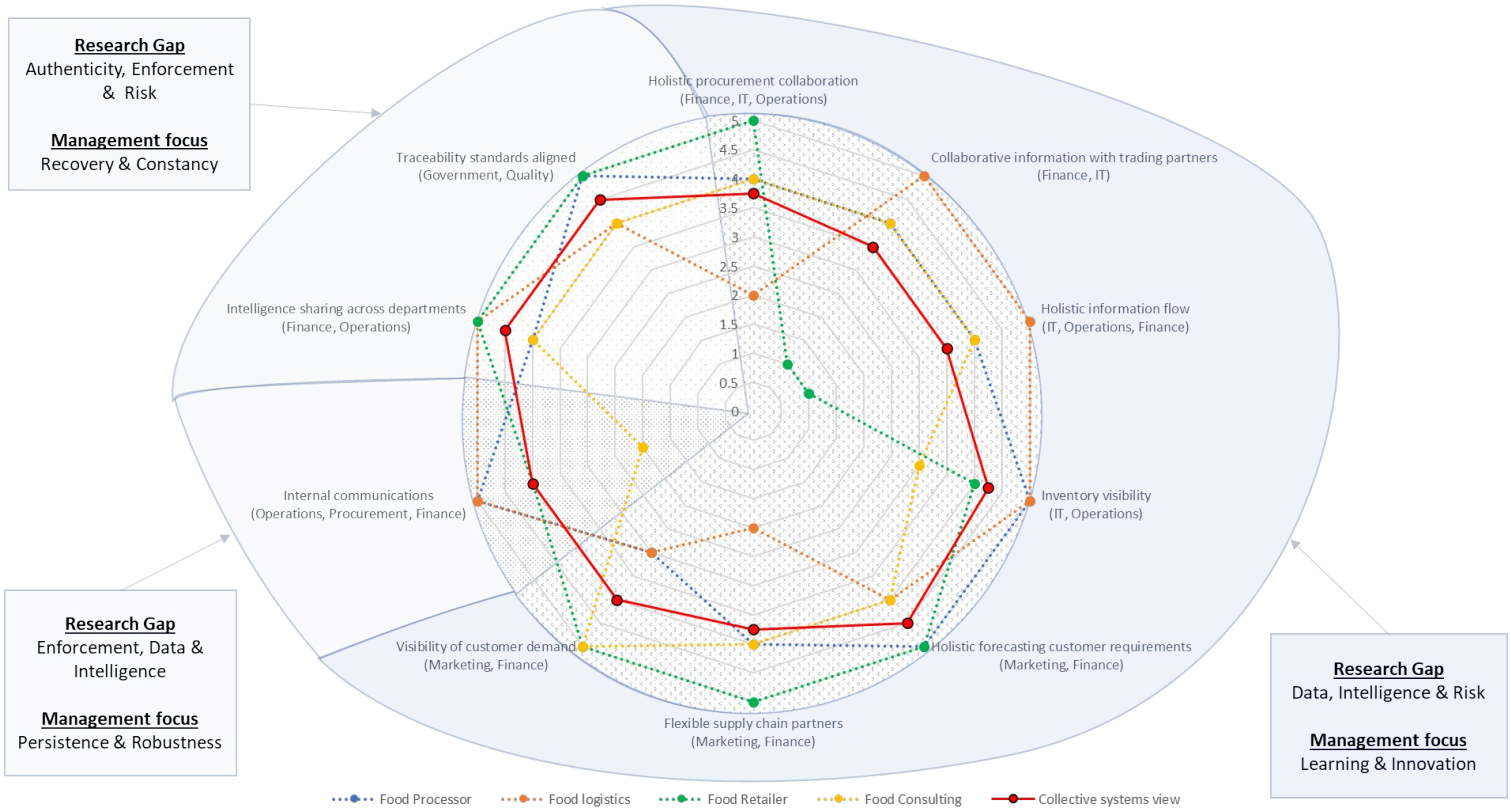

Fig. 6 Food Supply chain Capability Model. Numeric key – 0 Low agreement (High risk) – 5 High agreement (Low risk)

Lastly, while adopting aforementioned triangulated approaches this chapter will review in turn each element of the management focus (Fig.6). These three areas are noted from the literature

review as key for building resilience in food supply chains, and in the capability model (Fig.6) are broken down and represented on the outer ring allied to the research gaps that were identified by the research systematic literature review. Within the outer ring, the outputs of the Modified Delphi are represented, indicating the internal resilience measure responsible for building food supply chain resilience, along with the internal stakeholders responsible for same. The inner element of the capabaility model is a segmentation of the cross case study views against each of the resilience areas, with high scores indicating significant alignment (low risk), and lower scores lacking alignment and thus risk. This model will be utilised throughout chapter 5 to compare and contracts views in answering the research thesis question '*What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*.

5.1 Learning and innovation

The areas of Learning and innovation, Food processor, Food retailer and Food Consulting were all deemed as significant, with the metric of 'holistic procurement collaboration' and a MEAN of >4 being noted. However, Food Logistics scored fairly low [2] in this area, which indicates a disconnect residing between a wider connected supply chain view. Much of this view was related to the cost constrained environment that food logistics operates within. Therefore, in order to build true business collaboration required to achieve full food supply chain resilience (Hung, 2011; Nakandala et al., 2017), greater focus on food supply chains is required around Food logistics portions of a supply chain. This is further underpinned with research study participants from the retail sector investing significant resources in terms of cash and time with connecting and building provenance in their chains through collaborative engagement processes. However, in doing so, it appears that the Food logistics organisations did not receive any benefit from this investment, with Food retailers citing issues with a lack of cross actor

visibility. Therefore, it gives rise to the first challenge with building collaborative cultures, as factors such as lack of visibility and trust are linked with resilience building against fraud (Sarpong, 2014; Fassam et al., 2015; Kennedy, 2012; Huck et al., 2016). Thus, this research study purports a need for greater engagement with cross-functional supply chain stakeholders, as there is a clear disconnect in perceptions of holistic collaboration, which in itself is a risk. Furthermore, when reviewing wider resilience building, the metric of 'Holistic procurement collaboration' is cited as key, but it needs to be embraced in a systems manner across all supply chain stakeholders, and outputs from this research determined 'business collaboration' as key to achieving this (Table 36 & Fig.7).

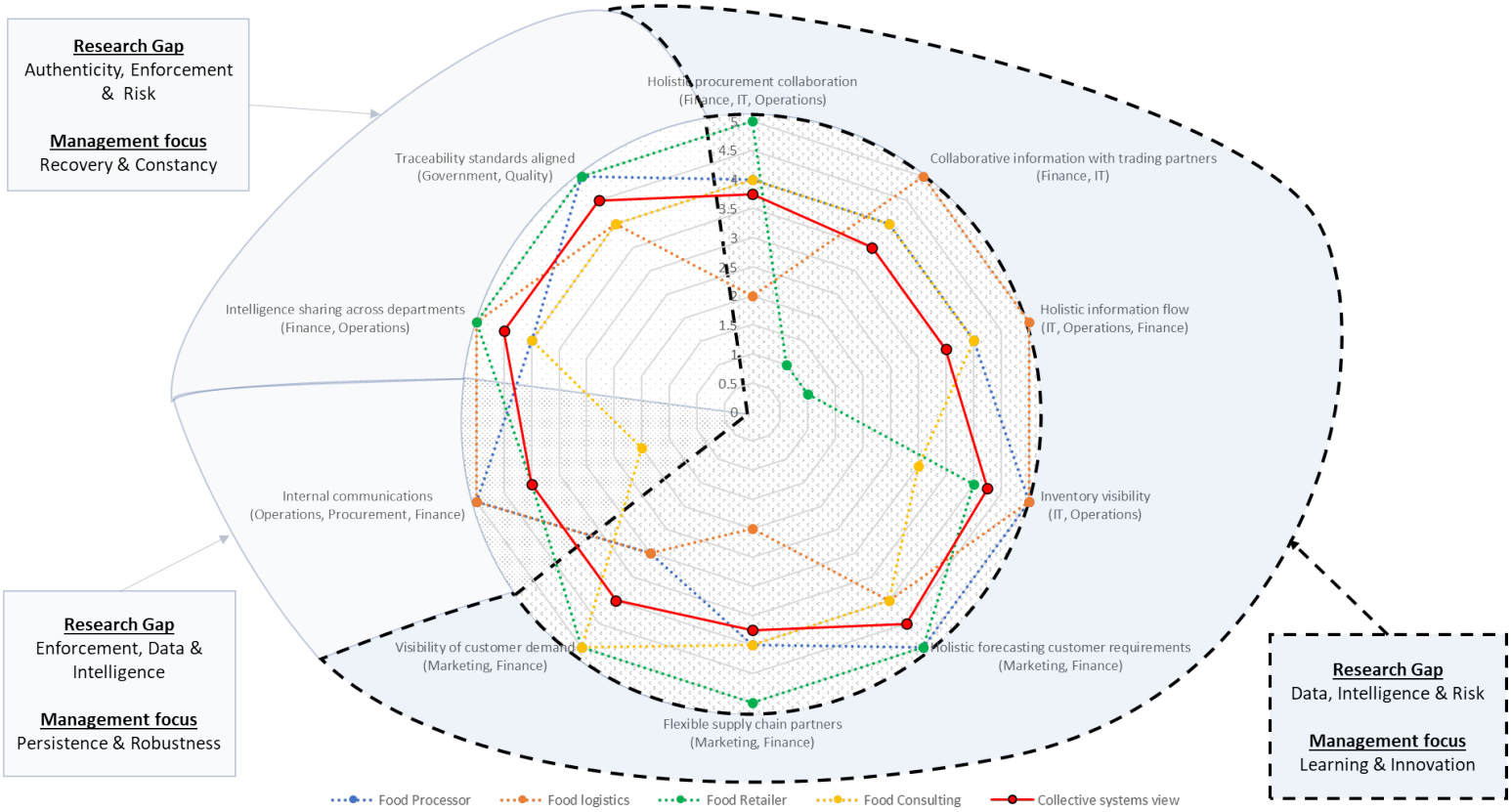

Fig. 7 Learning & Innovation – capability model. Numeric key – 0 Low agreement (High risk) – 5 High agreement (Low risk)

That said, there was distinct opinion across food processors that collaboration is only required in order to mitigate issues around lead time and cost. This lends itself to the focus purported across the food supply chain sector that there is too much attention paid to cost over other metrics in building resilience (Aramyan et al., 2007; Bigliardi & Bottani, 2010; Laosirihongthong & Dangayach, 2005; Sweeney et al. 2018; Vorst, 2006;). However, despite this view, there were no direct references to cost metrics within the CFSR matrix (Table 36). Thus, one would argue, given the food supply chain resilience literature cites areas such as creation of competitive value and agility being allied to cost efficiency (Laosirihongthong & Dangayach, 2005; Sweeney et al. 2018), these [cost factors] are hidden within the CFSR matrix. For example, lead time reduction, flexible planning systems and sourcing agility are historically associated with creating value and reducing cost. Therefore, it is assumed that all these actions are in themselves resilience builders in creating lower cost models based on historic supply chain risk management literature. However, the research found a disconnect with the true understanding of technology value engagement, with much of the focus being on cost rather than benefits of resilience building. This was particularly noted with the food consulting group, whom while being external to 'day to day' operations, seemed to have a greater appreciation of this, with all other participants being allied to the areas of cost and lead time. This would therefore indicate that issues around culture and lack of appreciation are still contained within the food supply chain (Bhagwat & Sharma, 2007; Hervani & Helms, 2005; Kache & Seuring, 2017; Pavlov et al., 2019). Of note, whilst there was a consistent MEAN of >4 with regard 'Collaborative information sharing with trading partners', there was a lack of interest regards this subject with the food retail participants. Much of the purported challenge with this [retail] relates to a lack of internal systems alignment. Therefore, this research finds that while literature supports connected data interchange as a resilience builder, there is work needed in reinforcing this as an approach for the modern-day food supply chain. As such, the

‘Management focus’ of ‘Learning and innovation’ is key with procurement departments in building greater ‘Collaborative information with trading partners’ in order to create a ‘systems view’ to building resilience against food fraud.

In bringing collaboration to life within the food supply chain, there was a purported need for technology connection to build integrated data sharing, which is also noted in the CFSR matrix (Table 36) through embracing better ‘internal communications’ and real time data sharing. This aspect is upheld within the research as crucial in building food supply chain resilience and giving cross tier connectivity (Angerhofer & Angelides, 2006; Kache & Seuring, 2017; Sweeney et al. 2018). However, despite this being noted by both the Modified Delphi group and semi-structured case study participants (Table 36), there is a lack of current research regarding its adoption as a resilience builder against supply chain food fraud (Elliott, 2014; Fassam & Dani, 2017; Manning, 2016). This is reinforced by the procurement professionals with a noted absence of upstream connectivity relating to data systems, therefore reinforcing the need for the metric ‘collaborative information sharing’ in building food supply chain resilience against fraud. In addition, this builds upon aforementioned issues with food logistics players with a lack of perceived value, and the food retail sector citing limited visibility as a key challenge, both of which would preclude ‘collaborative information sharing’. Additionally, there was clear agreement amongst operational participants of the research study regarding the need for ‘collaborative information sharing’. However, there was a lack of importance placed on this by consulting partners. Nonetheless, this research study does not support the view that consulting partners do not value this, as they [food consulting] support the need for collaboration and data sharing. Instead, the researcher purports that being external to operations, food consulting partners assume this to be undertaken, and would support the perception that a systems view of connectivity resides across food supply chains.

Yet, as this research has found, in the case study chosen, there is little evidence of this occurring across the wider supply chain. Much of this lack of engagement was driven by issues of trust, cited by food logistics and food producers as 'Blame culture', which is stifling true collaborative practices from being achieved. Therefore, there still remains a body of work to be undertaken in the education of food supply chain actors. This is particularly the case as while there is operational understanding of 'collaborative information sharing' benefits, there is a lack of agreement on the importance around the metrics that support this in 'holistic procurement collaboration' and 'collaborative information with trading partners'. Furthermore, blame cultures and trust have been found with this study to be a driver for stifling collaborative uptake. As such, this research recommends that when adopting the management focus to 'persistence and robustness' and embracing better 'internal communications' to foster resilience, a focus internally on 'blame cultures' is required to achieve sustained adoption.

Systems views, an area connected to the capability building research output of 'Holistic information flow', are held up as important in building food supply chain resilience in the globalised and complex food distribution system (Badia-Melis et al., 2015). However, there is a lack of connectivity according to Quested et al., (2010) and Manning and Smith (2015). This point is validated by the food logistics and food processor elements of procurement experts, and aligns with the systematic literature review which reports a lack of connectivity between actors in food supply chains (Fassam & Dani, 2017). In addition, the elements of cost were again advocated within food retail sectors as a key driver against systems views, which validates the opinion that cost is prevalent over other metrics within food supply chains (Pustjens et al., 2016; Spink & Moyer, 2011). However, it can be argued that embracing the top 10 metrics of the CFSR matrix (Table 36) in order to achieve food chain resilience, will

move food sector stakeholders towards mitigating cost issues in a food supply chain. This is supported with connectivity, governance and data being resilience factors against food fraud (Sarpong, 2014; Fassam & Dani, 2017; Kennedy, 2012; Huck et al., 2016). However, in order to drive greater resilience across food supply chains against food fraud, this study finds that this metric of 'Holistic information flow' is lacking amongst food retail participants. This directly correlates with a lack of food retail importance on 'collaborative information with trading partners'. Therefore, this research suggests that in order to create a 'systems view' to build resilience and bridge existent research gaps (Badia-Melis et al., 2015; Fassam & Dani, 2017), greater engagement is required with food retail sectors. It could even be argued that a lack of systems view is being driven by the retail sector, which breeds the trust issues cited by food logistics and food producers. Consequently, a finding of this study is that more research is required in understanding the constructs of retail engagement in building systems views of resilience against food fraud.

While there has been significant attention paid to traditional supply chain risk management in conventional management circles, there is a lack of focus placed specifically on the food industry (Diabat et al., 2012; Fassam & Dani, 2017). Food supply chains with increasingly complex and larger networks have reduced transparency, particularly with differing actors being located geographically further away and with minimal physical safeguards (Sarpong, 2014). This research study finds that transparency issues are noted with the food logistics and food producer sectors due to manual systems being in place, which is causing a cited lack of 'alignment' across this food supply chain case study. It can be clearly connected to the resilience metrics of 'visibility of customer demand', and comments from food logistics and food producer participants that there is minimal data in terms of forecasted demand. Not only does this stifle connectivity and visibility, but it also creates issues with managing inventory,

an area cited as key in building resilience in food supply chains (Fawcett et al., 2012; Hines, 2004). Furthermore, due to margin constraints in the sector [food logistics] there is a cited lack of uptake with technology, which validates risks associated with the food sector by Romsdal (2014) and Soman et al. (2004). Therefore, a key finding of this research is a lack of application with technology causing challenges around building resilience in terms of inventory management. This is of particular importance, as the aforementioned globally dispersed operations and manual processes leave gaps with manual interventions that can be manipulated and make it easier for fraudulent behaviours to occur. Consequently, it is incumbent on the wider industry to look toward solutions that can bridge the entire food supply chain as an output to address this issue, with particular focus needed on upstream actors with building resilience against food fraud. It is also aligned with the findings of research into European meat fraud, which cited 37% of fraudulent activity occurring in upstream elements (Robson et al., 2020). Thus, in building on aforementioned challenges around retail sectors with collaboration, culture and systems views, there is a need to engage with upstream actors to build resilience and create 'alignment' through sharing 'visibility of consumer demand'.

In addition, lack of visibility with tiers of suppliers is exacerbated with the duplication of efforts cited by procurement professionals [food logistics & food producer] with data. This further strengthens the need for end-end connectivity, and leaves the food supply chain open to risks, as without connectivity the likelihood of finding nefarious activities reduce (Everstine et al., 2013).

Without the connected systems that enable holistic procurement collaborations [Top resilience builder] there will be a lack of tiered visibility leading to poor supply chain governance, which increases the likelihood of fraudulent behaviour (Sarpong, 2014; Kennedy, 2012; Huck et al.,

2016). Therefore, the research author purports that many of the aforementioned challenges around blame, culture, trust and visibility are related to duplication of effort and a lack of aligned systems. All of this supports the findings of the research that resilience building begins with the management focus in this case study example of 'Learning & Innovation' to deliver 'Persistence & robustness' and 'Recovery & constancy'.

The effects of food fraud on a food supply chain can have significant economic and consumer effects, and when they happen, they give rise to challenges around product recalls (Spink et al., 2017). In a food supply chain when such occurrences happen they not only cause the aforementioned risks, but they also contest the overall forecasting system of food supply chains, meaning the process of forecasting needs to start from scratch. Furthermore, within the food processor and food retail sectors, it can be noted how procurement teams are best placed to manage the forecasting process, with forecasting upheld as a way to build resilience. However, it is increasingly difficult to forecast given the aforementioned disconnect between tiers of suppliers and manual data processes, which Charlebois et al. (2016) cite as a precursor to issues around trust and fraudulent events. These issues were identified within this case study with the food logistics sector being least connected with forecasting, which is enabling cited issues around cost and visibility to arise. As such, the benefits espoused in the CFSR matrix (Table 36) of 'holistic forecasting of customer requirements' are not truly connected, which give rise to challenges associated with 'data integrity'. Therefore, this research supports the need for greater integration of systems to shift mindsets from cost to quality, which could make consumers part of the resilience process (Brown et al., 2016). Thus, by embedding connected forecasting across food supply chain actors, not only would it meet the needs of resilience building supported by Modified Delphi experts, but also address the areas identified as devoid

in the systematic literature review of consumers, enforcement and intelligence (Fassam & Dani, 2017), with relation to food fraud.

5.2 Persistence and robustness

There is a significant number of studies that recognise the key driver behind fraud as being economically motivated, as is noted above with margin constrained operations in food logistics, and areas pertaining to competition between market players (Grunert & Aachmann 2016; Huisman, 2016; Manning & Soon, 2014). This was validated within the food logistics sector, being cited by procurement professionals as key [cost control] and a driver for focus within the business. This not only has issues around ethical behaviours being called into question, but lacks internal innovation, thus having connections to 'internal communications' in building 'persistence and robustness'. As mentioned above, in learning and innovation, it can be clearly noted how manual processes are stifling efficiency, therefore arguably a lack of internal connectivity and communication is driving this risk related to margin constrained businesses, such as that which was discussed in relation to food logistics. Thus, this research suggests that there is a direct correlation between collaboration and communication, alongside 'internal communication' in building internal resilience to food supply chain fraud, specifically in a food logistics operational setting.

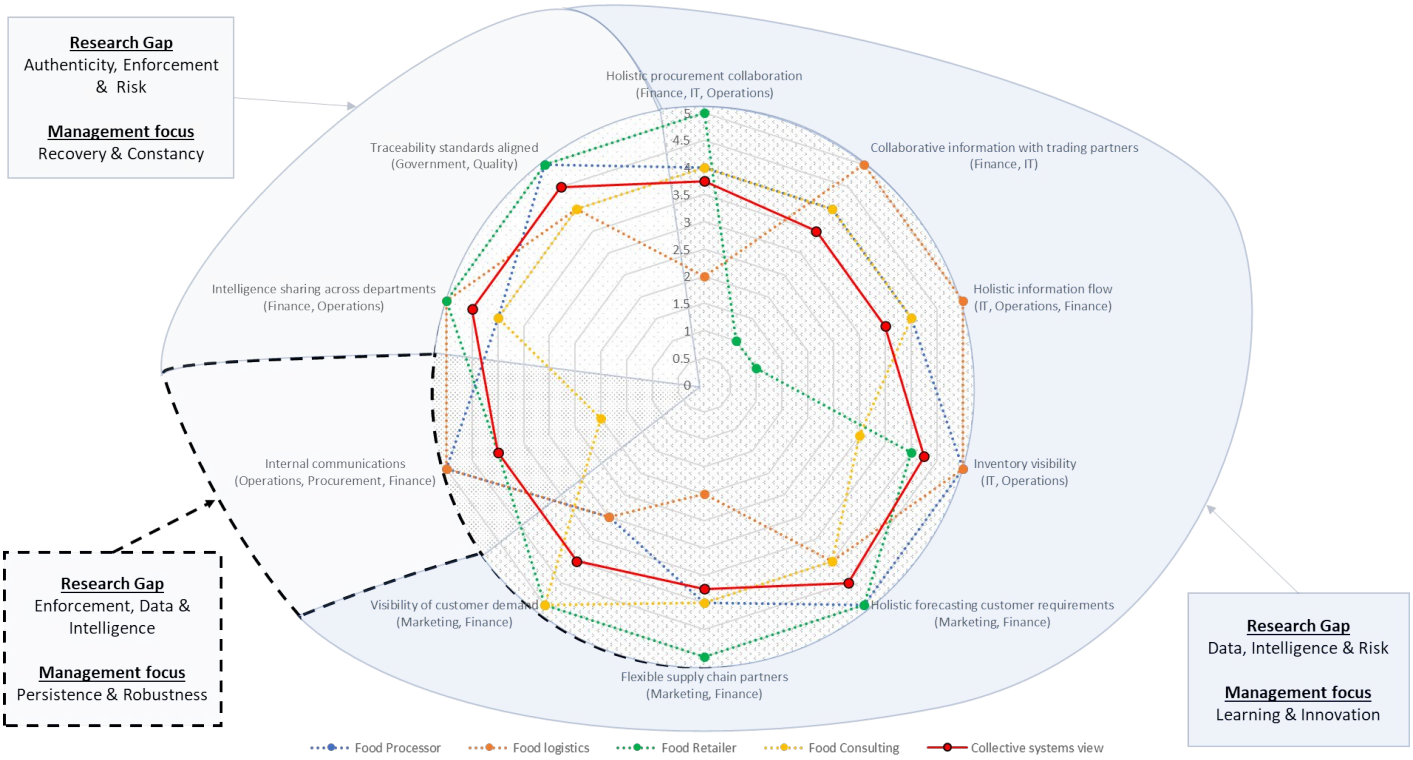

Fig. 8 Persistence & Robustness – capability model. Numeric key – 0 Low agreement (High risk) – 5 High agreement (Low risk)

In addition to operational cost, there is a clear need to embrace total cost of ownership across food supply chains. This not only assists in the management of cost, but goes toward building resilience by enabling responsiveness, flexibility and quality to be embraced by all food chain actors (Vorst, 2006; Aramyan et al., 2007; Bigliardi & Bottani, 2010). Therefore, in doing so it validates the need for having 'flexible supply chain partners' and 'inventory visibility' as resilience markers within food supply chains to build resilience against food fraud. However, flexibility and visibility alongside aforementioned collaboration will not occur unless the hidden cost and culture issues associated with 'persistence and robustness' are addressed. While the food logistics sector were most vocal around these issues [cost] when reviewing 'learning and innovation', they score highly on the need for 'inventory visibility' with 'persistence and robustness'. Therefore, this research has identified the connection in cost and culture challenges being linked to 'flexible supply chain partners', in line with the

aforementioned literature (Vorst, 2006; Aramyan et al., 2007; Bigliardi & Bottani, 2010) into food supply chain resilience building. Additionally, 'inventory visibility' is upheld as related to cost issues, and it would appear that in this case study the operational elements of the food supply chain case study all agreed strongly on this area, with a MEAN of >4.0. Therefore, in a food supply chain operational context, the operational stakeholders within this research study strongly agree that 'internal communications' is critical to building resilience against food fraud. This is a key finding against the objectives of this research, as it addresses the gaps with data and intelligence sharing within the current academic literature, whilst aligning the management focus of 'persistence and robustness' with a metric of 'internal communication'.

However, arguably a very subjective area, and one that resides in many businesses today, blame culture does nothing towards building the much-needed collaboration that academic research and CFSR model (Fig.8) outputs support. The requirement to abolish blame cultures is a must, with Polyviou et al. (2019) citing the need for social capital within food supply chain procurement in order to embed culture in an organisation that is more aligned with mitigation rather than backward looking blame cultures. However, it does appear that blame culture is endemic within food supply chains, and it is easy to understand why. Many of the key authors, including the UK Government report into food fraud (Elliott, 2014), cite the need for whistle blowing. Whilst this may be a quick way to identify challenges in the food supply chain, the research author cites this as a short-lived process that is damaging longer term to much needed supplier relationship management, and it was not a metric contained within the outputs of this research study with industry professionals. In addition, it is important to understand the three typologies of risk, namely internal, external to node (firm) and external to the food supply chain (Christopher & Peck, 2004; Mentzer, 2008; Olson & Dash, 2010). The idea of whistle blowing breaks down the fabric of risk identification and does not foster the 'internal communications'

needed to build food supply chain resilience [CFSR model] and 'holistic procurement collaboration' for external threats. Therefore, this research identifies that whistle blowing does not embrace the necessary internal constructs of the typologies of risk within food supply chains. Moreover, the research study asserts that food supply chain actors would be better served adopting greater 'intelligence sharing across departments' as per the CFSR model (Fig.8), in order to meet the research gap of data, intelligence and risk (Fassam & Dani, 2017).

In furthering the understanding between 'persistence and robustness' and building resilience, there is a need to review issues relating to training within organisations. As such, there reside challenges around uncertain internal management, weak control supervision, and misuse of people's authority, which give rise to challenges either internal and external of an organisation's environment with food supply chain resilience (Rodgers, 2012; SSAFE, 2015). The procurement experts at all stages were citing a lack of training being delivered in a cohesive manner, both internal and external to their respective organisations, and this was similar for both operational and non-operational teams. This gave rise to a myriad of differing standards across the food supply chains in question, and reinforced challenges around management perception. Furthermore, the challenges around training and management give rise to ethical issues such as anti-competitive behaviours, which are embedded in traditional supply chain risk management and are currently problematic (Isenberg, 2008; Mello & Flint, 2009; Mello & Stank, 2005). Moreover, these issues around training build cultures that preclude the balanced mix of top down and bottom up management associated with the aforementioned need to imbed social capital to permeate and build resilience (Polyviou et al., 2019). However, there was an agreement from all procurement professionals that more connected and holistic training would be welcomed, and would be beneficial to, for example, assist with interpretation of data or alignment of standards. This connects well with the findings

that ‘internal communications’ and ‘traceability standards aligned’ are key drivers to building resilience against food fraud. However, this research study finds that in order to achieve this there is a requirement to align training across the wider supply chain, which will reduce anti-competitive behaviours, an understood metric for mitigating risk. Therefore, this research purports that fostering ‘internal communications’ through adopting better training standards across the food supply chain works towards issues of blame cultures, a critical metric that stifles the aforementioned and much needed collaboration.

Therefore, in closing the gap on ‘persistence and robustness’ while only being aligned to one metric in the CFSR model (Fig.8) of ‘internal communications’ carried significant relevance in terms of building wider food supply chain resilience. There is a clear picture developing that whilst blame culture and trust are an issue within the upstream elements of this food supply chain case study [food logistics and food producer], there is an agreement amongst all stakeholders that ‘internal communications’ are important. Thus, a finding of this research is that in order to build collaboration and trust, there is a need to embrace greater social capital within food supply chains. As such, it is suggested that this is undertaken upstream with food producers to achieve ‘visibility of customer demand’ and with food logistics and ‘holistic procurement collaboration’, both of which are connected to the aforementioned areas of total cost of ownership and responsiveness, flexibility and quality. In addition, it identifies a connection between the objectives of this research in bridging the research gap with data, intelligence and risk and correlation between ‘internal communications’ and ‘blame cultures’. As such, outputs contribute to the academic body of knowledge in this area, and permit further exploration and direction.

5.3 Recovery and constancy

The integrity of data in building collaboration is coming out as critical in order to meet the needs of building food supply chain resilience, particularly as it [data] features across many of the CFRS metrics from the Modified Delphi (Table.36). There were two areas relating to 'recovery and constancy' with building internal capabilities to food fraud, namely 'intelligence sharing across departments' and 'traceability standards aligned'. All case study participants agreed these were important in building resilience, with a MEAN of >4.0 seen with both metrics and in all sectors. Furthermore, there was overwhelming agreement from the procurement professionals in each case study organisation that data formats and integrity were causing significant issues with building resilience. This, therefore, links to the aforementioned areas of manual processes identified with food logistics and food processor stakeholders, and therefore carries a cited risk to the issues around product recalls which shake consumer confidence (Spink et al., 2017). In addition, consumer confidence gets further compounded with issues arising from mislabelling of products or man-made operational mistakes leading to quality issues (Charlebois et al., 2016). These events were prevalent within the food system according to the procurement professionals, however, all procurement professionals agreed that better and more integrated data would assist in building internal and external perceptions.

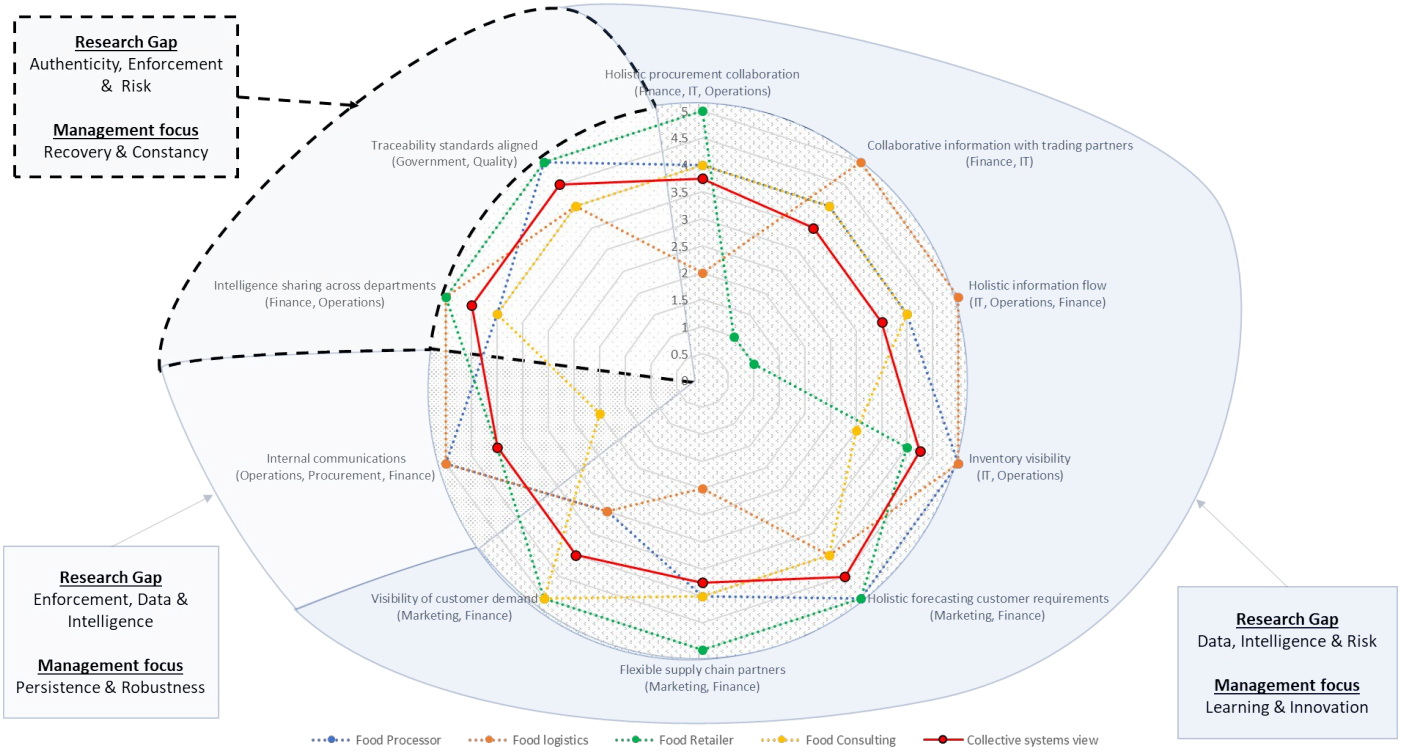

Fig.9 Persistence & Robustness – capability model. Numeric key – 0 Low agreement (High risk) – 5 High agreement (Low risk)

Also, the ability to implement systems that permit traceability and quality processes require significant data exchanges (Morin & Lees, 2015). One would argue, given the aforementioned challenges around innovation and integration, there is more work needed within the food supply chain to build true resilience against food fraud. Therefore, in order to meet constructs of the CFSR matrix (Table 36) in enabling the aforementioned 'integrated data interchange', all procurement professionals agreed this needed to begin with internal management through procurement functions. This therefore has a direct correlation with 'internal communications' and 'blame cultures', underpinning the importance of training and social capital implementation. In addition, this alignment of internal resilience building [procurement] through managed data interchange addresses the research gap of data and intelligence (Elliott, 2014; Fassam & Dani, 2017). Therefore, a direct correlation is made between the known

academic literature around food provenance, and the outputs of this research with a need for 'recovery and constancy' to deliver greater 'visibility' and 'data integrity'. In doing so, the research author purports that the issues with manual intervention, cost, culture and collaboration are addressed, while meeting the identified research gaps of authenticity, enforcement and risk.

In order to garner 'intelligence sharing across departments', there was significant agreement across all procurement participants that visibility is important to building resilience against food supply chain food fraud. It is stated that visibility is intrinsically linked to building supply chain governance and trust across actors (Sarpong, 2014; Fassam et al., 2015; Kennedy, 2012; Huck et al., 2016). It is a key construct to mitigating against key risks in a food supply chain, and can protect against demand fluctuations and vulnerabilities associated with external threats (Guan et al., 2011; Xiaoping, 2016; Mithun Ali et al., 2019). In this regard, food logistics and food procurement stakeholders had cited significant issues around lacking visibility, with more emphasis being placed on this metric by food retail sector participants. This is where this research validates the earlier issues around true understanding of technology value engagement with the management focus of 'learning and innovation'. As such what this research identifies is, there is currently in this case study a lack of visibility due to challenges around culture and understanding, but all of the case study organisations agreed 'visibility' is important, therefore giving importance to the capability metric of 'intelligence sharing across departments'.

In addition to traditional elements of supply chain risk management, the visibility that would be brought about by the CFSR matrix (Table 36) can also create better supplier and business partner selections (Diabat et al., 2012; Mithun Ali et al., 2019). Having better supplier reliability will mitigate against one of the most significant risk issues within food supply chains

(Prakash et al., 2017; Ali et al., 2018). The known instances of food fraud have been noted to be directly correlated to poor supplier governance, therefore validating use of connected systems to build food supply chain resilience. This further validates the capability metric of 'intelligence sharing across departments' and 'traceability standards aligned' as key in building resilience against supply chain food fraud.

There has been much discussion in traditional supply chain risk management about the auspices of supplier co-opetition strategies, and how these can assist geographically dispersed supply chains in achieving competitive advantage (Laosirihongthong & Dangayach, 2005; Sweeney et al., 2018). However, there is little in the food supply chain context to support this [co-opetition], despite there being a cited need to manage complex relationships in enabling collaborative working (Bourlakis & Weightman, 2004; Hung, 2011). Despite academic research being devoid, this need for collaboration was significantly cited by the procurement professionals within the management focus of 'learning and development', and arguably is needed to meet the requirements of the constructs of CFSR matrix (Table 36). In building co-opetition and collaboration strategies, it is argued that greater visibility and traceability would be enabled which would mitigate internal and external risks such as price vulnerability, climate volatility, food losses, nutrition security, regulation and governance issues (Gokarn & Kuthambalayan, 2017, 2017; Fredriksson & Liljestrand, 2015). Therefore, this research identifies a correlation between the academic gap with co-opetition strategies, with all case study participants citing 'visibility' with a MEAN of >4.0. Despite this, the strongest proponent of 'collaboration', 'alignment', 'data integrity' and 'visibility' are the food retail case study participants, while there reside significant shortcomings with other case study participants across these metrics. This underpins the aforementioned need for greater

engagement with upstream operations to build greater resilience against food fraud. It further strengthens the need for culture change, which supports the aforementioned aspects of social capital in building a balance between top down-bottom up approaches (Polyviou et al., 2019).

Given food supply chains specific characteristics, including foods that are perishable in nature and commodities spread across geographically spread networks, food chains are often more complex than other supply chains (Mithun ali & Nakade, 2014; Singh et al., 2018). As such, measures to mitigate the challenges associated with food supply chain fraud relate to intelligence gathering, laboratory service, audit, government support, leadership and crisis management (Elliot, 2014). Many of these elements are reactive in nature and often mean food supply chain data is out of date, therefore fraudulent behaviours have already occurred. Furthermore, often these audit led risk assessments are not always usable (Rathmore et al., 2017), with research outputs from food logistics and food producer procurement professionals citing a lack of a connected and automated process. This has given rise to an exhausting and manual process, that is creating audit fatigue with supply chains actors. Furthermore, the research with its procurement professionals identified how procurement teams are well placed to build internal resilience, but further espouse how these [procurements] can connect externally across differing nodes to deliver the holistic resilience building. Moreover, research into user-friendly food quality management systems found that micro and small businesses were the most difficult to integrate into food quality programs (Dora et al., 2013). This lack of embracement of a significant sector [SME] (90% of European food systems) (Fassam & Dani, 2017), creates challenges around food supply chain resilience. Therefore, in order to build the external resilience Ruth et al. (2017) purport how connected data led by procurement approaches can build resilience in the areas of traceability, alignment of standards and

collaborative sharing of information, which further bridge the lack of understanding around authenticity and enforcement (Fassam & Dani, 2017).

5.5 Cross case analysis – key take-aways

This chapter set out to discuss the outputs of the tri-method research under the thematic areas of 'Learning and innovation', 'Persistence and robustness' and Recovery and constancy'. As such, what became apparent quickly was no one capability metric can mitigate risk or build resilience to supply chain food fraud occurrences. In fact, they are intertwined, with any organisation serious about having robust food supply chain management needing to adopt a systems view approach. For example, there was a resounding issue with visibility and collaboration with upstream actors food logistics and food producers with regard to 'Learning and Innovation'. As the research discussion moved to 'Persistence and robustness' all operational stakeholders [Food Producer, Food Logistics and Food Retail] were fully engaged in the capabilities of internal resilience building, with food consulting, a non-operationally facing function not in agreement. However, there was common agreement amongst participants regarding 'Recovery and constancy' and the importance of the capabilities of internal resilience building. Therefore, the researcher suggests that, as there is a direct correlation between collaboration, data and visibility, it is wrong for this research to label one metric as more important than other.

Thus, this research enabled the creation of Capability matrix for food supply chain resilience (CFSR matrix) against fraud (Table 37). This table is a collation of the key findings, enabling academics and practitioners one view of research outputs. The CFSR matrix pulls together the characteristics of the Delphi for building resilience in a food supply chain. These are then mapped against the cross case study stakeholders (rows 1-4) with the stakeholders whom

engaged less with the identified research output [Delphi resilience measure] as higher risk (Red, Amber, Green – RAG) than those whom didn't. This [RAG matrix] was chosen as it is a proven method used by practitioners within the food industry to measure rish (Burnson, 2002; Sora, 2010; Von Tigerson, 2011). The CFSR matrix then proceeds to identify the internal resilience lead (Row 4), the key focus that relates to building the identified Delphi resilience metric (Row 5) and the internal business support functions required to support same (Row 6). Lastly, row 7 show cases the academic research gaps pertaining to each resilience metric.

		Food supply chain characteristics (Delphi output)									
	Supply chain entity	**Holistic procurement collaboration**	**Collaborative information with trading partners**	**Holistic information flow**	**Inventory visibility**	**Holistic forecasting customer requirements**	**Flexible supply chain partners**	**Visibility of customer demand**	**Internal communications**	**Intelligence sharing across departments**	**Traceability standards aligned**
Upstream - Downstream	**Food processor**	Medium	Medium	Medium	Low	Low	Low	High	Low	Medium	Low
	Food Logistics	High	Low	Low	Low	Medium	High	High	Low	Low	Medium
	Food retail	Low	High	High	Medium	Low	Low	Low	Medium	Low	Low
	Food consulting	Medium	Medium	Medium	High	Medium	Medium	Low	High	Medium	Medium
	Internal resillience lead	Procurement	Procurement	Procurement	Procurement	Procurement	Procurement	Procurement	HR	Procurement	Procurement
	Key focus	Business collaboration	Systems view	Systems view	Supplier co-opetition	Data integrity	Business collaboration	Alignment	Blame culture	Visibility	Data integrity
	Support functions to resillience lead	Finance, IT, Operations	Finance, IT	IT, Operations, Finance	IT, Operations	Marketing, Finance	Marketing, Finance	Marketing, Finance	Operations, Procurement, Finance	Finance, Operations	Government, Quality
	Research gap (literature)	Data, Intelligence, Risk	Data, Intelligence, Risk	Data, Intelligence, Risk	Data, Intelligence, Risk	Data, Intelligence, Risk	Data, Intelligence, Risk	Data, Intelligence, Risk	Enforcement, Data, Intelligence	Authenticity, Enforcement, Risk	Authenticity, Enforcement, Risk

Key – **GREEN** = Highest agreement (Low risk), **AMBER** = Medium agreement (Medium risk) and **RED** = Lowest agreement (Highest risk)

Table 37 Capability matrix for food supply chain resilience against fraud (CFSR matrix)

The capability matrix for food supply chain resilience against fraud (CFSR matrix) permits a correlation to be gleaned on areas of business need in order to build greater resilience against food fraud. However, it is worth reinforcing no one metric, as found by the research is a standalone metric against food fraud, and all intenral capabilities need to be addressed collectively. It further permits other researchers a directional view for further investigation against the identified themes, which were correlated to existent academic knowledge.

For example, if the first internal capability 'holisitic procurement collaboration' (column 1) was to be addressed. It can be noted the key focus for building resilience should relate to 'Business collaboration', with the internal resilience lead being procurement (row 5), and areas of finance, IT and Operations acting as support unit (row 7). Howevem the CFSR matrix enables academics and practitioners to go a step further, and deliver a focus area for initial review when looking at food supply chain resilience. In this chosen example of 'holistic procurement collaboration' the engagement with this metric was lower with food logistics and food processor stakeholders, and higher with food retailer. Therefore, operationally it can be noted upstream actors are more at risk of not complying or having challenges with 'collaboration' and 'procurement'. Thus, with this example, the CFSR matrix delivers areas of focus internally with organisation and permits an identification on the supply chain actor as to their risk in relation to adherance to the capabilities, along with their relative position in the supply chain [upstream-downstream]. However, while not being in scope of this research it would be suggested more research is required in order to build this theoretical approach into a balanced score card approach

The key take-aways from the research are:

- Greater engagement is needed with cross-functional supply chain stakeholders
- There are challenges with the perception of holistic collaboration
- A lack of technology value remains within resilience building
- Benefits of collaboration are understood, but culture and trust are standing in the way of truly co-opetitive data sharing intelligence processes
- Internal communications need to be developed to get past blame cultures
- More work is needed with the food retail sector in building systems views
- There are greater issues noted with transparency upstream in a food supply chain
- A lack of technology uptake is causing a duplication of effort with manual processes
- Engagement is needed with upstream actors to have greater visibility and alignment

5.6 Discussion chapter summary

This chapter set out to review the triangulated research outputs from the systematic literature reviews, Modified Delphi and semi-structured case study interviews against the research question *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*.

In doing so, it was found that the food supply chain's specific characteristics of having items that are perishable in nature in addition to the fact its commodities are spread across geographically spread networks make the food supply chain often more complex than other supply chains (Mithun ali & Nakade, 2014; Singh et al., 2018), and therefore susceptible to fraudulent behaviours.

In all streams of review and comparison a way to build resilience in the food supply chain against fraud was identified. However, there were challenges highlighted from the procurement expert participation related to a lack of connected data across all elements of the food supply

chains. Additionally, there was a cited lack of integrated data interchange within food supply chains, that was being driven by a lack of leadership, with elements of relationships stifling innovation, and not including the wider supply chain landscape, such as complications with SMEs. Cost control was a significant driver of challenge with resilience, with anti-competitive behaviours and a lack of management focus being drivers associated with a focus on resilience building as devoid.

In addition, a key take away from the research related to a lack of connected systems, which is arguably the key driver in building food supply chain resilience according to expert input into the constructs of CFSR matrix (Table.37). This is driven by an over emphasis on manual and often retrospective views of supply chain resilience building against food fraud [audits]. Additionally, these audits are often unreliable and do not include the SME in the process, thus precluding innovation, the much-needed metric of resilience building.

However, despite there being noted behaviours that create negative connotations in relation to food supply chain resilience building and fraud, there were direct correlations that supported procurement as the function to build internal and external resilience. It [procurement] furthermore was instrumental in weaving together all elements in the constructs of the CFSR matrix (Table 37). Furthermore, research outputs in the main led to building an understanding of the gaps identified in the systematic literature review.

In summary, the research, taking current literature into the areas of food supply chain resilience building, and through a triangulated approach, has developed a collection of actions of internal resilience building against food fraud through the management process of procurement and adoption of the Capability matrix for food supply chain resilience against fraud (Table 37).

Chapter 6 – Final thoughts

This final chapter will bring together the conclusions from the three strands of methodology, and compare them against the literature review as well as to respond directly to the research question *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'.* The chapter then goes on to review the research limitations, highlight any further areas for research focus and finish with concluding remarks from the thesis author.

6.1 Research objectives and answering the question

This research was constructed through a series of evolving methods to review key concepts in answering the research question *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*with four clear objectives:

1. Give background and context to research study by critically examining academic literature in the field of food supply chain resilience against food fraud.

   This objective was met in constructing a literature review of existent traditional supply chain risk management literature, food supply chain risk and resilience research and sector specific food supply food fraud challenges (Agriculture, Dairy and Meat). This delivered an understanding for critical discussion in relation to the aforementioned research question. In addition, this research thesis undertook a systematic literature review of supply chain food fraud literature, to deliver a gap analysis against the UK Government food fraud report (Elliott, 2014). These outputs were an enabler of

direction with this research, permitting a gap analysis to be performed in relation to supply chain food fraud and resilience building.

2. Build an understanding of the metrics needed to build resilience in a food supply chain against food fraud.

   By utilising the aforementioned drivers and gaps of resilience against food fraud in a supply chain context, this research undertook a Modified Delphi for answering *'What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*. Outputs of this Modified Delphi gave markers of the constructs needed within food operations that need to be considered for building internal resilience against food supply chain fraud.

3. Against the resilience markers, identify the internal business unit for leading the implementation of the resilience measure.

   The constructs of building food supply chain resilience reviewed the historic gap in existent food supply chain resilience literature against the business units that are proffered by the UK Government report into food fraud (Elliott, 2014). These business units were then identified against the aforementioned outputs of the Modified Delphi to deliver the constructs of internal resilience building against food fraud with a lead stakeholder unit for managing this and sub-units for supporting delivery.

4 Conceptualise the ability for business unit level focus to deliver internal resilience building through linking together existent research of resilience building in food supply

chains, the identified metrics of building food resilience and business unit for managing resilience.

The gaps identified with the systematic literature review (Fassam & Dani, 2017), alongside the enablers of resilience (learning and innovation, persistence and robustness, recovery and constancy) and three management metrics (supply chain dynamics and KPI, strategic leadership, decision leadership) associated with building resilience in food supply chains (Bourlakis et al., 2014; Edgeman & Wu, 2016; Manning & Soon, 2016; Ponomarov & Holcomb, 2009) created an existent knowledge base relating to food supply chain fraud and resilience. This was coded against the constructs of resilience building against fraud [Modified Delphi] and the business unit for managing the process of resilience building. The outputs delivered were thus Capability matrix for food supply chain resilience against fraud (Table.37).

In answering the research question '*What are the capabilities of internal supply chain actors to build supply chain resilience against food fraud?'*, this research thesis deployed a series of methodologies as outlined in chapter 3 that built on existent knowledge [gaps and enablers], capabilities of resilience building [Modified Delphi] and detailed understanding of current and future procurement function used to build resilience [semi-structured case study interviews].

In doing so, the research direction came from existent literature on food supply chain resilience to fraud with three key metrics to build resilience and three focal areas for management. These gave clarity when coded against the capabilities of internal actors [Modified Delphi]. In addition, having identified the internal business unit (resolving a knowledge gap) and researched in detail procurement professionals' views on food fraud resilience, an

understanding of resilience building was gleaned. This fully coded output [constructs of building food supply chain resilience] alongside the discussion chapter [5] have given a research output that answers the research question and contributes to the body of knowledge around food supply chain resilience and fraud.

However, the scope of this research thesis was not to discuss the detail around challenges associated with building resilience, but rather to foster research around the constructs of resilience building. Therefore, concepts and challenges highlighted in the research around the issues associated with food supply chain resilience building and fraud will be highlighted in section 6.4 [Areas of further research].

6.2 Contribution to knowledge

As of writing the thesis conclusion, and to be the best of the author's knowledge coupled with the identified gaps in the literature review, there is a paucity of literature pertaining to supply chain resilience building through the lens of food fraud.

Therefore, this thesis contributes to research in the aforementioned areas of resilience building in two ways, namely theoretical and practical. Firstly, this is achieved through establishing the theoretical need of organisations to combat risks and construct resilience, by identifying existent research in the field of food supply chain resilience. The outputs of this exercise identified two strands, enablers and gaps, both relating to food supply chain resilience building. By undertaking the systematic literature review, this research identified existent literature in the field of supply chain food fraud. The correlation between differing views were compared with 'practitioner', 'academic', 'academic' (Chartered Association of Business Schools) and 'UK Government report into food fraud'. This presented a series of gaps associated with key

concepts missing in the area of building food supply chain resilience, namely authenticity, consumers, data, enforcement, intelligence and risks. These gaps not only gave direction to this research study, but they further enabled a peer reviewed Chartered Association of Business Schools paper to be produced for use in academic research in the area of supply chain food fraud (Fassam & Dani, 2017), and as of concluding this thesis, the article has been cited a number of times in peer reviewed works.

In addition, through the literature review process into existent resilience factors relating to food supply chains, an understanding was achieved of the three resilience measures (learning and innovation, persistence and robustness, recovery and constancy) and three management metrics (supply chain dynamics and KPI, strategic leadership, decision leadership) associated with building resilience in food supply chains (Edgeman & Wu, 2016; Manning & Soon, 2016; Ponomarov & Holcomb, 2009). Therefore, having identified the gaps in academic contribution toward building resilience in food supply chain, an understanding of the research direction in the field of supply chain resilience construction can be gleaned by the wider academic research community. In addition, the building of enablers with relation to food supply chain resilience permits a better understanding with industry experts as to the issues that require addressing with this topic. At the time of writing this thesis, there was little understanding of the elements relating to social capital, human factors and business unit internal resilience builders with relation to food supply chain resilience. However, despite these being abundant in generic supply chain risk management approaches, there was scant evidence of this being collated in research to form robust outputs related to practitioner need or understanding.

Secondly, the impacts of this research relate to the practical impact and contribution by engaging with senior experts in the field of food supply chain management. The first element

was allied to the aforementioned identification of gaps and enablers, from the literature review which gave a valuable insight into the critical areas missing in food supply chain resilience, through a Modified Delphi ascertaining 'what are the actors of building supply chain resilience against food fraud'. This question was posed due to existent literature being devoid of understanding in this area, and much of the risk and resilience literature discussion not proffering much in the way of understanding in a food supply chain context. When reviewing this through the lens of food fraud, much has been undertaken, such as the UK Government report into food fraud (Elliott, 2014). However, this is very biased toward scientific testing and does not align itself well with the business and management aspects of food supply chains, an area this research aspired to address. The next steps engaged with procurement professionals as they had been identified as the business unit for managing resilience building [internally]. This process, whilst giving some first indication of what is devoid in the research [management unit], served to build a case study approach to understanding the constructs of resilience building outputs from the Modified Delphi outputs. In doing so, a series of correlations toward building greater understanding was achieved between the literature (enablers and gaps), and expert opinion on the actors of food supply chain resilience against food fraud, which identify business unit level actions to support.

The two elements of the research contribution [theoretical and practical] have built an understanding of food supply chain fraud resilience, with outputs against existent resilience literature building the 'Capability matrix for food supply chain resilience against fraud', that can be utilised by many in the formulation of business processes, policy formation or further research.

6.3 Research limitations

This research study followed an iterative process of research design, which was aligned with well-grounded research examples, as outlined in chapter 3. However, despite the process design and alignment with peer reviewed processes, there were four main limitations to this study.

Firstly, there was a limited amount of academic and practitioner research, particularly within the business focussed arena related to supply chain food fraud mitigation. This of course was mitigated against by adopting the abductive grounded theory and Modified Delphi, methods specifically designed for such instances and where there is an under-researched area in supply chain management (Stuart et al, 2002; Randal & Mello, 2012). Yet, it would have been more advantageous from a triangulation perspective to have had more literature to bring into the comparison. Another mitigation measure was the use of the UK Government report into food fraud (Elliott, 2014), which was used as a benchmark of excellence in the field of supply chain food fraud and as a comparison tool.

Secondly, the study aimed to embrace a secondary cross case analysis to bring in a final validation method of the link between procurement and mitigation of food fraud in a supply chain context. However, there is a lack of detailed case study literature available in the open source libraries, which made secondary case study use of little value. However, despite this, the scant secondary case study detail was collated by the researcher and included in the final chapter (5) to develop the theoretical outputs from the abductive grounded theory research into food supply chain food fraud and future research suggestions.

Lastly, the research espoused to engage with a true food value chain approach and have representative actors contained within the food supply chain. While the research managed to garner a connected chain of Processor, Food 3PL Logisticians, Food Retailer and Food Consulting, there was no inclusion of upstream farmers (growers). This was due to the complexity of ingredients contained within each SKU, and it was deemed by the researcher and focus group to be too complex and out of the scope of this particular research study.

6.4 Areas of further research

The business of food supply chain is complex and is no longer attributed to a series of local and regional networks. Instead, the food sector is a series of complex networks that span many thousands of kilometres and comprise a myriad of different actors. The food supply chain is open to a significant amount of shocks, many of which were out of the scope of this thesis and would make the topic too broad, an area of concern with current food supply chain resilience literature.

As of concluding this research thesis one of the largest food supply chain shocks [globally] in modern history is taking place. There are many examples within this issue of Covid 19 that highlight the gaps and challenges the research thesis experts identified with resilience building.

Whilst the majority of these challenges could be gathered into one research study, it is the author's view that this would follow the auspices of prior supply chain resilience research by being too top level. In order to resolve this in a manner that is applicable to research outcomes and gives practical application, it is the recommendation of this research that each of these themes are undertaken as distinct pieces of research in their own right.

In doing so, the researcher purports that firstly this research should be undertaken through a global lens with similar actors as this research thesis has done. This would enable a connection to be made with the contribution to academic knowledge that this research thesis has made, therefore addressing the salient points made by the expert contribution, and expanding the reach to a globalised approach.

Furthermore, in order to meet the needs of external resilience building, it is recommended that a wider research study be undertaken on a global level at SKU level, as the research identified through its literature review differing issues pertaining to varying industries such as agriculture, dairy and meat. Therefore, using the outputs of this research thesis against SKU and sector would expand the knowledge building with resilience of food fraud. In doing so this would deliver a piece research that is applicable to practitioners and expand knowledge around the issues with existent literature and support the findings of the UK Government report into food fraud.

In addition, while this research study was not focussed on culture, it has come out as a key theme, particularly around the benefits of social capital and this being devoid with academia and supply chain food fraud mitigation. Therefore, the research author suggests greater understanding should be sought against the research outputs, in order to build a greater body of knowledge in this area.

Lastly, the literature review undertook a process of review with three sectors of the food supply chain. It is the research author's recommendation that these be expanded as succinct pieces of research and include the upstream elements of farmer/producer. In addition, as food is a

globally traded commodity, and much of the sourcing crosses differing geographies and religions, inclusions must be made for specific processes such as the halal industry.

In summary, in addressing the recommendations above, it is the researcher's view that true understanding can be reached of the resilience constructs relating to food supply chain resilience, both the internal and external constructs across globally connected communities and cultures when combating food fraud.

Chapter 7 - References

Aastrup, J., Halidorsson, A. (2008). Epistemological role of case studies in logistics: A critical realist perspective. *International Journal of Physical Distribution & Logistics Management*, 38 (10), 746-763

Adamides, ED; Papachristos, G; Pomonis, N; (2012) Critical realism in supply chain research: Understanding the dynamics of a seasonal goods supply chain. *International Journal of Physical Distribution & Logistics Managemen*t, 42 (10) pp. 906-930

Adler, M., Ziglio, E. (1996). *Gazing into the Oracle: The Delphi Method and its Application to Social Policy and Public Health*. London: Jessica Kingsley

Africa Research Bulletin. (2013). 'Food security', Africa Research Bulletin: Economic, Financial and Technical Series, 50 (2)

Alba, I. (2017). *A food surveillance strategy for Scotland*. Food Standards Scotland. Retrieved from https://consult.foodstandards.gov.scot/2013- food-protection-science-and-surveillance/a-food-surveillance-strategy-forscotland/

Ali, S., Rahman, M., Tumpa, T., Moghul Rifat, A., Paul, S. (2018). Examining price and service competition among retailers in a supply chain under potential demand disruption. *Journal of Retailing and Consumer Services*, 40–47, 112-131

Allen, S., Schuster, E. (2004). Controlling the risk for an agricultural harvest. *Manufacturing and Service Operations Management*, 6 (3), 225–236

Allianz. (2014). *Allianz Risk Barometer*. Allianz, Retrieved from: http://www.agcs.allianz.com/assets/PDFs/Reports/Allianz-Risk-Barometer-2014_EN.pdf

Alveson, M., Karreman, D. (2007). Constructing mystery: Empirical matters in theory development. *Academy of Management*, 32 (4)

Angerhofer, B., Angelides, M. (2006). A model and a performance measurement system for collaborative supply chains. *Decision support systems*, 42 (1), 283-301

Angner, E. (2006). Economists as experts: overconfidence in theory and practice, *Journal of Economic Methodologies*, 13 (1), pp. 1-24

Aramyan, L., Lansink, A.,Van Der Vorst, J., Kooten, O. (2007). Performance measurement in agri-food supply chains: A case study. *Supply Chain Management*, 12(4), 304–315.

Arya, B. , and Z.Lin . 2007. "Understanding Collaboration Outcomes from an Extended Resource-Based View Perspective: The Roles of Organizational Characteristics, Partner Attributes, and Network Structures." Journal of Management 33 (5): 697–723

Assefa, T., Meuwissen, M., Oude, M. (2017). Price risk perceptions and management strategies in selected European food supply chains: An exploratory approach. *NJAS - Wageningen Journal of Life Sciences*, 80, 15–26

Aung, M. M., & Chang, Y. S. (2014). Traceability in a food supply chain: Safety and quality perspectives. *Food Control*, *39*(1), 172–184

Bacon, B. (2014). Supply Chains – with complexity comes uncertainty. *Supply Management,* 14th July. Retrieved from: http://www.supplymanagement.com/blog/2014/11/supply-chains-with-complexity-comes-uncertainty

Badia-Melis, R., Mishra, P., Ruiz-García, L. (2015). Food traceability: New trends and recent advances. A review. *Food Control*, *57*, 393–401

Bai, L., Shi, C., Guo, Y., Du, Q., Huang, Y. (2018). Quality Risk Evaluation of the Food Supply Chain Using a Fuzzy Comprehensive Evaluation Model and Failure Mode, Effects, and Criticality Analysis. *Journal of Food Quality*, 10 (1). 5-19

Barbour, R. (1999). The case for combining qualitative and quantitative approaches in health services research. *Journal of Health Services Research and Policy*, 4, 39–43

Becker, H. (1967). Whose side are we on?. *Social Problems*, 14, 239–247

Behzadi, G., O'Sullivan, M., Olsen, T., Zhang, A. (2018). Agribusiness supply chain risk management: A review of quantitative decision models. *Omega*, 79, 21–42

Bell, E., Bryman, A. (2007). The ethics of management research: an exploratory content analysis. *British journal of management*, *18*(1), 63-77.

Benson, C., Clay, E. (1998). *The Impact of Drought on Sub-Saharan African Economies: A Preliminary Examination*. World Bank Technical Paper 401, Washington, DC.

Bhagwarm R., Sharma, M. (2007). Performance measurement of supply chain management: A balanced score card approach, *Computers & Industrial Engineering*, 53 (1), 43-62

Bhalla, V., Grimm, P., Chertow, A., Pao, A. (2009). Melamine nephrotoxicity: an emerging epidemic in an era of globalization, *Kidney International*, 75 (2009), pp.774-779

Biaton, L., Werner, K. (2018). Fourth industrial revolution and managers' cognitive competences. *Marketing of Scientific and Research Organisations*, 27 (1), 81-106

Bigliardi, B., & Bottani, E. (2010). Performance measurement in the food supply chain: a balanced scorecard approach. *Facilities*, 28(5–6), 249–260

Bigot, C., Meile, J. C., Kapitan, A., Montet, D. (2015). Discriminating organic and conventional foods by analysis of their microbial ecology: An application on fruits. *Food Control*, *48*, 123–129

Bindt, V. (2016). Costs and benefits of the food fraud vulnerability assessment in the Dutch food supply chain. *Tesis*, August, 1–39

Biranjia-Hurdoyal, S., Latouche, M. (2016). Factors Affecting Microbial Load and Profile of Potential Pathogens and Food Spoilage Bacteria from Household Kitchen Tables. *Canadian Journal of Infectious Diseases and Medical Microbiology*, 23 (1), 110-123

Blaikie, P., 1995. *Understanding environmental issues. In: Morse, S., Stocking, M. (Eds.),* People and Environment. University College

London Press, London, 1–30.

Blome, C., Schoenherr, T. (2011). Supply chain risk management in financial crises – a multiple case-study approach, *International Journal of Production Economics*, 134 (1), pp.43-57

Bloor, M. (1978). On the analysis of observational data: a discussion of the worth and uses of analytic induction and respondent validation. *Sociology*, 12, 545–557

Bloor.M., Baker, S., Sampson, H., Dahlgren, K. (2013) *Qualitative Research: Theory, Method and Practice (2nd ed.)*. London: Sage, 305–324

Bloor, M., Datta R., Gilinskiy, Y.,Horlick-Jones, T. (2006). Unicorn among the cedars: on the possibility of 'smart regulation' of the globalised shipping industry. *Social & Legal Studies*, 15, 537–554.

Bloor, M., Sampson, H., Baker, S., Dahlgren, K. (2015). Useful but no Oracle: reflections on the use of a Delphi Group in a multi-methods policy research study. *Qualitative Research*, 15(1), 57-70

Bloor, M., Wood, F. (2006). *Keywords in Qualitative Research: A Vocabulary of Research Concepts*. London: Sage

Borràs, E., Ferré, J., Boqué, R., Mestres, M., Aceña, L., Busto, O. (2015). Data fusion methodologies for food and beverage authentication and quality assessment - A review. *Analytica Chimica Acta*, *891*, 1–14

Bourlakis, M., Maglaras, G., Gallear, D. and Fotopoulos, C. (2014), "Examining sustainability performance in the supply chain: the case of the Greek dairy sector", *Industrial Marketing Management*, Vol. 43 No. 1, pp. 56-66.

Bouzembrak, Y., Marvin, H. J. P. (2016). Prediction of food fraud type using data from Rapid Alert System for Food and Feed (RASFF) and Bayesian network modelling. *Food Control*, *61*, 180–187

Bowman, R. (2014). Companies are failing to detect financial fraud in supply chains: Deloitte, *Forbes*, April 16th

Boyer, K., Swink, M. (2008). The Operations & Supply Management (OSM) Forum—A New Feature. *Journal of Operations Management*, 26 (3), 337-348

Brannen, J. (1992). *Mixing Methods: Qualitative and Quantitative Research*. Aldershot: Ashgate

Brown, G., Rumsey, J., Worth, I., Lee, D., Scaife, A. (2016). *Food Statistics Pocketbook 2016*. 61.

Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done?. *Qualitative Research*, 6, 97–113

BSI. (2014). "PAS 96:2014 Guide to protecting and defending food and drink from deliberate attack." 1–44

Bulmer, M. (1982). *The Uses of Social Research*. London: Allen and Unwin

Burawoy, M. (2005). For public sociology. *American Sociological Review*, 70: 4–28

Burgers, K., Singh, P., Koroglu, R. (2006). Supply chain management: a structured literature review and implications for future research. *International Journal of Operations & Production Management*, 26 (7), 256-265

Burnson, P. (2002). Supplier audits remain essential. *Logistics Management,* 56 (8)

CAC, (1999). *Codex Alimentarius Commission. Principles and guidelines for the conduct of microbiological risk assessment*. CAC/GL-30. Retrieved from http://www. codexalimentarius.net/web/standard_list.do? lang=en

Cai, X., Chen, J., Xiao, Y., Xu, X., Yu, G. (2013). Fresh-product supply chain management with logistics outsourcing. *Omega*, 41(4), 752–765

Campbell, D., Stanley, J. (1963). *Experimental and quasi-experimental designs for research on teaching*. Handbook of research Teaching. Chicago: Rand Mcnally

Carr, J., Lee, D., Scaife, A., Stark, K. (2013). *Food Statistics Pocketbook 2013*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/243770/foodpocketbook-2013report-19sep13.pdf

Carter, E., Kofler, L., Forster, D., McCullough, M. (2015). A Series of MetaAnalytic Tests of the Depletion Effect : Self-Control Does Not Seem to Rely on a Limited Resource, *Journal of Experimental Psychology: General*, 144, 796 – 815

Carter, C. R. , T.Kosmol, and L.Kaufmann . 2017. "Toward a Supply Chain Practice View." Journal of Supply Chain Management 53 (1): 114–122. doi:10.1111/jscm.12130

Cassidy, M., Buede, D. (2009). Does the accuracy of expert judgment comply with common sense: caveat emptor, *Management Decision*, 47 (3), 454-469

Catlin, Michelle, Kautter, D. (2007). An Overview of the Carver Plus Shock Method for Food Secor Vullnerability Assessments. *In Food and Drug Administration*, 12, 1–14

Cavin, C., Cottenet, G., Blancpain, C., Bessaire, T., Frank, N., & Zbinden, P. (2016). Food adulteration: From vulnerability assessment to new analytical solutions. *Chimia*, *70* (5), 329–333

Cavana, R., Delahaye, B., Sekeran, U. (2001). *Applied business research: Qualitative and quantitative methods*. John Wiley & Sons.

Cawthorn, D. M., Steinman, H. A., Hoffman, L. C. (2013). A high incidence of species substitution and mislabelling detected in meat products sold in South Africa. *Food Control*, *32*(2), 440–449

Chan, F. (2003), Performance Measurement in a Supply Chain, *The International Journal of Advanced Manufacturing Technology*, 21, 534 – 548

Chang, W., Ellinger, A., Blackhurst, J. (2015). A contextual approach to supply chain risk mitigation. *International Journal of Logistics Management*, 26(3), 642–656

Chaudhuri, A., Srivastava, S., Srivastava, R., Parveen, Z. (2016). Risk propagation and its impact on performance in food processing supply chain: A fuzzy interpretive structural modelling based approach. *Journal of Modelling in Management*, 11 (2), 660–693

Chen, C. (2019). Developing a model for supply chain agility and innovativeness to enhance firms' competitive advantage. *Management Decision*, 57 (7), 1511-1534

Chen, L. (2017). International Competitiveness and the Fourth Industrial Revolution. *Entrepreneurial Business and Economics Review*, 5 (4), 111-133

Chopra, S., Sodhi, M.S. (2004), Managing risk to avoid supply-chain breakdown, *MIT Sloan Management Review*, 46 (1), pp. 53-61

Christopher, M., Lee, H. (2004). Mitigating supply chain risk through improved confidence, *International Journal of Physical Distribution and Logistics Management*, 34 (5)

Christopher, M., Peck, H. (2004). Building the Resilient Supply Chain. *The International Journal of Logistics Management*, 15 (2), 1–14

Chopra, S., Meindl, P. (2013). *Supply Chain Management 5th Ed*. Pearson Education: London

CIPS. (2013). *Ethical and Sustainable Procurement, Chartered Institute of Purchasing and Supply*. Chartered Institute of Procurement and Supply. Retrieved from: http://www.cips.org/Documents/About%20CIPS/CIPS_Ethics_Guide_WEB.pdf

Clarke, M., Oxman, A. (2001). *Cochrane Handbook for Systematic Reviews of Interventions, The Cochrane Collaboration*. Oxford Library, John Wiley & Sons, Chichester.

Coleman, M., Marks, H. (1999). Qualitative and quantitative risk assessment. *Food Control*, 10 (4–5), 289–297

Collis, J., & Hussey, R. (2009). *Business research: A practical guide for undergraduate and postgraduate students*. Macmillan International Higher Education.

Colquitt, J., Zapata-Phelan, C. (2007). Trends in Theory Building and Theory Testing: A Five-Decade Study of the Academy of Management Journal. *Academy of Management*, 50 (6)

Coote, A. Lenaghan, J. (1997). *Citizens Juries: Theory into Practice*. London: Institute for Public

Cragg, T., Mcnamara, T. (2018). An ICT-based framework to improve global supply chain integration for final assembly SMEs. *Journal of Enterprise Information Management*, 31 (5), 634-657

Cresswell, J. Plano-Clark, V. (2007). *Designing and Conducting Mixed Methods Research*. Thousand Oaks, CA: Sage

Cressey, D. (1953). *Other People's Money: A Study in the Social Psychology of Embezzlement*. Belmont, CA: Wadsworth

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches (2nd ed.)*. Thousand Oaks, CA: Sage.

Curll, J. (2015). The significance of food fraud in Australia. *Australian Business Law Review*, *43* (August), 270

Dabbene, F., Gay, P., Tortia, C. (2014). Traceability issues in food supply chain management: a review. *Biosystems engineering*, 120 (2014), 65-80

D'Amico, P., Armani, A., Castigliego, L., Sheng, G., Gianfaldoni, D., Guidi, A. (2014). Seafood traceability issues in Chinese food business activities in the light of the european provisions. *Food Control*, *35*(1), 7–13

Dairy Standards Version 4.2. (2019). *Red Tractor Assurance*. Retrieved from: https://assurance.redtractor.org.uk/contentfiles/Farmers-6802.pdf?_=637060417378500869

Dani, S. (2009). Predicting and Managing Supply Chain Risks. In: Supply Chain Risk: A Handbook of Assessment, *Management and Performance*. 23. 53-66

Dani, S., Deep, A. (2010). Fragile food supply chains: Reacting to risks. *International Journal of Logistics Research and Applications*, 13 (5), 395–410

Davidson, V., Ryks, J., Fazil, A. (2006). Fuzzy risk assessment tool for microbial hazards in food systems. *Fuzzy Sets and Systems*, 157 (9), 1201–1210

Decrop, A. (1999). Triangulation in qualitative tourism research. *Tourism management*, 20 (1), 157-161.

Defee, C., Williams, B., Randall, W., Thomas, R. (2010). An inventory of theory in logistics and SCM research, *International Journal of Logistics Management*, 21 (3)

DEFRA. (2012). *Foodpocketbook 2012*. DEFRA. Retrieved from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/183302/foodpocketbook-2012edition-09apr2013.pdf

DEFRA. (2013). *Food chain evidence plan: Food policy, competitiveness, growth & food security.* DEFRA, March, Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221070/pb13916-evidenceplan-food-chain.pdf

DEFRA. (2014). Food Statistics Pocketbook. *National Statistics*, 1–67.

DEFRA. (2015). *Food statistics pocketbook 2015*. DEFRA, Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/512112/foodpocketbook-2015report-31mar16.pdf

DeHoratius, N., Rabinovich, E. (2011). Field research in operations and supply chain management. *Journal of Operations Management*, 29 (5), 371-375

Denyer, D., Tranfield, D. (2006). Using qualitative research synthesis to build an actionable knowledge base. *Management Decision*, 44 (2), 102-113

Denzin, N. (1970). *The Research Act in Sociology*. London: Butterworth

Dhingra, R., Kress, R., Upreti, G. (20140. Does lean mean green?. *Journal of Cleaner Production*, 85, 1-7

Diabat, A., Govindan, K., Panicker, V. (2012). Supply chain risk management and its mitigation in a food industry. *International Journal of Production Research*, 50 (11), 3039-3050

Ding, M., Jie, F., Parton, K., Matanda, M. (2014). Relationships between quality of information sharing and supply chain food quality in the Australian beef processing industry. *International Journal of Logistics Management*, 25 (1), 85–108

Dong, Q., Cooper, O. (2016). An orders-of-magnitude AHP supply chain risk assessment framework. *International Journal of Production Economics*, 182, 144–156

Dore, M., Kumar, M., Van Goubergen, D., Molnar, A., Gellynck, X. (2013) Food quality management system: Reviewing assessment strategies and a feasibility study for European food small and medium-sized enterprises, *Food Control*, 31 (2)

Dreyer, H. C., Strandhagen, J. O., Romsdal, A. (2014). Supply Chain Control Principles in Local Food Production A Norwegian Case Study. *International Journal on Food System Dynamics*, 5 (2), 53–68

Dubois, A., Araujo, LM 2007, 'Case research in purchasing and supply management: opportunities and challenges', *Journal of Purchasing and Supply Management*, vol. 13, no. 3, pp. 170-181

Dumas, A. (1988). *"Silent Designers", in Clark PA & Starkey KP Organization Transitions and Innovation-Design*, London:Pinter.

Dunkerley, D., Glasner, P. (1998). Empowering the public? Citizens juries and the new genetic technologies. *Critical Public Health*, 8, 181–192

Duriau, V.J., Reger, R.K., Pfarrer, M.D., (2007). A content analysis of the content analysis literature in organization studies: research themes, data sources, and refinements. *Organizational Research Methods*, 10 (1), 99-109

Easterby-Smith, M., Thorpe, R., Jackson, P. (2012). *Management Research*. Sage: California
Economist. (2014). *'A la cartel'*, Economist, 15th March 2014, Retrieved from: http://www.economist.com/news/britain/21599028-organised-gangs-have-growing-appetite-food-crime-la-cartel

Edgeman, R., Wu, Z. (2016). Supply chain criticality in sustainable and resilient enterprises. *Journal of Modelling in Management*, 11 (4), 869-888

Eddine, M., Saikouk, T. and Berrado, A., (2019) Understanding Supply Chain Resilience: a Dynamic Approach Using Theory of Constraints Current Reality Tree. *International Conference on Industrial Engineering and Operations Management Pilsen, Czech Republic, July 23-26, 2019*

Edmonson, A., McManus, S. (2007). Methodological fit in management field research. *Academy of Management review*, 32 (4)

Eisenhardt, K. (1989). Building Theories from Case Study Research, *The Academy of Management Review*, 14 (4), 532-550

Eisenhardt, K., Graebner, M. (2007). Theory Building From Cases: Opportunities and Challenges. *Academy of Management Journal*, 50 (1)

Elliott, C. (2014). *'Elliott Review into the Integrity and Assurance of Food Supply Networks – Final Report'*, HM Government, July 2014, Retrieved from:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/350726/elliot-review-final-report-july2014.pdf

Emerson, R., Pollner, M. (1988). On the uses of members' responses to researchers' accounts. *Human Organization*, 47, 189–198

Esteki, M., Regueiro, J., & Simal-Gándara, J. (2019). Tackling Fraudsters with Global Strategies to Expose Fraud in the Food Chain. *Comprehensive Reviews in Food Science and Food Safety*, 18 (2), 425–440

Everstine, J., Spink, S., Kennedy, P. (2013). Analysis of Food Fraud and Economically Motivated Adulteration incidents, *Journal of Food Protection*, 4 (11)

European Commission. (2014). *Sustainable food, European Commission*, March, Retrieved from: http://ec.europa.eu/environment/eussd/food.htm

European Commission (2015). *Food fraud report 2015*, European Commission. April, Retrieved from: http://ec.europa.eu/food/safety/docs/official-controls_food-fraud_network-activity-report_2015.pdf

European Parliament. (2014). *Report – on the food crisis, fraud in the food chain and the control there of*. Committee on the Environment, Public Health and Food Safety, October 10

Fassam, L., Asefeavazi, S., Dani, S. (2020) Supply chain risk & resilience: literature review of the food challenge. Paper presented to: 6th International Conference on Food & Wine Supply Chain – Italy. (Online 2020)

Fassam, L., Dani, S. (2017). A conceptual understanding of criminality and integrity challenges in food supply chains, *British Food Journal*, 119 (1)

Fassam, L., Dani, S. and Hills, M. (2015). Supply chain food crime & fraud: a systematic literature review of food criminality. *Paper presented to: 20th International Symposium on Logistics (ISL 2015) : Designing Responsible and Innovative Global Supply Chains*, Bologna, Italy, 05-08 July 2015

FDA-Food & Drugs Administration in USA. (2005). *Current Good Manufacturing Practices (CGMPs) – Food CGMP modernization – A focus on food safety*. Rockville, MD, USA: Center for Food Safety and Applied Nutrition. Retrieved from https://www.fda.gov/food/guidance regulation/cgmp/ucm207458.htm

Fearne, A., Hornibrook, S., Dedman, S. (2001). The management of perceived risk in the food supply chain: A comparative study of retailer-led beef quality assurance schemes in Germany and Italy. *International Food and Agribusiness Management Review*, 4 (1), 19–36.

Fitzgerald, K. (2005). Big savings, but lots of risk. *Supply Chain Management Review*, 9 (9), 16–20

Flari, V., Hussein, Maeder, R., Huber, B., Marvin, H., Neslo, R. (2014). Ensuring the Integrity of the European food chain Deliverable: 8:1 Report on analysis of historical cases of food fraud, *Food Integrity*, 613688.

FM Global. (2015). *Resilience index annual report 2016*, Oxford metrica, December, Retrieved from: http://www.lemoci.com/wp-content/uploads/2016/05/2016-FM-Global-Resilience-Index-Annual-Report.pdf

Folke, C. (2006), Resilience: the emergence of a perspective for social-ecological systems analyses, *Global Environmental Change*, Vol. 16 No. 1, pp. 253-267

Fontana, A., & Frey, J. H. (2005). The interview: From neutral stance to political involvement.

Food Drink Europe. (n.d.). *Position Paper on Food Fraud*. 31–32.

Food today. (2013). *European Union Action Plan to tackle food fraud*. Food today, November, Retrieved from: http://www.eufic.org/article/en/food-safety-quality/farm-to-fork/artid/Tackling_food_fraud_in_Europe/

Fredriksson, A., Liljestrand, K. (2015). Capturing food logistics: a literature review and research agenda. *International Journal of Logistics Research and Applications*, 18(1), 16–34

Fritz, M., Schiefer, G. (2009). System dynamics and innovation in food networks. *British Food Journal*, 111(8). 102-114

FSAI. (2015). *What is food fraud*. Food safety authority Ireland, Retrieved from: https://www.fsai.ie/enforcement_audit/food_fraud.html

Gallagher, M., Thomas, I. (2010). Food Fraud: The deliberate Adulteration and Misdescription of Foodstuffs, European Food and Feed Law Review, 6 (1), 348

Garrod, B., Fyall, A. (2005). *Revisiting Delphi: the Delphi technique in tourism research*. Cambridge, MA: CABI Publications, 85–98

Gaudenzi, B., Borghesi, A. (2006). Managing risks in the supply chain using the AHP method. *The International Journal of Logistics Management*, 17 (1), 114–136

Gbegi, D., Adebisi, J. (2013). the New Fraud Diamond Model- How Can It Help Forensic Accountants in Fraud Investigation in Nigeria? *European Journal of Accounting Auditing and Finance Research*, *1*(4), 129–138

Georgiou, C. A., Danezis, G. P. (2017). *Food authentication: Management, analysis and regulation*. New Jersey, USA: Wiley Blackwell.

Ghadge, A., Dani, S., Kalawsky, R. (2012). Supply chain risk management: Present and future scope. *The International Journal of Logistics Management*, 23 (3), 313–339

Glaser, B., Strauss, A. (1967). *The Discovery of Grounded Theory*, Aldine Publishing Company, Hawthorne, NY

Goh, M., Lim, J. Y. S., & Meng, F. (2007). A stochastic model for risk management in global supply chain networks. *European Journal of Operational Research*, 182 (1), 164–173.

Goh, M., Pinaikul, P. (1998). Logistics management practices and development in China. *Logistics Information Management*, 11 (6), 359-369

Golicic, S., David, D. (2012). Implementing mixed methods research in supply chain management. *International Journal of Physical Distribution & Logistics*, 12 (6)

Gokarn, S., Kuthambalayan, T. (2017). Analysis of challenges inhibiting the reduction of waste in food supply chain. *Journal of Cleaner Production*, 168, 595–604

Gorod, A., Sauser, B., Boardman, J. (2008). System-of-Systems Engineering Management: A Review of Modern History and a Path Forward. *IEEE Systems Journal*, 2 (4), 484-499

Gossner, C., Schlundt, J., Embarek, P., Hird, S., Lo-Do-Wong, D., Beltran, J., Teoh, K., Tritscher, A. (2009). The melamine incident: implications for international food and feed safety, *Environmental Health Perspective*. 117 (12), 214-231

Govindan, K. (2018). Sustainable consumption and production in the food supply chain: A conceptual framework. *International Journal of Production Economics*, 195(March 2017), 419–431

Green, S. B., Yang, Y. (2009). Reliability of summed item scores using structural equation modeling: An alternative to coefficient alpha. *Psychometrika*, *74*(1), 155-167.

Guan, Z., Philpott, A. (2011). A multistage stochastic programming model for the New Zealand dairy industry. *International Journal of Production Economics*, 134(2), 289–299

Guba, E. (1990). *The paradigm dialogue*. Sage Publications: Washington

Guba, E. Lincoln, Y. (2005). *Paradigmatic controversies, contradictions, and emerging confluences*. In N. K. Denzin., Y. S. Lincoln (Eds.), The Sage handbook of qualitative research (3rd ed., pp. 191-216). Thousand Oaks, CA: Sage.

Gummerson, E. (2000). Qualitative Methods in Management Research 2nd Ed. Sage: London
Gunaekaran, A., Patel, C., McGaughey, R. (2004). A framework for supply chain performance measurement, *International Journal of Production Economics*, 87 (3), 333-347

Hakim, C. (1987). *Research Design: Strategies and Choices in the Design of Social Research*, Contemporary Social Research Series 13. London: Allen and Unwin

Hair, J., Anderson, R., Black, B., Babin, B. (2010). *Multivariate analysis*. Pearson Higher Ed: California

Handford, C., Campbell, K., Elliott, C. (2015). Impacts of Milk Fraud on Food Safety and Nutrition with Special Emphasis on Developing Countries. *Comprehensive Reviews in Food Science and Food Safety*, 15 (1), 121-128

Handfield, R.B., Handfield, R. and Nichols Jr, E.L., 2002. Supply chain redesign: Transforming supply chains into integrated value systems. Ft Press.

Hart, F. (1952). A History of the Adulteration of Food Before 1906, Food, Drug, Cosmetic *Law Journal*, 7 (1), 5-15

Hasson, F., Keeney, S., McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing*, 32 (4), 1008-1015

Heckmann, I., Comes, T., Nickel, S. (2015). A critical review on supply chain risk - Definition, measure and modelling. *Omega*, 52, 119–132

Hervani, A., Helms, M., Sarkis, J. (2005) Performance Measurement for Green Supply Chain Management. Benchmarking: *An International Journal*, 12, 330-353

Hittle, B., Leonard, K. (2011). Decision making in advance of a supply chain crisis, *Management Decision*, 49 (7), 1182-1193

HM Government (2013). *Review into the Integrity and Assurance of Food Supply Networks*. Retrieved from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/254806/riafsn-dairyuk-note-20130917.pdf Accessed on: 14th May 2020.

Ho, W., Zheng, T., Yildiz, H., Talluri, S. (2015). Supply chain risk management: a literature review. *International Journal of Production Research*, 53(16), 5031-5069

Hobbs, J. (2020) Food supply chains during the Covid-19 pandemic, *Canadian journal of agricultural economics*, 21st April.

Holland, J. (1992). Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, *Control, and Artificial Intelligence*. MIT Press: Boston

Holley, R. A., & Patel, D. (2005). Improvement in shelf-life and safety of perishable foods by plant essential oils and smoke antimicrobials. *Food Microbiology*, 22 (4), 273–292

House of Commons. (2013). *'Global Food Security: Government Response to the Committee's First Report of Session 2013-2014'*, House of Commons International Development Committee , (HC 626, 2013-14), Retrieved from: http://www.publications.parliament.uk/pa/cm201314/cmselect/cmintdev/176/176.pdf

Huck, C. W., Pezzei, C. K., Huck-Pezzei, V. A. (2016). An industry perspective of food fraud. *Current Opinion in Food Science*, 10, 32–37

Huang, Y., Han, W., Macbeth, D. (2020). The complexity of collaboration in supply chain networks. Supply Chain Management: *An International Journal*, 12 (1), 110-132

Hung, S. (2011). Activity-based divergent supply chain planning for competitive advantage in the risky global environment: A DEMATEL-ANP fuzzy goal programming approach, *Expert Systems With Applications*, 38
(8), 9053-9062

Hunt, S. D. , and D. F.Davis . 2012. "Grounding Supply Chain Management in Resource-Advantage Theory: In Defense of a Resource-Based View of the Firm." Journal of Supply Chain Management 48 (2): 14–20

Huss, H., Reilly, A., Embarek, K. (2000). Prevention and control of hazards in seafood. *Food Control*, 11(2), 149–156

Hsu, C. (2007) The Delphi Technique: Making Sense Of Consensus. *Practical Assessment, Research, and Evaluation*, 12 (10)

International Maritime Organisation. (2002). *International Safety Management (ISM) Code*. International maritime organisation Retrieved at www.imo.org/blast/mainframe.asp?topic_id=287

Irwin, A. (1995). Citizen Science. London: Routledge

Isenberg, D. (2008). *The Global Entrepreneur*. Harvard Business Review, 12th December. Retrieved from: https://hbr.org/2008/12/the-global-entrepreneur

Jaffee, S., Siegel, P., Andrews, C. (2010). *Agriculture and Rural Development Discussion Paper 47 Rapid Agricultural Supply Chain Risk Assessment: A Conceptual Framework*. World Bank. 55. Retrieved from http://www.worldbank.org/rural

Jagadeesan, P. (2013). Horse meat scandal – A wake up call for regulatory authorities, *Food Control*, 21 (2), 568

Johnson, R. (2014). *Food fraud and "Economically Motivated Adulteration" of Food and Food Ingredient*s. Federation of American Scientists, Retrieved from: https://www.fas.org/sgp/crs/misc/R43358.pdf

Johnson, R., Onwuegbuzie, A. (2004). Mixed methods research: a research paradigm whose time has come. *Educational Researcher*, 33, 14–25

Jones, P., Comfort, D., Hillier, D. (2004). A case study of local food and its routes to market in the UK. *British Food Journal*, *106*(4), 328–335. https://doi.org/10.1108/00070700410529582

Joshi, R., Banwet, D., Shankar, R. (2009). Indian cold chain: Modelling the inhibitors. *British Food Journal*, 111(11), 1260–1283

Jüttner, U. (2005). Supply chain risk management: Understanding the business requirements from a practitioner perspective. *The International Journal of Logistics Management*, 16 (1), 120–141

Kache, F., Seuring, S. (2017). Challenges and opportunities of digital information at the intersection of Big Data Analytics and supply chain management, *International Journal of Operations & Production Management*, 37 (1), 10-36

Kahkonon, A. (2011). Conducting a case study in Supply Management. *Supply chain management,* 4 (1), 21-29

Kalaian, S., Kasim, M. (2012). Terminating Sequential Delphi Survey Data Collection. *Practical Assessment, Research, and Evaluation*. 17 (5)

Kane, D. E., Hellberg, R. S. (2016). Identification of species in ground meat products sold on the U.S. commercial market using DNA-based methods. *Food Control*, *59*, 158–163

Keeney, S., Hasson, F., McKenna, H. (2011). *The Delphi Technique in Nursing and Health Research*. Chichester: Wiley-Blackwell.

Keessen, A., Hamer, J., Van Rijswick, H., Wiering, M. (2013). The concept of resilience from a normative perspective: examples from Dutch adaptation strategies, *Ecology and Society*, 18 (2), 1-12

Kennedy, S., 2012. *Emerging global food system risks and potential solutions. In: Improving Import Food Safety*. John Wiley & Sons, Inc, Hoboken, NJ, USA. pp. 1–20.

Khan, O., Burnes, B. (2007). Risk and supply chain management: Creating a research agenda. *The International Journal of Logistics Management*, 18 (2), 197–216

Kleindorfer, P., Saad, G. (2005). Managing disruption risks in supply chains. *Production and Operations Management*. 14, 53–68

Kock, T. (1994). Establishing rigour in qualitative research: the decision trail. *Journal of Advanced Nursing*, 19 (5), 976-986

Koehler, D., Brenner, L., Griffin, D. (2002). *The calibration of expert judgement: heuristics and biases beyond the laboratory*. The Psychology of Intuitive Judgment, Cambridge University Press: Cambridge

Kovacs, G., Spens, K. Abductive reasoning in logistics research. *International Journal of Physical Distribution & Logistics*, 35 (2)

Koulikoff-Souviron, M., Harrison, A. (2005). Using case study methods in researching supply chains. *Research methodologies in supply chain management*, 42, 267-282

Kowalska, A., Soon, J. M., Manning, L. (2018). A study on adulteration in cereals and bakery products from Poland including a review of definitions. *Food Control*, *92*, 348–356

Krížová, L., Vollmannová, A., Margitanová, E., Daniel, J., Medvecký, M. (2016). Can Be Blueberries the Risk Food and Raw Material? *Journal of Microbiology, Biotechnology and Food Sciences*, (6), 769–776

Kroll. (2014). *'2013/14 Global fraud report: who's got something to hide?'*, Kroll, April 2014, Retrieved from: http://fraud.kroll.com/wp-content/uploads/2013/10/Kroll-Global-Fraud-Report-2013-2014-WEB.pdf

Kwak, D., Seo, Y., Mason, R. (2018) Investigating the relationship between supply chain innovation, risk management capabilities and competitive advantage in global supply chains, *International Journal of Operations & Production Management*, 38(1), 2-21

Laosirihongthong, T., Dangayach, G. (2005). A comparative study of implementation of manufacturing strategies in Thai and Indian automotive manufacturing companies. *Journal of Manufacturing Systems*, 24 (2), 131-143

Landeta, J., (2006). Current Validity of the Delphi Method in Social Sciences. *Technological Forecasting and Social Change*, 73, 467–482

Level, J, Sonnino, R., Cheetham, F. (2019). Reconfiguring local food governance in an age of austerity: towards a place-based approach?. *Journal of Rural studies*, 69

Li, F., Hou, J., Xu, D. (2010). *Managing disruption risks in supply chain. Proceedings - 2010 IEEE International Conference on Emergency Management and Management Sciences*, ICEMMS 2010, 14 (1), 434–438

Lichtenstein, S., Fischoff, B., Phillips, L. (1982). *Calibration of probabilities: the state of the art to 1980, Judgement under Uncertainty: Heuristics and biases*. Cambridge University Press: Cambridge

Lii, P. , and F. I.Kuo . 2016. "Innovation-Oriented Supply Chain Integration for Combined Competitiveness and Firm Performance." International Journal of Production Economics 174: 142–155

Linstone, H., Turroff, M. (2002) *The Delphi Approach: Techniques and Applications*. Reading, MA: Addison-Wesley Publishing, 17-34

Liu, M., & Fan, H. (2011). Food supply chain risk assessment based on the theory of system dynamics. 2011 2nd International Conference on Artificial Intelligence. *Management Science and Electronic Commerce*, AIMSEC 2011 - Proceedings, 2010, 5035–5037

Lockamy, A. (2011). Benchmarking supplier risks using Bayesian networks. *Benchmarking*, 18(3), 409–427

Lopez-Vizcón, C., Ortega, F. (2012). Detection of mislabelling in the fresh potato retail market employing microsatellite markers. *Food Control*, *26* (2), 575–579

López, M. I., Colomer, N., Ruisánchez, I., Callao, M. P. (2014). Validation of multivariate screening methodology. Case study: Detection of food fraud. *Analytica Chimica Acta*, *827*, 28–33

Manders, J.H., Caniëls, M.C. and Paul, W.T., 2016. Exploring supply chain flexibility in a FMCG food supply chain. Journal of Purchasing and Supply Management, 22(3), pp.181-195.

Manning, L., Baines, R. (2007). Key health and welfare indicators for broiler production. World's Poultry Science Journal, 63 (01), 46 – 62

Manning, L. (2008). The impact of water quality and availability on food production. *British Food Journal*, 110 (8), 762–780

Manning, L. (2015). Determining value in the food supply chain, *British Food Journal*, 117 (11), 1-17

Manning, L. (2016). Food fraud: policy and food chain. *Current Opinion in Food Science*, *10*(2), 16–21

Manning, L., Baines, R.N. (2007). Globalisation: a study of the poultry meat supply chain, British Food Journal, 106 (10/11), 819-836

Manning, L., & Smith, R. (2015). Providing authentic(ated) food: An opportunity-driven framework for small food companies to engage consumers and protect the integrity of the food supply chain. *International Journal of Entrepreneurship and Innovation*, *16*(2), 97–110

Manning, L., Soon, J. (2014). Developing systems to control food adulteration, *Food Policy*, 49, 23-31

Manning, L., Soon, J. (2016). Building strategic resilience in the food supply chain. *British Food Journal*, 118(6), 1477-1493

Manning, L., Soon, J. (2016b). Food safety, food fraud and food defense: A fast evolving literature, *Journal of Food Science*, 81 (4), 823-834

Manning, L., Soon, J. M., Aguiar, L., & Eastham, J. (2017). 12th Research Workshop on Institutions and Organizations (12th RWIO). July.

Manuj, I., Mentzer, J. (2008). Global supply chain risk management strategies. *International Journal of Physical Distribution and Logistics Management*, 38 (3), 192–223

Marks, H., Coleman, M., Lin, C., Roberts, T. (1998). Topics in microbial risk assessment: Dynamic flow tree process. *Risk Analysis*, 18(3), 309–32

Marieschi, M., Torelli, A., Beghé, D., Bruni, R. (2016). Authentication of Punica granatum L.: Development of SCAR markers for the detection of 10 fruits potentially used in economically motivated adulteration. *Food Chemistry*, *202*, 438–444

Marucheck, A., Greis, N., Mena, C., Cai, L. (2011). Product safety and security in the global supply chain: Issues, challenges and research opportunities. *Journal of Operations Management,* 29 (7–8), 707–720

Masoon, S., Dani, S., Burns, N., Backhouse, C. (2006). Transformational Leadership and Organizational Culture: The Situational Strength Perspective, 220 (6)

Matuszek, T. (2012). Food production quality and risk assessment on machinery design. *Journal of Hygienic Engineering and Design* , 1, 66-71

Maxwell, J. A. (1996). Applied social research methods series, Vol. 41. Qualitative research design: An interactive approach. Sage Publications, Inc.

McCarthy, L. (2014). *Has globalization made corruption worse*. World Economic Forum, October 24th, Retrieved from: https://www.weforum.org/agenda/2014/10/globalization-anti-corruption-world-bank/

Mello, J., Flint, D. (2011). A refined view of grounded theory and its application to logistics research. *Journal of business logistics*, 30 (1), 107-125

Mentzer, J. (2008). GLOBAL SUPPLY CHAIN RISK MANAGEMENT. *Journal of Business*, 29 (1), 133–155

Mentzer, J., DeWitt, W., Keebler, J., Min, S., Nix, N., Smith, C., Zach, Z. (2011). Defining supply chain management, *Journal of business logistics*, 22 (2), 1-25

Meredith, J. R., Raturi, A., Amoako-Gyampah, K., Kaplan, B. (1989). Alternative research paradigms in operations. *Journal of operations management*, *8*(4), 297-326.

Meuwissen, M., Huirne, R., Hardaker, J. (2001). Risk and risk management: An empirical analysis of Dutch livestock farmers. *Livestock Production Science*, 69(1), 43–53

Mirzapour Al-E-Hashem, S., Malekly, H., Aryanezhad, M. (2011). A multi-objective robust optimization model for multi-product multi-site aggregate production planning in a supply chain under uncertainty. *International Journal of Production Economics*, 134 (1), 28–42

Mitenius, N., Kennedy, P., Busta, F. (2014). Food Defense. In *Food Safety Management: A Practical Guide for the Food Industry*. Elsevier Inc

Mithun, A., Moktadir, M., Kabir, G., Chakma, J., Rumi, M., Islam, M. T. (2019). Framework for evaluating risks in food supply chain: Implications in food wastage reduction. Journal of Cleaner Production, 228, 786–800

Mithun, A., Nakade, K. (2014). Scenario-based Supply Chain Disruptions Management Framework-A Quantitative Approach. *Innovation and Supply Chain Management*, 8 (3), 81–91

Moe, T. (1998). Perspectives on traceability in food manufacture, *Trends Food Science Technology*, 9 (1), 2111-2141

Mol, J., Oosterveer, P. (2015). Certification of markets, markets of certificates: Tracing sustainability in global agro-food value chains. *Sustainability (Switzerland)*, *7*(9), 12258–12278

Moloch, H. (1994). Going out. *Sociological Forum*, 9, 221–239

Moore, J. Spink, M. Lipp, J. (2012). Development and application of a database of Food Ingredient Fraud and Economically Motivated Adulteration from 1980 to 2010, *Journal of Food Science*, 77 (4)

Morling, A. (2016) *Food crime as a discrete typology is relatively uncharted territory for the criminologists*. I think that's exciting, [Twitter] 7th April

Morse, J. (2005). Evolving trends in qualitative research: advances in mixed-method design. *Qualitative Health Research*, 15 (1), 583–585

Motarjemi, Y., Wallace, C. (2014). *Incident management and root cause analysis*. Academic press. Waltham, MA. 873-887

Mueller, T. (2012). Extra virginity: The sublime and scandalous world of olive oil by Tom Mueller [review]. *The Observer*, *13*(2), 1–2. http://www.theguardian.com/books/2012/jan/13/extra-virginity-tom-mueller-review

Müller, C. E., Gaus, H. (2015). Consumer Response to Negative Media Information About Certified Organic Food Products. *Journal of Consumer Policy*, *38* (4), 387–409

Munhall, P. L. (2012) Ethical considerations in qualitative research In Munhall, P. L. (Ed.), *Nursing Research: A qualitative perspective* (5th Ed., pp.491-502). Ontario: Jones and Bartlett Publications.

Nakandala, D., Lau, H., Zhao, L. (2017). Development of a hybrid fresh food supply chain risk assessment model. *International Journal of Production Research*, 55(14), 4180–4195

National Audit Office. (2013). *Food safety and authenticity in the processed meat supply chain*, National Audit Office, Retrieved from: https://www.nao.org.uk/wp-content/uploads/2014/10/10255-001-Food-safety-and-authenticity.pdf

Nenadis, N., Heenan, S., Tsimidou, M. Z., Van Ruth, S. (2016). Applicability of PTR-MS in the quality control of saffron. *Food Chemistry*, *196*, 961–967

Neiger, D., Rotaru, K., Churilov, L. (2009). Supply chain risk identification with value-focused process engineering. *Journal of Operations Management*, 27 (2), 154–168

Nelleman, C., MacDevette, M., Manders, T., Eickhout, B., Svihus, B., Prins, A., Kaltenborn, B. (2009). *The environmental food crisis – The environment's role in averting future food crises'*, United Nations Environment Program, Retrieved from: http://www.unep.org/pdf/foodcrisis_lores.pdf

Nikou, S., Selamat, H. (2013). Risk management capability within Malaysia food supply chain. *International Journal of Agriculture and Economic Development*, 1 (1), 37–54.

Noble, D. (2014). *'Grim Convenience'*, Supply Management, 13th March. Retrieved from: http://www.supplymanagement.com/blog/2014/03/grim-convenience

Nooraie, S., Mellat P. (2015). A multi-objective approach to supply chain risk management: Integrating visibility with supply and demand risk. *International Journal of Production Economics*, 161, 192-200

Norrman, A., Jansson, U. (2004). Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident. *International Journal of Physical Distribution and Logistics Management*, 34 (5), 434–456

NRC-National Research Council. (2003). *In (Committee on the Review of the Use of Scientific Criteria and Performance Standards for Safe Food. & Institute of Medicine (U.S.) (eds.)*, Scientific criteria to ensure safe food. Washington, DC, USA: National Academies Press. Retrieved from https://books.google.com/books?id=uGWbAgAAQBAJ&pg=PT2&lpg=PT2&dq=Scientific+Criteria+to+Ensure+Safe+Food.+Committee+on+the+Review+of+the+Use+of+Scientific+Criteria+and+Performance+Standards+for+Safe+Food&source=bl&ots=w9UKgiEFo8&sig=BogX3W3UttuwirGN4mJ5zm

NSF. (2014). *The 'new' phenomenon of criminal fraud in the food supply chain*. NSF International, Retrieved from: http://www.nsf.org/newsroom/whitepaper-the-new-phenomenon-of-criminal-fraud-in-the-food-supply-chain

O'Cathain, A. (2010). *Mixed methods involving quantitative research*. Thousand Oaks, CA: Sage, 575–588

O'Conner, N., Yang, Z., Jiang, L. (2018). Challenges in gaining supply chain competitiveness: Supplier response strategies and determinants. *Industrial Marketing Management*, 72, 138

OECD (2003) *'Emerging risks in the 21st century'*. OECD Publication services. Retrieved from: http://www.oecd.org/governance/risk/37944611.pdf

Olson, D., Dash, D. (2010). A review of enterprise risk management in supply chain. *Kybernetes*, 39(5), 694–706

Oglethorpe, D. and Heron, G., 2013. Testing the theory of constraints in UK local food supply chains. International journal of operations & production management.

Oxborrow, L., Brindley, C. (2012) Regional resilience in recessionary times: a case study of the East Midlands. *International Journal of Retail & Distribution Management*, Vol. 40 (11) 882-899

Paksoy, T., Pehlivan, N., Özceylan, E. (2012). Application of fuzzy optimization to a supply chain network design: A case study of an edible vegetable oils manufacturer. *Applied Mathematical Modelling*, 36 (6), 2762–2776

Pardo, M. Á., Jiménez, E., Pérez-Villarreal, B. (2016). Misdescription incidents in seafood sector. *Food Control*, *62*(1184), 277–283

Parry-Langdon, N., Bloor, M., Audrey, S., Holliday, J. (2003). Process evaluation of health promotion interventions. *Policy and Politics*, 31, 207–216

Patton, A. (2006). Modelling asymmetric exchange rate difference. *International Economic Review*, 47 (2), 527-556

Pavolv, A., Pavlov, D., Zakharov, V. (2019). Possible ways of assessing the resilience of supply chain networks in conditions of unpredictable disruptions, *IFAC Papers Online*, 52(13), 1283-1288

Peck, H., Helen, P. (2006). *Defra report - Resilience in the Food Chain A study of BCM in the food and drink industry*. Department for Environment Food and Rural Affairs, Jul, 193.

Pei, X., Tandon, A., Alldrick, A., Giorgi, L., Huang, W. Yang, R. (2011). The China melamine milk scandal and its implications for food safety regulation, *Food Policy, 36 (3)*, 412-420.

Pegels, N., González, I., García, T., Martín, R. (2015). Authenticity testing of wheat, barley, rye and oats in food and feed market samples by real-time PCR assays. *LWT - Food Science and Technology*, *60*(2), 867–875

Polyviou, M., Croxton, K., Knemeyer, A. (2019). Resilience of medium-sized firms to supply chain disruptions: the role of internal social capital. *International Journal of Operations & Production Management*, 39(1), 68-9**1**

Ponomarov, S.Y., Holcomb, M.C. (2009). Understanding the concept of supply chain resilience, *International Journal of Logistics Management*, 20 (1), 124-143

Popli, M. , R. M.Ladkani, and A. S.Gaur . 2017. "Business Group Affiliation and Post-Acquisition Performance: An Extended Resource-Based View." Journal of Business Research 81: 21–30

Prakash, S., Soni, G., Rathore, A., Singh, S. (2017). Risk analysis and mitigation for perishable food supply chain: a case of dairy industry. *Benchmarking*, 24(1), 2–23

Punniyamoorthy, M., Thamaraiselvan, N., Manikandan, L. (2013). Assessment of supply chain risk: Scale development and validation. *Benchmarking*, 20(1), 79–105

Punter, A. (2013). *Supply Chain Failures*. London, UK: Alrmic.

Pustjens, M., Weesepoel, Y., van Ruth, S. (2016). Food Fraud and Authenticity: Emerging Issues and Future Trends. *Food Science, Technology and Nutrition*, 18, 3-20

Qiao, Z., Wang, Z., Zhang, C., Yuan, S., Zhu, Y., Wang, J. (2012). PVAm–PIP/PS composite membrane with high performance for CO_2/N_2 separation. AIChE Journal, 59(4), 215–228

Quested, T. E., Cook, P. E., Gorris, L. G. M., Cole, M. B. (2010). Trends in technology, trade and consumption likely to impact on microbial food safety. *International Journal of Food Microbiology*, *139*(SUPPL. 1), S29–S42

Rahmani, F., Leifels, K. (2018). Abductive grounded theory: a worked example of a study in construction management. *Construction management and economics*, *36*(10), 565-583.

Randal, W., Mello, J. (2012). Grounded Theory: An Inductive Method for Supply Chain Research*, International Journal of Physical Distribution & Logistics Management*, 42(8/9):863-880

Rao, S., Goldsby, T. (2009). Supply chain risks: A review and typology. *The International Journal of Logistics Management*, 20(1), 97–123

Rathore, R., Thakkar, J., Jha, J. (2017). A quantitative risk assessment methodology & evaluation of food supply chain*. International Journal of Logistics Management*, 28(4), 1272–1293

Rescher, N. (1998). *Predicting the Future: An Introduction to the Theory of Forecasting*. Albany, NY: State University of New York Press.

Riedl, J., Esslinger, S., Fauhl-Hassek, C. (2015). Review of validation and reporting of non-targeted fingerprinting approaches for food authentication. *Analytica Chimica Acta*, *885*, 17–32

Ritchie, B., Brindley, C. (2000). Disintermediation, disintegration and risk in the SME global supply chain. *Management Decision*, 38(8), 575-583

Robson, C. (1993). *Real World Enquiry: A Resource for Social Scientists and Practitioner-Researchers*. Oxford: Blackwell.

Robson, K., Dean, M., Brooks, S., Haughey, S., Elliott, C. (2020). A 20-year analysis of reported food fraud in the global beef supply chain. *Food Control*, 12 (1)

Rodgers, W., 2012. *Fraud and internal control. In: Rodgers, W. (Ed.), Biometric and Auditing Issues Addressed in a Throughput Model*. Information Age Publishing Inc., Scottsdale, AZ, USA. 261–318

Roth, A., Tsay, A., Pullman, M., Gray, J. (2008). Unravelling the food supply chain: Strategic insights from China and the 2007 recalls. *Journal of Supply Chain Management*, 44(1), 22–39

Roh, J., Hong, P., Min, H. (2014). Implementation of a responsive supply chain strategy in global complexity: The case of manufacturing firms. *International Journal of Production Economics*, 147 (13), 198-214

Rosales, F., Tomas, R., Pimenta, M., Batalha, M., Alcantara, R. (2012*). Risk and agri-food supply chain performance: Perceptions from initial analysis.* Presented at the 19th Int. An. EUROMA Conference, Amsterdam (February), 1–10

Ross, T., Sumner, J. (2002). A simple, spreadsheet-based, food safety risk assessment tool. *International Journal of Food Microbiology*, 77(1–2), 39–53

Roth, A., Tsay, A., Pullman, M., Gray, J. (2008). Unravelling the food supply chain: Strategic insights from China and the 2007 recalls. *Journal of Supply Chain Management*, 44(1), 22–39

Rousseau, D.M., Manning, J., Denyer, D., (2008). Evidence in management and organizational science: assembling the field's full weight of scientific knowledge through syntheses. *Academy of Management Annals*, 2 (1), 475–515

Rowe, G., Wright, G. (1999). The Delphi Technique as a forecasting tool: issues and analysis. *International Journal of Forecasting*, 15, 353–375

Rowe, M., Wright, G., Bolger, F. (1992). Reliability and validity in expert judgment., *Expertise and decision support*, 1, 47–76

Ruben, R., van Boekel, A., Tilburg, J., Trienekens, J. (2007). Tropical food chains; Governance regimes for quality management. Wageningen Academic Publishers, 309 p. Saenz, Netherlands

Ruth, S., Huisman, W., Luning, P. (2017). Food fraud vulnerability and its key factors. *Trends in Food Science & Technology*, 67 (1)

Saad M., Jones M., James P. A review of the progress towards the adoption of supply chain management (SCM) relationships in construction, *European Journal of Purchasing & Supply Management,* 8 (2), 173-183

Sachan, A., Datta, S. (2005). Review of supply chain management and logistics research. *International Journal of Physical Distribution & Logistics*, 36 (2)

Sackman, H. (1975). *Delphi Critique: Expert Opinion, Forecasting and the Group Process*. Lexington, MA: Lexington Books

Sanchez-Rodrigues, V., Potter, A., Naim, M. (2010). Evaluating the causes of uncertainty in logistics operations. *International Journal of Logistics Management*, 21(1), 45–64

Sanders, J. (2013). Evaluation of the EU legislation on organic farming, *Thunen Institute of Farm Economics,* Braunschweig.

Sanders, N. (2020) Covid-19 Supply-Chain Disruption, *Treasury & Risk*, 19th March

Sarkis, J., Gonzalez-Torre, P. and Adenso-Diaz, B., 2010. Stakeholder pressure and the adoption of environmental practices: The mediating effect of training. Journal of operations Management, 28(2), pp.163-176

Sarmiento, R., Whelan, G., Sprenger, J. (2018). Case Studies and Popperian Falsification: A Note on Flyvbjerg's "Five Misunderstandings About Case-Study Research". *Forum: Qualitative social research*, 19 (1), 23-26

Sarpong, S. (2014). Traceability and supply chain complexity: Confronting the issues and concerns. *European Business Review*, *26*(3), 271–284

Scally, G. (2013). Adulteration of food: What it doesn't say on the tin. *BMJ (Online)*, *346*(7898), 1–3

Schell, A., & Wilson, B. (2008). *The Goodman of Paris , 1928*.

Schultz, M., Hatch, M. (1996). Living with multiple paradigms the case study of paradigm interplay in organizational culture studies. *Academy of Management*, 21 (2)

Seale, C. (1999). *The Quality of Qualitative Research*. London: Sage

Shah, H., Sema, K. (2009). Which Is the Best Parametric Statistical Method For Analyzing Delphi Data?. *Journal of Modern Applied Statistical Methods*, 17 (17), 21-25

Shears, P. (2010). Food fraud - a current issue but an old problem. *British Food Journal*, *112*(2), 198–213

Sheffi, Y., 2005. Building a resilient supply chain. *Harvard Business Review,* October, 3–5

Shiferaw, B., Tesfaye, K., Kassie, M., Abate, T., Prasanna, B. M., Menkir, A. (2014). Managing vulnerability to drought and enhancing livelihood resilience in sub-Saharan Africa: Technological, institutional and policy options. *Weather and Climate Extremes*, *3*, 67–79

Shirani, M., Demichela, M. (2015). Integration of FMEA and Human Factor in the Food Chain Risk Assessment. International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering , 9(12), 4094–4097

Singh, A., Shukla, N., Mishra, N. (2018). Social media data analytics to improve supply chain management in food industries. *Transportation Research Part E: Logistics and Transportation Review,* 114, 398–415

Silverman, D. (2000). *Doing qualitative research : a practical handbook* . Thousand Oaks, CA: Sage.

Silvestre, B., Monteiro, M., Viana, F., de Sousa-Filho, J. (2018). Challenges for sustainable supply chain management: When stakeholder collaboration becomes conducive to corruption, *Journal of Cleaner Production,* 194, 766-776

Simatupang, T.M., Wright, A.C. and Sridharan, R. (2004), "Applying the theory of constraints to supply chain collaboration", Supply Chain Management, Vol. 9 No. 1, pp. 57-70.

Smith, R. (2004). Rural rogues: A case story on the "smokies" trade. *International Journal of Entrepreneurial Behaviour & Research*, *10*(4), 277–294

Smith, R. (2013). *Documenting and Investigating the entrepreneurial trade in illegal veterinary medicines in the United Kingdom and Ireland*. In Handbook of Veterinary Business and Enterprise. Oxford, England: Elsevier

Smith, R. (2015). Documenting the UK "Black Fish Scandal" as a case study of criminal entrepreneurship. *International Journal of Sociology and Social Policy*, *35*(3–4), 199–221

Smith, R., McElwee, G., Somerville, P. (2017). Illegal diversification strategies in the farming community from a UK perspective. *Journal of Rural Studies*, *53*, 122–131

Sodhi, M., Son, B., Tang, C. (2012), "Researchers' perspectives on supply chain risk management", *Production and Operations Management*, 21 (1), 223-231

Sodhi, M., Tang, C. (2012). *Managing Supply Chain Risk*. New York, USA: Springer.

Soman, C., Van Donk, D., Gaalman, G. (2004). Combined make-to-order and make-to-stock in a food production system SOM-theme A: Primary processes within firms. *International Journal of Production Economics,* 90, 223–235

Sora, D. (2010). Risk management. *Defense Resources Management in the 21st Century,* 21 (2)

Sousa-Poza, A., Kovacic, S., Keating, C. (2008). Systems of systems engineering: an emerging multidiscipline. *International Journal of Systems Engineering*, 1 (1/2)

Spink, J., Moyer, D. (2011). Defining the public health of food fraud. *Journal of Food Science*, 76 (9), 92-109

Spink, J., Moyer, D. (2013). Understanding and combating food fraud. *Food technology*, 67 (1). 30-35

Spink, J., Moyer, D., Park, H., Wu, Y., Fersht, V., Shao, B., Hong, M., Paek, S., Edelev, D. (2014) Introducing food fraud including translation and interpretation to Russian, Korean and Chinese languages. *UNSW Food Chemistry*, 83 (1)

Spink, J., Moyer, D. C., & Speier-Pero, C. (2016). Introducing the Food Fraud Initial Screening model (FFIS). *Food Control*, *69*, 306–314

Spink, J., Ortega, D. L., Chen, C., & Wu, F. (2017). Food fraud prevention shifts the food risk focus to vulnerability. *Trends in Food Science and Technology*, *62*, 215–220÷

Srivastava, S., Chaudhuri, A., Srivastava, R. (2015). Propagation of risks and their impact on performance in fresh food retail. *International Journal of Logistics Management*, 26(3), 568–602

Stake, R. E. (2008). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies of qualitative inquiry* (p. 119–149). Sage Publications, Inc.

Stiborov, M., Martinek, V., Rydlov, H., Hodek, P., Frei, E. (2002). Sudan is a potential carcinogen for humans. Evidence for its metabolic activation and detoxication by human recombinant cytochrome and liver microsomes, *Cancer Research*, 62, 5687-84

Stuart, I., McCutecheon, D., Handfield, R., McLachlin, R., Samson, D. (2002). Effective case research in operations management: A process perspective, *Journal of Operations Management*, 20 (5), 419-433

Sun, Q., Tang, Y. (2014). The Literature Review of Food Supply Chain Risk Assessment. *International Journal of Business and Social Science*, 5(5), 198–202

Svensson, G. (2000). A conceptual framework for the analysis of vulnerability in supply chains. *International Journal of Physical Distribution & Logistics Management*, 30(9), 731–750

Sweeney, E., Grant, D., Mangan, J. (2018). Strategic adoption of logistics and supply chain management, *International Journal of Operations & Production Management*, 38(3), 852-873

Tähkäpää, S., Maijala, R., Korkeala, H., & Nevas, M. (2015). Patterns of food frauds and adulterations reported in the EU rapid alarm system for food and feed and in Finland. *Food Control*, *47*, 175–184

Tang, C. S. (2006). Perspectives in supply chain risk management. *International Journal of Production Economics*, 103(2), 451–488

Tang, C., Tomlin, B. (2008). The power of flexibility for mitigating supply chain risks. *International Journal of Production Economics*, 116(1), 12–27

Tashakkori, A. Teddlie, C. (2003). *Handbook of Mixed Methods in Social & Behavioural Research*. Thousand Oaks, CA: Sage

The United States Pharmacopeial Convention. (2016). *Food Fraud Mitigation Guidance - Appendix XVII General Tests and Assays*. 1592, 1601–1604, 1612.

Thorelli, H.B., 1986. Networks: between markets and hierarchies. Strategic management journal, 7(1), pp.37-51.

Tranfield, D., Denyer, D., Smart, P. (2003) Towards a methodology for developing evidence informed management knowledge by means of systematic review, *British Journal of Management*, 14 (3), 31-34

Trappey, A., Trappey, C., Chang, S., Lee, W., Hsu, T. (2016). A one-stop logistics services framework supporting global supply chain collaboration. *Journal of Systems Science and Systems Engineering*, 25 (2), 229-253

Tummala, R., Schoenherr, T. (2011). Assessing and managing risks using the Supply Chain Risk Management Process (SCRMP). *Supply Chain Management*, 16(6), 474–483

USP-U.S. Pharmacopeial Convention. (2017). *Food Safety and Integrity Solutions*. Rockville, MD, USA: USP-U.S.

van der Meulen, B. (2015). Is current EU food safety law geared up for fighting food fraud? *Journal Fur Verbraucherschutz Und Lebensmittelsicherheit*, *10*(1), 19–23

Van Der Vorst, J. (2000). Product Traceability in Food-Supply Chains. *Accreditation and Quality Assurance*, 11 (1), 33-37

Van Maanen, J., Sorensen, J., Mitchell, T. (2007). The interplay between theory and method. *Academy of Management*, 32 (4)

Van Ruth., S. M., Luning., P. A., Silvis., I.C.J., Yang, Y. Huisman, W. (2018). Differences in fraud vulnerability in various food supply chains and their tiers. *Food Control*, *84*, 375-381.

Vasileiou, K., Morris, J. (2006). The sustainability of the supply chain for fresh potatoes in Britain. *Supply Chain Management*, 11(4), 317–327

Vedel, M., Ellegaard, C. (2014). Supply Risk Management Functions of Sourcing Intermediaries – An Investigation of the Clothing Industry. *Supply Chain management: An International Journal,* 18 (5), 509-522

Viswanadham, N., Kameshwaran, S. (2013). *Ecosystem-Aware Global Supply Chain Management*. World Scientific Publications, Singapore

Von Tigerstorm, B. (2011). Food labelling regulation to promote healthy eating. *Health Law Review,* 20 (1), 18-19

Vorst, J. Van Der. (2006). Quantifying the Agri-Food supply Chain. Quantifying the Agri-Food Supply Chain. *International Journal of food system dynamics*, 17 (2), 13-24

Wagner, S., Bode, C. (2008). an Empirical Examination of Supply Chain Performance Along Several Dimensions of Risk. *Journal of Business Logistics*, 29 (1), 307–325

Walker, B., Holling, C., Carpenter, S., Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems, *Ecology and Society*, 9 (2), 1-9

Waller, D. (2003). *Operations Management: Supply Chain Approach: Written by Derek L Waller*. 2003 Edition, (2nd edition) Publisher: Cengage Learning

Wang, X., Li, D., Shi, X. (2008). A fuzzy enabled model for aggregative food safety risk assessment in food supply chains. *Proceedings of 2008 IEEE International Conference on Service Operations and Logistics, and Informatics*, IEEE/SOLI 2008, 2, 2898–2903

Waters, D. (2007). *Supply Chain Risk Management: Vulnerability and Resilience in Logistics.* Kogan Page, London.

Wheatley, V. Spink, J. (2013). Defining the public health threat of dietary supplement fraud. *Comprehensive Reviews in Food Science and Food Safety*, 12 (6)

Which. (2013). *The future of food – giving consumers a day*. WHICH, 11th March, Retrieved from: https://press.which.co.uk/wp-content/uploads/2013/04/Future-of-Food-Report-2013_Final.pdf

Wiengarten, F., Humphreys, P., Gimenez, C., Mcivor, R. (2016). Risk, risk management practices, and the success of supply chain integration. *International Journal of Production Economics*, 171, 361-370

Winebrake, J., Corbett, J., Green, E., Lauer, A., Eyring, V. (2009). Mitigating the health impacts of pollution from oceangoing shipping: an assessment of low-sulphur fuel mandates. *Environmental Science & Technology*, 43, 4776–4782

World Economic Forum (2013) *Building Resilience in Supply Chains.,* World Economic Forum, (REF150113 – 2013), Retrieved from: http://www3.weforum.org/docs/WEF_RRN_MO_BuildingResilienceSupplyChains_Report_2013.pdf

Wu, T., Blackhurst, J., Chidambaram, V. (2006). A model for inbound supply risk analysis. *Computers in Industry*, 57 (4), 350–365

Xiao, J., Zhang, D., Ma, Z. (2009). The research on the BP neural network application in food supply chain risk management. *2009 International Conference on Information Management, Innovation Management and Industrial Engineering*, ICIII 2009, 1, 545–548

Xiaoping, W. (2016). Food supply chain safety risk evaluation based on AHP fuzzy integrated evaluation method. *International Journal of Security and Its Applications*, 10(3), 233–244

Yang, T., Fan, W. (2016). Information management strategies and supply chain performance under demand disruptions. *International Journal of Production Research: Supply Chain Dynamics, Control and Disruption Management*, 54(1), 8-27
Yang, Y., Huisman, W., Hettinga, K. A., Liu, N., Heck, J., Schrijver, G. H., Gaiardoni, L., & van Ruth, S. M. (2019). Fraud vulnerability in the Dutch milk supply chain: Assessments of farmers, processors and retailers. *Food Control*, *95*(August 2018), 308–317

Yates, J., Lee, J., Shinotsuka, H., Patalano, A., Sieck, W. (1998). Cross-cultural variations in probability judgement accuracy: beyond general knowledge overconfidence, *Organisational behavioural Human Decision Processes*, 74 (2), 89-117

Yeboah, N., Feng, Y., Daniel, O., Joseph. (2014). Agricultural Supply Chain Risk Identification- A Case Finding from Ghana. *Journal of Management and Strategy*, 5(2). 121-136

Yeung, H. (1997). Critical realism and realist research in human geography: a method or a philosophy in search of a method. *Progress in Human Geography*, 21 (1)

Yeung, R. M. W., Morris, J. (2001). Food safety risk: Consumer perception and purchase behaviour. *British Food Journal*, 103(3), 170–187

Yin, Robert. (1984/1994). *Case Study Research: Design and Methods*. Thousand Oaks, London, New Delhi: Sage

Yin, R. (2009). *Case study research: Design and methods*. Thousand Oaks, CA:SAGE

Zaridis, A., Vlachos, I., & Bourlakis, M. (2020) SMEs strategy and scale constraints impact on agri-food supply chain collaboration and firm performance, Production Planning & Control 1: 1-13

Zsidisin, G., Ellram, L., Carter, J., Cavinato, J. (2004). An analysis of supply risk assessment techniques. *International Journal of Physical Distribution and Logistics Management*, 34 (5), 397–413