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PAPER

Improving food supply chain resilience: a case study of chicken tikka masala

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Abstract

Food supply chain resilience can improve food security in the face of environmental disruptions such as climate change, extreme weather, and disease outbreaks. However, there are many definitions of resilience, and there is still a need to understand its components, barriers and enablers, in order to clarify how businesses and governmental regulators can maintain and enhance resilience. This study seeks to understand how resilience is perceived and operationalised by food chain actors. Resilience strategies in a specific supply chain are investigated, focusing on chicken tikka masala manufactured by a small and medium enterprise (SME). A theoretical framework, based on robustness, recovery, and reorientation, is presented and applied to analyse resilience strategies. The research employs an embedded case study approach comprising surveys, interviews, and a workshop with supply chain actors across three tiers. Thematic analysis reveals that actors prioritise robustness and recovery strategies. However, reorientation strategies, such as long-term adaptability and early warning systems, receive less focus due to perceived investment and capacity constraints, while visibility and collaboration are curtailed in SMEs with limited influence with larger actors. The study highlights key barriers such as fragmented information flows, limited government policy alignment, and challenges of digital technology adoption. Recommendations include the need for policy consultation frameworks that improve policymakers' understanding of food supply chains and actors' decision-making processes, and for a strategic vision for the food system that fosters resilience to long-term environmental change.

1. Introduction

Ensuring a safe, stable and sustainable supply of food is a critical objective of food supply chains to meet necessary quality thresholds (2016; Tendall *et al* 2015, Mu *et al* 2021). However, the resilience of food supply chains and thus their ability to deliver this objective is at risk from environmental disruptions such as extreme weather events and disease outbreaks (Azizsafaei *et al* 2021, Kovats and Brisley 2021). These are exacerbated by environmental disruption including an increasingly volatile climate (Kovats and Brisley 2021) and biodiversity loss (Mehrabi *et al* 2022), with clear evidence that climate change will have widespread impacts across the food supply chain (Tchonkouang *et al* 2024). Environmental disruptions have contributed to food shortages and food price inflation of 36% between January 2021 and April 2025 in the UK (House of Commons Environment Food and Rural Affairs Committee 2023, DEFRA 2025). Concerns surrounding food sustainability, safety and security have intensified (Stone and Rahimifard 2018, Kovats and Brisley 2021) and there is a growing consensus across food industry and academia that the UK food system is not prepared for shocks (Institute of Grocery Distribution 2024, Lang *et al* 2025).

Building resilience within supply chains is important to ensure longer-term sustainability (Stone and Rahimifard 2018). The UK Department for Environment, Food and Rural Affairs (DEFRA) has developed a National Adaptation Programme that aims to *'actively [coordinate] work across the food supply*

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chain to strengthen resilience planning which will help supply chains respond to climate and other emerging risks' (DEFRA, 2023). Given uncertainty in the natural environment, supply chain actors need to adopt strategies that not only mitigate disruptions but also enable recovery and adaptation to emerging challenges or to seize opportunities (Manning and Soon 2016). Resilience strategies can involve avoiding disruptions, accelerating recovery post-disruption, or reorienting long-term objectives, to achieve alternate outcomes in response to uncertainty (Zurek *et al* 2022). Although there is a body of literature that provides a conceptual understanding of resilience (e.g. Biggs *et al* 2015, Stone and Rahimifard 2018), there is low consensus on the most effective strategies for food supply chain resilience, and how they can be applied in practice (Stone and Rahimifard 2018, Gao *et al* 2021). Consequently, there is a gap in understanding the barriers to, and enablers for, resilience, and hence the role of policy and regulation in facilitating and enhancing resilience is unclear. Therefore, this study seeks to understand how resilience is perceived and operationalised by food chain actors, and to identify the main challenges and opportunities to enhance policy and research efforts to improve resilience.

Several research gaps have been identified in the literature. Firstly, much of the research on food system resilience focuses on analysing global food security related to agricultural production of key staple agricultural crops (Davis *et al* 2021). However, disruption can extend beyond primary production to impact logistics, post-production, processing and manufacturing, all of which play a major role in maintaining food availability (Garnett *et al* 2020). Disruptive impacts can cascade through the food supply chain, particularly where perishability of food relies on high levels of speed, integration and coordination in often brittle, lean supply chains with low profit margins and low resource stocks. These factors make them more vulnerable to instability (Garnett *et al* 2020, Kovats and Brisley 2021).

Secondly, there is a lack of practical guidance on interventions and strategies that can be adopted by food system actors to maintain and enhance supply chain resilience (Davis *et al* 2021, Rimhanen *et al* 2023). Yuan *et al* (2024) argue that a deeper understanding of supply chain resilience can be gained by integrating qualitative research insights from companies with theories of resilience strategies derived from literature. Béné *et al* (2023) and Zurek *et al* (2022) noted that measuring resilience is complex due to diverse factors influencing its development (e.g. places, timescales and relationships that shape how it develops). Hence, producing rigorous and reliable methods for measuring resilience has proved a challenge.

Thirdly, supply chain disruption may be more likely to impact food safety and continuity of supply in small- and medium-sized enterprises (SMEs) as they often lack the resources to maintain continuous food safety and quality (Food Standards Agency, & Camrosh 2023). Despite their important role in the food system, research on resilience in SMEs is limited (Polyviou *et al* 2020, Ali *et al* 2021). Moreover, resilience strategies can be different in SMEs compared with large food supply chain actors (Polyviou *et al* 2020), suggesting further research is needed to understand how resilience is practised within SMEs (Tukamuhabwa *et al* 2015).

Fourthly, there has been limited research involving multiple stages of the food supply chain (Seuring 2008). Supply chain actors' visibility across complex networks typically only extends to one tier above and below each individual actor, making it challenging to assess resilience strategies across the entire food supply chain network. Research involving multiple tiers can help build an understanding of the links between information flows, visibility and the strategies for resilience adopted by supply chain actors (Katsaliaki *et al* 2021),

This study addresses these research gaps through three objectives:

(1) To synthesise a theoretical framework for food supply chain resilience
(2) To apply and evaluate the framework in the context of a case study.
(3) To identify the barriers and enablers to resilience, providing insights for policy and research to enhance food supply chain resilience.

The next section of the paper outlines the methodology adopted to achieve the objectives. It describes a five-step process to: synthesise a theoretical framework for resilience in food supply chains; develop of research methods and instruments; gather data, and conduct thematic analysis. Then, the case is introduced, which includes an SME producing ready-prepared meals with a specific focus on the supply chain for chicken tikka masala. The theoretical framework is then applied to identify and explore actors' perceptions of supply chain resilience strategies, highlighting key challenges and priorities in the context of the case study. Finally, we outline opportunities for further research and policy development aimed at strengthening food chain resilience.

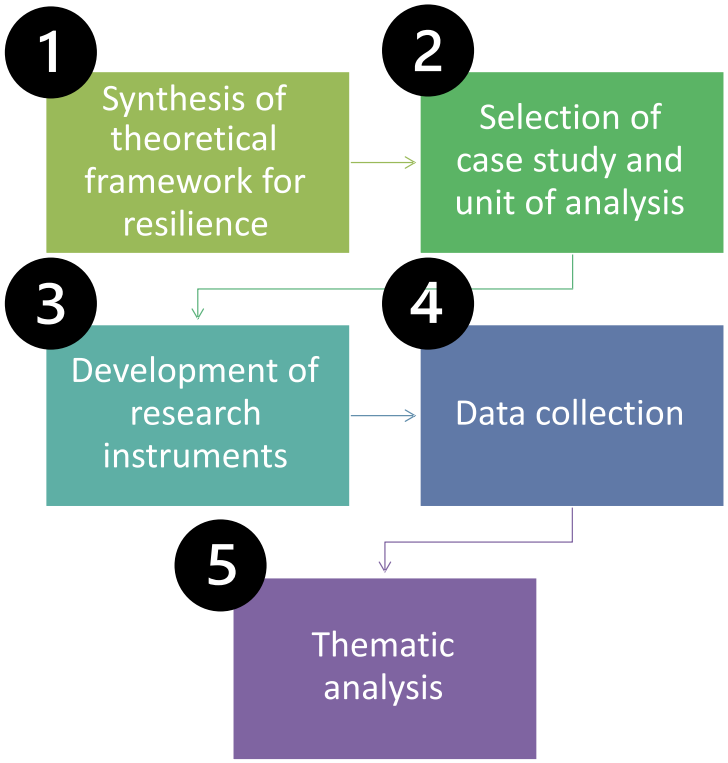

Figure 1. Overview of the research process (Michel-Villarreal 2023).

2. Methodology

2.1. Overall approach

The approach comprises the synthesis of a theoretical framework for food supply chain resilience; the application of the framework in the context of a case study to interpret how supply chain actors conceptualise resilience; the identification of barriers and enablers for resilience in supply chains, and an evaluation of the applicability of the framework in practice. The methodology incorporated a five-step process: (1) synthesis of the theoretical framework; (2) selection of the case study and unit of analysis; (3) design and development of the methodology and research instruments; (4) participant recruitment and data collection, and (5) thematic data analysis and evaluation of the framework (figure 1). Step (5) included data familiarisation and triangulation, use of initial findings to create stimulus materials for the supply chain stakeholder workshop, and iterative refinement of analytical themes in response to initial findings.

2.2. Concepts and characteristics of food supply chain resilience: a framework

Food supply chains are interconnected, complex networks involving multiple processes, organisations, resources, regulations, technologies, and feedback mechanisms across multiple functions of producing, processing, transporting and storing food. Supply chain resilience is of interest therefore to multiple actors across the chain. Food system resilience is commonly related to how a supply chain network responds to disruption (Helfgott 2018), or the capabilities and capacities of the system to support robustness, recovery and reorientation (Hasnain *et al* 2020). Resilience can entail both proactive and reactive action: proactive management to withstand, respond or change objectives ahead of the disruption, and the reactions to cope with or recover from disruption when it occurs. The disruptions can range from sudden onset events to continuous change (Tukamuhabwa *et al* 2015, Mu *et al* 2021, Bouchery *et al* 2024). Resilience to sudden-onset events has been termed operational resilience (e.g. of robustness to withstand a disruption), or recovery to a previous status quo (Manning and Soon 2016).

By contrast, strategic resilience can be used to describe longer-term adaptation to a constantly changing external environment, including incorporating opportunities presented as a result of external change (Manning and Soon 2016). Having adaptive capacity to identify, monitor and manage slowly changing variables, understand potential feedback loops in the external environment and to change in the long term requires re-ordering priorities, products or processes if required (Biggs *et al* 2015, Stone and

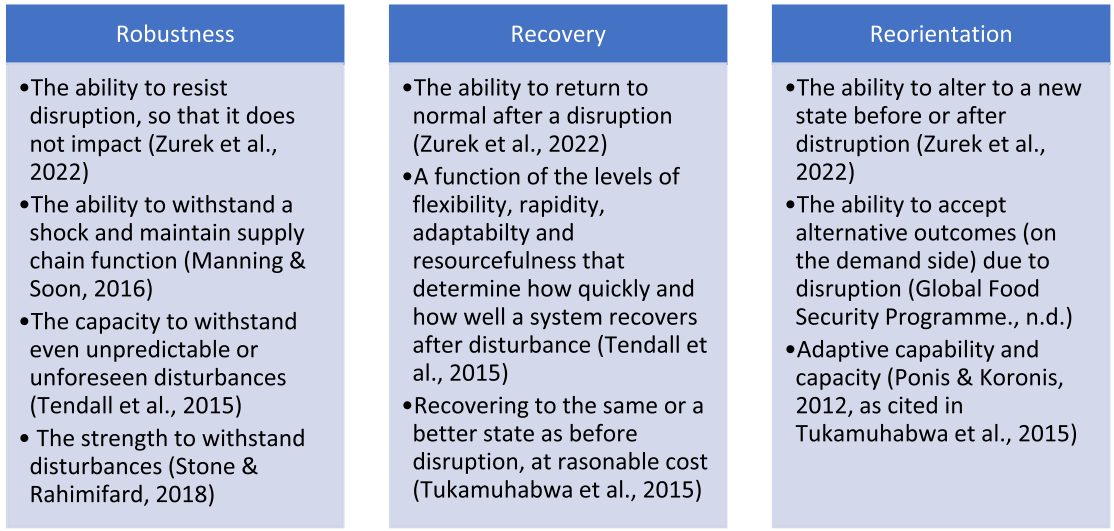

Figure 2. The roles of the three Rs of robustness, recovery, and reorientation in food system resilience (Zurek *et al* 2022).

Rahimifard 2018, Gao *et al* 2021). Individual supply chain actors may implement strategies for resilience, but these are based on differing priorities and perceptions of risk, disruption and the existing resilience of the operations they oversee (Wulandhari *et al* 2023) and therefore result in diverse outcomes. In the context of increasing environmental disruption, supply chain actors also need to work together to improve understanding of vulnerabilities, and the resources and capabilities above that can be used to improve or maintain resilience (Manning and Soon 2016).

2.2.1. Synthesising a theoretical framework for food supply chain resilience

Although much of the literature on resilience uses a wide range of terms, many of them can be grouped together. For instance, while Zurek *et al* (2022) and Tendall *et al* (2015) use the term 'robustness' to describe the ability of a supply chain to maintain functionality when disruption occurs, Stone and Rahimifard (2018) and Manning and Soon (2016) use 'withstand', while 'persistence' is selected by Wieland *et al* (2023). Despite such differences in the use of terms, resilience can be considered to encompass three distinct but overlapping domains—robustness, recovery and reorientation; the 'three R's' (Global Food Security 2018, Zurek *et al* 2022) (figure 2). Likewise, a number of distinct integrative frameworks for resilience have been developed in the literature with contrasting approaches, emphases and recommendations (see table 1).

The three Rs of robustness, recovery and reorientation presented in figure 2 can be combined with the nine resilience elements or practical strategies and activities reported by Stone and Rahimifard (2018) and elsewhere in supply chain resilience literature. The synthesis of these combines to formulate a theoretical framework that provides a practically applicable structure for analysing food supply chain resilience at the empirical level. While Zurek *et al* (2022) acknowledge that strategies may contribute to more than one of the three Rs, our framework builds on this conceptual foundation by making these overlaps explicit. Two of the diagnostic elements are intentionally positioned at the intersection of two Rs, and we show how long-term reorientation works through a feedback loop to support future robustness. This provides a novel and practical contribution, offering a more nuanced tool for analysing and operationalising resilience strategies in food supply chains. It links supply chain actors' strategies and activities to the literature on supply chain resilience by conceptualising their practice within the framework (see figure 3 and supplementary material table S.1).

2.2.2. Robustness

Robustness concerns the ability to withstand a shock and maintain functionality when disruption occurs, whether foreseen or unforeseen (Tendall *et al* 2015). Withstanding, rather than adapting in response to a disruption, implies taking preventive actions, so that the supply chain can operate 'as normal'; absorbing a disruption rather than requiring a response (Tendall *et al* 2015). An important element of robustness is the security of food supply chains to proactively maintain authenticity, and prevent fraud, theft, security breaches and food safety incidents (Mu *et al* 2021). It includes ensuring traceability; certification

Table 1. Comparison of key conceptual frameworks for supply chain resilience synthesised in the literature, alongside the conceptual framework synthesised and presented in this paper (Manning and Soon 2016, Stone and Rahimifard 2018, Katsaliaki *et al* 2021, Rimhanen *et al* 2023).

	Manning and Soon (2016)	Stone and Rahimifard (2018)	Katsaliaki *et al* (2021)	Rimhanen *et al* (2023)	Jones *et al* (2025)
Goal of resilience outlined in paper	Strategic capability of supply chain to function through disruption	Capacity to sustain core functions and adapt via strategies tailored to disruption phases	Management capability that enables supply chains to anticipate, adapt and respond promptly respond to unpredictable events	Capacity to improve the stability of food supply and prices in the face of disruptions	Capacity of supply chains to ensure safe, stable and sustainable food supply in the long-term
Thematic focus of paper: food	Food supply chain: general	Food system level: general	Supply chain: general	Food system level: specific country	Food supply chain: specific supply chain
Thematic focus of paper: disruptions	Examples across environmental, technological, legal (fraud and crime), marketing and pricing disruptions	Broad spectrum across climate, market/logistics, policy, social, technological	Broad spectrum across climate, market/logistics, demand, technical, policy, social, technological, and their propagation	Broad spectrum of overlapping, complex disruptions across climate, market, social, technological, geopolitical	Focus on environmental, referencing geopolitical, logistical, policy
Methodology	Narrative literature review and conceptual synthesis from business continuity and organizational resilience literature	Systematic literature review and synthesis into a diagnostic framework for practical application	Systematic literature review and thematic coding identifies resilience methods	Qualitative study based on semi-structured expert interviews; inductive content analysis	Mixed methods: literature review and synthesis into conceptual framework for practical application; qualitative study based on semi-structured expert interviews, expert survey and stakeholder workshop; thematic analysis
Resilience components	Five strategic resilience drivers identified at firm/supply chain level—values-based dynamics, supply chain structure, decision-making, leadership, performance metrics Four resilience categories: Efficiency, flexibility, responsiveness, product quality	40 overlapping resilience elements categorised into 10 'core' and other 'supporting'. Splits resilience elements into intra-organisational (flexibility, risk aware culture, redundancy, early warning systems, security) and inter-organisational (collaboration, flexibility, agility, visibility, adaptability, redundancy)	Three-stage response in supply chains: identify scale of disruption, design and deliver recovery package focusing on resistance and recovery. Identifies redundancy, flexibility, coordination, collaboration—achieved with support from modelling, digitalisation and contingency planning	Four core elements: system thinking; redundancy of activities and networks, diversity of production and partners, and buffering strategies	Nine components across three overlapping domains of robustness, recovery and reorientation (the 'three Rs'): security, redundancy, flexibility, collaboration, agility, visibility, risk-aware culture, adaptability, early warning

(Continued.)

Table 1. (Continued.)

Stakeholder engagement	None—framework derived from literature	None—framework derived from literature	None—concepts derived from literature	Nine expert participants across food system	10 expert participants across three supply chain tiers
Empirical validation	Conceptual—no empirical validation	Conceptual—no empirical validation	Conceptual—no empirical validation	Qualitative validation	Qualitative validation
Policy and practice levers	None specified	General practice measures encompassing the 10 core resilience elements	Recommends best practice levers for supply chain design; outlines future research agenda	Specific policy measures: domestic production of protein crops, strengthen power network, workforce measures to support seasonal work	Recommendations for policy and future research

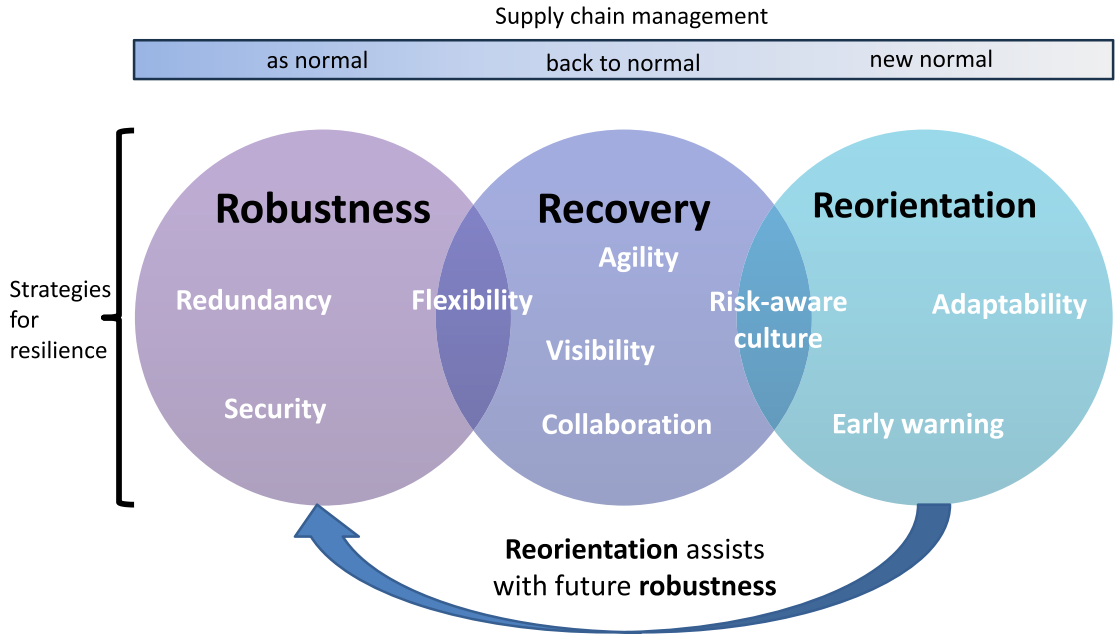

Figure 3. A theoretical framework for operationalising food supply chain resilience showing how nine resilience elements (Stone and Rahimifard 2018) contribute towards the three Rs of resilience. Terms in white show an indicative positioning within the framework.

and regulations to promote standardisation; and the management of areas of risk such as cybersecurity (Stone and Rahimifard 2018).

A second element associated with robustness is redundancy, identified by Stone and Rahimifard (2018) as the maintenance of buffer capacity and contingency planning. This involves having back-ups in supplies, storage and pathways between supply chain nodes; access to savings or capital (FAO 2023); and designing the supply chain so that transport, suppliers, storage and supplies themselves can be interchangeable (Rimhanen *et al* 2023). These strategies are put in place proactively and used in reaction to a disruption to avoid its negative impacts (Tukamuhabwa *et al* 2015).

2.2.3. Recovery

Recovery concerns the ability of food supply chains to recover in response to a disruption (Zurek *et al* 2022). Recovery is concerned with mitigating disruption to get 'back to normal' as quickly and efficiently as possible. It is a function of aspects of supply chain management including flexibility, rapidity, adaptability and resourcefulness (Tendall *et al* 2015); strategies that may be adopted reactively or proactively (Tukamuhabwa *et al* 2015).

Flexibility includes flexible labour arrangements, a variety of products and customers, or flexibility in order fulfilment to react to changes in downstream demand (Tukamuhabwa *et al* 2015). On the upstream side, having a diversity of inputs, suppliers and production systems contributes to flexibility by reducing the likelihood that a disruption will severely impact the supply chain (FAO 2023). Stone and Rahimifard (2018) identified flexibility as a proactive strategy that can be in place in readiness for disruption, implemented if needed in response to disruption (Tukamuhabwa *et al* 2015). Hence it can be seen as part of both robustness and recovery.

Visibility enables actors to see products, processes and structures across the whole supply chain (Tukamuhabwa *et al* 2015), and can aid recovery by enhancing decision-makers' knowledge before or during a disruption (Stone and Rahimifard 2018). It includes supply chain mapping and information sharing between actors. It can also be aided by information technology infrastructure such as shared inventory management systems that can send early disruption signals so that adaptations can be made (Katsaliaki *et al* 2021). Increasingly, technologies such as blockchain, artificial intelligence and the internet of things are seen as contributing to visibility as a strategy for responding to disruption (Gao *et al* 2021).

Whilst collaboration across supply chains can help mitigate disruptions before they occur, it is also a significant strategy to recover (Katsaliaki *et al* 2021). It typically goes further than information-sharing and visibility to foster sharing of risks, goals, and resources amongst supply chain actors (Tukamuhabwa *et al* 2015, FAO 2023). Effective collaboration relies on trust and investment in relationship building

to create a cohesive working culture. This may be easier to achieve in SMEs than some other resilience strategies (Stone and Rahimifard 2018, Polyviou *et al* 2020). Collaboration also reflects the dynamics of purchasing power and influence between supply chain nodes, that, along with strong relationships, lead to prioritising of some customers or suppliers during a disruption (Stone and Rahimifard 2018).

Agility concerns the speed and ease with which supply chain actors can respond when disruption occurs, and is related to flexibility (Do *et al* 2021). Activities including contingency planning and the adoption of agile business models are anticipated to grow in importance as the supply chain faces more uncertainty and 'unknown unknowns'; characterised by their novelty and hence a lack of understanding about their risk (Gao *et al* 2021).

2.2.4. Reorientation

Reorientation concerns the capacity for supply chains to adapt and change in the long-term (Ponis and Koronis 2012, as cited in Tukamuhabwa *et al* 2015), with the aim of orientating to a new model or state either before or as a result of disruption (Zurek *et al* 2022)—in other words, a 'new normal'. Accepting an alternative outcome may imply a compromise or taking advantage of an opportunity that results in improved quality, sustainability, profitability and/or food safety (Zurek *et al* 2022). Some authors (e.g. Béné *et al* 2023, Wieland *et al* 2023) refer to this process as transformation, referring to systems-level changes that result in, or from, behavioural or regulatory shifts. Hence Mu *et al* (2021) proposed that with increasing threats to food safety, supply chains that embed strategies for reorientation are more practical than those that focus purely on robustness. Strategies for reorientation can include feedback loops to reduce exposure to future risks and therefore to enhance future robustness and 'as normal' operations. They create new competitive advantage from enhanced resilience and through exploiting opportunities emerging as the external environment changes (Tukamuhabwa *et al* 2015).

A risk-aware culture can contribute to both recovery and reorientation, going further than risk management by fostering learning from the experiences of disruptions, and encouraging adaptation to mitigate future ones (Stone and Rahimifard 2018). It is influenced by individuals', teams' and actors' risk perception, self-efficacy and experience of disruption (Béné *et al* 2023) as it involves synthesising of intelligence and fresh decision-making.

Adaptability concerns the supply chain's ability to make ongoing or transformative changes as the external environment shifts, resonating with the concept—proposed by Biggs *et al* (2015)—of the management of slow variables and feedback for resilience. Transformative adaptability is seen as central to supply chain resilience as a long-term response to external change, also reducing future exposure to risks by anticipating them (Wieland *et al* 2023). It has similarities with risk-aware culture in that it requires structures for learning from past experiences (Stone and Rahimifard 2018). As previously described in relation to visibility, technologies such as blockchain and cloud computing can also enhance adaptability and anticipation but adopting them requires investment and changes in the capabilities of companies (Gao *et al* 2021). Adopting new technologies is thus part of long-term adaptability required to embed them in management processes, contributing to future robustness and ability to recover from shocks, via a feedback loop.

Early warning refers to the embedding of techniques such as foresight and analysis of plausible future scenarios to identify potential vulnerabilities in the supply chain, to generate forewarning of possible disruption and assist actors to focus more on preparing for disruption (Stone and Rahimifard 2018). This includes a focus on considering the possible impacts of unforeseen disruptions and incorporating the new knowledge gained from previous experience of them (Tendall *et al* 2015). It involves contingency planning and monitoring some variables both inside and outside the supply chain (FAO 2023), with intelligence gathering that can be aided using new technologies for collaboration and visibility (Stone and Rahimifard 2018, Katsaliaki *et al* 2021).

The above synthesis indicates consistencies and synergies between the domains of resilience—robustness, recovery, and re-orientation—and the nine resilience elements identified by Stone and Rahimifard (2018). Consequently, this framework is used to guide a case study examining resilience within a specific supply chain.

2.3. Case study approach and design

The theoretical framework in figure 3 was used to analyse the resilience of a specific case study, focused on the supply of chicken tikka masala to the UK. Chicken tikka masala is a widely consumed prepared meal in the UK that is available in most supermarkets and popular in restaurants (Lawson 2023). The unit of analysis was the chicken tikka masala supply chain with the subunit being individual actors involved in the supply chain (see figure 4).

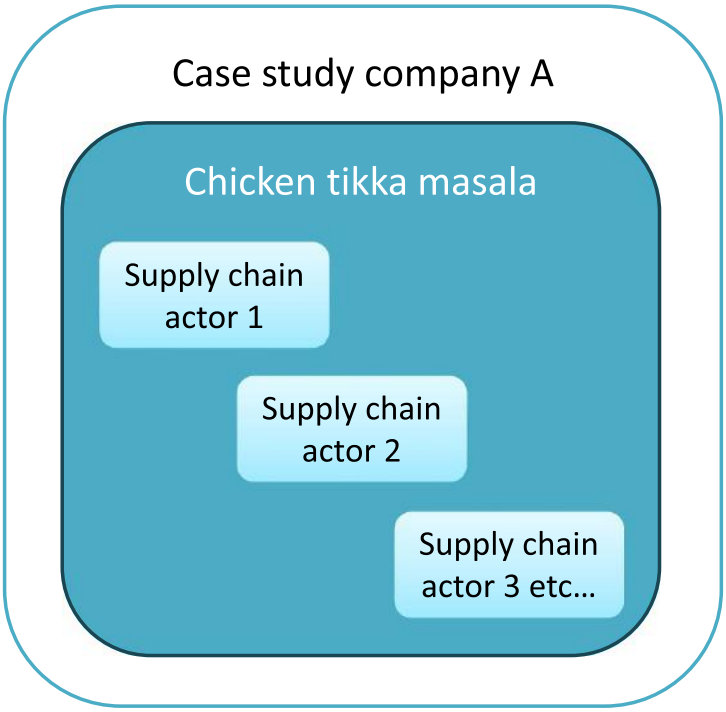

Figure 4. Single embedded case study design (Yin 2009).

The study involved a UK-based SME (company A), which had an annual turnover of £15–20 million in 2023 and was wholly owned by a large UK-based food supplier and distributor (company B) with an annual turnover of about £2 billion in 2023 (Companies House n.d.). This is a representative case (Flick 2023, p 16) as SMEs account for nearly 99% of businesses in the UK food and drink sector (DEFRA, 2024).

Case studies are widely used in research related to supply chains (e.g. Tukamuhabwa *et al* 2015). For example, Scheibe and Blackhurst (2018) used a qualitative, grounded theory case study to examine the factors contributing to disruption propagating in supply chains, while Polyviou *et al* (2020) used semi-structured interviews within a case study to explore companies' resilience capabilities.

The case study method is often selected for exploratory research (Seuring 2008), generating rich insights into complex social phenomena (Eisenhardt 1989, Yin 2009). In this study, it enables the examination of how resilience is operationalised both within and between companies with differing roles in the supply chain, highlighting the different expertise and priorities, with data gathered across multiple supply chain tiers (Seuring 2008). Given these considerations, making direct comparisons between individual companies as discrete cases was not appropriate for this study; rather, an embedded approach was adopted, recognising multiple, heterogenous subunits existed within a single case (Yin 2009).

To mitigate a key limitation of the embedded case study design, a multiple-methods approach—survey, interview and workshop—was employed to overcome the tendency to only focus on the subunits at the expense of the case overall (Yin 2009).

2.3.1. Data collection and analysis approach

The research approach, encompassing development of research instruments, data collection and analysis, is outlined in figure 5. Research instruments consisted of an online survey to gather both quantitative and qualitative data, semi-structured interviews, and a workshop (see supplementary material table S.2, figure S.1 and table S.3). To draw out rich and in-depth data, Eisenhardt (1989) indicates using a combination of data collection methods to facilitate triangulation, where the aim of triangulation is to mitigate the limitations of relying on a single data source, and strengthen the validity of the findings (Creswell and Poth 2018). Sadeghi Moghadam *et al* (2021) also recommend the use of multiple methods in operations management case studies. This also widens engagement by offering participants more feasible options to engage, given time constraints and personal preferences.

Survey and interview questions were structured around domain-specific probe questions (Hoffman *et al* 1995) addressing key themes, including environmental disruptions to the supply chain, resilience,

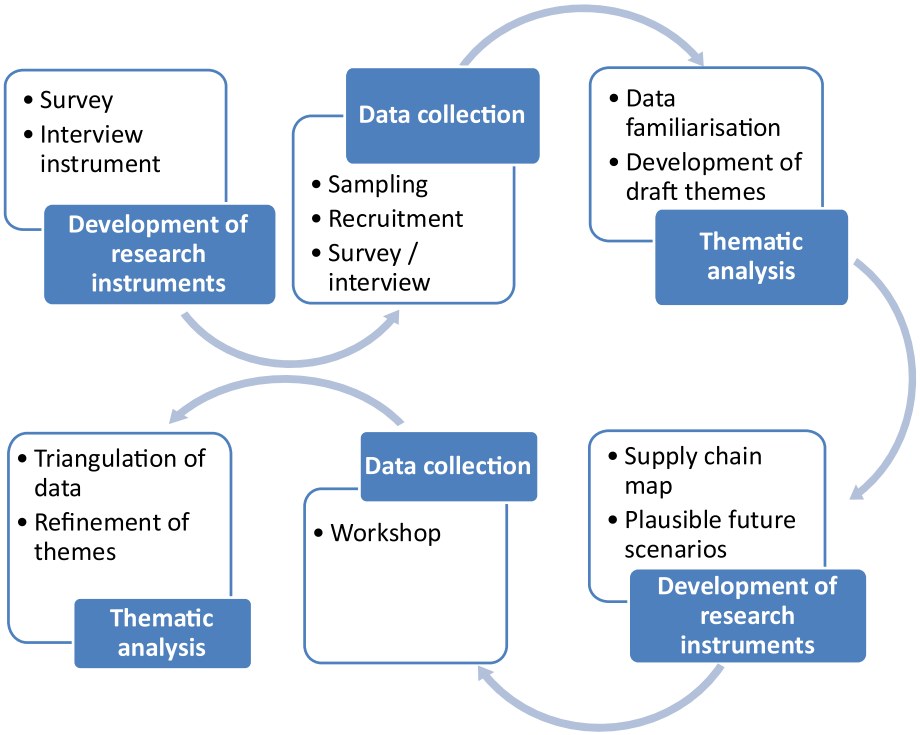

Figure 5. Research approach outline (thematic analysis process after Braun and Clarke (2006), as cited in Michel-Villarreal 2023).

barriers and enablers (e.g. information flows and technology), and the role of government in supply chain resilience (see supplementary material table S.2 and figure S.1). A supply chain map (see section 2.2.3, *data collection methods*) and a set of plausible future scenarios (see supplementary material table S.3) were created as boundary objects (Caccamo *et al* 2023), developed during the early stages of research with the objective of stimulating discussion in the workshop.

2.3.2. Sampling

A purposive sampling approach was adopted to gather in-depth insights across key nodes of the chicken tikka masala supply chain. The aim of purposive sampling is to gather a rich set of in-depth data from a diverse set of experts sampled according to their professional experience with experience of the phenomenon being studied, rather than to provide statistical representation (Creswell and Poth 2018, Knott *et al* 2022). The sampling approach targeted individuals who met a key criterion of having responsibilities in supply chain management and/or functions related to it (e.g. procurement, sales and marketing) in companies that are suppliers of components of, or customers of, the chicken tikka masala produced by Company A. This included Company B. Initially, 15 tier one suppliers were identified using the bill of materials from Company A and invited to participate. This constituted all tier-one suppliers, including non-food component suppliers to ensure maximum variation in responses, as suggested by Creswell and Poth (2018). A snowball recruitment technique (Bryman 2012, Flick 2023) encouraged participants to recommend other relevant suppliers or customers to take part in the study. The resultant sample comprised of nine tier-one and one tier-two actors with one actor fulfilling both tier-one and tier-two roles (table 2). One participant submitted responses via email, which was aggregated with the wider data set, and one participant commenced survey participation but did not complete it.

To maintain anonymity, participants were assigned a random participant number and invited to self-assign a functional one- or two-word 'tag' from a pre-defined list that best represented their supply chain role. These were: distributor, supplier, transporter, exporter, procurer, retailer, wholesaler, manufacturer, importer, processor, producer.

Data was collected from supply chain actors across multiple functions, supplying chicken; frozen vegetables; dried or tinned vegetables/spices/condiments; other dried or tinned ingredients; packaging or non-food products; and finished chicken tikka masala. However, seven of the sampled tier 1 suppliers did not participate. This resulted in the potential for bias in our findings, which we mitigated in part by triangulating multiple data sources, reducing reliance on any single method (see section 6, *Limitations*).

Table 2. Research participation across survey, interview and workshop, by supply chain actor (from most recent submitted accounts on Companies House n.d., where disclosed).

#	Organisational tag	Supply chain tier	Organisation annual turnover/revenue (2022 or 2023)	Survey participation	Interview participation	Workshop participation
1	Distributor (manufacturer) importer	1	Turnover £180 m	Yes	Yes	No
2	Supplier transporter	1	Revenue £2.1 bn	Yes	Yes	Yes
3	Supplier	1	Turnover £558 m	No	Yes	No
4	Supplier distributor	1	Turnover £2.1 m	No	Yes	Yes
5	Supplier[a]	1	Turnover £52.3 m	No	Yes[a]	No
6	Importer	1	Microbusiness	Yes	Yes	Yes
7	Supplier manufacturer importer	1/2	Turnover £53.3 m	Yes	No	No
8	Importer distributor (supplier importer on survey)	1	Revenue £17.5 m	Yes	Yes	No
9	Supplier importer	1	Small business	Yes	Yes	No
10	Procurer retailer	2	Revenue £167 m	Yes[b]	No	No

[a] limited questions answered by email; analysed alongside interview responses.

[b] not complete.

2.3.3. Data collection methods

Semi-structured interviews were conducted online using Microsoft Teams with in-built transcription software (Bryman 2012, Flick 2023). In addition, a Qualtrics online survey was used to complement the interviews and to securely gather qualitative and quantitative data (Bryman 2012) (see supplementary material figure S.1). An embedded design approach was applied to survey data, where the quantitative data played a supplemental role to qualitative data, given the small sample size (Creswell and Clark 2007, pp 67–9). The survey and interview questions overlapped, enabling participants to contribute meaningfully even if they engaged in only one method (e.g. interview not survey).

An online workshop, facilitated by the authors (KJ and PJB) and supported by independent facilitators, was completed with representatives from company A and B. A workshop was selected to stimulate discussion on supply chain vulnerabilities, making comparison between the status quo and possible future developments, as suggested by Storvang *et al* (2018). The workshop was conducted under Chatham House rules, recorded and transcribed. Preparatory materials included a draft chicken tikka masala supply chain map (on which figure 6 is based) and a set of plausible future scenarios (see supplementary material table S.3), developed from survey and interview data. These boundary objects supported knowledge integration, enhanced supply chain visibility, and facilitated discussion leading to co-creation (Caccamo *et al* 2023). Plausible future scenarios were produced prior to the workshop, using elements of the Intuitive Logic method (Wright *et al* 2013). This involved incorporating qualitative data gathered through survey responses and interviews to construct narratives describing possible future disruptions that could impact the supply chain (Bradfield *et al* 2005). Scenarios were analysed in small groups to elucidate potential vulnerabilities and impacts and to explore perceptions of resilience strategies.

2.3.4. Analytical framework

Analysis focused on understanding participants' reported actions, capabilities, experiences and perceptions of supply chain resilience. To achieve this, we used a thematic analysis approach (Knott *et al* 2022) to explore the data and build an understanding of participants' perceptions of and capabilities concerning the resilience of their supply chain (Cassell *et al* 2018). Initially, data was cleaned to ensure quality control of transcriptions, and a list of key thematic ideas was derived from the resilience framework. Data anonymisation using participant number and organisational tag also involved removing any references to specific products, companies and locations. This was followed by data familiarisation, as suggested by Gibbs (2018). A coding framework was developed and applied to systematically identify meaningful segments of data representing key patterns and themes in the data and assigning descriptive labels

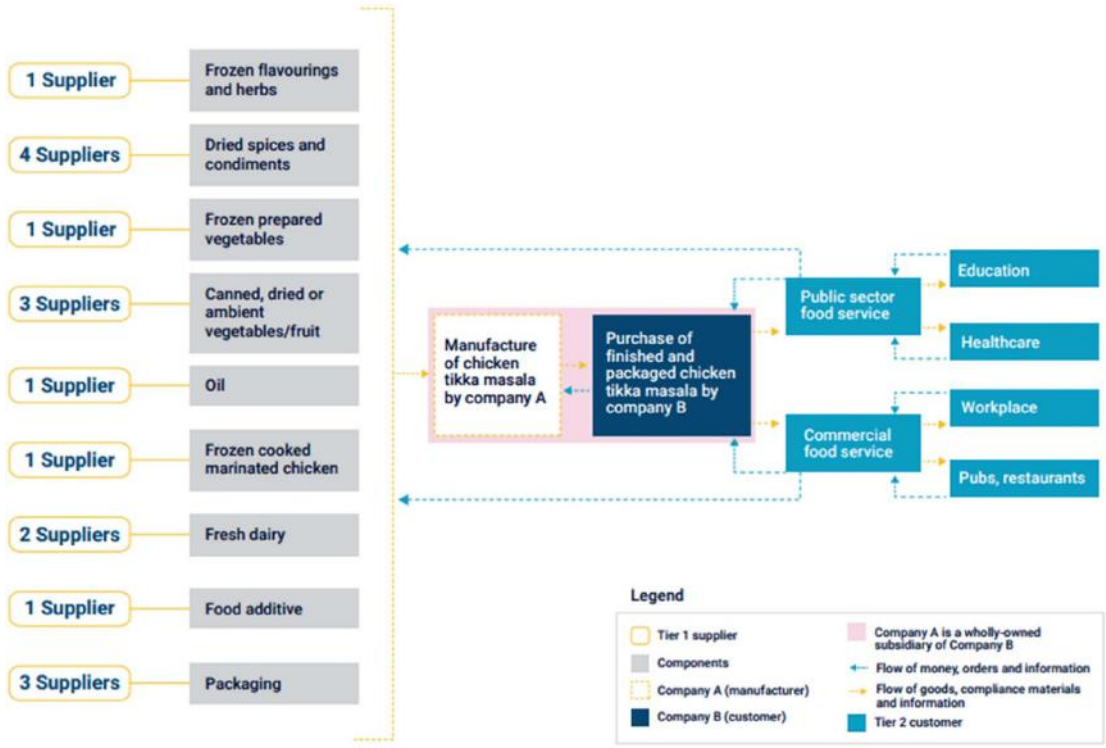

Figure 6. Chicken tikka masala supply chain map showing 17 identified upstream suppliers (two tier 1 participants supplied components in more than one category). Graphic design: By the Meadow Ltd.

Table 3. Initial and final themes and codes for thematic analysis across surveys, interviews and workshop.

Initial themes	Initial codes	Final themes	Final codes
Sourcing	• Strategy • Supply chain management decision drivers	Supply chain management	• Locations • Sourcing • Role • Strategy • Decision-making
Resilience	• Disruption avoidance strategy • Perception of supply chain resilience	Resilience perceptions and strategy	• Robustness • Recovery • Reorientation
Enablers	• Information flows • Government, regulation and policy • Technology	Barriers and enablers	• Information flows in and between organisations • Government, regulation and policy • Technology

to them (Cassell *et al* 2018). As coding progressed, the initial coding framework was iteratively refined and expanded, producing overarching categories, which were subsequently interpreted in relation to their broader implications (table 3 and supplementary material table S.5). The theoretical framework was used as the basis for categorising and analysing research participants' responses concerning their experiences and perceptions of supply chain resilience.

3. Results and discussion

3.1. The context: case study company A

Company A is a food manufacturing company specialising in the production of ready meals and specialist prepared food products for the care sector. Ingredients and components for chicken tikka masala are sourced from 15 suppliers based in the UK and arrived prepared (e.g. cooked, frozen, chopped, dried or pureed), ready to incorporate into the manufactured product. Ingredients are stored in a deep freezer,

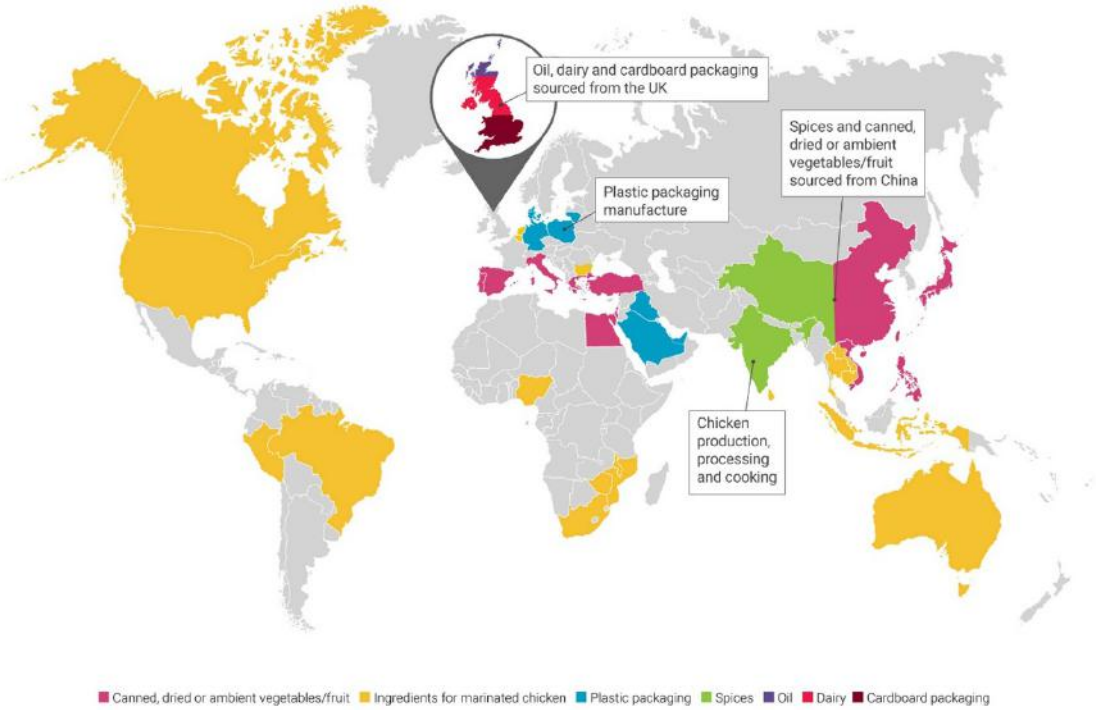

Figure 7. Map showing global production and processing locations for components in chicken tikka masala. Graphic design: By the Meadow Ltd.

refrigerated or kept at ambient temperatures in a warehouse onsite, and then combined and cooked in the onsite factory. They are then packaged into either large plastic bags or into single portion ready meal trays with plastic lids, packaged into boxes and rapidly frozen to −18 °C, then transported to company B and other customers. Over 20 ingredients in the final product, along with packaging materials, can be traced to production and/or processing in at least 36 countries (figure 7 and supplementary material table S.4).

Company B sources frozen chicken tikka masala from company A, to which it also supplies some ingredients. Company B owns physical infrastructure and its own transport network, supplying into food service customers in the private sector (restaurants, pubs, and quick service outlets) and public sector (including schools and hospitals).

During the study, companies A and B highlighted several challenges in the supply chain. These included shifts in demand and supplies during COVID lockdowns between 2020 and 2021 (Ali *et al* 2021), which resulted in Company B increasing its stock holding for redundancy. This was associated with increases in storage costs and waste where quality or safety of products decreased over time. Both companies also identified a shortage in vegetable supply between growing seasons. Delays to deliveries of spices and condiments had led to stoppages, and there was a perception that disruption to spice supply chains could increase in future. Price increases of supplies were also an issue and some increases were passed to customers. The private sector absorbed these increases because of their continued commitment to source a high-quality product, while customers in the public sector food service had few alternative sourcing options, and competitor prices were also rising. This meant that adaptation to mitigate inflation was not a seen as a priority strategy at that time.

Company A had recently changed strategy from an emphasis on make-to-order, to make-to-stock, providing menus to customers showing available options. This represented increased flexibility to fulfil demand, meaning that any shortages in supply did not result in an inability to fulfil orders. It also had adaptability built into the operating model, showing a growing emphasis on strategies for reorientation. Company A had also focused on recovery through supply chain visibility and collaboration, by digitalising its inventory supplier management system to improve communication with suppliers.

3.2. Supply chain management

3.2.1. Role

Three interview participants mentioned resizing as a key component of the processing business: sourcing in bulk via containerised shipping or tanker lorry, before palletising, cutting or repacking components

and selling to company A. This reflected company A's needs '*because they can offer lower volume*' (workshop participant, company A). The importer/distributor commented:

> '*Most of these manufacturers have typical lead times of 8-12 weeks - they campaign make* [manufacture a series of batches over a defined timescale] *in very large quantities. …. So, we sit in the middle ground.*'

This influenced the arrangement of the supply chain, with midstream companies adding value by focusing on customer service and supply chain knowledge. Grabs *et al* (2024) found that these actors are also critical information holders across the supply chain network, which may aid or hinder resilience depending on the extent to which actors within supply chains seek or are required to share information.

3.2.2. Location and sourcing

While all tier 1 actors were UK-based, components were sourced globally (see figure 7). This indicated supply chain complexity with long-distance logistics systems, which can increase risk and propagation of disruption through the supply chain (Gao *et al* 2021).

All participants who completed the survey (six), agreed with the statement *environmental disruptions are having an increased impact on supply chain operations*, potentially indicating a need for enhanced resilience. Five survey participants agreed with the statement *disruptions to my supply chain start with my suppliers*. In interview, the supplier importer said:

> '*Recent years have seen unseasonal rains in growing regions which have led to an increase in pest activity and heavy pesticide usage by farmers just before harvest. Sourcing pesticide-compliant material has been challenging as a result*'.

This pattern of disruption impact is supported by Marcucci *et al* (2024) who found that disruptions cascade downstream through the supply chain through a ripple effect.

The distributor importer pointed to the possibility that disruption can necessitate long-term sourcing changes:

> '*Historically, we were sourcing from Greece. They've been hit, the level of [harvest] coming into their factory has reduced due to flooding, from fires, from natural disasters. Their businesses decided [to change focus]*'.

However, in general, survey participants' confidence in the stability of their upstream suppliers' ability to consistently provide what was required, was higher than their confidence in stability of downstream demand. As actors fulfilling roles within the parts of the supply chain network between production and final purchase by consumers, research participants expressed views related to their experience of delivering for customers as well as around sourcing from suppliers. Results showed that participants perceived that if demand stability reduced amongst their customers, this would be hard to manage, and half of respondents indicated they sometimes struggled to keep up with orders. For example, asked if seasonal demand shifts were manageable, the supplier transporter said, '*To a level. We always get caught out*'. This dichotomy in confidence levels upstream and downstream may be a result of experiences of the recent COVID-19 pandemic as a demand shock; this is supported in the literature by King *et al* (2021) and Rivington *et al* (2020). Moreover, disruption itself increases demand for food (Ali *et al* 2021) which compounds demand instability. It also indicates the possibility that while disruptions are more likely to start with suppliers, supply chain actors' management strategies result in higher resilience to them than demand shocks.

3.2.3. Strategy and decision-making

Six of seven survey respondents noted Company A represented a small proportion of their business. This has implications for collaboration and information sharing for visibility, resulting from a power asymmetry in the supply chain identified by Company A because of its lack of buying power. For instance, during digitalisation of the inventory supplier management system, some suppliers had not provided the required information to continue supplying Company A. The prospect of no longer supplying Company A was not a sufficient incentive to prompt some suppliers to devote time and capacity to provide updated information. This meant that to continue to source the supplies required, Company A had to manually add information on suppliers' behalf. The implication was, '*suppliers—they are not losing our business*' (workshop participant, company A). This provides evidence that suppliers did not lose Company A as a customer even where there were failures in information sharing and collaboration. The literature is unable to explain this fully. Theories of supply chain governance proposed by Gereffi and

Fernandez-Stark (2016) and Kaplinsky and Morris (2000) assert that power asymmetry is central to supply chain governance but locate imbalances of power as favouring lead firms operating at or near the end use of the product rather than their suppliers. Wieland *et al* (2023) note that current supply chain resilience literature is unable to fully explain the reasons behind a lack of supplier compliance and that those reasons often go beyond economic considerations.

Interview participants spoke about meeting customers' needs as fundamental for their business strategy, prioritising reputation and reliability over cost. This is not widely discussed in food supply chain resilience literature, with business priorities characterised as running counter to resilience rather than part of it (Manning and Soon 2016). Additionally, the literature identifies the need to consider the synergies, trade-offs and costs of resilience strategies (Tukamuhabwa *et al* 2015). Prioritising meeting customers' needs, reputation and reliability over cost in supply chain management implies that the perceptions of supply chain actors align continuity with resilience. In other words, their strategy is underpinned by a need to operate 'as normal' during disruption; that, is, robustness. However, this perception risks ignoring that enhancing robustness is partly an outcome of the need to invest in learning from disruptions, adapting to the external environment and monitoring for change; that is, reorientation.

Survey participants' perceptions of the potential impact of future disruptions on operations showed that they draw on their experiences of past (known) disruptions. Disruptive weather events (e.g. flood, storm, heatwave) and disease in humans (e.g. COVID) were perceived as having highest potential impact. This was supported in interview:

> '*[Flooding's] been more of an issue than drought. Hot summers can be quite difficult for us from an internal perspective. From a supplier perspective, excess rain is probably more difficult.*' (distributor importer)

Conversely, potential novel or unknown disruptions—or at least not yet experienced—did not feature in responses across survey and interview. This may point to a supply chain management strategy that invests resources in planning for those disruptions or risks that are considered worth investment; that is, the better understood risks associated with known potential disruptions.

The supplier transporter explained that if costs rose due to disruption, this would likely lead to prices rising across the market rather than an individual supply chain.

> '*There are very few events meaning that we can't get the products that we want, and if we can't, neither [can] our competitors. All have the same product, the same issues*'.

This further supports the finding that the priorities for food supply chain actors are driven by the need to ensure continuity of supply and remaining competitive on cost. By implication, continuity was seen as more important than affordability or availability in and of itself. The importer noted '*you are only as good as your last delivery*'. This underpinned the redundancy and flexibility built into the supply chain and establishes a link between resilience, reputation and stability of food supply that may discourage consideration of strategies for reorientation. These contributions point to the opportunities and limits in the role that food supply chain actors can play in enhancing resilience for food security overall. Where the key driver is to maintain continuity of supply and reputation, supply chain resilience can be maintained by actors' interests. However, there may be a need for intervention by policymakers if food security is undermined by the decreasing availability and affordability of food (King *et al* 2021, Durand and Allegretti, n.d.). Policy intervention may also be needed if there is a desire to alter the outcomes of aspects of the food system, for instance driven by health or sustainability considerations, where supply chain actors' priorities are continuity of the status quo. Supply chain actors' strategies for resilience are presented and discussed below.

3.3. Resilience strategies

Interview participants mentioned a variety of approaches to improve resilience (table 4). Overall, these focused more on recovery and robustness than on reorientation, a result also observed by Katsaliaki *et al* (2021) and Stone and Rahimifard (2018). For two suppliers, robustness was the sole focus of resilience. In the survey, participants were asked about their perception of supply chain resilience by putting mark on a Venn diagram comprising robustness, recovery, and reorientation. Overall, the participants placed a higher emphasis on robustness than recovery and reorientation (figure 8). For example, the supplier transporter commented '*I thought [resilience] was going to be smack bang in the middle. I do not think it is. I think it is understanding what you would do in the event of an issue. Understanding where you'd likely get issues and doing something about it now so you are resilient through an issue.*' Participants' perceptions of what they consider resilience to be, did not necessarily reflect the strategies implemented in the supply chain they oversaw through their work. Table 4 shows elements of recovery were mentioned more as

Table 4. Elements for supply chain resilience mentioned by research participants when asked about what their organisation does to maintain and enhance resilience, in interview (I) and survey (S) responses.

	Robustness				*Recovery*										*Reorientation*			
Elements	Redundancy		Security		Flexibility		Visibility		Collaboration		Agility		Risk-aware culture		Adaptability		Early warning	
Participant no.	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I	S	I
1	✓	✓	✓	✓	—	✓	✓	✓	✓	✓	—	✓	✓	✓	✓		—	✓
2	✓	✓	✓	✓	—	✓	✓	✓	✓		—	✓	✓	✓			—	
3	O	✓	o		—	✓	o		o		—		o		o		—	✓
4	O	✓	o		—		o	✓	o	✓	—		o		o	✓	—	
5	O		o		—		o	✓	o	✓	—		o		o		—	
6		✓		✓	—	✓	✓		✓	✓	—	✓			✓		—	
7	✓	o		o	—	o		o	✓	o	—	o	✓	o		o	—	o
8	✓	✓			—	✓	✓	✓	✓	✓	—	✓		✓	✓	✓	—	
9		✓	✓	✓	—	✓	✓	✓	✓	✓	—		✓	✓		✓	—	✓
10	O	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Total	11/14		7/14		6/8		11/14		12/14		4/8		8/14		6/14		3/8	
Proportion (%)	79		50		75		79		86		50		57		43		38	

✓: mention; -: Not applicable; o: No participation.

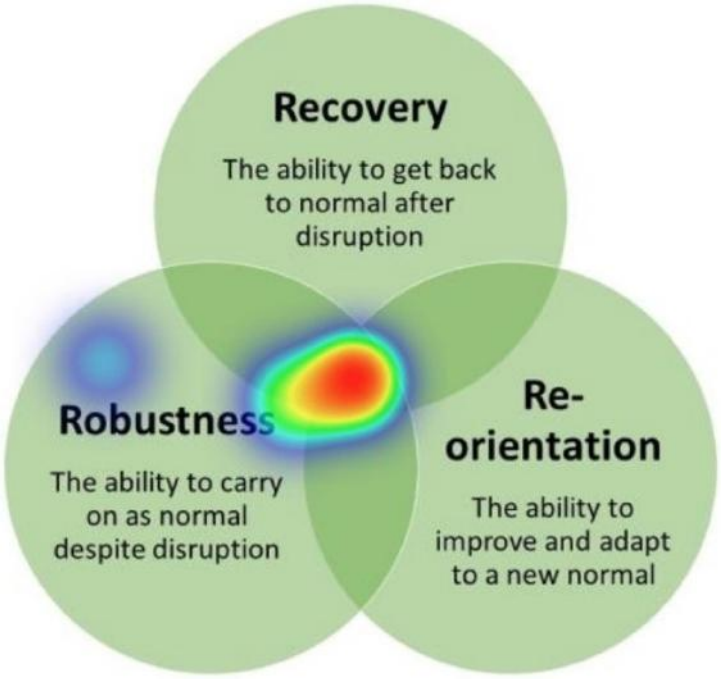

Figure 8. Survey responses to 'Where would you put a mark on this diagram? Resilience in food supply chains is about…' The heat map figure is a representation of data collected from the survey question. The coordinates participants selected are overlaid as colours to indicate the frequency of responses. The redder the area, the more respondents chose that position (Qualtrics 2023).

part of strategies for resilience than other aspects. This contrasted with participants' slight preference for robustness when considering what resilience meant to them.

3.3.1. Robustness

Only one survey respondent agreed with the statement '*my organisation's supply chain operations have not been negatively impacted by disruptions in the environment*', indicating that for the others environmental change could be a driver to enhance robustness. Survey participants' strategies included buffer or bulk stock and back-up suppliers (Food Standards Agency 2024). Five survey respondents mentioned stock-holding tactics of 2–26 weeks and four interview participants talked about extra, buffer or bulk stock.

3.3.1.1. Redundancy

Across interviews and surveys, 11 of 14 eligible responses (79%) across survey and interview included the incorporation of redundancy in supply chain management for resilience, higher than six of the other elements. The incorporation of redundancy in the supply chain was considered to increase confidence in its resilience. Six interview participants mentioned having multiple or back-up suppliers. The distributor linked this to risk reduction:

> '*[It's] a strategy to obviously minimise risk … We've probably got three suppliers … the advantage we have is if there's a disaster in [sourcing country], for whatever reason, then we can potentially offer product from another factory. That's how we crisis manage to a degree*'.
>
> The importer identified no significant concerns *'because we don't run a really tight stock. We've always got two or three suppliers we call on. We always use two different cold stores just in case. We use maybe five different transporters in case.*'

Buffer stock, and multiple suppliers, storage facilities and transporters, are proactive strategies put in place in case of disruption, so that supply chain actors can operate as normal if disruption occurs. This is supported by Stone and Rahimifard (2018) and Tukamuhabwa *et al* (2015) and reflects the positioning of redundancy as part of robustness inside the framework. However, these responses also point to linkages between redundancy and other elements of resilience, in particular flexibility and agility, with redundancy put in place to enable switching between suppliers or transporters and to ease crisis management.

We found that trade-offs related to resilience were discussed by four participants, with redundancy reducing efficiencies and increasing costs.

> '*We average probably about 20–22 working days' stock… We get delivery from suppliers three times a week. So why are we holding three weeks' worth of stock? A depot costs about £30 million to build … a lot to run it*' (supplier transporter).

This is supported in the literature by Bouchery *et al* (2024) and Jüttner and Maklan (2011), who noted that strategies for resilience may have trade-offs or limitations particular to SMEs for whom additional storage capacity may be out of reach financially. Resilience strategies also need to be cost-effective if they are to be adopted (Tukamuhabwa *et al* 2015).

Redundancy is closely related to flexibility, in that having spare capacity or alternative suppliers at hand enables flexibility in response to disruption. This interconnection is less prevalent in the literature. Stone and Rahimifard's (2018) review of supply chain literature points to linkages between agility and flexibility, but not between both these and redundancy. Linkages between redundancy and collaboration were also mentioned by a distributor in interview, who said:

> '*We'll make sure we've got stock, we have overlaps so that we know when you're going to run out, we prepare it ahead of that. So, there's a safety buffer in there*'.

This demonstrates that the ability to meet demand using buffer stock if disruption occurs is associated with collaboration with customers to understand their needs, allowing the supplier to prepare ahead with an overlap.

3.3.1.2. Security

Across interviews and surveys, only seven of 14 of eligible responses (50%) included the consideration of security in supply chain management for resilience. This perhaps shows a lower level of recognition than that reported by Stone and Rahimifard (2018) who proposed that security was increasingly significant in food supply chains. However, three survey respondents included processes for Hazard Analysis and Critical Control Points for food safety and Vulnerability Assessment and Critical Control Points in consideration of resilience. Interview participants made links between the need to adhere to legislation and certification, and its role in delivering supply chain authenticity, safety and avoiding fraud. All UK-based companies are required to adhere to food safety legislation (Food Standards Agency 2024), which may imply that security is perceived by actors as adherence to legal requirements, rather than as a resilience strategy. This was reflected in the results, with workshop comments demonstrating that food supply chain security is not always considered fully alongside supply chain management and pointing to the lack of comprehensive system to include all elements together:

> '*Our technical team, they have a matrix that they've developed which assesses mainly risks to food safety, rather than supply. But I think there's sort of a supply element as well sort of continuity of supply. You know, if we can't get it, what's the risk to the safety of the product? And yeah, they sort of give a score to each element of their matrix and then sort of spit out whether it's a red, amber or green supplier. So quite basic, there's not really a proper system or tool that we use*' (workshop participant, Company A).

3.3.2. Recovery

Five survey respondents indicated their organisation focused on recovery rather than planning for disruption. But the same number said the organisation also gets back to normal quickly after a disruption. This supports the widespread adoption of strategies for robustness outlined above. A workshop participant (company A) said:

> '*It has a lot to do with how quickly you can react to a problem rather than necessarily being able to predict what's going to happen*'.

The importer felt supply chain resilience was about *'having the flexibility at hand.'*

3.3.2.1. Flexibility

Across interviews and surveys, six of eight of eligible responses (75%) included the consideration of flexibility in supply chain management for resilience. Three interview participants indicated that when shortages or delays occur, their strategy involves elements of flexibility to assist recovery. We found that power dynamics between actors can impact flexibility both positively and negatively. One example of was that those customers with larger accounts or those on contract were prioritised by the supplier importer:

> '*We're not selling stock to anybody that's not got a contract [at the moment] because we don't have the stock*'.

The supplier distributor's experiences echoed this in relation to being able to source stock in a period of increased demand: *'relationships that we were able to almost pull rank on, got us to the front'*.

Existing supply chain resilience literature focuses on the contribution of different strategies for resilience to overall resilience rather than the potential negative impacts of adopting those strategies in isolation (e.g. Stone and Rahimifard 2018). Conversely, our findings highlight the possibility that flexibility could lead to a cascading disruption in the supply chain rather than aiding its recovery after disruption. SME customers are likely to be a small account to a large proportion of their suppliers. Even if they have multiple suppliers, the SME could potentially be deprioritised during disruption, as their alternative suppliers take steps to recover by prioritising some areas of the business over others. As a small account, the SME may have less buying power to pull rank compared to alternative suppliers, particularly those with whom they do not have a contract. Disruption could therefore cascade through the supply chain in a scenario where SME actors rely on flexibility upstream by having multiple suppliers. In a scenario where all suppliers' ability to fulfil orders is affected at the same time, having those alternatives offers no immediate benefit; this could be exacerbated in SMEs by their lack of buying power or sway with larger-scale suppliers. A workshop participant in Company A provided an example of this scenario:

> *'Our current supplier didn't have any in stock and wasn't getting any until mid-January. The second supplier didn't have any in stock either. So, we were stuck.'*

This could be a more likely scenario if a disruption impacted a particular commodity across multiple locations, or a breadbasket location; the potential for which is predicted to increase under climate change (Tchonkouang *et al* 2024). It has the potential to cause more negative economic impact than the direct effects of an environmental disruption (Davis *et al* 2021). This is an example of how relying on a single resilience strategy rooted in getting 'back to normal' could fail to mitigate plausible risks requiring reorientation. In the above example, shortages had led to discussions about adaptation through recipe alterations, indicating that a lack of robustness in place can lead to reorientation, which may then feed back to improve robustness, as indicated in figure 3.

The importer spoke regarding supplying composite products: '*we try to keep products fairly generic*'. Simplifying the product base to increase downstream flexibility was a strategy adopted by SMEs during Covid lockdowns (Do *et al* 2021). This finding provides an addition to the framework where flexibility not only indicates a variety of products and options for value-addition but can also involve supplying a generic product that meets a large number of customers' needs for value addition.

Flexibility can be linked to the capacity to balance trade-offs between efficiency and resilience. The supplier distributor noted:

> '*[If there's] instability in one country, we know that we can move to somewhere else. It might not be an easy move. It might be an expensive move, but we have options.*'

Participants also highlighted interactions between the need to ensure compliance for security which can cause delays during disruption, and the need to respond to disruption with agility:

> *'All the documentation, all the allergen risk assessments, masses of documentation relates to that specific factory. So, [if there is disruption] then we have to go through a process of approval'* (distributor importer).

In this case, going through documentation processes with back-up suppliers as part of standard procedure would increase flexibility and hence agility if disruption occurs, but require investment that may be seen as wasted where disruption risks are perceived as low.

3.3.2.2. Visibility

Across interviews and surveys, 11 of 14 eligible responses (79%) considered visibility in supply chain management for resilience, providing support for its inclusion in the framework. Visibility included supply chain mapping, which was seen by workshop participants as interesting although uncertainty was expressed in the workshop as to how supply chain actors could apply the insights from the increased visibility within their business strategy. However, some indicated that improving supply chain visibility could increase efficiency and resilience by reducing expenditure on redundancy strategies.

> '*We've got ERP [Enterprise Resource Planning] systems … using that technology within systems to help you control your stocks*' (distributor importer).

> '*The new demand planning system will aim to take about [20%–25%] of stock out in how we plan. Some [information] will be built in by applying service performance [for suppliers] … If their track record is poor, we'll hold more stock*' (supplier transporter).

Such observations, which can inform a prioritisation for buffer stock, support the use of technology to improve visibility, as reported by Tukamuhabwa *et al* (2015).

3.3.2.3. Collaboration

Across interviews and surveys, 12 of 14 eligible responses (86%) included the consideration of collaboration in supply chain management for resilience, higher than all eight other elements. We found that collaboration was closely linked with visibility, enabling actors to react to changes elsewhere in the supply chain where multiple strategies for resilience are embedded. Whilst this supports the linking of collaboration with recovery (figure 3), our findings indicate that collaboration was used both proactively as a regular part of management and reactively during disruption. The supplier distributor mentioned vertical proactive collaboration:

> '*We have a monthly meeting with [the manufacturers]. Our buyers relay the information to me, warn if lead times are changing. I'm always kept in the loop'.*

The distributor importer's experiences showed that collaboration is a requirement for resilience where supply chains are complex and operate in uncertainty:

> *'It's so complex, the supply chain. So, it genuinely is very difficult to predict. It's very difficult to generalise across and look at something that can solve everything because it's so variable with different countries, different routes of supply. That's the big challenge. Which is where the knowledge and the sharing of information is really important.'*

They also highlighted that vertical integration improved bargaining power in their relationship with a key supplier that means they buy at least 70% of its output:

> *'An important point on that is the influence that we have with the factory …. It's about influencing commitment. [Our] influence on them is stronger because we're taking lots of volume from them'.*

Both these examples in the data are evidence that collaboration is in part a factor of relational governance in the value chain, as argued by Gereffi and Fernandez-Stark (2016). They conclude that influence is more likely to support recovery where relationships are strong, or where purchasing power is large. A focus on building trust and both vertical and horizontal collaboration may aid SMEs with quicker recovery from disruption than relying on purchasing power or influence. However, Wieland and Durach (2021) point to the trade-off inherent in collaboration as it may require investment of capacity to develop relationships across the supply chain.

3.3.2.4. Agility

Across interviews and surveys, only four of eight eligible responses (50%) included the consideration of agility in supply chain management for resilience. Participants' contributions additionally pointed to the pivotal role for midstream companies bridging the gap between producers and manufacturers. The distributor's comments supported this:

> '*We're quite lucky as an organisation; we're not lucky, it's what we do. Because we're sourcing from different countries, you get a feel for what's happening. You can then feed that back up the supply chain to your customer.*'

The distributor importer's position as a midstream actor enabled them to respond to disruption with agility:

> *'Our advantage is we're not just dealing with one factory. So, our resilience is that we can switch to different countries of origin, different factories'.*

This capacity suits where *'most of the changes are temporary'* (distributor). Through their position as brokers, they can build intelligence about both supply and demand to ensure stability; their focus on visibility adds value and affords them influence in commodity supply chains, as previously observed by Grabs *et al* (2024).

However, we found that adopting a strategy of agility also has potential trade-offs as it requires investment which may be perceived as wasted, as shown by one workshop participant from Company A:

> *'It's all quite reactive. If there's an issue that's making headlines, I will reach out to suppliers to ask for their assurances, what stock level they have… maybe book some more material and work with them on a few forecasts. We don't really plan for any disruption because we hope that there isn't going to be any and we could spend, you know, every day speaking to suppliers, saying, what about this, what about that, but it may never happen*'.

3.3.3. Reorientation

All but two survey participants agreed with the statement *environmental disruptions have resulted in changes to processes at my organisation*, indicating that elements of reorientation had been required as a consequence of disruption. However, elements of reorientation were mentioned less frequently than other strategies in interviews. Participants' responses indicated that resilience may focus on how organisations can operate 'as normal' or get 'back to normal' rather than moving to a 'new normal'. This differs from much of the literature, where reorientation is seen as an increasingly critical element to maintain the long-term resilience of the UK food system while achieving sustainability goals (Zurek *et al* 2022).

3.3.3.1. Risk aware culture

Across interviews and surveys, eight of 14 eligible responses (57%) included the consideration of risk aware culture in supply chain management for resilience; this was the median response. This was primarily in relation to the reduction of risk and variability in the supply chain. Interview participants indicated there was limited capacity to plan for every eventuality and not all see the value in it:

> '*You could spend half your life - or waste half your life - planning for potential problems that never arrive*' (importer).

This sentiment was echoed by the supplier transporter in focusing on planning for '*the possible, but not for the weird and wacky*'. This supports the literature with Ali *et al* (2022), as cited in Bouchery *et al* (2024), finding that this process requires investment.

This sentiment was also expressed in the workshop considering two plausible scenarios for 2040 (see supplementary material table S.3). Participants did not consider that a shift away from primary production in the UK due to environmental change would have severe potential impacts. They discussed the current flexibility provided by the regulatory regime, meaning that this scenario would be preferable to react to, rather than plan for, and could improve profitability. This is supported by King *et al* (2021), noting that relying on imports also relies on standardisation, visibility and a supportive trade environment. This example provides evidence from the data of the perception that strategies for reorientation may be viewed as not worthy of investment across all actors in the supply chain.

While the literature shows risk aware culture can assist with mitigating future unforeseen disruptions (Tendall *et al* 2015, Stone and Rahimifard 2018), the data in our case study suggests that supply chain actors were not applying a risk aware culture. It could be argued that this had negative impacts, as the supplier importer noted that the disruptions having most impact were those that were not planned for or expected:

> '*The three biggest disruptions we've had over the last four years, have been ones that we were completely not anticipating at all. The first one being COVID. Second one being the Ever Given boat getting stuck in the Suez Canal. And the third one being this* [Red Sea shipping disruption]'.

It is difficult for supply chain actors to ensure that all the plausible risks to the resilience of their supply chains are productively considered. Actors' constrained ability to incorporate risk aware culture are also noted by FAO (2023) which acknowledges that there is a limit to anticipative capacity in supply chains as some disruptions are unforeseen (Tendall *et al* 2015). It could also indicate a discrepancy between the levels of focus on known disruptions versus unforeseen events. Even retrospectively, it can be difficult to evaluate the level of resilience (Black *et al* 2024), for example some authors (House of Commons Environment Food and Rural Affairs Committee 2023) considered that the UK food supply chain was resilient in its response to the COVID-19 pandemic, whilst others viewed the food system as susceptible to shocks (Benton 2021).

3.3.3.2. Adaptability

Across interviews and surveys, only six of 14 eligible responses (43%) included the consideration of adaptability in supply chain management for resilience. However, interview participants made links between long-term external change drivers—including climate change, legislative and regulatory frameworks, and consumer demands—and the potential future need to consider adaptation. This supports the inclusion of adaptability in the framework. The distributor differentiated long-term adaptability from recovery from disruptions:

> *'It's not as such disaster recovery, but it's a whole change of culture, of developing for next year and the year after … Working back from there to performance and the slow process to get it to a place that's acceptable.'*

This is supported in the literature, where Stone and Rahimifard (2018) distinguish long-term adaptability from the shorter-term recovery strategy of agility.

Interview participants also related adaptability to reputation and stability, indicating there were occasions when the customer accepts different outcomes in the longer-term, such as changes in price as contracts renew. However, reputation and commitment dictated existing contracts to customers must be met rather than renegotiated. This contrasts with Gao *et al* (2021) who argued that adaptability in response to the appearance of risks in the supply chain should include the renegotiation of contracts.

At the workshop, most participants expressed that future disruptions to chicken supply could potentially lead to adaptation of recipes, with dietary shifts with associated changes in the environmental impact of food (see supplementary material table S.3). The supplier importer noted that climate change requires alterations to the supplier base:

> *'As weather changes, we're seeing different regions in the world starting to be able to grow these crops'.*

The distributor was in the process of negotiating long-term change:

> *'I'm writing a piece for our key customers about what's going to change … What we're trying to do is give people the range of likely scenarios to try and help them make a decision'.*

Both these examples support Stone and Rahimifard (2018) who described adaptability as dependent on self-organisation, that is, the ability of the supply chain as a system to learn and reorganise itself internally when faced with changing operating environments. They also provide evidence that adaptability seeks to proactively take advantage of new opportunities in the supply chain as the external environment evolves.

3.3.3.3. Early warning

Across interviews and surveys, only three of eight eligible responses (38%) included the consideration of early warning in supply chain management for resilience which was the lowest response across all nine elements. The distributor importer pointed to the limits of traditional risk assessment and to the need for supply chain collaboration to facilitate early warning, noting:

> *'We can't predict things that we don't know are going to happen, but you get a feel from all the various sources - what our suppliers are saying, what our shipping companies are saying. We gather that and then we decide on positions'.*

FAO (2023) also reports that information gathering is an important key facet of early warning capabilities (FAO 2023).

Three interview participants mentioned discussion of future scenarios for disruption, and monitoring for early warning of disruptions was mentioned by two. The supplier importer noted that trust facilitates early warning and timely decision-making to support stability, supporting Stone and Rahimifard (2018) who drew links between early warning and collaboration:

> *'Getting that data … I'll be acting on that now and going to all of our customers and saying this is the situation with the crop this year … If you want to have continuous supply, you need to be acting on this now rather than waiting three or four months hoping that the price is going to fall because it's probably not going to. Without that information coming through from suppliers, we wouldn't be able to do that with our customers, and we wouldn't be able to function'.*

The workshop (see supplementary material table S.3) highlighted that there were potentially severe and long-lasting impacts to the supply chain with a need for reorientation, including adaptation to new growing regions and alternative suppliers. This was seen as more of a threat to the chicken tikka masala

supply chain than both vegetables and chicken. It also reflected actors' concerns in interviews, with several examples of existing and potential disruptions associated specifically with spices. However, there was a limit to the willingness of participants to respond proactively to this plausibility, and broad agreement with the view that:

> *'It's probably more efficient to wait for some of these things to affect us, and react to it, than to do a lot of complex scenario planning in advance'* (workshop participant, Company B).

This provides further evidence of the limits to the investment that food supply chain actors can make within the structure of their business models and perhaps highlights a role for government support (see section 3.4.2). While early warning was not fully developed for the majority of supply chain actors' strategies, its interaction with other areas of resilience, as well as actors' assertions of the need for it, warrants its continued inclusion in the framework.

3.4. Barriers and enablers

This section considers the role of information and trust, government and regulation, and new and emerging technologies in enabling improved resilience.

3.4.1. Information flows and trust

Information and data sharing, building relationships of trust, and intelligence gathering were seen by all interview participants as important. Where information sharing is insufficient, disruption may be more likely:

> *'I've got the product being produced in North America, I need it here by the end of April. It's going to be made the second week of April and it takes three weeks on a boat. The factory didn't tell us about that. I have two principal customers for it - we're talking now about how we might work around it'* (distributor).

The impact of unequal information flows up- and down-stream necessitated enhanced redundancy in the supply chain, with associated increased costs and capacity. Survey responses indicated that actors received more information from their suppliers than they did from customers. The distributor importer commented:

> '*Some customers will provide good forecasts, some will not. Recognising that this might well be driven by the forecasts etc., that they receive from their customers.*'

Their response is to '*hold a level of stock in the UK which we are continuously monitoring*'. The supplier distributor highlighted challenges where downstream actors '*do not know what their order pattern is … that was quite difficult*', with the response to use existing data to try to forecast future demand:

> '*Everything that I put in place in terms of the stock orders, I personally keep a view over that. So, I know what lead time is against reordering and a rough idea of what they're going to order when they order it.*'

Wieland *et al* (2023) noted that communication across the supply chain can enhance resilience, and it was considered important by research participants. However, our study highlights that there are also limits to information-sharing:

> *'It will vary as some suppliers, the information can be business sensitive… Not all customers will inform us who their customers are'* (supplier).

This supports Scheibe and Blackhurst (2018) who found that in complex supply chain networks, levels of information sharing can be hard to get right, and sub-optimal visibility can lead to supply chain disruption propagation.

The state of information flows may have a bearing on the ability of organisations to fulfil orders, if information about customers and their needs is limited. The supplier distributor invested time in capacity-building with positive impact on reliability:

> '*The stock sheets that I do personally - really, I think that's where it could go wrong if I didn't do that… We can all see the information that I've got, and we all work from that … We'll all discuss, just to get everything right… time frame and any information. We also have a monthly sales meeting where … we talk about other things that we know within the marketplace.*'

The above observations of the importance of effective information flows and social capital have also been reported by Tukamuhabwa *et al* (2015) and Katsaliaki *et al* (2021).

3.4.2. Government, regulation and policy

Regarding the contribution of legislative and regulatory frameworks to resilience, a workshop participant from Company B noted that *'legislation guides behaviours but gives confidence to an ever more aware public'* around supply chain security and quality assurance. This was particularly the case regarding legislation in response to safety scares. Security is critical to food supply chains but comes with potential trade-offs: for instance, the importer mentioned that new sourcing countries looking to enter the market: *'[have] no idea what regulations they need to achieve to be able to export'*. In the context of long-term climate change, governments seeking to enhance resilience of food supply could engage with actors in emerging markets to provide guidance on regulatory requirements (Benton *et al* 2019). *'International cooperation'* (supplier importer) was also felt to be needed to improve the resilience of global-scale, privately owned and managed supply chain functions such as shipping, as previously reported by Ghadge *et al* (2022).

In the workshop, participants commented that government policy emphasises recovery, for instance a workshop participant from Company A commented:

> *'Government tend[s] to have a very short-term view on things so that they react and respond to pressure. It's very much 'How do we fix this problem so we'll go back to normal?'*

This can result in government's role being seen as *'short term, and short sighted'* (importer, comment during workshop) whereas investment or adaptation decisions taken by supply chain actors have longer-term implications. Workshop participants commented that clarity and guidance is needed from government around *'future challenges we are likely to face'* (workshop participant, Company A), in particular, the need to mitigate carbon emissions, with *'the UK market from a supply perspective paying no attention to climate change.'* (workshop participant, Company A). This assessment reflects Heo and Seo's (2021) analysis of UK government strategic foresight, which showed that there had been a loss of capabilities to use foresight techniques to anticipate plausible long-term futures, and to act in response to findings. Workshop participants acknowledged that government has a role in using tax and incentives to change business behaviour, particularly regarding the need for incentives for long-term planning to deliver reductions in greenhouse gas emissions. The need for a clear vision for the food system that enables a move from short-term problem-solving to longer-term resilience is echoed in some areas of government (Food Standards Agency, & Camrosh 2023, House of Lords Food Diet and Obesity Committee 2024).

Several research participants expressed concerns about the level of understanding by policymakers about how food supply chains work. In interview, the distributor importer commented:

> *'I think their role is first of all to understand it, fully, from all the stakeholders throughout the supply chain before you try and improve it or put constraints on it'.*

3.4.3. New and emerging technologies

The adoption of technologies can be considered part of reorientation; a long-term adaptation requiring investment, training and changes to business practices that contributes towards a supply chain actor's future robustness and capabilities for recovery. Three interview participants saw new technologies primarily as enablers for efficiencies and contributing to robustness. The supplier importer provided an insight into its contribution to agility and visibility:

> *'It's given us a lot more visibility on the supply chain. One of the suppliers we work with, they will give you a QR code of a shipment and you scan the QR code, and it gives you details of what farm the [products] were growing in … And I think it also [gives] a lot more clarity on shipping as well … we now have systems that update to say when a shipment is delayed … We can now plan for that, whereas that was much more difficult before when the information might only come through a week after the delay had taken place.'*

This is supported by Mu *et al* (2024), also noting that improved traceability also contributes to resilience through management of food safety risks.

The distributor importer cited technology's role in supporting stock management as part of planning for robustness:

> *'We've got ERP [Enterprise Resource Planning] systems … you're using that technology within systems to help you control your stocks.'*

Inventory management acts as part of a monitoring system, providing information to support for early warning systems (Stone and Rahimifard 2018).

The supplier transporter cited the positive impact of supply chain mapping technology for visibility:

> *'Supply chain mapping technology is very simple. It takes a bit of time to put into place. I know [where] I buy the products from… In many, I know what the ingredients are, [but I] don't know the quantities, the importance or where they come from. I'm now starting to engage with [supply chain mapping software] that can map this for me, and also then make conclusions on that mapping. What I do about it is another thing.'*

These observations indicate a potential gap between the data that technologies can supply, the understanding of those data (and the uncertainty) to enhance decision-making for resilience, and action. This aspect is not widely discussed in literature and warrants further exploration to enhance understanding, together with a cost-benefit appraisal. Further recommendations for research and policy are discussed below.

4. Recommendations for research and policy

The participants in the case study highlighted the need for policymakers to develop a deeper understanding of how legislation and regulation impacts SMEs and the resilience of food supply chain during and after disruptions. A similar observation was identified by Jones *et al* (2024). One way to achieve this is to consult and test interventions with supply chain actors operating at different functional levels and scales. The stakeholders should also include those providing non-food components such as packaging, and it is particularly useful to engage with midstream actors who have an in-depth knowledge of commodities and markets. Tchonkouang *et al* (2024) and the Global Food Security Programme UK (2018) also argue that there is also a need for greater insights into the challenges faced by post-harvest supply chain actors and their response to disruptions.

To foster an environment for decision-making for long-term change in the context of increasing uncertainty, Heo and Seo (2021) recommend including all levels of stakeholders in futures thinking. This can be defined as a strategic approach to explore and critically consider future scenarios in order to define the most preferable ones for people and society (Canina *et al* 2022). In the context of supply chain resilience, futures thinking is not about predicting the future. Rather, it is about developing qualitative capacities to devise policy interventions that consider future uncertainty and that can accommodate future events, whether expected or novel (Holling 1973, as cited in Mu *et al* 2021).

The use of case studies to reflect on the impacts of past disruptions and supply chain actors' responses can also be informative. Workshops with participants in case studies can also be used to look forward and to examine perceptions of current and future risks from environmental disruptions to provide insights into how these factors influence decision-making. For example, in our study, participants were in favour of government providing a clearer long-term strategic vision for the food system that would, for example, highlight environmental impacts and thereby provide a basis for companies to reorientate their strategies and operations. This has also been observed by the House of Lords Food Diet and Obesity Committee (2024). Our study also highlighted an interest in how new technologies could be implemented in practice.

The participants in our case study indicated that, during disruption, they tended to prioritise robustness, reputation and continuity ahead of cost considerations which may or may not be passed on to consumers. Whilst the supply chain may absorb the costs of short-term disruptions, the longer-term effects of environmental disruptions are likely to affect food affordability for consumers. The study also provides evidence that, under persistent disruption, supply chain actors may adopt more resilient sourcing strategies such as increasing the number of suppliers or switching origin country, despite higher costs. Whilst this enables stability, it may stifle reorientation as actors' often aim to maintain operations 'as normal' rather than adapting to a 'new normal'. Furthermore, the findings suggest a reticence to invest in reorientation strategies that account for potential future change. Hence it could be argued that there is a role for government support and guidance to highlight long-term goals and roadmaps that can inform reorientation by the sector to improve resilience.

The study also highlights the tension between the benefits of redundancy (as a component for robustness) and the drive to use collaboration and visibility to reduce 'unnecessary' redundancy and thereby costs. The balance between resilience and efficiency has been a focus of various system studies, with Fath *et al* (2019) highlighting that for many systems there is a sweet spot. Too much resilience can create stagnation while too much efficiency can create brittleness. Fath *et al* (2019) argue that healthy systems operate in a 'window of vitality' that creates a balance.

Finally, this study highlighted that concerns over resilience varied with food categories, with global supply chains for spices considered to be more volatile than chicken production or UK vegetable production. While spices may be less critical to food security than major commodities such as cereals, the

cascading nature of disruptions means food shortages or price spikes of one ingredient can have knock-on effects on entire chains. The European Commission (2023) regularly provides a matrix of the relative importance and the relative risk of supply chains for critical minerals. It may be appropriate to construct a similar matrix for food ingredients as part of future food security reports (DEFRA 2021). This could enhance policymakers' understanding of how disruption can cascade through complex international supply chains, and even inform future trade policy.

5. Conclusions

This study has contributed to the understanding of food supply chain resilience with the synthesis and application of a theoretical framework for resilience. The framework builds on existing theory and applies it to a case study involving supply chain actors across the chicken tikka masala supply chain network. The framework, encompassing robustness, recovery, and reorientation, combined with nine elements of resilience, was used to analyse the strategies implemented by food supply chain actors. Our findings show that the framework is effective in its application to a food supply chain context and a useful model for the empirical analysis of resilience strategies. It could be applied in future comparative or multi-case studies to test and extend our findings. This would enhance understanding of the trends and patterns in resilience strategies in use in practical contexts including similar supply chains of complex, composite products, in particular in SME contexts, to better inform policymaking that enhances food supply chain resilience.

Presenting a theoretical framework as the basis for data gathering and analysis of qualitative data resulted in effective interpretation and hence understanding of the strategies that actors implement to maintain and enhance resilience to environmental disruption. Our analysis shows that actors in the chicken tikka masala case study food chain tend to prioritise the robustness and recovery elements of resilience, rather than reorientation. A key driver for this prioritisation is their supply chain management strategy, which identifies potential risks to resilience based on, and influenced by, their experiences of previous disruptions. This relates to participants' perceptions of risk and crisis management, with decision-making driven by considerations of reputation and reliability. This leads to an emphasis on maintaining operations 'as normal'. Whilst this may have been effective in the past, in the context of anticipated greater environmental disruption due to climate change and the overshooting of other planetary boundaries, we argue that there is also a need to consider how reorientation can improve resilience. Because reorientation has a focus on the long-term, there is a potential role for researchers to highlight the impacts of environmental risks and opportunities, and for government to articulate long-term goals and road maps for the sector.

The embedded case study approach highlighted some new insights in decision-making, perceptions and strategy relevant to SMEs, that were not considered in the initial framework. Whilst collaboration and information were demonstrated, the ability of an SME to maintain resilient supply chains is also affected by power dynamics within the supply chain. Buying power is limited in SMEs, and where they are sourcing from suppliers who may be operating at a larger scale, this limited buying power may have a negative impact on the continuity of supply during disruption, as most important customers are prioritised. Information-sharing can also be curtailed for SMEs where their suppliers or customers choose not to divulge information that could improve resilience or fail to prioritise providing it. These power dynamics affect the ability of individual actors to improve collaboration, visibility and flexibility to enhance resilience.

The case study also demonstrated that, perhaps as expected, the primary focus of SMEs in maintaining resilience of a food supply chain is on robustness and recovery, rather than reorientation. Reorientation was often linked to the need for new investment, with elements of short-term thinking acting as a barrier to it, along with the challenges of considering uncertain future disruptions. There is a potential role for government to facilitate and support reorientation through the adoption of a long-term vision for food security that takes into consideration a range of plausible future scenarios for the food system, and that supports food supply chain actors to consider them in the context of their strategies for resilience.

6. Limitations

This study involved multiple research methods to collect data from three tiers in the same supply chain, to improve understanding of how interactions between tiers influence resilience strategies in practice. We included all tier one suppliers in the initial sample, including non-food component suppliers, and leveraged support from Company and Company B. Additionally, we adopted a snowball approach to

reach tier two suppliers and customers as outlined in the methodology. Nevertheless, engagement was necessarily limited by participants' availability and capacity to participate, their level of interest, and their perceived confidence with the research topic.

While participant selection resulted in diversity of responses with regard to company scale and supply chain role (see table 1), as well as a variety of food and non-food components, no suppliers of dairy components participated. Findings from additional suppliers, performing different roles in the supply chain or in different supply chain tiers may have contributed broader perspectives and distinct experiences of supply chain resilience.

Our study is based on an embedded case study analysis of a single supply chain in an SME, selected for its popularity in the UK as an appropriate example of a prepared meal. The study focuses on generating rich in-depth insights to identify resilience perceptions and actions from a diversity of actors, rather than seeking to produce statistically representative insights into UK supply chains in general. However, the conceptual framework for supply chain resilience serves as an accessible diagnostic tool that can be applied to studies of other similar supply chains.

Data availability statement

A Non-Disclosure Agreement is in place between Cranfield University and Company B that includes all sensitive and commercial data gathered. Due to the nature of the research, all data is considered sensitive in that sharing it might feasibly compromise not only the privacy of research participants but also the commercial interests of their organisations in relation to Company B. Therefore, supporting data is not available.

The following are available at https://doi.org/10.57996/cran.ceres-2770.

1. Interview instrument.
2. Survey instrument.
3. Plausible future scenarios (narratives).
4. Codebook for thematic analysis.

Restrictions apply. Data cannot be shared publicly via a URL/DOI.

Data supporting this study cannot be made available due to commercial, ethical and legal restrictions.

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For the purposes of open access, the authors have applied a Creative Commons Attribution (CC BY) licence to any Accepted Author Manuscript version arising from this submission.

Ethical statement

This research was conducted in accordance with the principles embodied in the Declaration of Helsinki and in accordance with Cranfield University Research Ethics System. Ethics approval was provided by the Cranfield University Research Ethics Working Committee (CURES/21029/2023). All participants gave informed consent to participate in the study.

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