Links between risk source identification and resilience capability building in agri-food supply chains: A comprehensive analysis

Abstract

Agri-food supply chain (AFSC) resilience is receiving increasing attention as AFSC stakeholders perceive its benefits in recovering from unexpected disruptions. However, which resilience capabilities are more effective in mitigating AFSC risks remains unclear. To address this gap, this paper presents a novel AFSC risk and resilience analysis based on a systematic literature review (SLR). Ninety-five journal articles on AFSC risk and resilience management published between 2004 and 2020 are analysed to identify key risks and resilience capabilities in AFSCs, the relationships, correlations and causalities between them, and research gaps and future research directions in the field. Our SLR reveals eight types of AFSC risk and seven types of AFSC resilience capability, and enables us to develop a one-to-one resilience-risk correspondence model. Suggestions for future research include: cross-country comparative analysis to gain a deeper understanding of risk and resilience management; identification of risk and resilience strengthening strategies through a multi-sectoral approach; longitudinal studies to determine the long-term effects of resilience capabilities; research to understand resilience from the perspectives of supply-chain collaboration, traceability, redundancy, knowledge management, innovation, leadership and flexibility; investigations of the positive effects of AFSC risks in triggering resilience capabilities; and cross-disciplinary research to understand the relationships between resilience and other disciplines.

Keywords: Agri-food supply chain; Supply chain risks; Supply chain resilience; Systematic literature review; Relationships between risk and resilience

1. Introduction

The world's current population of 7.8 billion is expected to increase significantly to 8.5 billion by 2030 and to 9.7 billion by 2050 (United Nations. 2019). This drastic growth, coupled with accelerating urbanisation, will place enormous pressure on agri-food supply systems, as more affluent and urbanised populations demand more nutritious, affordable, sufficient, high-protein, and safe agri-food products (WHO. 2019). Furthermore, globalisation, increasing competition, uncertain business environments, rapid and dynamic customer demand behaviour, and the perishability of agri-food products are naturally driving agri-food supply chain (AFSC) practitioners to build connections between key agri-food players in order to capture the latest agricultural technologies, knowledge and high-quality agri-food products, as well as reducing operational costs (Simangunsong et al. 2016; Moazzam et al. 2018; Zhao et al. 2021). AFSCs have become longer, more complex and more prone to various risks (Christopher et al. 2011; Srivastava et al. 2015; Prakash et al. 2017). In addition, understanding and analysing AFSCs has become increasingly complex owing to unexpected risks linked with emerging disruptions and vulnerabilities that affect food systems (Zhong et al. 2017).

AFSCs can be understood as moving agri-food products from production to final consumption literally, from "farm-to-fork" (Dani and Deep. 2010; Zhao et al. 2020). In this process, agri-food products must be farmed, cleaned, tested, categorised, packaged, refrigerated, distributed and marketed (Iakovou et al. 2010) all of which, involve agri-food research institutes, farmers, manufacturers, logistics service providers and wholesalers. This complexity leads to considerable interdependence amongst AFSC stakeholders, particularly in relation to product, information and decision flows, which also increases vulnerability and risk. Risk can be viewed from various perspectives, including *environmental* risks from droughts, floods, forest fires and earthquakes, *supply* risks relating to supplier reliability, information and communication technology (ICT) infrastructure, supply quality and supplier capability, *demand* risks arising from data errors, customer preferences and forecasting errors, and process risks from technological changes and production and transportation issues (Tummala and Schoenherr. 2011; Zhao et al. 2020). However, beyond these traditional sources, further risks relating to perishability, product contamination, storage and transportation, and climate conditions must also be considered (Pereira et al. 2020). These are likely to disrupt information, material, technology and knowledge flows in AFSCs, causing discontinuity and reduced profitability (Tang. 2006; Urciuoli et al. 2014). Therefore, research domains such as supply chain risk management (SCRM) are seeking to provide better understandings and analyses of the implications of these risks, particularly in terms of their identification, assessment, mitigation and monitoring (Song and Zhuang. 2016; Bogataj et al. 2017; Rosales et al. 2020). AFSC-related risks affect a large proportion of the agri-food sector, and their wide variety and effects on AFSC performance mean that they must be both managed and anticipated, in order to enhance recovery from unexpected events and risks.

Resilience has been explored in various contexts, including engineering, ecology, psychology, economics and management (Vlajic et al. 2013; Coulson et al. 2017; Bag et al. 2019). In the context of management, as external threats increase, two areas have attracted particular research interests: organisational resilience and supply chain resilience (SCRes) (Linnenluecke. 2017). Resilience is generally seen as a desirable

capability allowing supply chains, organisations and their members to prepare for, resist and recover from unpredictable disruptions (Linnenluecke. 2017; Kahiluoto and Makinen. 2020). Recent reviews of the literature on supply chain risks and resilience (e.g., Ho et al. 2015; Kamalahmadi and Parast. 2016; Stone and Rahimifard. 2018; Bak et al. 2020) find that, although research has identified supply chain risks and SCRes in various industries, the agri-food industry seems have been neglected. In Ho et al's (2015) literature review of SCRM, only six out of 90 papers focused on the agri-food industry, whereas in Bak et al.'s (2020) review paper of SCRes, only eight out of 101 papers focused on the agri-food industry, indicating a clear gap in the literature. Besides, SCRes are generally considered as a heterogeneous and fragmented area, with very different elements, stages, issues and research contexts involved. For example, these issues include resilience building using various strategies (e.g., supply chain collaboration and redundancy), application of old features (e.g., flexibility) in various industries (e.g., manufacturing, services, pharmaceuticals, and automotive), and investigation of new issues (e.g., robotics, blockchain technology, and artificial intelligence) and their effects on resilience. Taking this into consideration, a systematic literature review (SLR) is necessary to summarise existing findings, synthesise knowledge, and propose research directions to guide future research. Studies have addressed definitions, principles, strategies, elements and phases of SCRes (Scholten and Schilder. 2015; Ali et al. 2017; Pettit et al. 2019), but few have established clear connections between supply chain risks and SCRes (Hosseini and Ivanov. 2020). This research gap requires urgent attention through conducting a SLR.

Responding to current industry and research needs, we conducted a SLR of studies on AFSC risks and AFSC resilience. We sought to highlight risks that may have severe effects on AFSCs, identify resilience capabilities that can be used in an AFSC context, build connections between AFSC risks and AFSC resilience capabilities, and propose the most promising directions for future research. The aim was to gain a fuller understanding of the connections between risk and resilience by building a one-to-one resilience-risk correspondence model to reveal correlations and causalities. Four research objectives are formulated: (1) To identify risks that may have severe effects on AFSCs; (2) To identify resilience capabilities that can help AFSCs to respond to and recover from disasters or disruptions; (3) To build connections between identified AFSC risks and resilience capabilities through extracting evidence from the literature; and (4) To identify research gaps and propose future research directions.

This study makes several contributions to theory and managerial practices. As for the contributions to theory, *first*, a novel one-to-one resilience-risk correspondence model in terms of AFSCs was built through an exhaustive search and analysis of the relevant literature. Previous literature reviews on SCRes or SCRM tend to focus on summarising their definitions (Ho et al. 2015; Tukamuhabwa et al. 2015), framework development (Kochan and Nowicki. 2018), SCRes principles and performance analysis (Kamalahmadi and Parast. 2016; Singh et al. 2019), or modelling techniques (Behzadi et al. 2018; Ribeiro and Barbosa-Povoa. 2018; Hosseini et al. 2019). Very few studies give a clear overall picture of the relationship between risks and resilience capabilities. To the best of our knowledge, this is the first literature review that aims to build relationships between risks and resilience capabilities specifically for AFSCs. *Second*, this study identifies 20 valuable directions for future research from seven perspectives, such as the methodology adopted and AFSC risk identification and assessment. *Third*, we identified 50 AFSC resilience capability factors and 77 AFSC risks that exist in AFSCs. This study provides an overview of risks and resilience capabilities involved in the AFSCs. As for the managerial implications, this study helps AFSC managers to reduce the time and effort required to mitigate AFSC risks, as we build a one-to-one resilience-risk correspondence model. More than 70% agri-food companies are small-and medium-sized enterprises (SMEs), which indicates that they do not have unlimited resources to mitigate risks. Our study provides clear guidance for them to mitigate or avoid risks using dedicated resilience capabilities. Furthermore, this study raises the risk and resilience awareness of AFSC practitioners through identifying various AFSC risks and resilience capabilities. *Finally*, this study sheds some light on which resilience capabilities should be used to mitigate risks, as we summarised their frequency of use from the literature. For example, information sharing, blockchain-based technology, and multiple sources are frequently mentioned by scholars.

In the remainder of this paper, Section 2 describes the research methodology and Section 3 analyses the literature. In Section 4, we discuss the major findings and contributions of this study and propose future research directions before drawing some conclusions in Section 5.

2. Research methodology

SLR was selected as the research methodology for this study for several reasons (Denyer and Tranfield. 2009). *First*, the aim of this study was to identify risks associated with AFSCs and propose corresponding risk mitigation and avoidance strategies to help build AFSC resilience. Furthermore, because resilience has been explored in various fields, SCRes is a fragmented and somewhat inconsistent research field (Stone and Rahimifard. 2018). SLR provides an opportunity to overcome this fragmentation by conducting an exhaustive search for relevant studies in a systematic, replicable, scientific and transparent manner (Tranfield et al. 2003). *Second*, SLR helps to minimise bias and errors generated in the course of data collection and analysis (Danese et al. 2018; Zahoor et al. 2020). *Third*, SLR enhances the quality of the review and its outcomes, as quality control mechanisms are embedded in the process (Linnenluecke. 2017; Sweeney et al. 2018; Calabro et al. 2019). *Finally*, SLR has been

successfully applied to a range of research topics, including omni-channel retailing (Melacini et al. 2018), supply chain agility and flexibility (Fayezi et al. 2016), and human resource management (Nolan and Garavan. 2016), and is thus widely used in business and management. The SLR in this study involved three steps: (1) research question formulation, (2) study identification, selection and evaluation, and (3) analysis and synthesis (see Figure 1).

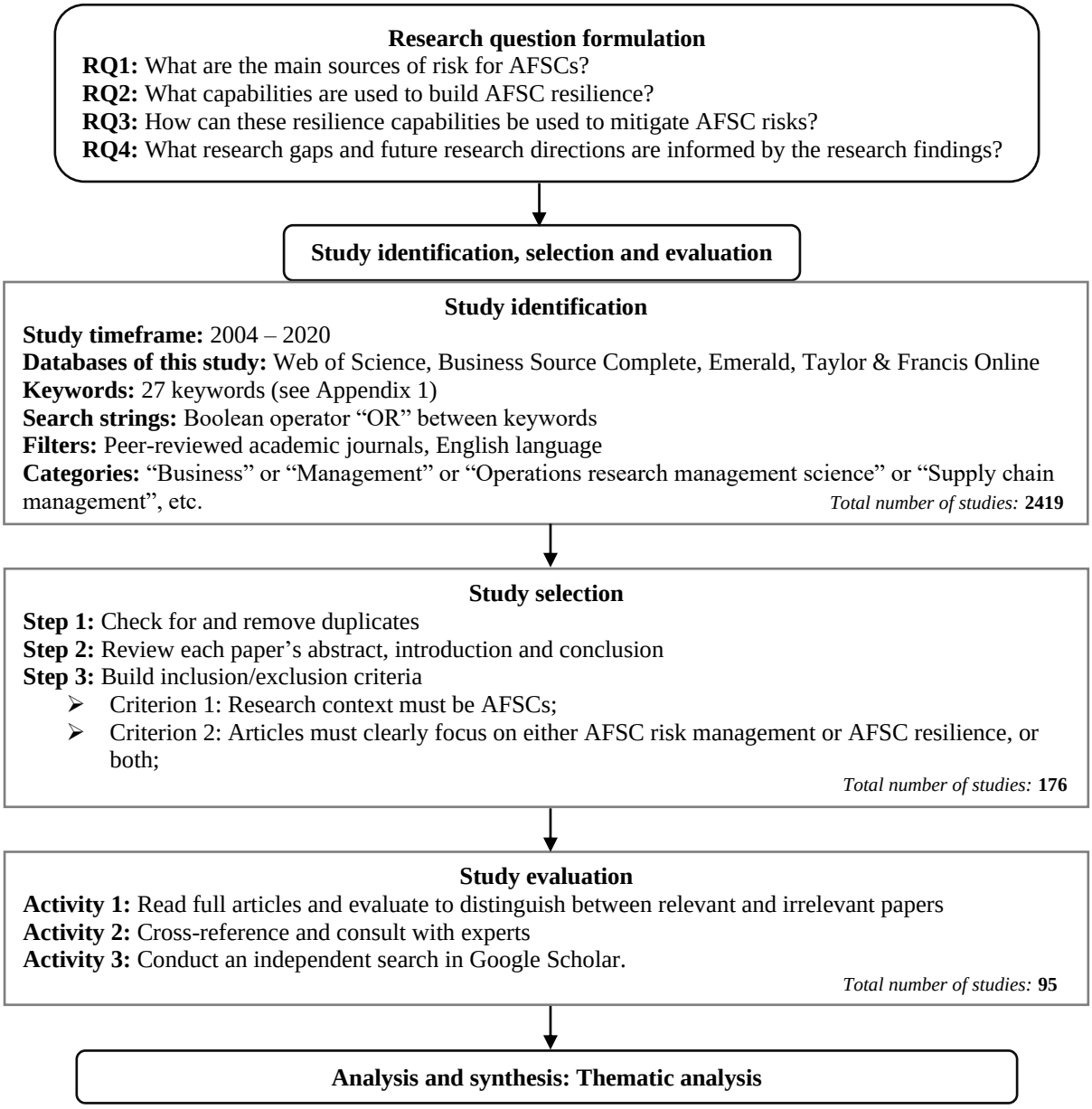

Figure 1. A summary of the SLR process

2.1 Research question formulation

Managing risk in the supply chain is a key capability for the survival of supply chain stakeholders in an increasingly volatile and unpredictable business environment (Colicchia and Strozzi. 2012). Therefore, SCRM is a key area of interest, encompassing risk identification, assessment, mitigation, and monitoring (Ho et al. 2015; Fan and Stevenson. 2018; Getele et al. 2019). The literature addresses issues such as risk sources in supply chains, the typology of supply chain risks, strategies to mitigate supply chain disruptions, and quantitative methods to assess supply chain risks (Rajagopal et al. 2017; Sreedevi and Saranga. 2017; Ribeiro and Barbosa-Povoa. 2018). Most studies focus on a particular industry such as automotive, electronics or aerospace, but the agri-food industry remains relatively unexplored (Ho et al. 2015; Bak et al. 2020). This is because the latter has evolved over time under the influence of various changing factors, such as population growth, dietary choices, technological progress, income distribution, and the state of natural resources (UNFAO. 2018), posing problems for investigation. The few studies that do concentrate on the agri-food industry focus either on the AFSC resilience (Stone and

Rahimifard. 2018) or specifically on AFSC sustainability (Beske et al. 2014). No previous studies appear to have systematically identified both AFSC risks and AFSC resilience capabilities, nor built clear connections between the two. Therefore, in this SLR, we conducted an exhaustive search, identification, and categorisation of relevant literature on both topics, aiming to build a unified framework that would provide insights into the relationships between AFSC risks and AFSC resilience, highlight AFSC risk factors, AFSC resilience capabilities and their corresponding relationships, summarise research gaps, and propose future research directions. Thus, the following four research questions were investigated: (1) What are the main sources of risk for AFSCs? (2) What capabilities are used to build AFSC resilience? (3) How can these resilience capabilities be used to mitigate AFSC risks? and (4) What research gaps and future research directions are informed by the research findings?

2.2 Study identification, selection and evaluation

The main purpose of this step was to build a comprehensive database of studies on AFSC risk and resilience pertinent to the review questions (Denyer and Tranfield. 2009). Four databases - Web of Science, Business Source Complete, Emerald and Taylor & Francis Online - were selected to search for relevant studies as these include the world's major journals, conference proceedings and book chapters, with a strong focus on business and management, and have been extensively used in literature reviews (Lahiri. 2016; Melacini et al. 2018; Athwal et al. 2019). Our timespan for relevant publications was set from 2004 to 2020 for several reasons. *First*, the concept of resilience can be traced back to Hollings's 1973 seminal work on "Resilience and stability of ecological systems", but was first applied to the context of supply chain management with Christopher and Peck's (2004) "Building the resilient supply chain". *Second*, risk sources in AFSCs and mitigation strategies used to build AFSC resilience are constantly evolving, and were heavily impacted by the COVID-19 pandemic in 2020 (Ribeiro and Barbosa-Povoa. 2018). We assumed that this would prompt further research on AFSC resilience and, therefore, set our end date to 2020. Consistent with previous literature on supply chain risk and resilience (Ho et al. 2015; Kamalahmadi and Parast. 2016; Linnenluecke. 2017; Stone and Rahimifard. 2018), 27 keywords (e.g., disruptions, risk, vulnerability and uncertainty) and search strings were employed to identify relevant publications in English from their titles, keywords, and abstracts (see Appendix 1). Since the focus of this study was on AFSC risk identification and resilience capability building, publications were limited to those pertinent to the areas of "business" or "management" or "operations research management science" or "supply chain management", based on the categorisations of the various databases. Furthermore, to ensure quality, only international peer-reviewed journal articles were included for further analysis, as such articles are evaluated by international peers through a rigorous review process (Podsakoff et al. 2005). Thus, other document types such as conference proceedings, book chapters, corrections and meeting abstracts were excluded. The initial search resulted in 2,419 journal papers.

Table 1. Step-by-step analysis of SLR

Filter	Description	Web of Science	Business Source Complete	Emerald	Taylor & Francis Online	Total
Filter 1	Articles contain selected key words	401	549	856	613	2419
Filter 2	Check for and remove duplicates					943
Filter 3	Review each paper's abstract, introduction and conclusion Apply inclusion/exclusion criteria					176
Filter 4	Read full articles and eliminate non-relevant ones Cross reference and consult with experts					95

Search criteria for Web of Science: Timespan: January 2004 – December 2020; Citation databases: Science Citation Index Expanded (SCI-EXPANDED)--1970–present; Social Sciences Citation Index (SSCI) –1970-present; Arts & Humanities Citation Index (A&HCI)—1975-present; Emerging Sources Citation Index (ESCI)--2015-present; Restrict results by language and document types: English and Article; Web of Science Categories: Business; Management; Food science technology; Operations Research Management Science; Agricultural economics policy; Agriculture multidisciplinary; Countries/Regions: All. Search strings searched in the title or topic.

Search criteria for Business Source Complete: Search modes and expanders: Boolean/Phrase and apply related words; Limit your results: Scholarly (Peer Reviewed) Journals; Published Date: January 2004 – December 2020; Publication type: Academic journal; Language: English; Document type: Article; Subject: Supply chains; Supply chain management; Operational risk; Emergency management; NAICS/Industry: Distribution and logistics service; Geography: All.

Search criteria for Emerald: Advanced search: Journal articles; Data range: 2004-2020; Access type: Journal articles; Search strings searched in the title or topic.
Search criteria for Taylor & Francis Online: Date range: 2004-2020; Search strings searched in the title or keywords; Subject: Business, Management and Accounting; Industry & Industrial Studies.

The publications identified were then checked for duplicates. Their full records were imported into EndNote X8 bibliographic software. Using the command "Find Duplicates" embedded in EndNote X8, the number of papers was reduced from 2,419 to 943. Next, each paper's abstract, introduction and conclusion were assessed to check whether the basic criteria for relevance were fulfilled (Calabro et al. 2019; Ceipek et al. 2019), which resulted in 176 articles remaining. Articles included for further analysis must have specific characteristics. *First*, their research context must be AFSCs; thus, articles focusing on enterprise resilience, enterprise risk management, resilience in SMEs, and general SCRes or risk management were excluded. However, articles focusing on how to build AFSC resilience from a focal company perspective were included, as the unique power of focal firms may structurally influence the whole supply chain (Wieland and Wallenburg. 2013; Tukamuhabwa et al. 2017; De Sa et al. 2020). *Second*, the selected articles had to have a clear focus on either AFSC risk management or AFSC resilience, or both. Articles concentrating on AFSC risk management were included, because risks must first be identified to enable risk categorisation, assessment, mitigation, and monitoring (Aqlan and Lam. 2015). Articles focusing on AFSC resilience principles, AFSC resilience strategies and AFSC resilience measurement were also included.

Next, the remaining 176 articles were read in full to distinguish between relevant and irrelevant papers, which narrowed the pool to 86 articles. By cross-referencing and consulting with two professors in operations management and decision-making, a further nine articles were identified, leading to a final sample of 95 articles. Finally, we conducted an independent search in Google Scholar to ensure that all key articles were included in this study (Mol et al. 2015; Zahoor et al. 2020). The steps in this analysis are presented in Table 1.

2.3 Analysis and synthesis

Thematic analysis was selected for analysing the qualitative data for several reasons. *First*, thematic analysis is useful for summarising the key features of a large data set (Braun and Clarke. 2006). As 95 articles required analysis, thematic analysis was the most appropriate method for this study. *Second*, thematic analysis allows high levels of flexibility, simplicity and tangibility in the analytical process. Other qualitative data analysis methods, such as narrative analysis and discourse analysis, may provide a highly flexible theoretical framework, but may fall short of identifying broader structural influences or producing tangible answers to research questions (Earthy and Cronin. 2008; Fairclough et al. 2011) making them inapplicable to this study. *Finally*, thematic analysis is able to highlight similarities and differences between different datasets, making it extremely useful for generating unanticipated insights (Braun and Clarke. 2006). Thus, thematic analysis was applied to analyse the qualitative data in this study.

We started by analysing each study to identify descriptive elements (e.g., author(s), year of publication, methodology, geographical location and type of AFSCs), and major findings. Each paper was classified according to the primary methodology used, including theoretical and conceptual papers, case studies/interviews, surveys, modelling papers, and literature reviews (Seuring and Muller. 2008; Winter and Knemeyer. 2013). Information on each study was recorded in a Microsoft Excel worksheet. In order to ensure credibility and reliability, two coders were involved in line-by-line coding of each study, resulting in an inter-coder reliability of $k = 0.81$ (Cohen. 1960). NVivo 12 was used in the coding process, as this made it easy to identify, highlight, categorise, and link related AFSC risks and AFSC resilience capabilities (Zahoor et al. 2020). Finally, we synthesised the thematic analysis results and identified avenues for further research.

3. Literature analysis

In the following, sub-section 3.1 presents the results of our descriptive analysis relating to the distribution of journals, the number of journal articles over the years, authors' country, types of AFSCs, and the research methodology adopted (see Appendix 2). Sub-section 3.2 describes the results of our thematic analysis, summarising the sources of risk to AFSCs, their resilience capabilities, and relationships between the two.

3.1 Descriptive analysis

Table 2 presents the distribution of articles on AFSC risks and/or AFSC resilience across 43 different journals. *Supply Chain Management: An International Journal* has the highest number of papers (n = 12, 12.63%) on these topics, as it aims to publish works that contribute to extending supply chain knowledge beyond a dyadic perspective and solving challenges posed by issues such as globalisation and disruption. A significant number of articles have also been published by *PP&C* (n = 7, 7.37%), *IJOPM* (n = 6, 6.32%), *IJPR* (n = 6, 6.32%), *IJPE* (n = 5, 5.26%), *IJLM* (n = 5, 5.26%), *EJOR* (n = 4, 4.21%), and *IJPDLM* (n = 4, 4.21%). These journals aim to publish leading research on developing and implementing strategies, systems, processes, and practices in operations and supply chain management. We also note that journal articles relating to AFSC risks and resilience have been published in other subject areas, including marketing, information management, social sciences, sector studies, and general management, ethics, and social responsibility. This is because new technologies and digitalisation have gradually transformed traditional AFSC, requiring researchers to re-consider the associated

risks and resilience (Min. 2019). Also, diverse AFSC risks must be tackled from different research angles, which may provide innovative approaches and new ideas to identify, categorise, analyse, monitor, and mitigate risks (Ali et al. 2019).

Table 2. Distribution of articles across journals in the review

#	Journal title	Article count	%
1	Supply Chain Management: An International Journal	12	12.63
2	Production Planning & Control (PP&C)	7	7.37
3	International Journal of Operations & Production Management (IJOPM)	6	6.32
4	International Journal of Production Research (IJPR)	6	6.32
5	International Journal of Production Economics (IJPE)	5	5.26
6	Journal of Cleaner Production (JCR)	5	5.26
7	The International Journal of Logistics Management (IJLM)	5	5.26
8	European Journal of Operational Research (EJOR)	4	4.21
9	International Journal of Physical Distribution & Logistics Management (IJPDLM)	4	4.21
10	Sustainability	3	3.16
11	Journal of Marketing Channels	2	2.11
12	Omega	2	2.11
13	OR Spectrum	2	2.11
14	Risk Analysis	2	2.11
15	Transportation Research Part E: Logistics and Transportation Review	2	2.11
16	Benchmarking: An International Journal	1	1.05
17	Business Horizons	1	1.05
18	Business Process Management Journal	1	1.05
19	China Agricultural Economic Review	1	1.05
20	Computers and Operations Research	1	1.05
21	Computers & Industrial Engineering	1	1.05
22	Health, Risk & Society	1	1.05
23	International Journal of Engineering Business Management	1	1.05
24	International Journal of Information Management (IJIM)	1	1.05
25	International Journal of Logistics: Research and Applications	1	1.05
26	Journal of Business Ethics	1	1.05
27	Journal of Dairy Science	1	1.05
28	Journal of Environmental Planning and Management	1	1.05
29	Journal of Food Distribution Research	1	1.05
30	Journal of Food Quality	1	1.05
31	Journal of Global Information Management	1	1.05
32	Journal of International Development	1	1.05
33	Journal of Modelling in Management	1	1.05
34	Journal of Operations and Supply Chain Management	1	1.05
35	Journal of Supply Chain Management	1	1.05
36	Knowledge and Process Management	1	1.05
37	Kybernetes	1	1.05
38	Management Decision	1	1.05
39	Supply Chain Forum: An International Journal	1	1.05
40	Technovation	1	1.05
41	The International Review of Retail, Distribution and Consumer Research	1	1.05
42	Thunderbrid International Business Review	1	1.05
43	World Development	1	1.05
	Total	95	100

With regard to the number of journal articles over the years, although fluctuations are observed in 2007, 2011, 2013, 2016, and 2018, a growing trend for publications on AFSC risks and/or AFSC resilience is observed from 2004 to 2020, reaching a peak in 2020 (n = 20; see Figure 2). This indicates that research relating to AFSC risks and/or AFSC resilience is consistently attracting more attention as time passes, particularly as the COVID-19 pandemic caused severe AFSC disruptions globally from 2019 to 2020 (Sharma et al. 2021). We assumed that the number of publications on AFSC risks and/or AFSC resilience would continue to increase in the following

several years for several reasons. *First*, COVID-19 vaccines are successful but it will take time to administer them globally. *Second*, greenhouse gas emissions will continue to worsen climate change until at least 2030, when they reach the peak set by the Paris Agreement in 2016. More uncertain impacts of climate change will further increase the production risks faced by the agricultural sector (Arora. 2019).

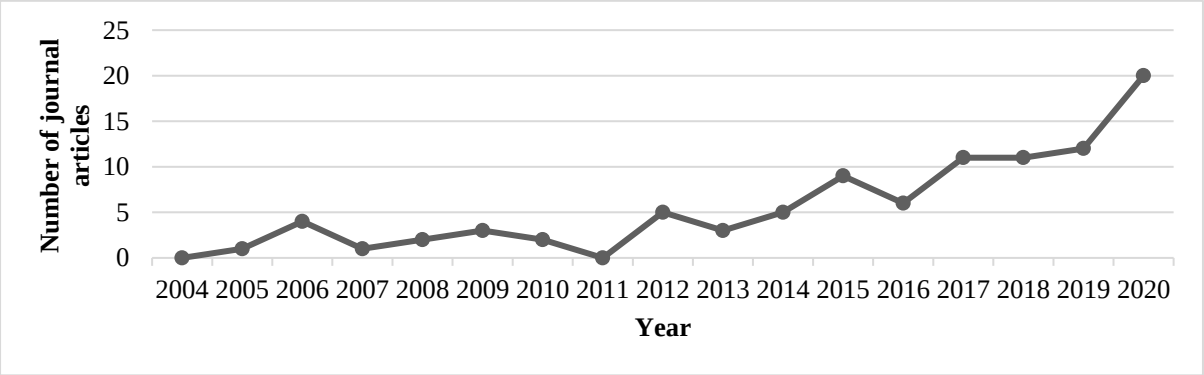

Figure 2. Number of relevant journal articles published 2004 – 2020

With regard to author's geographical locations, we find authors affiliated to institutions in 24 countries around the globe. The agricultural industry has received significant attention globally because agricultural growth raises the incomes of the poorest two to four times more effectively than other sectors (The World Bank. 2020). Most authors are affiliated to institutions in the United Kingdom (n = 14, 14.74%), USA (n = 13, 13.68%), China (n = 11, 11.58%), India (n = 8, 8.42%), Australia (n = 7, 7.37%), Brazil (n = 7, 7.37%), the Netherlands (n = 6, 6.32%), and New Zealand (n = 5, 5.26%). Interestingly, only one author was affiliated to Denmark, even though Denmark is a food and farming country that exports 24% of its agricultural product (Danish Agriculture & Food Council. 2019). This may be because AFSC risks are less severe in Danish AFSCs, as farmers are well-educated, major enterprises are farmer-owned co-operatives, knowledge is transferred efficiently across AFSCs, and intensive agricultural research and innovation activities are conducted (Danish Agriculture & Food Council. 2019).

Regarding types of AFSCs (see Table 3), considerable academic attention has been devoted to the AFSCs' risk management and resilience building in general (n = 51, 53.68%), but only a limited amount to different types of AFSCs (n = 44, 46.32%). For example, among countries in Asia (China, India, Iran, and Pakistan) and Oceania (Australia and New Zealand), emphasis has been placed mainly on SCRM for dairy products, grain, citrus, and wine. Dairy products have been a particular focus for several reasons. *First*, widespread use of melamine in infant milk formula severely disrupted China's milk production and consumers' confidence and trust in dairy producers (Xiu and Klein. 2010), thus attracting attention to risk management in Chinese dairy supply chains. *Second*, India has the highest level of milk production and consumption of all countries, but its dairy industry-related services are underdeveloped with a scarcity of fodder resources, lack of vaccinations for cows, and a shortage of access to credit, making quality control of its dairy supply chain a critical issue (Prakash et al. 2017). *Third*, Iran is 100% self-sufficient in milk and seeks to export its milk products to other countries (Beldman et al. 2017), while New Zealand's dairy products are its most important export commodity. Therefore, appropriate risk management and resilience strategies throughout their dairy supply chains are critical for opening up foreign markets. European studies (Italy, the United Kingdom, Germany, Denmark, the Netherlands, Switzerland and Portugal) have devoted considerable attention to risk management relating to fresh vegetables and fruits (e.g., potatoes, strawberries, and mushrooms), processed foods (e.g., canned tomatoes, oils, tomato sauce and beverage), and meat (e.g., pork, broilers and horsemeat). Risk management of beverage supply chains has been a particular focus in the UK and Italy, as beverages are the UK's largest manufacturing industry (Department for International Trade. 2020) and beverage industry revenues in Italy are expected to grow dramatically from $317 million in 2017 to $1,054 million in 2025 (Statista. 2020). Risk management relating to meat products in Europe has also received attention, particularly in the UK following the horsemeat scandal in 2013. Interestingly, the widest variety of AFSCs (e.g., potatoes, strawberries, mushrooms, meat and fast-moving consumer goods) investigated for resilience building among countries in Europe has been in the Netherlands. This is because the Netherlands has been ranked top for potato, strawberry and mushroom exports, and is the second-largest exporter of vegetables overall in terms of value. It also has highly intensive agricultural research and innovation activities (Runhaar. 2017; Banasik et al. 2019). In North America (Canada and the USA) considerable attention has been given to risk management of fruits, vegetables, eggs-and processed food, whereas in South America (Brazil), the focus has been on beef, sugarcane, mangoes and oranges.

Table 3. Emerged countries and associated AFSCs

Country	Examples of AFSCs	Author(s)(year)
Australia	Citrus and fresh food	Ali et al. (2017), Lau et al. (2018)
Brazil	Beef, sugarcane, orange, and mango	Klein et al. (2014), De Sa et al. (2018), Rodrigues et al. (2019), De Sa et al. (2020), Pereira et al. (2020), Rosales et al. (2020)
Canada	Fruit, dairy and vegetable	Blandon et al. (2009), Chen et al. (2014)
China	Grain, wine, milk and infant milk formula, fresh food	Ting et al. (2014), Yang and Xu (2015), Li et al. (2019), Yan et al. (2020)
Denmark	Dairy, broilers	Jensen et al. (2015)
Finland	Pork and oils	Kahiluoto et al. (2020)
Germany	Canned tomato, dairy	Pinior et al. (2015)
India	Grain, dairy, and halal food	Prakash et al. (2017), Maiyar and Thakkar (2020), Khan et al. (2020), Maiyar and Thakkar (2020), Rathore et al. (2020),
Iran	Rice, dairy, and packaged food products	Baghalian et al. (2013), Yavari and Zaker (2019)
Italy	Beverage and tomato sauce	Cigolini and Rossi (2006), Bottani et al. (2019)
Netherlands	Potato, meat, strawberry, mushroom, and fast-moving consumer goods	Kuwornu et al. (2009), Vlajic et al. (2013), Rijpkema et al. (2014), Scholten and Schilder (2015), Banasik et al. (2019)
New Zealand	Wine and dairy	Forbes and Wilson (2018), Moazzam et al. (2018)
Pakistan	Citrus	Naseer et al. (2019)
Portugal	Processed food	Amorim et al. (2016)
Switzerland	Canned tomato	Busse et al. (2017)
United Arab Emirates	Packaged food products	Laeequddin et al. (2009)
United Kingdom	Pork, horsemeat, drink, and beer	Leat and Revoredo-Giha (2013), Regan et al. (2015), Madichie and Yamoah (2016), Purvis et al. (2016), Gimenez-Escalante et al. (2020)
United States of America	Egg, processed food, and fresh vegetables	Kumar and Budin (2006), MacKenzie et al. (2017), Bumblauskas et al. (2020)

Regarding the research methodology adopted, case studies are frequently used (n = 34, 35.79%), including both single (21.05%) and multiple case studies (14.74%). We assumed that case studies would be the preferred research methodology in operations management because they are a powerful research technique for capturing the complexity of a single case and building a theory (Ebneyamini and Moghadam. 2018). Modelling (n = 23, 24.21%), theoretical and conceptual approaches (n = 12, 14.74%), surveys (n = 6, 6.32%) and literature reviews (n = 6, 6.32%) are also popular research methodologies. Other papers adopt a mixed-methods approach, including modelling and case study (n = 6, 6.32%), survey and modelling (n = 4, 4.21%), case study and survey (n = 3, 3.16%), and literature review and case study (n =1, 1.05%).

3.2 Thematic analysis

We analysed the 95 papers through thematic analysis. *First*, we uploaded each paper into NVivo 12 to assist the analysis process. *Second*, we thoroughly read each paper and categorised them into four categories, such as risk identification (n = 7, 7.36%), assessment (n = 16, 16.84%), mitigation (n = 71, 74.75%), and monitoring (n = 1, 1.05%) (see Appendix 3). In this process, some studies (e.g., Nyamah et al. 2017; Pereira et al. 2020) identified AFSC risks and also proposed risk mitigation measures, so we categorised them under risk mitigation. Other studies such as Gokarn and Kuthambalayan (2017) and Zhao et al. (2020) conducted an analysis of different AFSC risks involved risk identification and assessment; thus, we categorised them under risk assessment. Studies related to resilience such as supply chain collaboration and traceability, are all related to mitigation measures. Accordingly, we categorised them under risk mitigation. *Third*, we coded each paper such as relevant sentences and paragraphs that described risks or mitigation measures, highlighted them, and aggregated them into different themes. In this study, we are focusing on identification AFSC risks and resilience capabilities, and establishment connections between them. Thus, we extracted different risks from the literature and categorised them into eight categories (as shown in Table 4), as well as extracted different resilience capabilities from the literature and then categorised them into seven categories (as shown in Table 5). *Finally*, we generated a report related to various AFSC risks, AFSC resilience capabilities, and the linkages between AFSC risks and resilience capabilities.

3.2.1 Sources of risk for AFSCs

In many studies, supply chain risk is defined vaguely and ambiguously, with few clear and concise definitions (Baryannis et al. 2019). According to a recent literature review on SCRM, 82% of studies do not explicitly define

supply chain risk (Heckmann et al. 2015); instead, they either imply supply chain risk as a deviation from the expected objective, or provide no insight into the definition of risk (Ho et al. 2015). In this study, we chose to use Heckmann et al.'s (2015, p. 130) definition to identify AFSC risks, as it covers all core characteristics of supply chain risks: objective-driven risk, risk exposition and risk attitude. This defines supply chain risk as "the potential loss for a supply chain in terms of its target value of efficiency and effectiveness evoked by uncertain developments of supply chain characteristics whose changes were caused by the occurrence of triggering events".

The literature presents many AFSC risk sources and risk categorisations (Leat and Revoredo-Giha. 2013; Pereira et al. 2020). Early attempts to categorise AFSC risk adopted binary classifications, such as internal and external risks (Juttner et al. 2003), risk arising from either intentional or unintentional causes (Agiwal and Mohtadi. 2008), and macro- and micro-risks (Ho et al. 2015). AFSCs are facing greater risks as the lean philosophy has been widely applied to production and logistics to increase the efficiency of the whole supply chain, and firms are increasingly going global (Snyder et al. 2016). Therefore, researchers and practitioners are aware of a need to continuously review AFSC risk sources and develop appropriate AFSC risk classification schemes (Hudnurkar et al. 2017). For example, AFSC risks have been classified into three categories based on their level in the supply chain network: (i) risks from sources within the firm (process and control risk); (ii) risks from sources external to the firm but internal to the supply chain network (supply and demand risk); and (iii) risks from sources external to the supply chain network (environmental risk) (Leat and Revoredo-Giha. 2013). Pereira et al. (2020) extend this to six categories with the inclusion of sustainability risk, based on the assumption that the source of environmental risk lies in the macro-environment, whereas the source of sustainability risk lies in the organisation and supply chain. In terms of the supply chain process, AFSC risks can be classified into five categories: (i) sourcing risk; (ii) delivery risk; (iii) manufacturing risk; (iv) infrastructural risk, and (v) environmental risk (Christopher and Peck. 2004). These AFSC risk classification methods are similar, categorising risks based on either supply chain network levels or supply chain processes. However, they do not reflect the characteristics of agri-food products. Therefore, in this study, we classify AFSC risks into eight categories: supply risk, demand risk, financial risk, biological and environmental risk, weather-related risk, management and operational risk, logistical and infrastructural risk, and policy and regulatory risk. This is because characteristics of agri-food products, such as perishability, make them extremely vulnerable to climate change, biological risk and infrastructural problems (Firdaus et al. 2019), and because a majority of AFSC companies are SMEs, which are liable to be affected by financial and policy change problems (Zhao et al. 2020) (see Table 4).

In the supply risk category, ten AFSC risks are identified. Five articles (Diabat et al. 2012; Nyamah et al. 2017; Rathore et al. 2017; De Sa et al. 2020; Zhao et al. 2020) mention that farmers' inability to supply is a critical risk for two reasons. *First*, most agri-food products are seasonal and farmers production is limited, so they cannot respond to this risk if there is an increase in demand. *Second*, farmers globally are struggling with excess supplies of their products, as their harvests cannot be transported to potential customers owing to the COVID-19 pandemic (Pereira et al. 2020). Interestingly, ethical issues, such as collusion amongst suppliers to ration supplies and increase prices, may cause uncertainty in supply chains, as observed in the Indonesian food industry (Simangunson et al. 2016).

In the demand risk category, seven AFSC risks were identified. For example, food safety incidents include the "Chinese milk scandal" which led to the hospitalisation of 54,000 babies (Li et al. 2019), the "horsemeat scandal" that engulfed at least seven European countries and caused a dozen retail giants to recall beef products (Madichie and Yamoah. 2017), and foodborne diseases that caused 127,836 Americans to be hospitalised (Morris. 2011). These food safety disruptions have not only permanently damaged consumers' confidence, but have also caused reputational risks and have compromised the performance of the entire AFSC (Resende-Filho and Hurley. 2012). Governments are therefore seeking to formulate more strict food safety standards, but this will impose great pressure on AFSC participants (Nyamah et al. 2017; Rosales et al. 2020). Another stream of literature analyses the risk of power asymmetry/imbalance among AFSC partners. For example, Madichie and Yamoah (2017) conclude that, in a single supplier-multiple buyer relationship, buyers may tolerate unethical decisions by the supplier. Simangunsong et al. (2016) suggest that the Indonesian food industry is subject to abuses of power by large retailers at the expense of smaller competitors.

In the financial risk category, seven AFSC risks are identified. These would have severe effects on aspects of AFSCs such as production, market access, purchases agri-chemical products and insurance. Four articles (Gorton et al. 2006; Leat and Revoredo-Giha. 2013; Nyamah et al. 2017; Zhao et al. 2020) mention that delays in payment and even non-payment are frequent in AFSCs, as most farmers have weak bargaining power in the supply chain. Most agricultural activities are season- and weather-dependent, and all processes and stages of the AFSC are closely interconnected (Aday and Aday. 2020). Therefore, a slight delay or non-payment may trigger a butterfly effect, resulting in a substantial loss in yield and outputs (UNFAO. 2020).

Biological and environmental risks are associated mainly with reduced yield and quality disrupting AFSCs' flows of food and services. In the biological and environmental risk category, 13 AFSC risks are identified. Risks from pests and diseases have received considerable attention (Diabat et al. 2012; Pinior et al. 2015; Ali et al. 2017; Zhao et al. 2020) for two reasons. *First*, with globalisation and increased trade and travel, pests and

diseases are able to cross borders more easily and spread into new areas. *Second*, approximately 20-40% of global crop production is lost annually due to pests and diseases (UNFAO. 2019). In addition, skilled labour shortages, agro-terrorist attacks, political uncertainty, and economic downturns all receive relatively high attention. For example, skilled labour shortages are a serious, widely experienced problem in different countries. This is because, as skilled labour is more wage-oriented, agricultural automation and digitisation are increasingly forcing existing labour out of the agri-food industry, and COVID-19 will reinforce anti-globalisation and impede labour migration (Christiaensen et al. 2021). Weather-related risks have increased in recent years owing to rapid population growth and the influence of global warming. For example, extreme drought has been observed to affect Brazil's sugarcane supply chains (De Sa et al. 2018) and Australia's perishable product supply chains (Ali et al. 2017). In 2019, Australian bushfires burnt 14% of agricultural land (Strahan et al. 2019).

In the category of management and operational risk, extremely high attention has been given to forecasting and planning errors and potential restrictions on waste disposal. The former occurs frequently in AFSCs due to stakeholders' opportunistic behaviour in their quest for higher profit margins, the high perishability of agri-food products, difficulties in keeping safety stock, and heavily reliance on human judgements in planning (Ali et al. 2017; Nyamah et al. 2017). Food waste has various negative effects on AFSCs, reducing profit, labour productivity and wage, and increasing the emissions of greenhouse gases (Gokarn and Kuthambalayan. 2017). Most AFSC stakeholders are currently tackling agricultural waste through burning. However, stricter environmental standards will make this impossible in the future (European Court of Auditors. 2016).

Finally, 22 AFSC risks are categorised as logistical and infrastructure risk, and policy and regulatory risk.

Table 4. AFSC risks identified in the literature

AFSC risk categories	AFSC risk factors	Author(s)(year)
Supply risk	Farmers' inability to supply (5), supplier delivery delay (1), poor quality (1), fluctuations in supply market (2), limited knowledge of market requirements (1), collusion amongst suppliers to ration supplies and increase prices (1), distortions in information sharing (1), lack of information sharing among suppliers (4), forecast error (3), poor planning (1)	Chavez and Seow (2012), Diabat et al. (2012), Simangunson et al. (2016), Zsidisin et al. (2016), Nakandala et al. (2017), Nyamah et al. (2017), Prakash et al. (2017), Rathore et al. (2017), Naseer et al. (2019), Rodrigues et al. (2019), De Sa et al. (2020), Pereira et al. (2020), Zhao et al. (2020)
Demand risk	Volatile customer demand (5), customer preference changes (2), food price fluctuations (3), imbalance in offer and demand (2), changes in food safety requirements (5), power asymmetry/imbalance (2), lack of consumer trust and confidence (1)	Simangunsong et al. (2016), Ali et al. (2017), Lu and Koufteros (2017), Madichie and Yamoah. (2017), Nakandala et al. (2017), Nyamah et al. (2017), Rathore et al. (2017), Hendry et al. (2019), Zhou et al. (2019), Rosales et al. (2020), Zhao et al. (2020)
Financial risk	Inadequate financial support (1), delays in accessing financial support (2), uncertain financial support (credit) (1), uncertain interest and exchange rate policies (3), delay in payment and potential non-payment (4), bad debts (1), transaction risks (1),	Gorton et al. (2006); Leat and Revoredo-Giha. (2013), Nyamah et al. (2017), Stranieri et al. (2017), Zhao et al. (2020)
Biological and environmental risk	Thief (2), labour strikes (2), skilled labour shortage (3), high labour costs (1), pests and diseases (4), agro-terrorist attacks (3), contamination relating to poor sanitation and illness (1), contamination affecting food safety (3), contamination and degradation of production and processing processes (1), political uncertainty (e.g., war and protest) (3), economic downturns (3), rapid technological development (2), poor working conditions for employees (2)	Turvey et al. (2007), Chen. (2008), Diabat et al. (2012), Wang et al. (2012), Pinior et al. (2015), Ali et al. (2017), Nakandala et al. (2017), Prakash et al. (2017), Rathore et al. (2017), Forbes and Wilson. (2018), Hendry et al. (2019), Li et al. (2019), Pereira et al. (2020), Rosales et al. (2020), Zhao et al. (2020)
Weather-related risk	Excess rain (1), heatwaves (2), bushfires (2), extreme drought (3), flooding (2), extreme wind (1), big thunderstorms (1)	Ali et al. (2017), Nyamah et al. (2017), De Sa et al. (2018), Naqvi et al. (2020), Rathore et al. (2020),

		Zhao et al. (2020), Ali and Golgeci. (2021)
Management and operational risk	Use of outdated seeds/inputs (1), restricted water supply (1), forecast and planning errors (7), poor quality control (1), poor management decisions in asset allocation (1), tax evasion (1), lack of investment in promoting agri-food products (1), oral contract or agreement with partners (1), potential restrictions on waste disposal (7), decentralised supply chain structure (1), organisational mimicry (1),	Leat and Revoredo-Giha. (2013), Chen et al. (2014), Ali et al. (2017), Nyamah et al. (2017), Rathore et al. (2017), Voldrich et al. (2017), Hendry et al. (2019), Liu and Lee (2019), De Sa et al. (2020), Zhao et al. (2020)
Logistical and infrastructural risk	Poor performance of logistics service providers (1), inadequate storage capacity) (1), in-transit loss (1), many intermediaries (4), poor infrastructure and insufficient transportation planning (3), lack of timely availability of vehicles (1), poor packaging and preservation (1), poor handling-loading and unloading at different locations (1), changes in transportation (1), high energy costs (3), non-availability of procurement centre (2), power disruption (1), low technology risk (2),	Laeequddin et al. (2009), Srivastava et al. (2015), Ali et al. (2017), Nyamah et al. (2017), Rathore et al. (2017), Yavari and Zaker (2019), Pereira et al. (2020), Rathore et al. (2020), Rosales et al. (2020),
Policy and regulatory risk	Changing or uncertain monetary situation (1), fiscal and tax policies (4), changing and/or uncertain land policies and tenure system (1), changing and/or uncertain trade and market policies (3), changing and/or uncertain regulatory/legal policies and enforcement (1), animal welfare legislation adversely impacting competitiveness (3), inappropriate production policies (1), constitutional change (1), stricter environmental standards (1)	Maloni and Brown (2006), Taylor and Fearne (2006), Leat and Revoredo-Giha (2013), Srivastava et al. (2015), Simangunsong et al. (2016), Nyamah et al. (2017), Hendry et al. (2019), Khan et al. (2020)

Note: Numbers in brackets refer to the number of papers mentioning each risk

3.2.2 AFSC resilience capabilities

To identify capabilities that can be used to build AFSC resilience, we analysed the collected papers to find common themes. As illustrated in Table 5, the contributions are heterogeneous. *First*, seven resilience capabilities are identified that may significantly build AFSC resilience: supply chain collaboration, traceability, innovation, knowledge management (KM), redundancy, leadership, and flexibility. Of these, supply chain collaboration has received the most attention (Cadilhon et al. 2005; Laeequddin et al. 2009; Regan et al. 2015; Yan et al. 2020), and leadership the least (Adamides et al. 2012; Zsidisin et al. 2016). *Second*, an emerging trend is observed for scholars to adopt a KM perspective on building AFSC resilience. For example, knowledge sharing inversely moderates the adverse effect of operational risks (Ali and Gurd. 2020), mutually created knowledge enables visibility, velocity and flexibility (Scholten and Schilder. 2015), relational networking generates both industry and supply chain knowledge (Schoenherr et al. 2015), and effective employee training enhances food safety knowledge (Kumar and Budin. 2006; Ali et al. 2017). *Third*, to mitigate the effects of food safety disruptions and increase resilience, it is suggested that traceability should be embedded in AFSCs (Ringsberg. 2014). Traceability means the ability to track any food, feed, food-producing animal or substance that will be used for consumption through all stages of production, processing, and distribution (European Commission. 2007). Some authors (e.g., Stranieri et al. 2017; Min. 2019; Bumblauskas et al. 2020; Iftekhar et al. 2020; Rogerson and Parry. 2020) propose building traceability from a blockchain perspective. With regard to building redundancy, various measures are used, but insurance and multiple sources have received most attention (Leat and Revoredo-Giha. 2013; Yang and Xu. 2015; Zhao et al. 2020), such as non-payment of insurance to ensure that AFSC members are paid promptly (Leat and Revoredo-Giha. 2013), and contingent sourcing to help processors to recover quickly from disasters (Yang and Xu. 2015). *Finally*, innovation is suggested as a capability for building AFSC resilience. Recent literature focuses on two perspectives on facilitating innovation: the application of new technologies (e.g., blockchain, internet-of-things, mobile technology and detection technology) and organisations' soft environment building (Cadilhon et al. 2005; Klein et al. 2014; Bogataj et al. 2017; Kangogo et al. 2020).

Table 5. AFSC resilience capabilities identified in the literature

AFSC resilience capability	AFSC resilience capability factors	Author(s)(year)
Supply chain collaboration	Weather risk-reward contract (1), information sharing (4), collaborative communication (2), joint relationship efforts (1), long-term relationships with suppliers (1), trust (1), coordination contracts based on revenue sharing and wholesale price (2), collective action (2), ICT applications (3), option contract (2), joint purchasing (1), high social capital through active engagement within consortia (1), horizonal and vertical collaboration (1), collaborative planning forecasting and replenishment (1), public-private collaboration (2), consumer trust (3), accountability (1), farmer-buyer relationships (1), farmer entrepreneurship (1), low technology risk (2)	Cadilhon et al. (2005), Cigolini and Rossi. (2006), Taylor and Fearne. (2006), Chen (2008), Blandon et al. (2009), Kuwornu et al. (2009), Laeequddin et al. (2009), Diabat et al. (2012), Leat and Revoredo-Giha (2013), Regan et al. (2015), Scholten and Schilder (2015), Simangunsong et al. (2016), Ali et al. (2017), De Sa et al. (2018), Fu et al. (2018), Hendry et al. (2019), Zhou et al. (2019), Ali and Golgeci. (2020), Ali and Gurd. (2020), De Sa et al. (2020), Fan et al. (2020), Kangogo et al. (2020), Rosales et al. (2020), van Hoek (2020), Yan et al. (2020), Zhao et al. (2020),
Traceability	Blockchain-based technology (5), transaction risk (1)	Roth et al. (2008), Rong and Grunow (2010), Resende-Filho and Hurley. (2012), Stranieri et al. (2017), Min (2019), Bumblauskas et al. (2020), Iftekhar et al. (2020), Rogerson and Parry. (2020),
Innovation	Mobile technology applications (1), detection technology (1), internet-of-things infrastructure (1), industry 4.0 (1), blockchain's application (5), organisational culture (1), cloud computing (1),	Cadilhon et al. (2005), Klein et al. (2014), Bogataj et al. (2017), Madichie and Yamoah (2017), Forbes and Wilson (2018), Min (2019), Bumblauskas et al. (2020), Iftekhar et al. (2020), Ralston and Blackhurst. (2020), Rogerson and Parry. (2020),
Knowledge management	Mutually created knowledge (1), relational networking (1), effective employee training (2), knowledge sharing (1),	Kumar and Budin. (2006), Schoenherr et al. (2015), Scholten and Schilder (2015), Ali et al. (2017), Ali and Gurd. (2020), Morton (2020)
Redundancy	Supplier response diversity (1), supplier selection (2), distributed networks of locations (2), multiple sources (3), safety stock (1), insurance (3), government aid (1), contingency planning (2), two-layer network model for electricity (1), corporate social responsibility (1), multiple supply chains (1),	Kumar and Budin. (2006), Maloni and Brown (2006), Leat and Revoredo-Giha. (2013), Rijpkema et al. (2014), Pinior et al. (2015), Yang and Xu. (2015), Amorim et al. (2016), MacKenzie and Apte. (2017), Forbes and Wilson (2018), Lau et al. (2018), Reis (2019), Yavari and Zaker (2019), Behzadi et al. (2020), Gimenez-Escalante et al. (2020), Kahiluoto et al. (2020), van Hoek (2020), Zhao et al. (2020),
Leadership	Top management support (1), risk management attitude of leaders (1),	Dani and Deep (2010), Adamides et al. (2012), Zsidisin et al. (2016)
Flexibility	Supply chain re-design (1), business certifications (2), flexible transportations (1), globalisation (1), resilient work force (1),	Ali et al. (2017), Forbes and Wilson (2018), Yavari and Zaker. (2019), Ali and Gurd. (2020),

Note: Numbers in brackets refer to the number of papers mentioning each resilience capability factor

3.2.3 One-to-one resilience-risk correspondence model

This section explores relationships between AFSC risks and AFSC resilience capabilities by building a one-to-one resilience-risk correspondence model (see Figure 3). Our review results are heterogeneous. *First*, supply chain collaboration and traceability are both frequently identified as reducing AFSC risks, whereas other resilience

capabilities have received less attention. *Second*, supply, demand, biological and environmental and weather-related risks are significantly mitigated by applying various resilience capabilities, whereas other risks are seldom considered by scholars. *Third*, the benefits of maintaining a certain level of risk are completely neglected by scholars. In the next sub-sections, we demonstrate how supply chain collaboration, blockchain-enabled traceability, innovation, KM, redundancy, leadership and flexibility are used to reduce AFSC risks.

Supply chain collaboration has various benefits. For example, it facilitates access to new markets, provides sources of new knowledge, and increases innovation capacity, resource efficiency and stakeholders' negotiating power in the collaborative network (Camarinha-Matos and Abreu. 2007). It plays a critical role in reducing several AFSC risks. For example, more collaborative communication between upstream suppliers and downstream buyers may reduce delivery delays (Ali et al. 2018). Option contracts associated with stock-out penalties between farmers and retailers may force retailers to share market information with farmers and facilitate AFSC coordination, with the aim of mitigating the risk of uncertain demand (Zhou et al. 2019). Vertical and horizontal collaboration (e.g., information gathering and sharing, innovation, and lobbying) are effective in responses to constitutional change (Hendry et al. 2019). Sharing of available information (e.g., weather conditions, the number of agri-food products, and the available transportation methods) among different AFSC stakeholders may reduce the effects of dependence on a single model of transportation (Pereira et al. 2020). However, Cadilhon et al. (2005) and Taylor and Fearne (2006) state that information sharing among AFSC stakeholders is insufficient and must be accompanied by joint planning. Thus, some AFSC risks such as imbalance in offer and demand, opportunism, and weather-related risks, may be mitigated or avoided. Kangogo et al. (2020) suggest a novel way to reduce weather-related risks through building farmers' entrepreneurship. Working in combination helps farmers to access greater financial, technological, knowledge and network resources. Active engagement with consortia to accumulate social capital is also an effective method of helping AFSC stakeholders to recover from weather-related risks (Ali and Golgeci. 2021). To achieve a win-win situation under the influence of adverse weather, it is suggested that a guaranteed price mechanism-based risk-reward contract should be signed between farmers and wholesalers (Fu et al. 2018), enabling extreme weather conditions to be hedged and farmers' profits to be guaranteed. To reduce the risk of uncertain exchange rates to an acceptable level, Nyamah et al. (2017) suggest building collaborative relationships with financial companies and using a range of financial instruments such as financial hedges and operational hedges. Interestingly, suppliers' accountability to consumers has positive effects in mitigating or avoiding collusion issues, such as food adulteration and collusion amongst suppliers to ration supplies and increase prices (Regan et al. 2015; Simangunsong et al. 2016). Being accountable may force suppliers to question who is responsible and why these collusion issues occur, ultimately leading them to improve their behaviour. Finally, low technology risk is considered to be a positive factor in building trusting relationships among AFSC stakeholders, as it increases pressure on AFSC companies and the likelihood of AFSC investing in vertical integration (Laeequddin et al. 2009; Rosales et al. 2020).

Blockchain technology is an emergent digital technology with the four beneficial characteristics of being decentralised, immutable, consensual, and democratic (Zhao et al. 2019). It is playing an increasingly important role in enhancing AFSC resilience and reducing the risk of intermediaries' interventions (Min. 2019). Therefore, a combination of blockchain technology and the internet-of-things (IoT) has been extensively applied in AFSCs to enhance traceability, transparency and visibility. However, increased transparency and availability of data on supply structure may cause substantial damage to AFSC stakeholders if data are leaked (Pinior et al. 2015). Therefore, a two-layer structure based on blockchain is suggested, one for AFSC stakeholders and the other one for the public (Zhao et al. 2019). Bumblauskas et al. (2020) propose a blockchain-based framework for monitoring the humidity, location and temperature of eggs in the distribution process. Their research results indicate that blockchain-enabled traceability has positive effects in reducing food contamination, food fraud and food loss. Rogerson and Parry (2020) confirm that, to enhance AFSCs' visibility and increase consumer trust, blockchain-enabled traceability should be placed as a priority, as its decentralised and fully digitalised characteristics enable customers to know "when", "where" and "how" products are processed. Finally, blockchain-based traceability may reduce the risk of collusion if stakeholders address the problem of how to govern their blockchain networks properly (Rogerson and Parry. 2020). Although blockchain-based traceability allows agri-food products to be traced and tracked with high-precision, Resende-Filho and Hurley (2012) state that high-precision traceability systems do not strengthen food safety, whereas intensive contingent payments may encourage more engagement in food safety. Regarding voluntary adoption of traceability standards, Stranieri et al. (2017) propose that to reduce exogenous risks, traceability standards must be sufficiently flexible to respond to unexpected changes in market dynamics whereas, to reduce internal transactional risks, complex traceability standards are required, as these foster effective management across the whole AFSC.

Innovation is increasingly important for tackling AFSC risks, particularly in the era of industry 4.0. Deploying smart systems releases human intelligence and, therefore, encourages people to generate and utilise knowledge in their working processes, with positive impacts on dynamic inventory management, skills development, quality improvement, new marketing ideas and risk reduction (Ralston and Blackhurst. 2020). For example, analysing historical meteorological data using a combination of Big Data technology and IoT is an

effective way to address weather-related risks (Nyamah et al. 2017). To mitigate the effects of earthquakes, Forbes and Wilson (2018) suggest migrating essential transactional IT systems and databases to cloud computing platforms that can be fully accessed from any location. Embedding IoT in the cyber-physical system to monitor the movements of logistics services, will reduce post-harvest loss through automatic rerouting (Bogataj et al. 2017); and to ensure the quality of red wine, logistics data can be continuously mined to support ongoing planning and monitoring of quality assurance practices in the supply chain network (Ting et al. 2014).

KM is essential to enable AFSC partners to gain sufficient knowledge through efficient knowledge sharing and knowledge flows (Lee. 2004; Marra et al. 2012). Lack of professional knowledge and relevant expertise may cause bottlenecks in tackling AFSC risks (Zsidisin et al. 2016). To reduce food waste, knowledge of challenges to preventing and reducing waste must flow efficiently among AFSC partners (Gokarn and Kuthambalayan. 2017). Building reciprocal knowledge-sharing relationships with long-term AFSC partners to share data on production and distribution would bring huge benefits in controlling supply demand mismatch (Ali and Gurd. 2020). Ali et al. (2018) suggest that training and development opportunities to enable food organisations' employees to acquire knowledge play a critical role, as trained employees use resources more efficiently in response to disruptions. Scholten and Schilder (2015) find that joint knowledge creation and sharing relates to indirectly to mitigating disruptions by providing a deeper understanding of each company's processes to increase supply chain visibility and velocity. Besides knowledge generated within the AFSC, informal relationships among individuals, such as unplanned and random exchanges of information, may also help to assure agri-food product safety (Schoenherr et al. 2015). All members of the public, and particularly the poorly educated, should be given some knowledge of food safety and the food chain as this will have positive effects in changing consumers' perceptions of food system vulnerability (Turvey et al. 2007). Furthermore, changing consumers' perceptions will lead to AFSC stakeholders taking more responsibility for monitoring and truth-telling when food scandals occur (Chen. 2008). According to Zsidisin et al. (2016), knowledge of suppliers' quality management practices is effective in tackling poor-quality risk management.

Creating redundancy is an effective way to enhance resilience and reduce risks across supply chains (Kamalahmadi and Parast. 2016). To reduce food contamination, primary criteria such as quality and food safety should be considered in the supplier selection process (Lau et al. 2018). Critical attention should be given to suppliers that fulfil the requirements for business certification and accreditation schemes such as Hazard Analysis and Critical Point (HACCP), ISO22000, FASCAT and other food safe standards as they have lower rejection and return rates, and implement quality tests prior to each delivery (Huff et al. 2015; Ali et al. 2018; Li et al. 2019; Pereira et al. 2020). HACCP suggests using radio frequency identification (RFID) to avoid food recalls (Kumar and Budin. 2006). Furthermore, AFSC organisations must demonstrate corporate social responsibilities, for example with regard to animal welfare, sustainable supplies, responsible procurement, and fair trade. This will enable them to build their reputation and avoid negative criticism from society, as well as making them more able to respond to policy and regulatory risks (Maloni and Brown. 2006; Leat and Revoredo-Giha. 2013). Reis (2019) summarises the key issues for governments formulating food contingency plans, which include building a shared control and responsibility network among AFSC stakeholders, and involving more stakeholders in decision making. These measures may mitigate the effects of severe weather events. Government aid is another form of intervention that may help AFSC stakeholders to recover from natural disasters, although its use depends on the unit recovery cost compared with other methods, such as backup suppliers (Yang and Xu. 2015). Yavari and Zaker (2019) suggest that a two-layer electricity network may improve AFSCs' resilience and avoid power disruptions. Redundant electricity generation capacity is extremely important in the response and recovery phases, as it allows AFSC stakeholders to keep products refrigerated and access business systems and customer databases (Forbes and Wilson. 2018). To reduce the effects of volatile demand, a distributed localised manufacturing strategy is suggested. This enables the scale and location of manufacturing facilities to be modified (Gimenez-Escalante et al. 2020), thus avoiding long-distance transportation of raw materials and quickly adjusting production volumes to customer requirements.

Leadership is an essential capability for building AFSC resilience. For example, Dani and Deep's (2010) analysis of three food safety incidents (salmonella poisoning in peanut butter, Wal-Mart's response during Hurricane Katrina and the Chinese milk scandal), concludes that, amongst the factors identified (e.g., communication, multi-partner collaboration, resource allocation, escalation, and speed of response), leadership was the most important. Top management support is critical in rearranging resources to respond to disruptions, particularly involving multiple departments within a company (Zsidisin et al. 2016). At a supply chain level, only the leader of the supply chain (e.g., focal company) has the power to reconfigure resources to take control of a disruption. Thus, De Sa et al. (2020) propose that AFSC resilience should be built from the focal company perspective, rather than relying on each company in the AFSC to do so.

Flexibility is defined as the ability to adapt quickly to abnormal situations by adopting different measures (Lee. 2004). To avoid the effects of weather-related risks, Ali et al. (2018) propose acquiring flexible transportation capabilities by building long-term, reliable relationships with logistics service providers. They also suggest that taking advantage of globalisation is a flexible measure, as it will provide opportunities for local

farmers to access global markets. All flexible measures require implementation by the workforces. Therefore, Forbes and Wilson (2018) highlight the importance of staff willingness to do whatever it takes to recover and adapt.

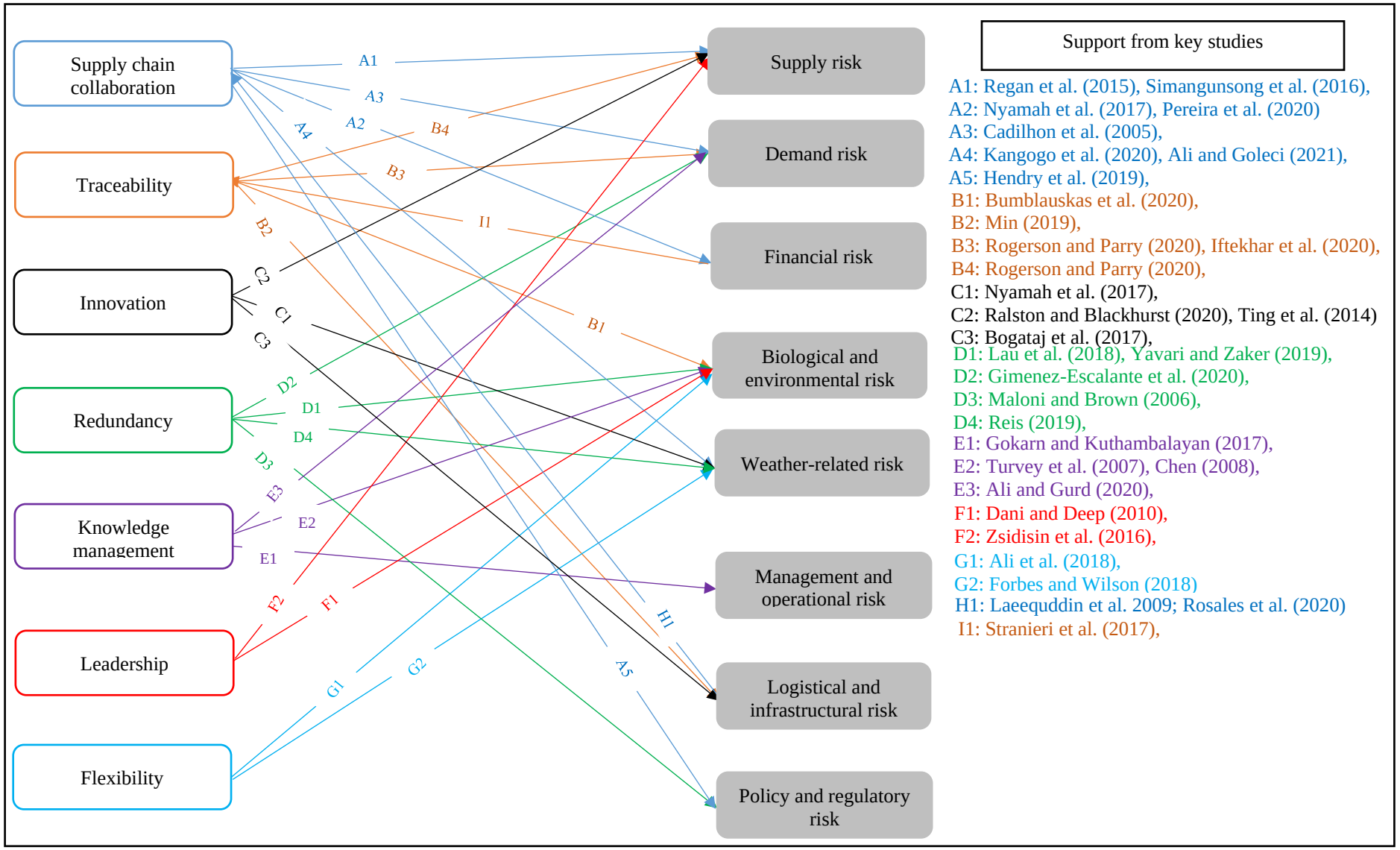

Figure 3. One-to-one resilience-risk correspondence model

4. Discussion, future research directions and contributions

In this section, we discuss research gaps in the extant literature, such as country coverage, agri-food products, methodologies, and content (see Table 6), and propose future research directions. Thereafter, we discuss the contributions of this study.

4.1 Directions for future research development

To address country-related gaps, we propose two future research directions. *First*, there is a need to conduct AFSC risk and resilience studies in African and South American countries, as existing studies focus mainly on countries in Asia, Europe, North America, and Oceania. Studies of Africa are extremely important, since 70% of its population relies on agriculture for a living, and more than 100 million people on the African continent face acute hunger (UNFAO. 2020). *Second*, comparative, cross-country AFSC risk and resilience analyses are needed to gain a deeper, more sharply focused understanding that offers new perspectives. Using comparative methods to test theories in different settings and examine existing AFSC resilience and risk mitigation models across different contexts will improve the adoption and implementation of AFSC resilience measures. In particular, comparative analyses of European and African countries will provide valuable insights into how underexplored countries can build AFSC resilience.

To address gaps relating to AFSC risk identification and assessment, our findings reveal that existing research employs a range of methods for prioritising risks and building interrelationships, such as interpretive structural modelling (ISM) (Diabat et al. 2012; Srivastava et al. 2015) and the fuzzy analytical hierarchy process (AHP) (Wang et al. 2012). However, each study adopts only one multiple-criteria decision-making (MCDM) method of risk assessment. Practical application of these research results may be challenging, as each MCDM method has its own limitations. Future research might combine two or more MCDM methods to overcome these limitations. For instance, combining AHP and ISM to identify key AFSC risks may provide more robust and reliable results for AFSC stakeholders. Comparison of the results of AHP and ISM may yield fruitful insights and deeper understanding. Furthermore, cross-case comparisons are necessary to understand product- and country-specific risk types, as current studies fail to provide comparative analyses of risk faced by various agri-food products. For example, both Iran and New Zealand have achieved 100% self-sufficiency in milk and export their milk products to other countries. However, our systematic literature search reveals that no comparative studies have analysed the risks faced by these two countries' milk supply chains. Therefore, cross-case comparisons should be conducted to provide AFSC practitioners with a clear understanding of product- and country-specific risk types.

To address the gaps relating to AFSC resilience building, several future research directions are proposed. *First*, there is a need to clarify the relationship between the resilience of the focal firm and that of whole AFSC, as AFSC resilience does not require all organisations to become resilient, but rather relies on the focal company being able to reconfigure resources to control disruptions (De Sa et al. 2020). Research should seek to evaluate firms' positions in the AFSCs and their inter-firm relationships to determine which firms are focal, how focal firms can activate resilience by deploying specific resources, structures and processes, and what focal firms should do to leverage resilience across the whole AFSC. *Second*, future research should investigate what resilience capabilities are suitable for different AFSCs, as each agri-food product has different characteristics and infrastructure. For example, tropical fruits and infant food have differing expiry and perishability dates, requiring different resilience capabilities to respond to the same AFSC disruptions. *Third*, there is a need to understand how to evaluate AFSC resilience, because insufficient understanding of the level of AFSC resilience, makes it difficult to assess the effectiveness of resilience strategies implemented in the anticipation, resistance, recovery, and response phases (Kamalahmadi and Parast. 2016; Linnenluecke. 2017). Existing studies consider how to assess SCRes associated with various disruptions such as natural disasters and uncertain demand (Yang and Xu. 2015; Maiyar and Thakkar. 2020), but only a few studies provide a unified framework for evaluating AFSC resilience. Future research might investigate and summarise the different resilience assessment schemes used in discrete case examples to provide a unified framework that is more generalisable to different contexts and settings. *Fourth*, existing studies have investigated traceability from various perspectives (Stranieri et al. 2017; Min 2019; Bumblauskas et al. 2020; Iftekhar et al. 2020), including technology, planning and conceptualisation perspectives. However, no studies appear to have identified and prioritised the various resilience capability factors that have positive effects in building AFSC traceability. An empirical study might be conducted to identify which factors are most beneficial for building AFSC traceability, using modelling methods such as AHP and ISM to prioritise these factors, which will enable practical guidance to be provided to AFSC stakeholders on deploying traceability technology. *Fifth*, although industry 4.0 technologies such as blockchain, Big Data, robotics, and IoT have been found to be effective in developing new skills and enhancing human resource capabilities (Ralston and Blackhurst. 2020), their efficacy in building AFSC resilience has not been extensively explored. This maybe because industry 4.0 technologies are new, and their application needs time and presents challenges, including the need for standards, farmers' ability to modernise, and modernisation of infrastructure. Thus, interviewing experienced AFSC stakeholders may help reveal which industry 4.0 technologies may be most beneficial for which dimensions of AFSC resilience (e.g., flexibility and redundancy). *Sixth*, there is a need to investigate the relationship between

supply chain collaboration and other AFSC resilience capabilities, since existing research focuses on detailed collaborative activities such as information sharing, trust-building, and contract application (Kangogo et al. 2020; Rosales et al. 2020; van Hoek 2020; Yan et al. 2020), rather than considering supply chain collaboration as a whole. Future research might investigate interrelationships between different AFSC resilience capabilities to examine whether supply chain collaboration may help foster other resilience capabilities. *Seventh*, there is a need to understand what kinds of resources and capabilities - both tangible and intangible - should be built and configured to achieve optimal resilience. For example, it is vital to investigate the roles of knowledge, collaborative capacity, accountability, customer connectivity, and innovative spirit in building AFSC resilience, as these intangible resources are increasingly important in building sustainable and resilient AFSCs (Sumane et al. 2018). The *eighth* gap lies in the need to strengthen research on KM, as knowledge exchange hubs in Europe and North America reveal the important role of KM in building AFSC resilience. Thus, investigating cross-boundary knowledge mobilisation is necessary. Future research might explore what kinds of knowledge (e.g., local, practice-based, tacit and explicit) are most beneficial for building AFSC resilience, what knowledge networks should be built to facilitate knowledge transfer, and how knowledge networks and trans-disciplinary knowledge can be combined to overcome knowledge boundaries to maximise effectiveness. Finally, there is a need to explore how to achieve AFSC resilience from the consumers' perspective. In fact, it is widely accepted that consumers' trust in manufacturers and third-party logistics fosters their confidence in food safety - for example in relation to milk products (Li et al. 2019), and that consumers' sense of responsibility accelerates the process of food product recalls (Regan et al. 2015). Further studies might investigate the role of consumers' trust and responsibility in fostering AFSC resilience, and identify the related mediators and drivers.

Concerning gaps relating to the relationship between AFSC resilience capabilities and AFSC risks, it is widely recognised that the former have positive effects in reducing the latter. However, existing studies fail to consider that a certain level of supply chain risk may help to elicit collaborative activities among AFSC stakeholders (Stranieri et al. 2017; Rosales et al. 2020), as researchers assume that risks always have adverse effects. Future research might: examine what risks may be intentionally tolerated by AFSCs to facilitate collaboration and coordination. Future studies might also investigate the positive effects of AFSC risks, to determine whether a certain level of risk may elicit collaborative activities and greater risk awareness among AFSC stakeholders, and further increase AFSC resilience. Extant research fails to clarify the relationship between AFSC resilience capabilities and AFSC risks, so empirical studies are required in different contexts and settings to build a one-to-one correspondence between AFSC resilience capabilities and AFSC risks and produce generalisable results.

Agriculture and food production are the main drivers toward achieving the United Nations goal of net-zero emissions no later than 2050 (United Nations. 2019). In this context, considerable research attention has been given to ways to achieve environmental sustainability and AFSC resilience simultaneously (Gokarn and Kuthambalayan. 2017; Ali et al. 2019; Banasik et al. 2019; Yavari and Zaker. 2019; Gimenez-Escalante et al. 2020). However, existing studies neglect to integrate the lean, agile, resilient and sustainable (LARS) characteristics to achieve less waste, fewer emissions, and faster responses by AFSCs. This opens avenues for further research on how to equip employees with new skills using existing digital technologies and to fulfil the core characteristics of industry 5.0. Resilience is a multi-disciplinary concept that has been successfully applied in various disciplines, including ecology, psychology, economy, metallurgy and engineering (Coulson et al. 2017; Bag et al. 2019). However, studies taking a holistic view on resilience from different disciplinary perspectives are lacking. Attempts to "borrow" concepts, resilience capabilities, and resilience capability factors from other disciplines should be encouraged, as this may reveal new dimensions and have a significant impact on AFSC resilience.

4.2 Contributions to theory and managerial practices

This study makes several important contributions to theory and managerial practices. As for the contributions to theory, *first*, the novelty of this study compared with existing SLRs is that it provides a one-to-one resilience-risk correspondence model. None of the recent literature reviews on SCRes and SCRM match risks with resilience capabilities in the context of AFSCs. For example, Bak et al. (2020) conducted a SLR of SCRes in SMEs. Their research results concentrate on four focal areas for building resilience - collaboration and culture, SME's capabilities, information systems, and cost and financing. Phillips and Chao (2022) discuss resilience definitions from the system theory perspective. Fan and Stevenson (2018) present SCRM definitions, theory used, and future research agenda, whereas Spieske and Birkel (2021) investigate industry 4.0 and SCRes. Empirical studies either focus on SCRes assessment (Choudhary et al. 2021; Shi and Mena. 2021), SCRes framework building (Dubey et al. 2019; Vanany et al. 2021), or explore the relationships between SCRes and operational performance (Bag et al. 2021; Yu et al. 2022). As a general consideration, a comprehensive analysis that links AFSC risks and resilience capabilities based on existing literature is scant. This study fills this gap through reviewing 95 articles and building a framework to link AFSC risks and resilience capabilities. *Second*, this study presents a clear picture of the recent developments of AFSC resilience and risks based on the relevant features, such as the methodology adopted, AFSC risk sources, agri-food products investigated, and others. We synthesised existing evidence from the

literature, proposed research gaps, and generated corresponding future research directions. We proposed 20 future research directions based on the country, agri-food products, methodology adopted, AFSC risk identification and assessment, AFSC resilience capabilities, the relationships between AFSC risks and resilience capabilities, and the relationship between resilience and other disciplines. Because AFSC resilience is a fragmented and heterogeneous area, a SLR is critical for guiding future research. *Third*, we refreshed researchers' knowledge in terms of risks and resilience capabilities that exist in the context of AFSCs. For example, we identified 55 resilience capabilities that were used to mitigate AFSC risks, and 77 AFSC risks that exist in AFSCs.

This study also makes contributions to managerial practices. *First*, a critical question for most of AFSC practitioners is how to mitigate risks, particularly for those practitioners who lack knowledge in several areas, such as what approaches and techniques are available to use, and what strategies can be implemented and their effects. The situation is even worse for the low-educated practitioners living in rural areas, such as most of the farmers are running their family-business and have limited channels to receive knowledge. Our study sets out clear guidance for AFSC managers and assists them in the decision-making process in how to use resilience capabilities to mitigate risks, as we linked each risk with resilience capabilities through extracting information from the existing literature. *Second*, we did not only summarise frequently mentioned AFSC risks (e.g., farmers' inability to supply and volatile customer demand) and resilience capabilities (e.g., insurance and blockchain-based technology); we also draw attention to the rarely mentioned ones. Our study has the potential to increase the risk and resilience awareness of AFSC practitioners and update their knowledge related to SCRes and SCRM. *Third*, our study elicits how to embed resilience into AFSCs. That is, from the *supply chain collaboration* perspective, implement collaborative initiatives (e.g., collaborative communications, collective action, and public-private collaboration) and deploy ICTs such as cloud computing to deliver services through the internet; use IoT-based blockchain to monitor the logistic service; facilitate information sharing at the department, organisational and supply chain levels, and keep low technology risk to force AFSC partners to meet regularly and check their systems. From the *innovation and traceability* perspectives, we suggest that practitioners follow the latest academic developments to deploy industry 4.0 technologies (e.g., blockchain and IoTs), facilitate digital transformation, and nurture innovation culture at the organisational level. From the *KM* perspective, effective employee training to facilitate knowledge sharing is necessary (e.g., quality management and technology adoption), which can be achieved through forming university-industry collaboration or linking with knowledge hubs across the EU or other non-profit agricultural organisations. From the *redundancy* perspective, safety stock, multiple stocks, and insurance are critical for AFSC practitioners' survival from disasters and disruptions, particularly in the environment where climate change is accelerating. Finally, from the *leadership and flexibility* perspectives, the awarding of universal applied business certifications such as food safety certificate ISO22000 to ensure product quality, and acquiring top management's support to build risk management culture will be useful for AFSC practitioners to survive in this volatile business environment.

Table 6. Proposed future research directions based on the literature

	Evidence of literature	Research gaps	Future research directions
Country	▪ Focus on countries in Asia, Europe, North America and Oceania ▪ Analyse only single countries' AFSC	• Lack of studies on countries in Africa and South America • Lack of comparative analysis of country- and product-specific risk/resilience	➢ Conduct AFSC risk/resilience studies in Africa and South America ➢ Conduct comparative cross-country AFSC risk/resilience analysis with interdisciplinary teams of researchers
Agri-food products	▪ Focus mainly on dairy products, wine, beef, fruit, fresh vegetables, and processed food	• Lack of studies on pork, infant food, animal feed and beverage supply chains	➢ Conduct research on building AFSC resilience in pork, infant food, animal feed, and beverage supply chains
Methodology	▪ Use various research methodologies, including case study (34) (21.05% single case study and 14.74% multiple case studies), modelling (23), theoretical and conceptual (12), surveys (6), literature review (6), and mixed-methods approaches (14) ▪ All studies adopt a cross-sectional strategy	• Lack of cross-country analysis using multiple case studies as a research methodology • Lack of research using longitudinal strategy	➢ Conduct cross-country analysis of AFSC risk/resilience management using multiple case studies ➢ Conduct research using a longitudinal strategy
AFSC risk identification and assessment	▪ Explore AFSC risks from different perspectives: risk prioritisation and interrelationships building (9), quantitative decision models for agri-food business (1), the impact of risks on AFSC performance (2) and transportation systems (1), power asymmetry in AFSC crises (1), identification and analysis of how AFSC risks impact on AFSC's coordination (1), potential for climate shocks to cascade within a region (1)	• Lack of risk identification and assessment using cross-case analyses • Lack of prioritisation and interrelationship building using two or more methods	➢ Conduct cross-case comparisons to better understand product- and country-specific risk types ➢ Perform risk prioritisation and interrelationship building using two or more decision-making methods
	▪ Help to understand AFSC resilience with a focal company perspective (1), a critical realist paradigm (1), AFSC resilience features (3) and resilience theoretical framework building (2) ▪ Identify AFSC resilience capabilities' in different types of supply chains, including mango (1), cold chains (1), perishable products (1), processed foods (1), and milk supply chain (3) ▪ Quantify AFSC resilience in different contexts, such as perishable good with possible port shut downs (1), grain supply chain with an upstream natural disaster	• Failure to examine the relationship between a focal company's resilience and the whole AFSC's resilience • Failure to identify resilience capabilities from the perspective of the wine, infant food, and animal feed supply chains • Failure to measure AFSC resilience	➢ Examine whether a focal company's resilience may foster the whole AFSC's resilience and through which channels ➢ Conduct exploratory case studies to understand what AFSC resilience capabilities can be used for pork, infant food, animal feed, and beverage supply chains ➢ Develop a unified resilience assessment framework to evaluate AFSC resilience

	(1), robust supply chain design or optimisation with uncertain supply and intentional disruptions (3), recovery model for food contamination (1), identification and quantification of AFSC resilience performance indicators (1), ▪ Investigate traceability from different perspectives, such as information systems and technology development (5), production and distribution planning (2), information asymmetry and traceability incentives (1), traceability framework building (1),	• Failure to identify and prioritise different resilience capability factors in building AFSC traceability	➢ Conduct empirical research to identify and prioritise different resilience capability factors in building AFSC traceability
Resilience capabilities for building AFSC resilience	▪ Investigate innovation to build AFSC resilience, such as industry 4.0 (9), and mobile technology (1), ▪ Explore AFSC collaboration in supplier selection (2), collaboration level (1), collaborative commerce (1), farmers' entrepreneurship and participation (2), contract application (3), trust-building (1), and vertical and horizontal collaboration (2), ▪ Explore redundancy in corporate social responsibility (1), contingency plans (3), sourcing strategies (1), multiple supply chains (1), and response diversity (1) ▪ Investigate KM to build AFSC resilience, such as knowledge sharing (1) and relational networking (1), ▪ Analyse consumer effects on building AFSC resilience, such as consumers' responsibility (1), trust (2), consumers' perceptions of risks (1), and AFSCs' coordination based on consumers' behaviour (1)	• Lack of empirical research on the impact of the application of different industry 4.0 technologies on AFSC resilience • Failure to consider supply chain collaboration as a whole and investigate its relationship with other resilience capabilities • Failure to consider what kinds of resources (tangible and intangible) and capabilities should be reserved to promote resilience • Failure to consider the role of knowledge mobilisation in building AFSC resilience • Failure to investigate how to foster resilience from the consumers' perspective	➢ Conduct empirical research on the impact of industry 4.0 technologies on AFSC resilience ➢ Consider supply chain collaboration as a whole, and investigate whether it may foster other resilience capabilities ➢ Investigate what resources and capabilities should be fostered and configured to achieve optimal resilience outcomes ➢ Conduct research on boundary-crossing mechanisms to tackle knowledge boundaries in AFSC ➢ Conduct exploratory case studies to understand the impact of consumers' trust/responsibility on AFSC resilience
The relationships between AFSC resilience capabilities and AFSC risks	▪ Analyse the effects of different resilience strategies on AFSC risks, such as knowledge sharing on operational risks (1), resilience strategies to reduce ethical issues (1) and COVID-19 pandemic impacts (2), resilience model to reduce quality risks (2), social capital for reducing climate risks (1), trade-offs between disruption and resilience strategies (1), local AFSC resilience to constitutional change (1), food inspection agency to reduce food safety issues (1), resilience model for earthquakes (1), vertical and horizontal supply chain collaboration to reduce	• Failure to clarify the relationship between AFSC resilience capabilities and AFSC risks • Failure to consider the positive effects of AFSC risks in facilitating AFSC resilience	➢ Develop empirical resilience models to clarify the relationship between AFSC resilience capabilities and AFSC risks ➢ Revisit existing studies and conduct exploratory case studies to investigate a what level of risk triggers which activities in the AFSC and fosters AFSC resilience

	vulnerabilities (1), and collaboration to reduce demand uncertainties (1)		
Understanding the relationship between resilience and other disciplines	▪ Resilience and environmental management, for instance to understand the alignment between resilience and environmental sustainability (2), and the relationship between resilience practices and environmental sustainability (2), and analyse factors inhibiting resilience and environmental sustainability (2) ▪ Resilience and human immune systems, such as using the concept of human immune systems to build SCRes (1)	• Failure to consider how to build LARS (Lean, Agile, Resilient, Sustainable) AFSCs • Failure to consider resilience in other systems/disciplines and clarify the relationship with AFSC resilience	➢ Summarise the characteristics of lean, agile, and sustainable AFSCs, and combined with the characteristics of resilient supply chains to create a LARS AFSC model ➢ Consider academic cross-pollination from other disciplines (e.g., medicine and engineering) and add new dimensions to AFSC resilience

Note: Numbers in brackets refer to the number of papers

5. Conclusions

In this study, we adopted a SLR approach to identify and analyse 95 articles published between 2004 and 2020 in 43 scientific journals on AFSC risk and resilience management. Overall, this review suggests that, despite some progress in understanding AFSC risks, AFSC resilience and the relationships between AFSC risks and AFSC resilience capabilities, significant gaps remain.

This study makes two key contributions to the field. *First*, we build a novel one-to-one resilience-risk correspondence model by summarising the AFSC risks, AFSC resilience capabilities and their interrelationships identified in the literature. Our literature review reveals that most studies propose resilience capabilities to reduce supply, weather-related and biological and environmental risks, whereas other risk types receive relatively little attention. Furthermore, a certain level of transactional and technological risk may promote traceability and collaborative activities. Future research might investigate whether a certain level of risk may trigger AFSC resilience, and through what channels, methods and activities.

Second, this study illustrates recent issues in the AFSC risk and resilience management area by summarising key characteristics of recent research (e.g., years, countries, research context, and research methodology), thereby identifying trends and research gaps. For example, with regard to the countries investigated, most empirical studies have used data collected from a single country (e.g., the United Kingdom, the USA, China, India, Australia), highlighting a need for more comparative cross-country analysis. The evidence also suggests that more empirical research should be conducted in less explored countries, such as in Africa and South America. Regarding the agri-food products investigated, the results are heterogeneous, but the focus has been on dairy products, wine, beef, fruit, fresh vegetables and processed foods. Our results suggest that research should be conducted on a wider variety of agri-food products, such as pork, infant food, animal feed, and beverage as each product has particular characteristics. Regarding the research methodologies adopted, we identify overreliance on cross-sectional research strategies, whereas longitudinal research is lacking. The latter may be more effective for capturing which AFSC resilience capabilities may have a long-term effects in reducing risks, since more than 80% of companies in AFSCs are SMEs (Dong. 2021). With regard to the content of research, we categorise the papers into four groups that address (1) AFSC risk identification and assessment, (2) resilience capabilities for building AFSC resilience, (3) relationships between AFSC resilience capabilities and AFSC risks, and (4) understanding the relationship between resilience and other disciplines. Most studies have focused on identifying capabilities for building AFSC resilience in different settings and research contexts, whereas the other three areas have received less attention. Our analysis of group 1 establishes a need to conduct cross-case comparisons and use different assessment methods to acquire a deeper understanding of AFSC risks. The analysis of group 2 reveals that most studies address AFSC resilience from the perspectives of the supply chain collaboration, traceability, and redundancy, whereas very few consider this topic from the perspectives of focal company, consumer trust/responsibility or knowledge mobilisation. Furthermore, our findings suggest that most research fails to consider AFSC resilience measurement, the influence of industry 4.0 technologies on AFSC resilience, and how to configure resources and capabilities to achieve optimal resilience outcomes. In group 3, although resilience capabilities promise positive results in reducing AFSC risks, the outcomes are vague with respect to which resilience capabilities are useful for reducing which AFSC risks. Therefore, a one-to-one correspondence model was suggested to build between AFSC resilience capabilities and AFSC risks through conducting empirical studies. Finally, the analysis of group 4 reveals that studies have considered how to achieve "resilience plus" by integrating other disciplines, such as AFSC resilience and environmental sustainability. Future research might investigate how to create a LARS AFSC and add new dimensions to AFSC resilience through academic cross-pollination from other disciplines.

A weakness of this study is that certain literature sources were neglected, including unpublished works, book chapters, and conference papers. Nevertheless, we are confident that our literature review makes a worthwhile and meaningful contribution to knowledge and research through its systematic, clear, and rigorous approach to searching for relevant journal publications.

Data availability statement: The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials.

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Appendix 1. Keywords and search strings

Keywords	"disruptions", "risk", "vulnerability", "uncertainty", "risk management", "sources of risk", "risk analysis", "risk assessment", "crisis", "threat(s)", "risk assessment", "resilience", "resiliency", "resilient", "robustness", "mitigation", "food supply chain/food value chain", "agricultural supply chain/agricultural value chain", "agri-food supply chain/agri-food value chain", "agribusiness", "perishable supply chain/perishable value chain", "seasonal goods supply chain/seasonal goods value chain"
Databases	Web of Science, Business Source Complete, Emerald, and Taylor & Francis Online
Search strings	("disruptions" OR "risk" OR "vulnerability" OR "uncertainty" OR "risk management" OR "sources of risk" OR "risk analysis" OR "crisis" OR "threat(s)" OR "risk assessment") AND/OR ("resilience" OR "resiliency" OR "resilient" OR "robustness" OR "mitigation") AND ("agricultural supply chain/agricultural value chain" OR "food supply chain/food value chain" OR "agri-food supply chain/agri-food value chain" OR "agribusiness" OR "perishable supply chain/perishable value chain" OR "seasonal goods supply chain/seasonal goods value chain")

Appendix 2. Literature analysis (Submission for review)

Studies	Focus of investigation	Research methodology	Geographical location	Types of AFSCs	AFSC risks involved	Risk reduction method/Resilience strategy used
Cadilhon et al. (2005)	To demonstrate that collaborative commerce is not restricted to trade in branded products between large, multi-national organisations	Single case study	Vietnam	Not specified	Not mentioned	Collaborative commerce
Cigolini and Rossi (2006)	Develop and test a methodology to evaluate the most appropriate collaboration level within a given supply chain	Single case study	Italy	Food and beverage supply chain	Supply risk	Supply chain collaboration
Kumar and Budin (2006)	Explore prevention and management of product recalls	Theoretical and conceptual	USA	Processed food	Food product recalls	Insurance, effective employee training, hazard analysis and critical control point, and radio frequency identification
Maloni and Brown (2006)	Develop a comprehensive framework of supply chain corporate social responsibility in the agri-food industry	Literature review	USA	Not specified	Public criticism of corporate social responsibility	Not mentioned
Taylor and Fearne (2006)	Highlight the problems with and propose a framework for improving demand management in retail food supply chains	Multiple case studies	United Kingdom	Not specified	Customer demand volatility, poorly manage demand, mis-alignment of demand and activity along the chain	From technology and organisation two dimensions to improve resilience
Turvey et al. (2007)	Explore consumers' perception of food system vulnerability to an agro-terrorist attack	Survey	USA	Not specified	Agro-terrorist	Not mentioned
Chen (2008)	Investigate the relationships between consumer's trust in food safety and the antecedents of risk perceptions of foods	Survey and modelling	Taiwan (China)	Not specified	Food safety	Consumer trust
Roth et al. (2008)	How to improve product quality through supply chain quality management	Theoretical and conceptual	USA	Not specified	Food quality risk	Trust, training, traceability, transparency, testability, and time
Blandon et al. (2009)	Explore the role of transaction costs and collective action in shaping small-scale farmer participation in the fresh and vegetable supply chain to supermarkets	Theoretical and conceptual	Canada	Fruit and vegetable	Not mentioned	Low transaction cost and collective action

Kuwornu et al. (2009)	Assess the interaction of marketing channel members through the use of contracts and its impact on incentives, coordination costs, risk aversion, risk allocation, and risk management strategies	Theoretical and conceptual	Netherlands	Potato	Not mentioned	Increase in incentives to producers and wholesalers
Laeequddin et al. (2009)	Develop trust among supply chain partners' through risk evaluation	Survey	United Arab Emirates	Packaged food products	Economics risk, technology risk	Not mentioned
Dani and Deep (2010)	Identify and understand the varied approaches, the contributing factors and the relevant legislation towards risk control as a reactionary measure in the food sector	Theoretical and conceptual	United Kingdom	Not specified	Food safety incidents	Leadership, communication, multi-partner collaboration, etc.
Rong and Grunow (2010)	Develop a production and distribution planning model for food supply chains to address food safety risks	Modelling	Finland	Not specified	Food safety risks	Production and distribution planning
Adamides et al. (2012)	How a critical realist paradigmatic stance and its associated research methodology can contribute to supply chain research	Theoretical and conceptual	Greece	Not specified	Promotion bias of the manufacturer, risk management attitude of resellers	Not mentioned
Chavez and Seow (2012)	Propose an integrated supply chain risk management framework for practitioners that can provide directions for how to evaluate food quality risk in the global supply chain	Theoretical and conceptual	United Kingdom	Not specified	Quality risk, price risk, technology risk, and environmental risk	Trust, training, traceability, testability, transparency
Diabat et al. (2012)	Analyse the various risks involved in a food supply chain with the help of interpretive structural modelling	Modelling and case study	United Arab Emirates	Not specified	Twenty AFSC risks were identified and analysed	Not mentioned
Resende-Filho and Hurley (2012)	Explore how traceability could improve food safety by facilitating incentive based contracts that encourage upstream firms to exert effort into providing safer material	Modelling	Brazil	Not specified	Food safety risk	Traceability, food regulation, and food policy
Wang et al. (2012)	AFSC risk assessment	Modelling	United Kingdom	Not specified	Food safety and quality risk	Not mentioned
Baghalian et al. (2013)	Design a network of multi-product supply chains comprising several capacitated production facilities, disruption centres and retailers in markets under uncertainty	Modelling and case study	Iran	Rice	Supply and demand uncertainties	Supply chain reengineering

Leat and Revoredo-Giha (2013)	Examine one of Scotland's major pork supply chain and seek to identify the key risks and challenges involved in developing a resilient AFSC	Single case study	United Kingdom	Pork	Production risk, market risk and institutional risk	Animal welfare guarantees, contracted access, disease monitoring and control, insurance, input price support, etc.
Vlajic et al. (2013)	Use vulnerability performance indicators to attain food supply chain robustness	Modelling and case study	Netherlands	Meat	Not mentioned	Not mentioned
Chen et al. (2014)	Explore quality control in food supply chain management	Single case study	Canada	Dairy	Food safety	Information visibility, corporate social responsibility, and regulatory action
Klein et al. (2014)	Analyse the use of mobile technology for management and risk control in the Brazilian beef supply chain	Single case study	Brazil	Beef	Food safety	Mobile technologies
Rijpkema et al. (2014)	Assess whether an existing sourcing strategy can effectively supply products of appropriate quality with acceptable levels of product waste if applied to an international perishable product supply chain	Case study and modelling	Netherlands	Strawberry	Food waste	Costs for expected shelf life losses in logistics, product cost information
Ringsberg (2014)	Increase our understanding of perspectives on food traceability in four supply chain risk management approaches to ensure food safety	Literature review	Sweden	Not specified	Food safety	Traceability
Ting et al. (2014)	Propose a decision support framework that will reveal possible quality sustainability solutions in food supply chains	Single case study	Hong Kong (China)	Wine	Food quality risks	Supply chain quality sustainability decision support system
Chen et al. (2015)	Examine the effectiveness of popular recovery strategies used to address unpredictable disasters that derail supply chains	Modelling and case study	Taiwan (China)	Not specified	Food contamination	Radical, rapid, costly recovery strategy should be adopted
Huff et al. (2015)	Compare food system criticality	Modelling	USA	Not specified	Different AFSC risks	Not mentioned
Jensen et al. (2015)	Reduce the campylobacteria in Danish broiler supply	Modelling	Denmark	Broilers	Food safety risk	Four interventions at the farm level and four interventions at the processing stage were introduced

Pinior et al. (2015)	Identify the source of contamination and its entry source in the dairy industry	Single case study	Germany	Dairy	Food contamination	Not mentioned
Regan et al. (2015)	Examine to what extent, and to what effect, responsibility, blame and accountability figure in consumer reactions in the immediate aftermath of a food crisis	Survey	United Kingdom	Horsemeat	Deceitful practices, supply chain complexity	The centrality of blaming as a response to disaster and risk within society
Schoenherr et al. (2015)	Develop a framework for the assurance of food safety via relational networking	Modelling and survey	USA	Not specified	Food contamination	Customer pressure has positive effects on food contamination detection
Scholten and Schilder (2015)	Explore how collaboration activities influence supply chain resilience	Multiple case studies	Netherlands	Fast-moving consumer goods	Not mentioned	Information sharing and collaborative communication, mutually created knowledge, and joint relationship efforts, etc.
Srivastava et al. (2015)	Analyse potential supply chain risks and performance measures in fresh food retail	Modelling	India	Not specified	Twenty-four AFSC risks were identified and analysed	Not mentioned
Yang and Xu (2015)	Assess the disruption and resilience of grain supply chain	Modelling	China	Grain	Upstream natural disaster	Contingent source and government aid
Amorim et al. (2016)	Build an integrated framework for deciding about the supplier selection in the processed food industry under uncertainty	Modelling	Portugal	Processed food industry	Lead-time uncertainty	Supplier selection
Madichie and Yamoah (2016)	Explore the role of power asymmetry in the food supply chain	Literature review	United Kingdom	Horsemeat	The power asymmetry/imbalance	Not mentioned
Purvis et al. (2016)	Explore one company's approach to translating management theories into a practical tool for the design, development and implementation of a supply chain resilience strategy	Single case study	United Kingdom	Drink	Supply and demand volatility	Redundancy, agility, robust, flexibility, and leanness
Simangunsong et al. (2016)	Investigate effective management strategies for 14 sources of supply chain uncertainty, with a particular emphasis on uncertainties or strategies that involve ethical issues	Multiple case studies	Indonesia	Not specified	Three ethical risks and fourteen supply chain uncertainties	Joint purchasing
Zsidisin et al. (2016)	Provide a framework for identifying and managing supply quality risk	Multiple case studies	USA	Not specified	Ten types of supply quality risks were identified	Integrative supply chain quality management practices
Ali et al. (2017)	Identify various factors involved in building resilient perishable product supply chains	Single case study	Australia	Citrus	Transportation risks, financial risks,	Ten elements were identified effective for

					climatic risks, and supply-demand mismatch	building AFSC resilience, including consortium support, multi-sourcing, and collaboration, etc.
Bogataj et al. (2017)	Reduce food loss through building smart system	Modelling	Italy	Not specified	Food loss and perishability	Smart cyber-physical systems
Busse et al. (2017)	Investigate how buying firms facing low supply chain visibility can utilise their stakeholder network to identify salient supply chain sustainability risks	Single case study	Switzerland	Canned tomato	Low supply chain visibility	Access to stakeholders' knowledge
Gokarn and Kuthambalayan (2017)	Analyse the challenges inhibiting the reduction of food waste	Modelling	India	Not specified	Food waste	Not mentioned
Lu and Koufteros (2017)	Explore food supply chain security practices	Theoretical and conceptual	USA	Not specified	Food security	Food supply chain security practices
MacKenzie et al. (2017)	Quantify elements that make fresh produce supply chains vulnerable to disruptions to quantify the benefits of different disruption-management strategies	Modelling	USA	Fresh vegetables	Food contamination, etc.	Holding additional safety stock, improve traceability, etc.
Nakandala et al. (2017)	Assess fresh food supply chain risk	Modelling	Australia	Not specified	Ten types of AFSC risks were identified	Not mentioned
Nyamah et al. (2017)	Examine the key risk components (probability and consequence) and their respective thresholds affecting AFSC operations in Ghana	Survey	Ghana	Not specified	Nine types of AFSC risks were identified	Not mentioned
Prakash et al. (2017)	Analyse the risks present in the perishable food supply chain and determine the most effective risk mitigation strategies	Modelling	India	Dairy	Seventeen types of AFSC risks were identified	Thirty-two mitigation strategies were proposed
Rathore et al. (2017)	Develop a risk assessment framework for a typical food supply chain	Single case study	India	Not specified	Sixteen AFSC risks were categorised and ranked	Not mentioned
Stranieri et al. (2017)	Investigate the determinants leading firms to choose among different voluntary standards within the food supply chain	Survey and modelling	Italy	Not specified	Transaction risks	Traceability standards
Voldrich et al. (2017)	Monitor AFSCs through building a monitoring model resources	Modelling	Switzerland	Not specified	Operational risk	New monitoring system including processing

						time and cost with operational risk
Aboah et al. (2018)	Present a framework for the operationalisation of the concept of socioecological resilience in agricultural value chains	Literature review	New Zealand	Not specified	Not mentioned	Flexibility, adaptability, resourcefulness, and collaboration
Ali et al. (2018)	Develop a model based on broad empirical evidence, of the interplay between cold chain logistics risks, resilience and firm performance in perishable product supply chains	Multiple case study and survey	Australia	Not specified	Temperature breakdown, natural disaster, substandard packaging, deterioration of product quality due to delivery delays	Business certifications, multi-skilled workforce, quality management system, multi-sourcing, public-private collaboration, globalised operations
Behzadi et al. (2018)	Provide a review of quantitative models for agribusiness supply chain risk management	Literature review	New Zealand	Not specified	Sixty-seven risk factors were identified	Perishability modelling and risk modelling used for building resilient and robust strategy
Fu et al. (2018)	Design effective contracts to stand by sustainable agricultural practice	Modelling	China	Not specified	Weather-related risks and price volatility	A guaranteed price mechanisms and a risk-reward contract
Forbes and Wilson (2018)	To examine the resilience of supply chains to a disaster	Single case study	New Zealand	Wine	Earthquake	Building performance, distributed networks of locations and IT, owned assets, critical infrastructure, and adaptable work force
Hendry et al. (2018)	Investigate how local supply chains prepare for and respond to the threats and opportunities presented by constitutional change	Multiple case studies	United Kingdom	Not specified	Constitutional change	Vertical and horizontal supply chain collaboration
Lau et al. (2018)	Develop a business process decision model to assess the non-compensating food safety sub-criteria	Single case study	Australia	Fresh food	Food safety risks	Fresh-food supplier evaluation
Moazzam et al. (2018)	Measure AFSC performance and risk through a new analytical framework	Single case study	New Zealand	Dairy	Food quality risks	Not mentioned
De Sa et al. (2018)	Analyse how collaboration activities among members of the sugarcane-energy supply chain have been able to increase their resilience	Multiple case studies	Brazil	Sugarcane	Drought	Vertical collaboration between buyer and focal company

Stone and Rahimifard (2018)	Identify which multidisciplinary aspects of resilience are applicable to AFSCs and to generate a novel AFSC resilience framework	Literature review	United Kingdom	Not specified	Not mentioned	Forty AFSC resilience capabilities were identified and analysed
Ali et al. (2019)	Develop a sustainable framework to develop food waste	Modelling	Bangladesh	Not specified	Lack of skilled personnel, poor leadership, failure within the IT system, capacity, and poor customer relationship	Continuous training and development, leadership training, better planning and capacity flexibility, and Big Data application
Banasik et al. (2019)	Analyse and evaluate the economic and environmental impacts to account for uncertainty in AFSCs	Single case study	Netherlands	Mushroom	Production and demand uncertainty	Optimising production planning decisions
Bottani et al. (2019)	Design a food supply chain that is resilient enough to ensure business operations continuity in the event of risks or disruptions	Modelling and case study	Italy	Tomato sauce	Fluctuations of market demand	Multi-sourcing
Li et al. (2019)	Explore consumer confidence in the safety of milk and infant milk formula	Survey and modelling	China	Milk and infant milk formula	Food safety	Consumer confidence
Liu and Lee (2019)	Test whether the adoption of multiple supply chains, which adopt both traditional and shortened supply chains, can be used to manage uncertainty and mitigate the risk associated with a supply chain	Survey	Taiwan (China)	Not specified	Environmental and behavioural uncertainties	Multiple supply chains
Min (2019)	Explore blockchain for enhancing supply chain resilience	Theoretical and conceptual	USA	Not specified	Not mentioned	Blockchain technology has the ability to prevent risk occurrence, reduce the impact of supply chain disruptions, etc.
Naseer et al. (2019)	List of key issues or constraints in the production and marketing to sustainable supply chain management of citrus industry in Pakistan	Multiple case studies	Pakistan	Citrus	Climate change, high production cost, seed quality, etc.	Not mentioned
Reis (2019)	Explore how governments can empower food supply chain resilience	Multiple case studies	Australia	Not specified	Extreme weather events	Contingency plan
Rodrigues et al. (2019)	Examine the role of the food inspection agency in detecting contamination among producers in the global beef supply chain	Single case study	Brazil	Beef	Food contamination	Coercive control, greater heterogeneity of facilities, surrounding operating environment

Yavari and Zaker (2019)	The design of a resilient green-closed loop supply chain network for perishable products under the risk of electric power network disruption	Single case study	Iran	Dairy	Electric power network disruption	Design an interdependent two-layer network structure
Zhou et al. (2019)	Develop a coordination mechanism that can be applied to achieve the channel coordination and information sharing simultaneously in the fresh AFSC with uncertain demand	Multiple case studies	China	Not specified	Demand uncertainty	Optimal stock-out penalties and optimal option contract
Ali and Golgeci (2020)	Devise a model delving into critical climate risks and the role of consortia and social capital to mitigate these risks	Case study and survey	Australia	Not specified	Climate risks including heatwaves, bushfire, floods, droughts	Higher social capital and active engagement with consortia
Ali and Gurd (2020)	Investigate the extent to which operational risks affect supply chain performance and the moderating role of knowledge sharing	Survey	Australia	Not specified	Operational risk	Knowledge sharing
Behzadi et al. (2020)	Develop a metric for assessing supply chain resilience	Modelling	New Zealand	Not specified	Port closure disruption risks	Resilient backup strategy
Bumblauskas et al. (2020)	Explain the implementation of blockchain technology in the production and supply chain delivery system for eggs from farm to consumer	Single case study	USA	Egg	Food fraud, product loss, and food recalls	Blockchain for improving traceability and transparency
De Sa et al. (2020)	Investigate how resilience at different nodes in the supply chain influences overall supply chain resilience during an extreme weather event	Multiple case studies	Brazil	Sugarcane and orange	Extreme drought	Intensify information sharing, flexibility, redundancy, and supply chain collaboration
Fan et al. (2020)	Review several pandemic emergencies and examine China's experiences and lessons in ensuring food and nutrition security	Literature review and case study	China	Not specified	Food and nutrition security risk	Governmental proactive policies, global supply chain cooperation and coordination
Gimenez-Escalante et al. (2020)	Increase the sustainability and resilience of food production through a transition towards a "Distributed Localised Manufacturing" (DLM) strategy	Single case study	United Kingdom	Beer	Not mentioned	Distributed localised manufacturing strategies
Iftekhar et al. (2020)	Trace a food package using a blockchain technology	Theoretical and conceptual	China	Not specified	Food safety risk	To integrated traditional supply chain management practices with blockchain technology

Kahiluoto et al. (2020)	How an organisation should structure its supply base to be resilient to supply uncertainties and disruptions	Multiple case studies	Finland	Pork and oils	Domestic strike and global price volatility	Maintenance of sales
Kangogo et al. (2020)	Explore farm resilience to climate change	Theoretical and conceptual	Netherlands	Not specified	Climate change	Farmer entrepreneurship, support farmer organisations, and strengthen farmer-buyer relationships
Khan et al. (2020)	Identify and analyse the elements of Halal supply chain management and their significant risk dimensions	Modelling	India	Halal supply chain	Forty-two risks were identified	Not mentioned
Maiyar and Thakkar (2020)	To develop a robust and sustainable intermodal transportation to facilitate single type of food grain commodity shipments while considering procurement uncertainty	Modelling	India	Grain	Procurement uncertainty	Supply chain reengineering
Morton (2020)	Discuss the advantages of adopting a conceptual framework previously used to discuss the impact of the HIV/AIDS pandemic on agriculture and rural livelihoods	Theoretical and conceptual	United Kingdom	Not specified	COVID-19 global pandemic situation	Community response
Naqvi et al. (2020)	Assess the risk of multiple breadbasket failures	Modelling	India	Not specified	Multiple breadbasket failures	Not mentioned
Pereira et al. (2020)	Identify the main sources of risk and how different members in an international supply chain manage risk, considering contingency effects	Single case study	Brazil	Mango	Exchange rate fluctuation and dependence on a single transport	Supply chain collaboration, agility, design, and management culture
Ralston and Blackhurst (2020)	Gain a better understanding of smart systems and the autonomous process of industry 4.0 on AFSC resilience	Multiple case studies	USA	Not specified	Not mentioned	Smart systems could improve AFSC resilience
Rathore et al. (2020)	Model dynamic feedback effects and complex interactions among risks affecting food grains transportation using a system dynamics approach	Modelling	India	Food grain	Eight AFSC risks were identified	Not mentioned
Rogerson and Parry (2020)	Enhance how blockchain can be used for enhancing visibility and trust in supply chains	Multiple case studies	United Kingdom	Not specified	Food fraud and food safety	Blockchain is demonstrated as an enabler of visibility in supply chains
Rosales et al. (2020)	Identify the risks to which AFSCs are exposed and to analyse how these risks impact the degree of coordination of the chain	Case study and survey	Brazil	Meat	Ten types of AFSC risks were identified	Supply chain coordination

Van Hoek (2020)	Suggest a pathway for closing the gap between supply chain resilience research and efforts in industry to develop a more resilient supply chain	Multiple case studies	USA	Not specified	Supply risk, demand risk, control risk	Holding more inventory, rebalance supply lines, change product lines, digitisation
Yan et al. (2020)	Investigate how to coordinate a fresh agricultural product supply chain with the consideration of strategic consumer behaviour	Modelling	China	Fresh food	Not mentioned	Supply chain coordination
Zhao et al. (2020)	A comprehensive analysis of AFSC risks by identifying various risk factors, structuring interrelationships among them, and distinguishing key risks	Modelling	United Kingdom	Not specified	Sixteen AFSC risks were identified	Not mentioned

Appendix 3. Studies' categorisation

Aggregation dimensions	Relevant studies
Risk identification (7)	Cigolini and Rossi (2006), Roth et al. (2008), Adamides et al. (2012), Madichie and Yamoah (2016), Nyamah et al. (2017), Banasiket al. (2019), Morton (2020)
Risk assessment (16)	Wang et al. (2012), Vlajic et al. (2013), Pinior et al. (2015), Srivastava et al. (2015), Gokarn and Kuthambalayan (2017), Nakandala et al. (2017), Prakash et al. (2017), Rathore et al. (2017), Behzadi et al. (2018), Ali et al. (2019), Naqvi et al. (2020), Naseer et al. (2019), Khan et al. (2020), Rathore et al. (2020), Rosales et al. (2020), Zhao et al. (2020)
Risk mitigation (71)	Cadilhon et al. (2005), Kumar and Budin (2006), Maloni and Brown (2006), Taylor and Fearne (2006), Turvey et al. (2007), Chen (2008), Blandon et al. (2009), Kuwornu et al. (2009), Laeequddin et al. (2009), Dani and Deep (2010), Rong and Grunow (2010), Chavez and Seow (2012), Diabat et al. (2012), Resende-Filho and Hurley (2012), Baghalian et al. (2013), Leat and Revoredo-Giha (2013), Chen et al. (2014), Klein et al. (2014), Rijpkema et al. (2014), Ringsberg (2014), Ting et al. (2014), Chen et al. (2015), Huff et al. (2015), Jensen et al. (2015), Regan et al. (2015), Schoenherr and Narasimhan (2015), Scholten and Schilder (2015), Yang and Xu (2015), Amorim et al. (2016), Purvis et al. (2016), Simangunsong et al. (2016), Zsidisin et al. (2016), Ali et al. (2017), Ali et al. (2017), Bogataj et al. (2017), Busse et al. (2017), Lu and Koufteros (2017), MacKenzie and Apte (2017), Stranieri et al. (2017), Voldrich et al. (2017), Aboah et al. (2018), De Sa et al. (2018), Forbes and Wilson (2018), Fu et al. (2018), Hendry et al. (2018), Lau et al. (2018), Moazzam et al. (2018), Stone and Rahimifard (2018), Bottani et al. (2019), Li et al. (2019), Liu and Lee (2019), Maiyar and Thakkar (2019), Min (2019), Reis (2019), Yavari and Zaker (2019), Zhou et al. (2019), Ali and Golgeci (2020), Ali and Gurd. (2020), Behzadi et al. (2020), Bumblauskas et al. (2020), De Sa et al. (2020), Fan et al. (2020), Gimenez-Escalante et al. (2020), Iftekhar et al. (2020), Kahiluoto et al. (2020), Kangogo et al. (2020), Pereira et al. (2020), Ralston and Blackhurst (2020), Rogerson and Parry (2020), van Hoek (2020), Yan et al. (2020)
Risk monitoring (1)	Rodrigues et al. (2019)