

Interdisciplinary challenges associated with rapid response in the food supply chain

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Abstract

Purpose – This paper aims to explore the interdisciplinary nature of coordination challenges in the logistic response to food safety incidents while distinguishing the food supply chain positions involved.

Design/methodology/approach – This adopts an exploratory qualitative research approach over a period of 11 years. Multiple research periods generated 38 semi-structured interviews and 2 focus groups. All data is analysed by a thematic analysis.

Findings – The authors identified four key coordination challenges in the logistics response to food safety incidents: first, information quality (sharing information and the applied technology) appears to be seen as the biggest challenge for the response; second, more emphasis on external coordination focus is required; third, more extensive emphasis is needed on the proactive phase in the logistic response; fourth, a distinct difference exists in the position's views on coordination in the food supply chain. Furthermore, the data supports the interdisciplinary nature as disciplines such as operations management, strategy and organisation but also food safety and risk management, have to work together to align a rapid response, depending on the incident's specifics.

Research limitations/implications – The paper shows the need for comprehensively reviewing and elaborating on the research gap in coordination decisions for the logistic response to food safety incidents while using the views of the different supply chain positions. The empirical data indicates the interdisciplinary nature of these coordination decisions, supporting the need for more attention to the interdisciplinary food research agenda. The findings also indicate the need for more attention to organisational learning, and an open and active debate on exploratory qualitative research approaches over a long period of time, as this is not widely used in supply chain management studies.

Practical implications – The results of this paper do not present a managerial blueprint but can be helpful for practitioners dealing with aspects of decision-making by the food supply chain positions. The findings help practitioners to systematically go through all phases of the decision-making process for designing an effective logistic response to food safety incidents. Furthermore, the results provide insight into the distinct differences in views of the supply chain positions on the coordination decision-making process, which is helpful for managers to better understand in what phase(s) and why other positions might make different decisions.

Social implications – The findings add value for the general public, as an effective logistic response contributes to consumer's trust in food safety by creating more transparency in the decisions made during a food safety incident. As food sources are and will remain essential for human existence, the need to contribute to knowledge related to aspects of food safety is evident because it will be impossible to prevent all food safety incidents.

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Originality/value – As the main contribution, this study provides a systematic and interdisciplinary understanding of the coordination decision-making process for the logistic response to food safety incidents while distinguishing the views of the supply chain positions.

Keywords Supply-chain management, Food industry, Coordination, Food security, Information transparency, Quick response

Paper type Research paper

1. Introduction

Globally, every year, the food industry deals with an estimated 600 million cases of foodborne diseases and 420,000 deaths that are attributed to unsafe food (WHO, 2023). Over the past few years, various developments in the food supply chain impacted the response to food safety incidents, such as the introduction of more stringent food legislation in Europe, an increase in the number of monitoring programmes, a growing awareness of corporate social responsibility and more focus on enabling technological solutions (Jose and Shanmugam, 2020; Pandey et al., 2022; Possas et al., 2022). Even so, food safety incidents such as the salmonella bacteria in chocolate products marketed to children in April 2022 (EFSA, 2022) still illustrate how vulnerable and interdependent the food chain is and how quickly the chain can collapse. It also demonstrates the importance of transparent response processes, and despite the many investments in technology developments in recent years, supply chains still appear to struggle with these challenges in the decision-making process (Astill et al., 2019; Hofmann et al., 2015; Holgado and Niess, 2023; Li et al., 2023). As stakeholders in the food supply chain demand (full) transparency, and as it is impossible to prevent every food safety incident, there is a need for more research into an effective logistic decision-making process for the logistic response to food safety incidents because health risks, branding and food safety costs are at stake (Arun and Prasanna Venkatesan, 2019; Song et al., 2020).

Food safety is defined as “the assurance that food will not cause adverse health effects to the consumer when it is prepared and/or eaten according to its intended use” (FAO and WHO, 2022). As no world-wide legislation is applicable to food safety, varying approaches and requirements for the response to food safety incidents are seen from different countries, creating challenges between the food actors. A further challenge to the supply chain response is that it not only involves those formal structures and procedures of the food actors but is also pertinent to informal values and cultural norms (Horak et al., 2020). It is essential to ensure that the coordination plans specified on paper are in agreement with how they work in actual practice, as the gap between stipulated and practised coordination in crisis management also merits further theoretical considerations (Christensen and Ma, 2020). So, it is of interest to gain a better understanding of how logistic response decisions to food safety incidents are made in the food supply chain. Furthermore, as each food safety incident is unique, further research is needed to get more insight into the required countermeasures that can react to unique risks (Manning and Soon, 2016). Research states that the logistic response to incidents should be, first and foremost, a coordinated process (Wankmüller and Reiner, 2020), and for food security, in particular, there is also a need for

interdisciplinary collaboration with involved parties to face the challenges of food safety (Doherty et al., 2019).

Food supply chains are being studied from a wide range of disciplines and differing theoretical perspectives, indicating that they are by nature interdisciplinary and boundary spanning (Acevedo et al., 2018; Doherty et al., 2019). Interdisciplinary research refers to cooperation between several disciplines, with more emphasis on knowledge exchange than on integration by the involved actors (Choi and Pak, 2006). These disciplines include food safety management, organisational sciences, sociology, marketing, sales and logistics and supply chain management. In the food supply chain, the actors can be positioned more or less upstream, midstream or downstream (Nardi et al., 2020a; Van Hoek, 1999). Interest in the concept of supply chain positions relates to “power dependencies in the chain” but is also apparent in recent studies that identify “perception” as a key element for determining how the positions will deal with emerging topics in the supply chains, such as risks and emergency food preparedness (Gerhold et al., 2019). More upstream positions, such as producers, are more able to gather information at the supplier side, whereas more downstream positions, like wholesalers and retailers, have more (in)direct contact with the consumer. Moreover, theories suggest that more upstream positions tend to be more reactive and conservative in nature concerning topics related to risks than retailers downstream (Lo, 2013). According to Li et al. (2019), an important element in decision-making is the dominance in the relationship between two supply chain positions. Previous research indicates the relevance of understanding the relationship between the supply chain positions and how they deal with specific topics and disciplines related to coordination in the food supply chain (Minnens et al., 2019; Nordin et al., 2010; Schmidt et al., 2017).

So far, no research has been dedicated to exploring the interdisciplinary challenges of coordination in the response to food safety incidents and the views of various supply chain positions in relation to the logistic response. A better understanding and more knowledge about this will help to improve the inter-organisational development practice and alignment in decision-making for an effective logistic response to food safety incidents. The research questions that will be answered in this paper are:

- RQ1. What are the key coordination challenges in the logistics response to food safety incidents?
- RQ2. To what extent are the identified coordination challenges interdisciplinary in nature?

The results of this study are based on PhD research into food supply chains (Van Beusekom – Thoolen, 2022).

We identified four key coordination challenges in the logistics response to food safety incidents:

- 1 firstly, information quality (IQ) (sharing information and the applied technology) appears to be seen as the biggest challenge for the response;
- 2 secondly, more emphasis on external coordination focus is required;
- 3 thirdly, more extensive emphasis is needed on the pro-active phase in the logistic response; and
- 4 fourthly, a distinct difference exists in the position's views on coordination in the food supply chain.

Furthermore, our data supports the interdisciplinary nature, as disciplines such as operations management, strategy and organisation, but also food safety and risk management have to work together to align a rapid response, depending on the incident's specifics.

We first describe the theoretical background of various disciplines that relate to coordination in the logistic response to food safety incidents. This is followed by an explanation of the research methodology used. Thirdly, this paper presents the results of the collected data over various research rounds over a period of 11 years. Fourthly, this paper provides a thematic case study analysis, which leads to the discussion and suggestions for further avenues of research.

2. Theoretical background

2.1 Food safety incidents

Food safety is a concept that has been discussed by many researchers in various disciplines over the years, as well as by authorities world-wide, to monitor and ensure food safety (Auler *et al.*, 2017; Nardi *et al.*, 2020a). In the literature, definitions of food safety incidents are very similar, mostly initiated by the legislature (governmental agencies) due to their statutory basis. According to the UK Food Safety Authority (FSA), the definition of a food safety incident is:

[. . .] any event where, based on the information available, there are concerns about actual or suspected threats to the safety, quality or integrity of food and/or feed that could require intervention to protect consumers interests (FSA, 2017).

This definition has a statutory foundation for some requirements of the response, which may lead to a withdrawal or recall that will result in costs and related responsibilities that need to be part of an unequivocal policy.

Food safety incidents can vary, from a relatively high to a relatively low level of uncertainty and complexity, and anything in between (Soon *et al.*, 2020). The higher the level of uncertainty and complexity of a food safety incident, the more challenged the accurate evaluation of the implementation of response plans and this may negatively impact effective response plans (Song *et al.*, 2020). So, it is important to have insight into the key aspects of food safety incidents. Besides the literature review of food supply chains and food safety incidents, we also reviewed additional literature from various disciplines such as risk, crises, disaster and emergency management, as they also focus on preventing and minimising consequences that can be caused by natural factors and technological or human errors, similar to food safety incidents (Al-Dahash *et al.*, 2016; Al Kurdi, 2021). Based on this review, the key distinctive interdisciplinary aspects of food safety incidents are presented in Table 1.

The emergence and extensiveness of distinct aspects in an incident underscore that each food safety incident is unique, and further research is needed to get more insight into the required countermeasures that can act against unique risks (Manning and Soon, 2016).

2.2 Logistics response in food supply chain

As food supply chains become more complex and consumers more demanding, the appropriate effective response to food safety incidents is challenged by the ability to align and manage food safety by all (inter)nationally related supply chain actors (Song *et al.*, 2020). Formulating an adequate effective response to food safety incidents is complicated by several factors (Wiegerinck, 2006):

- increased complexity of the production, manufacturing, distribution and retailing of products;
- increased distance between place and time of production and place and time of consumption;
- more advanced technical knowledge of food ingredients;
- technical development of the media; and
- link between firms in the supply chain.

Furthermore, the response to a food safety incident requires a relatively high level of traceability and transparency; it must move quickly and decisively under time pressure while complying with strict legislation (Astill *et al.*, 2019). To manage the response to food safety incidents, most food organisations have specific procedures and tools in place. These distinguish different risk levels in food safety incidents, for example, “routine incidents” (relatively small and innocent incidents) and “major incidents” (involving a significantly high level of health and political risks) (CA Commission, 2013).

According to the response model of Van Beusekom – Thoolen (2022), the decisions relating to the procedures and tools in response to food safety incidents refer to the ex ante (pro-active) part of the logistics response model (see Figure 1).

Moreover, this response model suggests that in the ex ante part, the impact on a food safety incident is moderated or regulated, by the firm's own rules, processes and structures. In the assessment phase, the requirements are determined for the further response strategies to be executed in the ex post phase to ensure that the final result of the response is sufficient. Finally, the phase lessons learned enhances continuous improvement by feedback and learning, forming an “open system” that interacts with the environment and “continually takes in new information, transforms that information and gives information back to the environment” (Shockley-Zalabak, 1999, p. 43). Other response models from various theoretical perspectives in the literature were also reviewed (CFIA, 2020; Vljajic *et al.*, 2012; Våland and Heide, 2005), but since we are interested in the decision-making process for the logistic response in food supply chains, we chose the management response model of Van Beusekom – Thoolen (2022) to get more insight into the underlying set of decisions made in this process. Moreover, this model is based on process-tracing, which makes it feasible to identify the key events, processes or decisions that link the hypothesized cause or causes with the outcomes (George and McKeown, 1985).

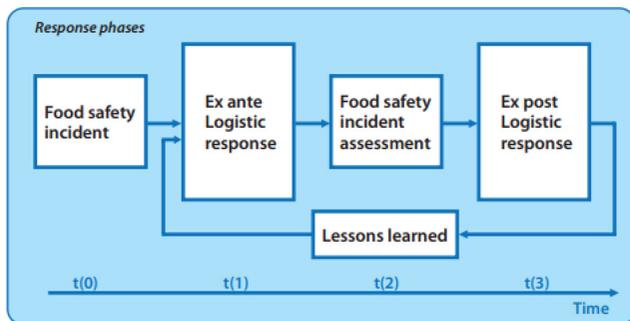
As each food safety incident has its unique elements, it is virtually impossible to have procedures that cover the response

Table 1 Key interdisciplinary aspects of food safety incidents

Author(s)	Food safety incident aspects	Description
FSA (2017); Gizaw (2019); Lin (2010)	Health risks Political risks Business risks	May have negative health consequences due to physical, chemical or microbiological hazard May affect political sensitivity on (inter)national level May cause financial and reputational damage in short term and long term
Charlier and Valceschini (2008); EFSA (2022); Wilson et al. (2016)	Compliance aspects	Legislation plays an important role in the response to an incident
Adeseun et al. (2018); Assefa et al. (2017); Auler et al. (2017); Jose and Shanmugam (2020); Manning and Soon (2016); Soon et al. (2020); Song et al. (2020); Trienekens et al. (2012)	Interdependency Parties involved Supply chain stage	Actors involved may be dependent on other food supply chain actors in their response May involve multiple food actors such as producers, retailers and logistic service providers Incidents can occur at any stage in the food supply chain, whether more upstream or more downstream
Assefa et al. (2017); Zhang et al. (2014); Diabat et al. (2012); FAO & WHO (2022); Hamer et al. (2014); Song et al. (2020); Soon et al. (2020); Verbeke et al. (2007)	Scale impact Time pressure Response action Level of uncertainty	May affect wide geographical areas and large population groups Time is critical for the response to health risks, and there is time pressure for quick decision-making and action An incident requires some form of action by food supply chain actors The level of uncertainty can vary from rather low to high depending on the nature of the incident, which is often unpredicted and unprecedented

Source: Authors' own work

Figure 1 Logistics response model in case of food safety incidents



Source: Van Beusekom – Thoolen (2022)

details for every possible incident. Each incident involves a unique supply chain response consisting of “multiple, single actor logistic responses” that need to be aligned and managed to be effective. An effective logistic response “must have the intended or expected effect on the individual consumers” health risk, political risk and business continuity. Van Asselt et al. (2017) indicate in their research findings that time pressure and real-time decision-making are important coordination challenges in the response to food safety incidents. Furthermore, to enhance an effective response, the intention of the single actor plays an important role in this logistic response, as each actor is focused primarily on their own business, more than on the performance of the food supply chain as a whole (Speranza, 2018). This illustrates the interest to better understand how the involved positions perceive the coordination challenge in the response.

2.3 Supply chain positions

To manage incidents effectively, it is critical for any incident management system to create collective and cooperative incident teamwork from all supply chain positions (Subramaniam et al., 2010). According to Li et al. (2019), an important element in decision-making on the logistic response is the dominance in the relationship between the supply chain positions. Previous research indicates the relevance of understanding the relationship between the supply chain positions and how they deal with specific topics (Lo, 2013; Schmidt et al., 2017; Tacheva et al., 2020). The interest in the concept of supply chain positions relates to “power dependencies in the chain” but is also apparent in recent studies that identify “company size”, “industry”, “perception” and “extent of operability” as key elements for determining how the positions will deal with emerging topics in the supply chains, such as sustainability (Gallo and Jones-Christensen, 2011). Even so, the critical role of power dependence in supply chain relationship management deserves more attention in food supply chains to get full insight and knowledge (Schmidt and Wagner, 2019).

The generic food supply chain has four distinct types of key stakeholders (see Table 2): food business, consumer, (business) community and food regulatory and enforcement agencies (Minnens et al., 2019). These stakeholders all play a role in the supply chain response to food safety incidents, each from their own perspective. Based on the main logistic activity of the stakeholders in the food supply chain (Aung and Chang, 2014), supply chain positions are distinguished.

As stated above, the positions can be more or less upstream, midstream or downstream in the food supply chain (Van Hoek, 1999) and are defined by the structural position of an organisation’s logistic value creation activities, measured on the

Table 2 Overview of stakeholders and the related food supply chain positions

Stakeholder	Chain position	Up-/downstream	Main (logistic) activity
Food business	Producer	Upstream	Adding value to the product/service
	Wholesaler/retailer	Downstream	Storage and sales
	Logistic service provider	Overall	Transport and distribution
Consumer (Business) community	Consumer	Downstream	Consumption and disposal
	Branch organisation	Overall	Representing industry members as a front man for the supply chain positions
Regulatory agencies	Authority	Overall	Monitoring, and if required, enforcement to ensure food safety

Source: Authors' own work

basis of the tier distance from the consumer (Schmidt *et al.*, 2017). As the response to food safety incidents requires a joint approach, all positions may play a role in the supply chain response to food safety incidents, each based on their own stakeholder's perspective and main logistic discipline; this calls for alignment in monitoring, prevention and response to food safety incidents by food organisations from all over the world (Leialohilani and De Boer, 2020).

2.4 Coordination

Food safety incidents require coordination and information exchange by the actors in the food chain. It is essential to understand the specifics of the incident and, moreover, to know what kind of decisions are necessary to take coordinated countermeasures. Critical elements in decision-making may differ as the response objective may differ per incident (Jiang and Yuan, 2019). Effective decision metrics can help practitioners make quick decisions and improve responsiveness, but can also benefit the coordination of several interdependent tasks among various actors and streamline the response to the food safety incident (Balcik *et al.*, 2010). Research into overcoming destructive incidents indicates that coordination is an essential critical element for decision-making (Wankmüller and Reiner, 2020).

Various definitions of coordination in the field of supply chain management are given in the literature. Such as: "The process of managing dependencies between activities" (Malone and Crowston, 1994). In relief supply chain management, Wankmüller and Reiner (2020) defined coordination as: "The process of organizing, aligning and differentiating of participating non-governmental organisations (NGOs)" actions based on regional knowledge, know-how, specialisation and resource availability to reach a shared goal in the context of disasters'. In essence, strong coordination adds to an efficient and effective logistic response, and it is often seen as a prerequisite for cooperation and collaboration (Ergun *et al.*, 2014).

For the purpose of this study, we define coordination based on Wankmüller and Reiner (2020) as: "The process of organizing, aligning and differentiating of participating actors' actions based on knowledge, know-how, specialisation and resource availability to add to an effective and efficient process". This stipulates that the primary intent is to organise, manage and align the activities in the food supply chain (Charlier and Valceschini, 2008) by decomposition or the division of labour among partners, communication and integration between partners (Castañer and Oliveira, 2020).

2.5 Interdisciplinarity in food research

Food research covers agricultural and nutritional science but also includes scientific aspects of food safety and food processing, next to the science of enabling food technology (Ward *et al.*, 2015). This interdisciplinary approach involves scientists from multiple disciplines, such as chemistry, physics, physiology, microbiology, biochemistry, food safety management, marketing, sales, risk management, branding value, organisational sciences and supply chain management (Wynstra *et al.*, 2019). Despite the demarcations for each research field, "disciplinary boundaries [...] do not have sharp edges" (Tarafdar and Davison, 2018, p. 6). The interdisciplinary competences support the enhancement of knowledge on how to deal with risks in the food supply chain, and create an interdisciplinary research agenda (Doherty *et al.*, 2019; Horton *et al.*, 2017).

Our study seeks to identify the coordination challenges in the logistics response to food safety incidents while distinguishing the views of the supply chain positions. Finally, we explore to what extent these coordination challenges are interdisciplinary of nature.

3. Research methods

3.1 Exploratory qualitative study

Given the relatively scarce availability of interdisciplinary research into logistic responses in relation to food safety incidents in general and supply chain positions' views in particular, there is a need to better understand the coordination decisions made in response to food safety incidents. We used an exploratory qualitative study design over a long period of time, in a total of 11 years, to provide a more robust outcome. In our research, we aim to study and understand the phenomenon of logistic response to food safety incidents, with its interaction between the various contexts and the views on coordination of the supply chain positions. We have opted for a research approach in which we gathered the information over a longer period of time, to better understand the context and provide more compelling results; the overall research is therefore regarded as being more robust (Yin, 2018). By remaining open to emergent phenomena in the research period, our understanding of the dynamics of food safety incident processes within its complex social reality may be expected to increase. Qualitative research supports researchers in situations where there are no simple explanations or simple solutions, where the problems are complex and have a specific, often unique, context. Many variables play a part, and decisions are made at the end of a complex decision-

making chain in which many stakeholders play an important role. Our aim to study the supply chain decisions made in response to food safety incidents suggests that a qualitative approach may help us to explore what happens during these incidents.

By analysing according to an abductive research approach, we neither followed the pattern of pure deductive nor of pure inductive: we adopted theory-building elements by simultaneously performing the data collection and theory development over the different research periods (Håkan and Gyöngyi, 2005). The logistic response model of Van Beusekom - Thoolen (2022) was applied as a loose framework (Lämsä and Takala, 2000) to organise and categorise the findings from a process-tracing perspective (George and McKeown, 1985). This approach helps us to go back in time and identify key events, processes or decisions that link to the logistic response.

3.2 Quality requirements

To evaluate the quality of the research design in this study, the assessment approach by Lincoln and Guba (1985) is chosen, as we followed a pragmatic research philosophy to develop knowledge that can be used to improve a situation. Simply put, the pragmatic value of the research is that “it works” for managers and practitioners. A qualitative researcher must be transparent about the way the research is conducted to enable the readers of the study report to establish that the research is trustworthy. Trustworthiness is refined by Lincoln and Guba (1985) in four criteria, which are widely recognised and used to evaluate the quality of qualitative research. These four evaluation criteria are credibility, transferability, dependability and confirmability (Nowell et al., 2017). The credibility of a study is determined if readers (co-researchers) can recognise the findings and match these with their own experiences. In our study, credibility is realised by peer briefings and by prolonged engagement with the team of researchers and the actors in the research. Transferability refers to the generalisability of the research findings. In qualitative research, findings and conclusions do not go beyond the applicability in the studied cases. However, transferability is important in this kind of research and refers to how the reporting of the research enables the reader to judge if the findings are also useful to his/her case or situation. With the underlying pragmatic paradigm in this study, we tried to achieve that by providing a thick description and quotes to give the reader a feeling of “being there”. We chose multiple research periods and data sets to provide more compelling support for the propositions and strengthen the transferability of the findings (Lincoln and Guba, 1985). Dependability is assured by demonstrating that the research

process is logical, traceable and clearly documented. In this study, we show that data analysis has been conducted in a precise, consistent and exhaustive manner through archiving of the raw data, systematising and disclosing the methods of analysis. Finally, confirmability refers to the quality of the study, that the researcher’s interpretations and findings are clearly derived from the data. The researcher has to clearly state how interpretations of the data and the conclusions have been reached so that the reader/co-researcher is able to understand which decisions are made and why during the research process. Confirmability is realised by the audit trail and reflexivity, as the research team discussed the interpretations of all research rounds.

3.3 Data collection method

Over a period of 11 years, representatives from the various supply chain positions were asked to elaborate on their logistic decision-making process and response to food safety incidents (see Table 3); this ensured data triangulation to improve the robustness of our research findings to better understand the decisions made in responding to food safety incidents throughout food supply chains. The selection process of the participants was defined by a combination of factors. Firstly, we aimed to select participants from each of the five supply chain positions: producer, logistic service provider, wholesaler/retailer, branch organisation and (food safety) authority (in particular, the enforcement department). Furthermore, the participants should be responsible for the logistic decision-making process in the case of a food safety incident within their organisation. Some participants were selected from the existing network of contacts of the researchers involved, but most were selected by snowball-sampling from our networks. After the pilot study, we conducted 38 semi-structured interviews and organised two focus groups with the various supply chain positions. We wanted to collect data from the same participants (units of observation) over time, but participants switched jobs and organisations and, so there were 26 units of observation in total. On average, the participants were involved in two of the research periods (at least once and at most four times).

The aim of the one-on-one semi-structured interviews was to collect rich and in-depth data, experiences and views, whereas the aim of the focus groups was to explore and capture the experiences and views of the various supply chain positions with regard to the critical decision-making element of coordination. Subjects of the discussions in the focus groups were related to the challenges or opportunities in the decision-making process for the logistic response to food safety incidents. All semi-structured

Table 3 Overview of the research periods and supply chain positions

Research period	Data	Participating supply chain positions
2010	Pilot interview	Producer
2010	Four interviews	Producer and wholesale/retail
2012	Focus group A	Producer and wholesale/retail
2012/2013	Twenty-one interviews	Producer, wholesale/retail, logistic service provider, branch organisation, authority
2013	Focus group B	Producer, wholesale/retail, logistic service provider, branch organisation, authority
2015	Six interviews	Producer, wholesale/retail and logistic service provider
2020	Seven interviews	Producer and wholesale/retail

Source: Authors’ own work

interviews and focus groups were transcribed and coded in NVivo (Miles and Huberman, 1994). Finally, the data was analysed by coding the transcripts or minutes, which led to the thematic analysis (Braun and Clarke, 2006). Similar coding was used for all interviews and focus group meetings based on the question, “What are coordination challenges and opportunities for designing an effective logistic response to food safety incidents?” After coding, the code list was checked for duplication and similarities, and codes were combined or deleted.

Our research team has expertise in many relevant disciplines (logistics and supply chain management, food safety, food law, social theory and organisational science), strengthening the interdisciplinary character of the study.

4. Findings

We started by analysing the 38 interviews and two focus groups on the basis of the textual data generated, collected from 2010 to 2020. In total, 1,391 references are coded to coordination in NVivo.

4.1 Thematic analysis: emergences of categories for coordination

A thematic analysis in NVivo of the rich data led to the identification of four categories for coordination: internal coordination, external coordination, IQ and branding (see Table 4).

Comparing the results from the supply chain positions, distinct differences are apparent in the emphasis on the categories per position (see Figure 2). In all research periods, all positions stressed the category of IQ by far the most, as a challenge or opportunity in the logistic response to food safety incidents.

Of all positions, the FSA is seen to place by far the most emphasis on challenges or opportunities of coordination. This relatively high emphasis by the authority on these elements may indicate that they perceive coordination as the key challenge in the logistic response to food safety incidents. Another possible explanation is that coordination challenges directly relate to their main task priority in their daily work as FSA staff, in which they are involved in all food safety incidents and not just one food supply chain.

4.2 Analysis coordination in relation to phases response model

To create a better understanding of the coordination challenges, we next analysed the coordination references in relation to the phases of the logistics response model (see

Figure 1). The results show that although coordination emerged in all five phases in all research periods, a distinct and persistent picture is the relative emphasis of coordination references between the five phases (see Figure 3).

The ex post phase is discussed by far the most extensively, accounting for two-thirds of all coordination references. The ex ante phase always came in second, with participants discussing aspects of the ex post phase twice as much as aspects of the ex ante phase. This indicates that the participants emphasised aspects of the reactive part of the logistic response far more than the proactive aspects. As a result of this distinct and persistent picture of emphasis over all research periods, further analysis will be discussed by the key results over time and positions' views.

4.3 Analysis per position from 2010 to 2020

Analysing of the coordination references suggests that all positions primarily emphasise (reactive) ex post phase challenges, during the whole research period, although the logistic service provider also paid considerable attention to ex ante (pro-active) aspects. Another marked finding of this analysis over time is that both the producer and wholesale/retail show a pattern of a gradual shift in emphasis from internal coordination towards external coordination (ex post) over the years (see Figure 4).

Over time, both the producer and wholesale/retail increasingly stress the need for adequate external alignment, information sharing and traceability in the food supply chain for an effective logistic response. It is also interesting that they emphasise that in the decision-making process, they have no other option but to rely on their suppliers to share reliable and complete information. However, we found no consistency in the interpretation of what defines adequate external coordination. Some participants define it as “correct information from the outset”, whereas others see it as “sharing information with the whole supply chain immediately after a notification of a food safety incident”.

4.4 Analysis views various supply chain positions

4.4.1 Wholesale/retail

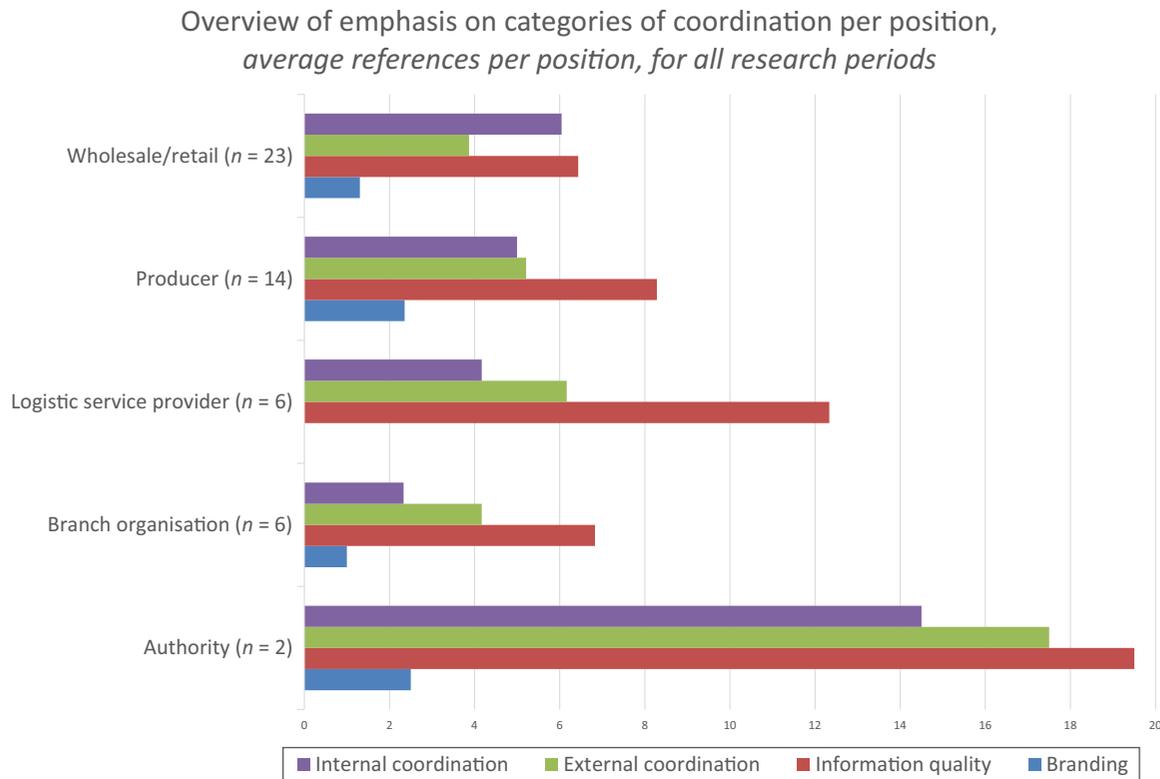
Firstly, a marked finding is that wholesale/retail rated branding as a key decision-making element for an effective logistic response strategy, second only to health risks, and that costs play a less important role. Secondly, the data did not indicate that the severity of the food safety incident had any formal relationship to the logistic response procedures. Wholesale/retail has to deal with various food safety incidents every week, and they indicated that in most cases, they also have to deal

Table 4 Identified categories of coordination based on thematic analysis

Identified categories of coordination	Description
Internal coordination	Aspects of organising, managing and aligning of activities from an intra-organisational perspective
External coordination	Aspects of organising, managing and aligning of activities from an inter-organisational perspective
Information quality (IQ)	Information that is shared and distributed to the involved food actors is used to manage efforts for the logistic response, including the aspects mentioned on the applied technology
Branding	Aspects mentioned on the process of establishing and growing a relationship between a brand and consumers (by e.g. a name, term, sign symbol [or a combination of these])

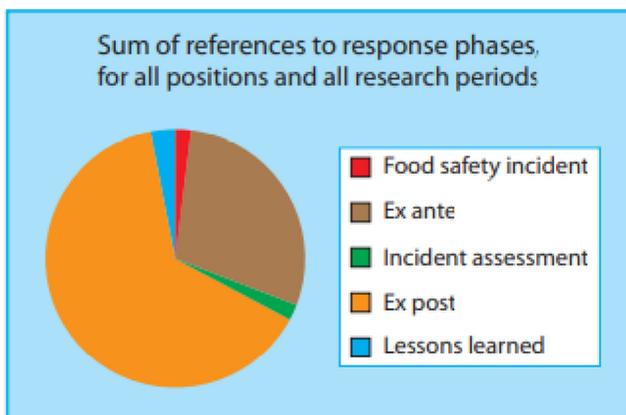
Source: Authors' own work

Figure 2 Overview of emphasis on categories of coordination per position



Source: Authors' own work

Figure 3 Overall overview of coordination references to response phases



Source: Authors' own work

with update(s) of each individual incident (also referred to as revisions). These revisions, and even revision on revision, occur when new information requires a re-assessment of the food safety incident specifics. They usually imply that more products are affected, which leads to an additional workload and also to more potential mistakes. As a precaution, wholesale/retail mentioned that they often remove more than the required affected products after the initial assessment notification:

Quote wholesale/retail: “We tell our supplier: ‘Right guys, we have decided to remove this product. We are done with it!’ [...] This is based on the batches initially listed for recall; in our experience, the number of recalled batches usually increases over time”.

Another finding is that the primary focus of wholesale/retail is on internal aspects of the logistic response, the challenges or opportunities from their own internal organisational perspective rather than the external supply chain. Market power and (consumer) trust in the food supply chain are also mentioned as important aspects for an effective logistic decision-making process:

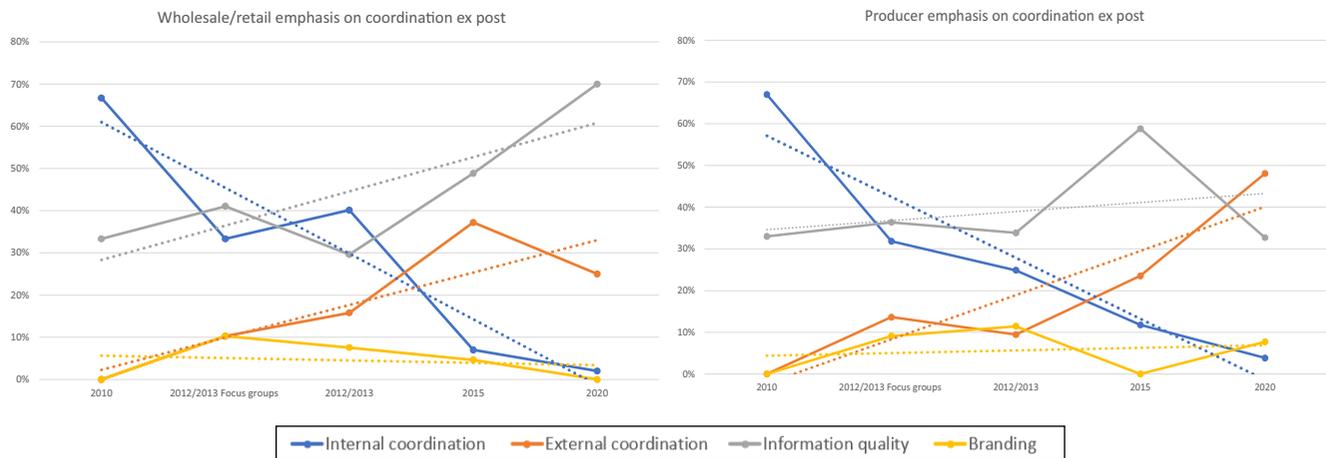
Quote wholesale/retail: “Yes, I worked with companies that try to turn their back on issues. Suppliers who want to slow us down or just do not want to see the issue. They are a problem! But what can you do? [...] I hesitate to say it [...] but I’ll say it anyway: you use your market power”.

Wholesale/retail notes that many coordination decisions are made under time pressure and without full information. One other finding is an inconsistency in the level of organisational learning, as some in wholesale/retail applied aspects of single-loop learning while others did not.

4.4.2 Producer

The lack of (full) chain transparency poses severe challenges for the producer when dealing with food safety incidents under time pressure. Costs and branding are seen as highly important decision-making criteria, although health risks are the first priority:

Quote producer: “Yes [...] having a private label or not, makes quite a difference for the choices to be made”.

Figure 4 Analysis results from 2010 to 2020 for producer and wholesale/retail positions, ex post; linear interpolation shown in dotted lines

Source: Authors' own work

The producers also emphasised that when working in an internationally oriented supply chain, the various cultures and the large variety of foreign governments involved also challenge the decision-making process. Other findings are that the producer is mainly interested in internal coordination aspects of the logistic response, implying that the primary focus is on issues and/or opportunities for the logistic response from their own internal organisational perspective rather than the external supply chain perspective. Procedures, tools and aspects of the physical goods flow are discussed, matters such as removing products, blocking products and managing the product return flow. Many of these discussions include challenges of data gathering and available information systems, which makes rapid traceability almost impossible in their perspective:

Quote producer: "What makes the logistic response successful are your procedures, your information systems, and your personnel. That combination is what needs to work. You also need to mobilise your internal organization. That is certainly also a success factor".

4.4.3 Logistic service provider

In marked contrast to the other positions, the logistic service provider put as much emphasis on the coordination challenges or opportunities from proactive perspective of the logistic response. Also, the logistic service provider stressed issues of external communication, discussing the challenges of getting in contact with external actors, and how communication is done via phone, email, in person, etc. More personal contact is seen to improve the speed of communication, compared to email, for example.

Due to relatively short-term contracts in the market, the logistic service provider indicated the need to balance relatively high information technology investments against the level of traceability and transparency provided. Finally, we again found inconsistency in organisational learning: not all logistic service providers applied aspects of single-loop learning.

4.4.4 The branch organisation

The branch organisation strongly emphasised external aspects of coordination from a reactive perspective. This suggests that they are focused on external challenges in the food supply chain

and appear to strive for external integration. Main topics discussed are about challenges related to trust, (reliable) information sharing and market power. It is interesting that they stressed the need for a consumer perspective by creating chain integration to deliver more services for the end-consumer. Reliability of information and health safety are seen as essential starting points for the logistic response, although they suggested the need for speedier information sharing between the various actors in the food supply chain in cases of food safety incidents. Another finding is that the branch organisation emphasised the impact of social media on the decision-making process. They mentioned, for example, that social media is one of the most powerful tools that NGOs could use to influence the logistic decisions made, both upstream and downstream in the food supply chain. Finally, all branch organisations emphasised the importance of incident evaluation to stimulate organisational and even supply chain learning.

4.4.5 Authority

A key finding is that the FSA put far more emphasis on aspects of coordination than the other positions. They stressed the need for external integration, although they noted that (full) chain transparency is still a long way off due to aspects such as the various levels of automation available within food organisations world-wide:

Quote authority: "If a supervisory authority asks 'Shouldn't we do more to create a chain approach?', I'll say 'Yes, that is a nice concept. Now try to follow through[...]'".

Finally, a main issue when creating (full) chain transparency has to do with trust. This issue is strongly emphasised, according to the authority, in relation to certification. The predictability of the auditing process was mentioned, as well as issues related to the reliability and trustworthiness of certificates, for example, as a result of inconsistent certification authorities:

Quote authority: "[...] let me just put it this way[...] the supply chain network relies on certification; however, that same chain knows how unreliable that certification is. So, it is a tight rope act. That is what this sector does."

5. Discussion

In this section, we will discuss the key findings of the identified coordination challenges in the logistic response to food safety incidents and, secondly, to what extent these findings are interdisciplinary in nature.

5.1 Information quality perceived as biggest coordination challenge

IQ is the most prominent challenge found in all research periods when discussing challenges related to information sharing, (full) transparency and traceability. This corresponds to the findings of [Astill et al. \(2019\)](#), as described in the literature review, where they conclude that transparency is a challenge for all food supply chain actors. Recent research in enabling new technology, such as blockchain that strives to increase the level of transparency, traceability and trust also concludes that many challenges must be overcome to incorporate it into the food supply chain ([Duan et al., 2020](#); [Pandey et al., 2022](#); [Schmidt and Wagner, 2019](#)).

It is interesting that over time, the positions show a growing tendency towards more emphasis on the categories of both external coordination and IQ. This is in line with the studies of [Kaipia \(2021\)](#), [Wankmüller and Reiner \(2020\)](#) and [Yu and Ren \(2018\)](#), which indicate that, on the one hand, the attention to (full) chain transparency is growing, while, on the other hand, this creates more challenges. In all research periods, we found the perception of an ongoing challenge related to the need for (full) transparency and traceability in the food supply chain. This might be explained by the unique character of each food safety incident (see [Table 1](#)), requiring countermeasures aligned with the needs of the incidents ([Manning and Soon, 2016](#)). Concurring with the research gaps defined in the literature review on block-chain enabled information sharing in the supply chain by [Wan et al. \(2020\)](#), our study also indicates issues such as trust and relatively low automation levels of some chain actors through all research periods.

The findings also indicate the great and varied importance of information when designing effective logistic responses to food safety incidents. As food safety incidents require fast, full and reliable supply chain traceability, a primary implication for food organisations based on this study is that all positions considered accessibility of information as a kind of ongoing hygiene factor. Therefore, it is recommended that future studies pay extra attention to define what criteria need to be met to create an adequate level of accessibility of information in the food supply. It is interesting that our findings correspond with previous research by [Van der Vorst \(2004\)](#): our results also suggest a need for more research into “full food traceability” in relation to supply chain process integration. Apparently, nearly two decades later, the food industry is still struggling with issues of traceability, as already pointed out in 2004 by Van der Vorst.

5.2 Increasing emphasis on external coordination poses challenges

Another key finding is the gradual shift towards more emphasis on external coordination by the producer and wholesale/retail, which may be due to an increasing awareness of the need for supply chain collaboration and coordination. However, according to [Christopher \(2016\)](#), the extensive focus on

challenges from internal aspects suggests that there is room for improvement in the level of internal integration. Since 2015, the data indicates that producer and wholesale/retail are gradually shifting towards an external orientation and focus far less on internal orientation. This is in line with the literature in Section 2, in which we concluded that supply chain thinking is becoming more central in and outside the food industry. According to the participants, the food industry faces a long, bumpy road ahead to create (full) supply chain integration:

Quote Authority (2012/2013): “How much energy should we put into this chain transparency? I could put 100 people on this, but it would still be impossible to figure out the how and what”.

Quote Wholesale/retail (2015): “As retail, it is very difficult to oversee the whole supply chain”

According to various studies, such as [Huo \(2012\)](#) and ([Pradabwong et al., 2017](#)), internal integration should generally precede external integration. This suggests that the producer and wholesale/retail have improved their level of internal integration over the years. To achieve external integration, previous research in the agri-food industry suggests the relevance of the concepts trust and commitment as enablers ([Ramirez et al., 2020](#)). The need to study the relationship between supply chain collaboration and performance is also recognised in research by [Paciarotti and Torregiani \(2021\)](#) in the context of sustainable collaboration. It appears that the importance of supply chain integration has featured more prominently on the agenda of the food industry recently because of aspects such as the occurrence of severe food safety incidents like the *E. coli* 0104 outbreak in 2011, which was the deadliest bacterial foodborne outbreak in Europe. It is not yet clear whether new technologies, such as blockchain or smart packaging, can support transparency and traceability for the regular food business activities, as well as for responding to food safety incident responses ([Astill et al., 2019](#); [Bechtsis et al., 2019](#); [Chen et al., 2020](#); [Moreno et al., 2020](#); [Song et al., 2020](#)).

5.3 Extensive emphasis on ex post phase

Furthermore, the research findings indicate that the coordination challenges most strongly relate to aspects of the ex post phase, referring to the reactive aspects of the response. An explanation for the strong emphasis on the ex post phase could be that responding reactively is perceived as far more challenging than preparing proactively in the ex ante phase. Another explanation might be that our results concur with findings in a study into risk management by [Kırlmaz and Erol \(2017\)](#), who found that, in general, supply chain managers are more focused on reactive (mitigation) parts of risk management, primarily to reduce costs, than proactive aspects. Also, the result may reflect the relatively smaller amount of effort put into creating a culture and organisation that withstands issues from proactive perspective ([Coleman, 2011](#)). According to [Cadden et al. \(2013\)](#), more attention to cultural evaluation in the supply chains might also lead to enhanced trust and openness. Recently, studies indicate that managers have begun to attach more importance to supply chain continuity and resilience from a proactive perspective ([Kırlmaz and Erol, 2017](#)). Our data does not confirm this, however, as from the first until the last round of research, the main emphasis was on reactive aspects of the logistic response (in the

ex post response phase). Although aspects of the ex ante phase received less attention than the ex post phase, the data does suggest that this phase is considered important, with many proactive aspects of the logistic response being discussed extensively. The difference found between these two phases might also be explained by the fact that we interviewed mainly experts on operational and tactical levels, who might address other aspects of decision-making. This concurs with the literature of Kotler *et al.* (2020), that suggests that decisions are made on several hierarchical organisational levels by different individuals in the decision-making unit; and all this in the context of dealing with unique characteristics per incident.

5.4 Distinct difference in views of the supply chain positions on coordination

Comparing the results from the supply chain positions, distinct differences appear to exist in the emphasis on coordination in the five response phases, as shown in Figure 3. Of all positions, the FSA appears to stress by far most strongly the challenges or opportunities of coordination ex post. This relatively high emphasis by the authority on these elements may indicate that they perceive these as the main challenges in the logistic response to food safety incidents. Another possible explanation is that coordination challenges directly relate to their main task priority in their daily work as FSA staff, in which they are involved in all food safety incidents and not just one food supply chain.

Another key finding is a distinct difference that appears to exist between the position's wholesale/retail and producer. Wholesale/retail considers risks to branding and name reputation as outweighing cost-effectiveness, whereas the producer balances aspects of branding, reputation, health impact and also related costs in each incident. This is consistent with our literature review (Gerhold *et al.*, 2019; Nardi *et al.*, 2020b), where we found that more upstream positions, such as producers, appear to have more access to information at the supplier end; on the other hand, more downstream positions, such as wholesale/retailers, appear to be more in contact with the consumer end and therefore more focused on branding and reputation aspects. Branding includes the perceptions held by current, past and potential customers about a company's products and services (Czinkota *et al.*, 2014). Reputation is far more than that. Reputation is "the expression of corporate conduct aimed to differentiate the company from competitors in the perception of competitive rivalry" (Czinkota *et al.*, 2014, p. 95). Theories of branding and reputation posit that these factors play an important role in food supply chains and that food safety incidents might lead to new and often threatening trends and pressures that negatively impact the company's reputation and its supply chain (León-Bravo *et al.*, 2019). Our data supports this as we found that branding plays an important role in the decision-making for the logistic response:

Producer (2020): "There is always a risk. The financial side is the most obvious one. It will always cost you more to refund their products and produce them once again. But reputation of your company is more important because if that goes to the news media then the damage will be greater".

The fact that branding is perceived as an important factor in the logistics response may be a consequence of the awareness that brands are used to identify the company more readily as the

source of risks in situations of foodborne illness (Parker *et al.*, 2020). As a final point, it is interesting to note that name branding trade-offs for a private label producer differ from those for an A or B brand producer because their name is not printed on the product label. So, they primarily face only branding damage within the food industry itself, but not towards the end-consumers.

5.5 Interdisciplinary nature of coordination challenges

Finally, our study seeks to contribute to insights into the discipline-based origins of coordination challenges in the context of food supply chains. Our findings support previous research into food science (Acevedo *et al.*, 2018; Doherty *et al.*, 2019; Horton *et al.*, 2017), as they also exhibit interdisciplinary aspects. The findings indicate that coordination involves challenges related to aspects such as information sharing, risk analysis, collaboration, branding and (human) decision-making. Therefore, the expertise of various disciplines must be integrated in a joint, synchronised response to be effective. This implies that theories, such as supply chain management, information processing, operations management, strategy and organisation, risk management, decision-making, food safety management, marketing and consumer behaviour should all be considered as part of an adequate effective response to food safety incidents, depending on the incident's specifics (see Table 1).

Furthermore, we explored the disciplinary origins of the categories of coordination in the logistic response to food safety incidents in particular. The codes of the category "internal coordination" appear to be mainly related to aspects addressed by the discipline of operations management, as the data primarily emphasises elements of creating effective and efficient transformation processes. Within this category, elements of management and organisational processes were also discussed, albeit less extensively, linked to aspects addressed by the discipline strategy and organisation. Within the category "external coordination", the prevalence of aspects of the disciplines strategy and organisation are most strongly emphasised, and the discipline of operations management to a lesser extent, to arrive at an effective and efficient chain. For the category "information quality", aspects addressed by the discipline of information processing are most strongly discussed, stressing the elements of information sharing and its applied technology to enhance the process flow. Finally, the category "branding" is most strongly linked to aspects addressed by the disciplines of marketing and consumer behaviour.

As the data collected is mainly based on insights of logistics and supply chain experts, there was little or no discussion involving disciplines such as chemistry, physics, physiology, microbiology and biochemistry. Even so, we recognise that these may also play an important role in the interdisciplinary response to food safety incidents (Acevedo *et al.*, 2018; Doherty *et al.*, 2019; Horton *et al.*, 2017).

The results clearly indicate the need for robust interdisciplinary research. Moreover, the need for (full) chain transparency and external integration suggests that this should have a high priority on the food research agenda for researchers from multiple disciplines, as accessibility of information

throughout the supply chain is perceived as a kind of hygiene factor for achieving an effective logistic response.

6. Conclusion and implications

6.1 Recommendations to interdisciplinary field of food supply chain management

This research dealt with the interdisciplinary coordination challenges associated with the rapid response in food supply chains. Logistics and supply chain management in the realm of food safety are usually separate fields that are studied by different groups in academia. This research integrates both fields and shows that decision-making theory is useful to better understand the complexity of the logistic response to food safety incidents in a supply chain perspective while using the views of the different supply chain positions on coordination. The theory of supply chain management is mainly focused on integrating vertical and horizontal collaborations between the actors, whereas the theory of logistics is primarily focused on aligning internal functions, such as procurement, production, distribution and transport, in which the trade-off between the aspects: costs, quality and time, are leading. Food safety theory emphasises aspects such as nutrition and contamination of ingredients. Our empirical data supports the need to integrate these theories as the food industry strives for a more integrated and effective approach while they face many interdisciplinary coordination challenges in the food supply chain for an effective logistic response to food safety incidents to minimise health, political and business risks. More attention needs to be paid to the views of the supply chain positions on the decision-making process for the logistic response to improve this process.

To answer the first research question (*RQ1*), we identified four key challenges of coordination in the logistics response to food safety incidents while distinguishing the supply chain positions. Firstly, the study findings show that IA (by sharing information and its applied technology) appears to be seen as the biggest challenge for the response, by all positions in the past decade. This leaves much room for improvement in the response to become more transparent, and intensify collaboration between food actors. Moreover, it is recommended that future studies pay extra attention to defining what criteria need to be met to create an adequate level of information accessibility within the food supply chain. As new technologies are continuously in development to enhance traceability, such as blockchain and smart packaging, this might create possibilities to support information sharing within food organisations but also throughout the food supply chain. Further research is recommended to better understand how these technologies can support an effective response in case of food safety incidents. Moreover, as trust appears of high importance for information sharing, further research on how trust impacts the willingness to share information in food supply chains is recommended. Secondly, a marked finding is that the identified challenges primarily relate to the ex post phase, leaving many research opportunities to enhance insight and knowledge concerning proactive measures (in procedures, guidelines and tools). Thirdly, the findings of research conducted over a decade suggest an increase in attention for external coordination challenges by the producer and wholesale/retail. More empirical research is needed on how the positions deal with the internal

versus external focus to support them in improving their response performance. Finally, food supply chain positions differ in their perception of coordination challenges. This suggests the need for more empirical research on how each of these positions should coordinate an effective response to food safety issues. To create a more holistic interdisciplinary approach, research into food science would benefit from the involvement of researchers from various disciplines, such as behavioural science, food safety, supply chain management, information processing theory and risk management. When meeting contemporary challenges, such as sustainability, interdisciplinary research could also help to develop knowledge, guidelines and procedures that may be more effective (Kumar *et al.*, 2022).

To some extent, the above already answers the second research question (*RQ2*), “To what extent are the identified coordination challenges interdisciplinary in nature?”. Aside from these findings, our data supports the interdisciplinary nature as disciplines such as operations management, strategy and organisation, but also food safety and risk management have to work together to align a rapid response, depending on the incident’s specifics. So, we can conclude that food safety, and an adequate response associated to incidents, should be considered from an interdisciplinary perspective in the food supply chain. To this end, a high priority on the interdisciplinary food research agenda is required to stimulate progress towards (full) chain transparency and external integration, integrating the various disciplines to ensure food safety. An interesting question is also how interdisciplinarity, impacted by topics such as legislation, (social) media, marketing and cultures, will evolve in the near future. Insight into the decisions made to respond to food safety incidents, as consumers appear to expect (full) transparency and a joint response, is a pre-requisite. The consequences of making mistakes in the response to food safety incidents might lead to more severe and diverse attention, impacting on branding and reputation, but also impacting on food safety. Therefore, we encourage the need for more robust interdisciplinary research in food supply chains.

The study findings also indicate a need for more attention to organisational learning, in the phase lessons learned, contributing to the academic debate of logistics and supply chain decisions in cases of food safety incidents. Our results show that this debate should not only improve health and cost-effectiveness but also shift the attention to the supply chain perspective, as the end-consumer perceives the logistic response by all involved organisations. To the best of our knowledge, no empirical research has been conducted into the coordination decision-making process for the logistic response to food safety incidents while the views of the supply chain positions are used. Focus on the views of the different supply chain positions supports a better understanding of why challenges in the logistic response still occur and, therefore, deserves more attention from researchers.

Furthermore, the applied exploratory qualitative research approach over a long period of time is not widely used in logistics and supply chain management studies. Methodology designs and protocols for this type of research design are still scarce, resulting in some challenges and debates on the design but also on the evaluation for this type of qualitative research (Welch and Piekkari, 2017). The debate on the evaluation of qualitative research stems mainly from the institutionalised nature of the

academy, which suggests that there is a continuous pressure to standardise the evaluation criteria (Welch, 2018). However, Welch states (p. 410): “It is highly inappropriate to insist that all qualitative research conform to a particular template for demonstrating quality”. To our understanding, the current debate between positivist (Eisenhardt, 1989; Yin, 2018) and naturalist (Lincoln and Guba, 1985) criteria for evaluating qualitative research in the field of logistics and supply chain management is rather underexposed. We hope to encourage an active debate and stimulate researchers to maintain an open dialogue and raise awareness for methodological advances to further stimulate creativity and innovation.

6.2 Recommendations to interdisciplinary field of food supply chain management practice

The results of this study do not present a managerial blueprint but can be helpful as a sense-making decision framework for practitioners dealing with the design of coordination in the logistic response to food safety incidents. Firstly, the findings help practitioners to systematically go through all phases of the decision-making process for designing an effective logistic response to food safety incidents. A systematic approach helps them to reflect on their own business processes to improve the effectiveness of the logistic response to food safety incidents by managerial sense-making. According to all positions, this is perceived as important since the decision-making process is highly challenged by the lack of (full) transparency in combination with an existing legal time-pressure. Furthermore, the results provide insight into the views of the supply chain positions on the coordination decision-making process. As those views appear to be distinctly different with respect to coordination in the five phases, it is helpful for managers to better understand in what phase(s), and why other positions might make different decisions. The food industry can apply these insights to further enhance the effectiveness of the logistic response to food safety incidents where health, political and business risks may be at stake. An important insight is that accessibility of information is perceived by all positions as something of a hygiene factor for creating an effective logistic response to food safety incidents, which should make the food industry aware of the need to focus on this aspect.

Finally, besides the managerial contributions, the findings add value for the general public, as an effective logistic response contributes to consumer’s trust in food safety, by creating more transparency in the decisions made during a food safety incident. As food sources are and will remain essential for human existence, the need to contribute to knowledge related to aspects of food safety is evident because it will be impossible to prevent all food safety incidents.

6.3 Limitations

While this study is based on extensive empirical data obtained over a considerable period from various supply chain perspectives, our approach has some limitations. Firstly, there are no clear guidelines for conducting the abductive and exploratory research approach over a longer period of time used in this study. There is no single best way of matching theory and reality in abductive research, according to Dubois and Gadde (2002), and what works or does not work “can only be evaluated afterwards”. What we found effective in the research process is the collaboration with both the participants of the

study, i.e. the actors in the logistic food chain, and the team of fellow researchers. The data collections were started and interpreted within our own experiences and existing ideas as researchers and humans. Future studies are recommended to explore and develop guidelines for exploratory and abductive research. A second limitation relates to the participants, the experts. As the topic of food safety is perceived as highly sensitive throughout the food supply chain, participation in the focus groups and/or interviews was sometimes difficult to achieve. As a result, not all positions were included in each research round. Furthermore, the level of experience, skills and knowledge of each expert may differ. It is recommended that future studies apply the similar protocol and collect more data with respect to the supply chain positions to provide more generalisability. Future studies are also recommended to explore the cause-and-effect interrelationship between the logistic response characteristics and the response performance.

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