# Master Thesis

## Resilient Dutch food supply chains before, during and after COVID-19: a case study of an entire supply chain


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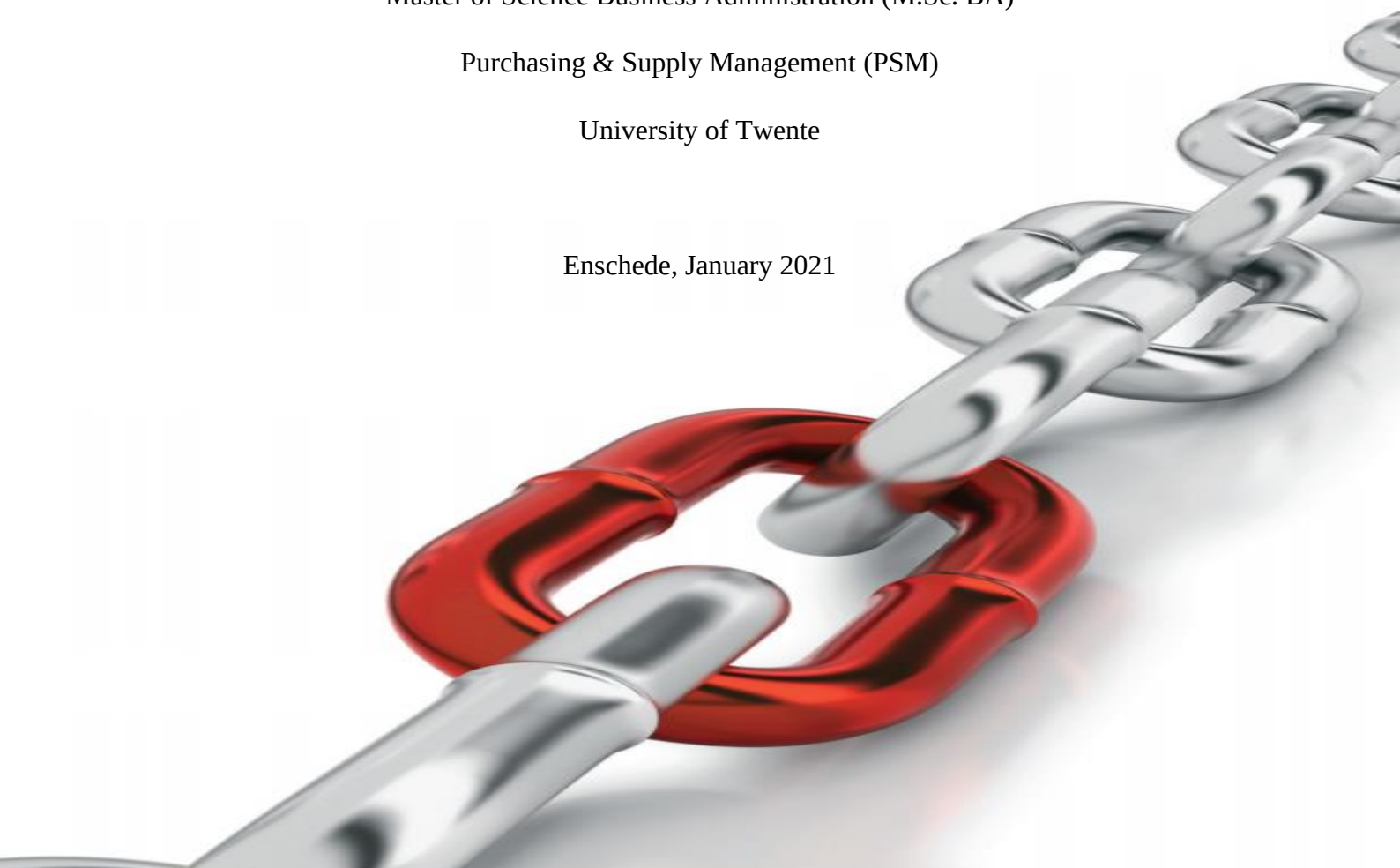

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I wish you a pleasant reading!

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# Abstract

**Motive**: Supply chains nowadays are becoming more vulnerable to disruptions. The current COVID-19 pandemic impacts supply side, operations as well as demand side of supply chains. A vital part of societies is the food supply chain. Literature provides measures to manage supply chain risks. While supply chain risk management seems only cause-oriented, supply chain resilience is an extension which aims to make sure a supply chain can recover from risks regardless of the cause. Yet, little is known about how food supply chains respond before, during and after pandemics such as the current COVID-19 pandemic and what strategies enhances supply chain resilience of food supply chains in general.

**Purpose:** Therefore, this research aims to provide insight in how Dutch food supply chains should synchronise (e.g. allow timely availability of material, product and information flows among all supply chain partners) a resilient supply chain before, during and after the current COVID-19 crisis. A framework with strategies for Dutch food supply chains to synchronise supply chain resilience is explained.

**Method**: After a structured literature review in supply chain resilience, a qualitative study was applied in the form of a case study interview methodology for one Dutch food supply chain to explore the taken strategies before, during and after the current COVID-19 crisis. The author interviewed 8 managers from supermarkets, distribution centres, head quarter and a supplier. Additionally, internal documents and online publications were used to support the findings.

**Findings**: This research demonstrates how Dutch food supply chains can synchronise resilience before, during and after a pandemic through a created framework and is of exploratory nature. The framework indicates Dutch food supply chains should be proactive by having contingency plans to prepare for unexpected disruptions. This could lead to adapt or absorb the negative impact of the risk, followed by a quick response to recover to the regular performance. In all supply chain links, no concrete contingency plans were found. Furthermore, collaboration both internally and externally with supply chain partners seems to be an important driver for supply chain resilience. The case company should improve its external collaboration with suppliers in times of pandemics rather than focusing on cost efficiencies. Finally, the size of the supply chain seems to be a moderating effect. A smaller food supply chain as shown in this case study seems to be impacted less by pandemics.

**Practical implication**: Five strategies have been identified in the framework that should be used by food supply chains before, during and after a pandemic to prevent, mitigate and recover from pandemic disruptions: 1) Multiple sourcing, 2) Safety stocks, 3) Collaboration, 4) Agility, 5) Focus on key products. Although this research analysed specifically one Dutch food supply chain, the results can also be adapted by other food supply chains.

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# List of abbreviations

| **Acronym** | **Definition** |
|---|---|
| DC | Distribution Centre |
| F&R | Forecast and Replenishment |
| R | Respondent |
| SCRE | Supply Chain Resilience |
| SCRM | Supply Chain Risk Management |

# 1 Introduction

In the last decades, the rise of globalisation and emerging production techniques made supply chains more efficient, but also more complex and vulnerable to risks (Kırılmaz & Erol, 2017). Many trends such as globalisation, outsourcing, transitioning to lean operations and threats such as terrorist attacks and other threats contributed to an increased importance of supply chain risk management (Ponomarov & Holcomb, 2009). Supply chain risks can be divided into operational risks and disruption risks (Sodhi, Son, & Tang, 2012; Tang, 2006). While operational risks are about daily issues such as lead-times and demand fluctuations, disruption risks such as tsunamis, earthquakes, strikes or legal disagreements have a lower frequency but a higher impact (Tang, 2006).

The impact of disruption risks on supply chains are strong because some links in the supply chain such as suppliers, factories, wholesalers and transportation could become unavailable (Tang, 2006). Besides, supply shortages and delivery delays might lead to the ripple effect and a decrease in performance, productivity, revenues and service levels (Tang, 2006). Although supply chain management initiatives could make operations leaner, they increase the fragility and vulnerability of supply chains to disruptions (Wagner & Bode, 2008). Supply chain risk management (in this research referred to as SCRM) strategies that provide guidance for practitioners need to be developed (Fan & Stevenson, 2018). Sodhi et al. (2012) mention there are very few articles in literature about SCRM focusing on disruption risks. Moreover, De Oliveira, Espindola and Marins (2018) analysed 248 articles about SCRM and argue that a majority of the articles do not teach readers how to conduct SCRM. The authors mention researchers should focus on “how” to carry out each step of SCRM. For example, what tools, techniques, approaches and procedures should be used to identify, assess, mitigate and monitor the risks to supply chains (De Oliveira et al., 2018).

One specific case of supply chain disruptions are epidemic outbreaks. Unlike other disruption risks, epidemic outbreaks start small but scale fast and disperse over many graphic regions leading to disruptions to global supply chains. For example, Kumar and Chandra (2010) assessed the impact of the avian flu pandemic on global supply chains. The authors mention the logistical challenges posed by pandemics are different than other disruption risks, because pandemics may impact more links of a supply chain. Therefore, it is important that organisations assess continuity plans to keep the business going (Kumar & Chandra, 2010). Examples of epidemic outbreaks which affected supply chains are SARS, MERS, Ebola, Swine flu (Wong et al., 2015). The most recent outbreak is the coronavirus COVID-19 where the first

major outbreak occurred in Wuhan, China. Around January and February 2020, this virus grew exponentially in China which affected Chinese suppliers and reduced the availability of supplies in global supply chains (Baker McKenzie, 2020). Araz, Olson and Salman (2020) mention the COVID-19 outbreak is one of the biggest disruptions during the last decades which is "breaking many global supply chains" (p. 1). Within a couple of months, the number of COVID-19 cases has exponentially increased in Asia, Europe and USA resulting in border closures and quarantines. In May 2020, the World Health Organisation announced the pandemic given more than 5 million people were infected with COVID-19 across more than 200 countries (Worldometer, 2020).

A vital supply chain of societies is the food supply chain. Huff, Beyeler, Kelley and McNitt (2015) mentioned there may be a food shortage when the next global pandemic will occur. Food supply chains are vulnerable to disruptions such as pandemics (Zsidisin and Ritchie, 2009), which can affect transportation to stop delivering vital cargo (Luke & Rodrigue, 2008). Zsidisin and Ritchie (2009) mention "on average food travels 1,300 miles from farm to fork" (p. 295). Kohn et al. (2012) conducted a study about the impact of a disaster on customer's behaviour, where the responses were panic stockpiling on food, water and supplies. According to Peck & Helen (2006), retailers in the food and drink industry also have panic buying behaviours in times of pandemics. These behaviours would raise demand while the production and transportation of food are vulnerable, leading to potentially more shortages. McKinnon (2006) conducted a study which revealed that bread would be out of stock in two days in supermarkets in the United States if transportation trucks would be unavailable.

Pandemics create uncertainty and volatility in consumer demand, making it difficult to maintain food inventories in a just in time economy (Vo & Thiel, 2008). Peck and Helen (2006) mention in lean, mean and margin-pressured industries like food and drink, logistics or packaging, managerial time is already short. Managers are not always aware of the best strategies and guidelines for business improvement and need a clear guideline for new managers in the food and drink industry (Peck & Helen, 2006). Moreover, potential supply side shocks as a cause of pandemics are labour shortages, disruptions to transportation and cross-border disruptions (Hobbs, 2020). During the Ebola virus outbreak in 2014, West African countries faced food supply chains to shut down because of a shortage of workers and production and trade reductions (Food and Agriculture Organisation of the United Nations, 2014).

In short, an unprecedented shock as the current COVID-19 pandemic impacts supply side, operations as well as demand side of food supply chains. In case food supply chains get disrupted, people will not be able to buy food leading to potential starvation. It is crucial to

make food supply chains resilient during a pandemic (Huff et al., 2015). Supply chain resilience, in this research referred to as SCRE, has become important in the topic of supply chain management because of increased disruptions in the global supply chain (Chowdhury & Quaddus, 2017). Ponomarov and Holcomb (2009) argues while SCRM is only cause-oriented, SCRE is an extension which aims to make sure a supply chain can bounce back from risks regardless of the cause. SCRE is a multidisciplinary concept which will be defined in the next chapter. Ivanov and Das (2020) mention literature on analysing the impacts of epidemic outbreaks on supply chains is scarce. A gap in literature exists in how food supply chains respond to pandemics such as the current COVID-19 crisis and what strategies enhances SCRE of food supply chains (Hobbs, 2020). The timeframe of how food supply chains acted before, during and after the coronavirus can provide insightful analysis on how the supply chain got impacted and returned to the normal operating state. The way supply chain partners synchronise the timeframe is important to become resilient as (Ghiassi & Spera, 2003) mention synchronized supply chains allow timely availability of material, product and information flows among all supply chain partners.

Therefore, this research focuses on how Dutch food supply chains should synchronise a resilient supply chain before, during and after the current COVID-19 crisis. The objective is to provide a framework with strategies for Dutch food supply chains to synchronise SCRE. This research uses a Dutch food supply chain as a case study. The following central research question is formulated:

**“How should Dutch food supply chains synchronise supply chain resilience before, during and after the current COVID-19 crisis?”**

To answer the central research question, the following sub questions have been developed:

1. What measures to create SCRE during pandemics are mentioned in literature?
2. Which strategies did the case company take before, during and after the COVID-19 crisis?

This research makes several theoretical and practical contributions to the existing literature about SCRE. In particular, it will examine how food supply chains, which are a vital part of societies, enhance resilience during the current COVID-19 crisis. This research provides information about supply chain resilience in the food supply chain context, which is a scarce but important contribution. Furthermore, this research delivers a validation of several strategies mentioned in the supply chain resilience literature. Huff et al. (2015) examined the resilience

of food systems in the United States and calls for empirical research and models for food supply chains to get ahead of the next pandemic. This study aimed to consolidate the dispersed literature about SCRE and develop a model for food supply chains to enhance resilience during the current COVID-19 crisis. This study adds to the understanding of researchers and practitioners of the strategies taken by different perspectives from the whole supply chain through empirical findings from suppliers, distribution centres and retailers of one specific case in the Netherlands. None of the current studies assessed the demand side, supply side and operations side at the same time through a multi-tier assessment of the impact of such a crisis on a whole food supply chain (Mussell, Bilyea, & Hedley, 2020). This research investigates different entities in the one whole supply chain, which is a new contribution to literature. There is also a call for qualitative analysis regarding SCRE models (Chowdhury & Quaddus, 2017; Jain et al., 2017). Empirical explored models about a severe shock impacting demand, production and supply at the same time do not yet exist (Mussell et al., 2020). This research is set up as qualitative research with empirical data and will partly imitate a case study from (Simba, Niemann, Kotzé, & Agigi, 2017; Tukamuhabwa, Stevenson, & Busby, 2017) about SCRE in developing countries.

This bears also the inclusion of practical implications for the case company by validating their supply chain resilience strategies throughout the supply chain with the literature. Moreover, the different perspectives taken into account in this research provides the case company an insight in the whole supply chain. Although this research gathers information and provides advice to the case company, a model with strategies, which will be validated, amended or extended, can also be adopted by other supply chains to synchronise supply chain resilience.

The outline of this research is as follows. In chapter 2, the current literature about SCRE is reviewed which results in the development of a protype SCRE model. Subsequently, chapter 3 present the methodology of this research. The methodology explains how, why, where, what and from whom data and information was obtained. Chapter 4 discusses the results of this research, followed by chapter 5 which provides the conclusions and limitations of this research and suggestions for further research.

# 2 Literature review: Developing a supply chain resilience model

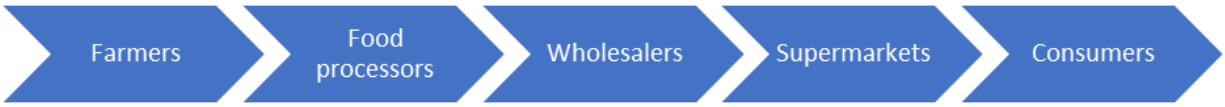
In this chapter, an overview of the literature will be given to outline the key concepts such as food supply chains, supply chain risk management, the characteristics and potential impact of the current COVID-19 crisis, supply chain resilience, and papers and theories that are used in this research. This results in the creation of a prototype model for supply chain resilience.

## 2.1 Food supply chain process

Food supply chains are a complex network with many entities linked from farmer to customer including farmers, suppliers, transporters, wholesalers, retailers and consumers (Folinas, Aidonis, Triantafillou, & Malindretos, 2013). According to Roth, Tsay, Pullman and Gray (2008), typical food supply chains are large, vertically integrated and controlled by multinational private and public corporations with a high degree of product diversity in which more than 80% of food is delivered through the global supply chain with a major focus on low cost and high efficiency. The food chain starts with a farmer using farm supplies such as machinery, seeds, fertilisers, pesticides etcetera (Folinas et al., 2013). The farmers then use logistics providers to transport the food either directly to the food processor or indirectly through storage and marketing via a cooperative group or consolidator (Folinas et al., 2013). The involvement of the farmer is often limited up to the processor and does not extend down to the customer or even the distributor (Folinas et al., 2013). Huff et al. (2015) indicated that “due to the small profit margins across the majority of food industries in the United States pressure to reduce cost has led to the consolidation of food companies, which results in only a few companies controlling most of the volume of food products in the global food system (e.g., Archer Daniels Midland, Cargill, Kraft, Nestle, PepsiCo, Unilever, and Walmart)” (p. 339).

Dutch food supply chains consist of several steps and entities (see figure 1). These steps are explained by the PBL Netherlands Environmental Assessment Agency (2012). The first step of this chain starts with 65,000 Dutch farmers who produce food formed by natural inputs. Next, 6,500 food processors transforms these outputs into semi-finished products, ingredients and consumer products. These are sold to 1500 transporters which sell the products to 5 wholesalers. The products are then sold to 25 retail brands and distributed afterwards through 4400 Dutch supermarket. Subsequently, these product reach 7 million households consisting of 17 million consumers (PBL Netherlands Environmental Assessment Agency, 2012).

Figure 1: Process Dutch food supply chains




When looking at the global market, the Netherlands is a key trading partner. First of all, many inputs to farming and processing are imported (PBL Netherlands Environmental Assessment Agency, 2012). Due to the many imports, processing and transiting, the Netherlands is the second biggest agricultural exporter after the United States in the world with a share of 7.5% in global agricultural export (PBL Netherlands Environmental Assessment Agency, 2012). Half of exports are meat, dairy products, vegetables and fresh fruit, which are for countries nearby such as Belgium, Germany, France and the United Kingdom (PBL Netherlands Environmental Assessment Agency, 2012). Furthermore, Dutch ports such as Rotterdam have a key role as transit route for products such as cocoa, soy and potatoes (PBL Netherlands Environmental Assessment Agency, 2012). The Netherland has also state-of-the-art agricultural technology and one of the best fertile agricultural land (PBL Netherlands Environmental Assessment Agency, 2012; Various authors, 2014).

## 2.2 Supply chain risk management

Managing supply chain risks has become an important priority for researchers and organisations. According to Truong Quang and Hara (2019) the rise of interest in supply chain risk management has two reasons. Firstly, natural disasters and crises which have taken place in the last decades are showing the world is becoming more unpredictable and unstable. Natarajarathinam, Capar, and Narayanan (2009) argue there are strong predictive signals that these disasters and crises are becoming more repetitive. Secondly, modern supply chains have become more complex and lengthy due to globalisation and thus more vulnerable to disruptions (Kırılmaz & Erol, 2017; Truong Quang & Hara, 2019).

Although several definitions of supply chain risk management exists in literature, there is no agreed definition provided by researchers. Fan and Stevenson (2018) suggest that supply chain risk management involves the “identification, assessment, treatment, and monitoring of supply chain risks, with the aid of the internal implementation of tools, techniques, and strategies and of external coordination and collaboration with supply chain members so as to reduce vulnerability and ensure continuity coupled with profitability, leading to competitive advantage” (p. 210). Supply chain risk management has also been defined by Wieland and Marcus Wallenburg (2012) as “the implementation of strategies to manage both every day and

exceptional risks along the supply chain based on continuous risk assessment with the objective of reducing vulnerability and ensuring continuity" (p. 888). A more widely accepted definition was created by (Singhal, Agarwal, & Mittal, 2011), which was later adopted by other researchers (Raghunath & Devi, 2018). According to this definition, supply chain risk management is defined as an extension of supply chain management to identify potential causes of risks and action plans to mitigate these risks and make supply chains more resilient against probability of risks occurring (Pujawan & Geraldin, 2009). This definition will be adopted in this research as it was adopted by other researchers in recent studies and specifies the link with SCRE.

The steps of the SCRM process have been determined by several researchers. For example, Ghadge, Dani, Chester and Kalawsky (2013) developed and tested a supply chain risk framework work with a case study. The framework consisted of the three steps risk identification, assessment and mitigation. According to Hachicha and Elmsalmi (2014) and later cited in the article of Fan and Stevenson (2018), the process of SCRM is composed of four stages. Risk identification, risk assessment, risk treatment and risk monitoring. This is also reflected in the steps of ISO 31000 (2009) which provides a standard for risk management namely: risk identification, assessment, treatment and monitoring. Furthermore, De Oliveira, Espindola and Marins (2018) conducted a research about the steps in the SCRM process based on the comparison of 23 articles from the period 2003 until 2015. The authors showed that the following steps are mentioned most: risk identification, risk assessment, risk mitigation and risk monitoring (De Oliveira et al., 2018). Research carried by Simba, Niemann, Kotzé and Agigi (2017) used the same steps as indicators for the SCRM process.

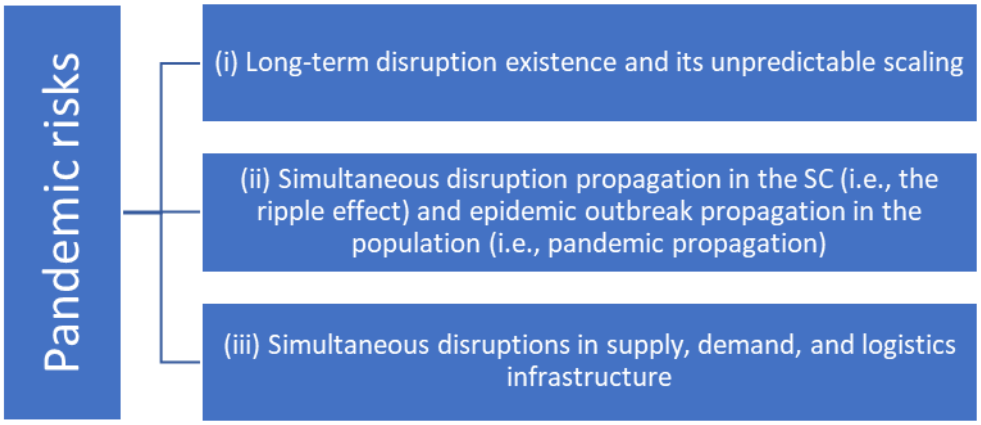
The concept SCRM is often related to SCRE which focuses on the recovery of a supply chain after a risk occurred (Ponomarov & Holcomb, 2009). The relationship of SCRM to SCRE has been supported in literature (Simba et al., 2017). For example, risk-oriented actions such as supply chain risk effect and knowledge management have been shown to have a positive impact on resilience strategies such as flexibility, velocity, visibility and collaboration (Simba et al., 2017). The resilience strategies are linked together with those of SCRM, because they mitigate risks throughout the supply chain (Simba et al., 2017). Additionally, some recent studies indicate that SCRM is the most important resilience driver because it enhances coordination within relationships in the supply chain which are essential to building resilience (Jain et al., 2017; Kamalahmadi & Parast, 2016; Singh, Soni, & Badhotiya, 2019; Tukamuhabwa et al., 2017). In short, SCRM and SCRE are mentioned to supplement each other as tool to minimise threats for business continuity (Kırılmaz & Erol, 2017) and supply chains to recover from

threats (Kamalahmadi & Parast, 2016). While SCRM is indicated as most pronounced enabler of SCRE, SCRE plays an important part of SCRM. This indicates the relation between the two concepts are circular, but this is not clear yet in literature. SCRE will be further elaborated on in paragraph 2.4.

## 2.3 Characteristics and potential impact of COVID-19

The current COVID-19 crisis has unique characteristics. Sheffi (2015) discusses pandemics as supply chain risks which are different than other disruptions because pandemics not only threatens human life, but also the global supply chain. Sheffi (2015) continues to define the difference between local disruptions (accidents, terrorist strikes and natural disasters) and global crisis's such as a pandemic which impacts multiple countries and industries. The same goes on for Ivanov (2020) who mentions the risk from pandemics on supply chains can be divided in three dimensions (see figure 2).

Figure 2: Three dimensions pandemic risks on supply chains




Pandemics are unique disruptions because they impact supply chains internal (e.g. worker illness) and external (e.g. supply shortages, demand increases) (Golan, Jernegan, & Linkov, 2020). Previous pandemics have impacted several links of supply chains such as suppliers, transportation, distribution and customers (Golan et al., 2020). According to Hobbs (2020), COVID-19 potentially impacts both demand side and supply side of supply chains. Demand side impacts have been panic buying by consumers leading to empty shelves in supermarkets (Hobbs, 2020). Kohn et al. (2012) conducted a study about the impact of a disaster on customer's behaviour, where the responses were panic stockpiling on food, water and supplies. According to Peck & Helen (2006) retailers in the food and drink industry also have panic buying behaviours in times of pandemics. These behaviours would raise demand while the

production and transportation of food are vulnerable, leading to potentially more shortages. Panic buying from retailers may lead to the bullwhip effect (Mussell et al., 2020; Tang, 2006). For a food distribution system built around just-in-time manufacturing and delivery, which is applicable to not-perishable products, the sudden and unexpected spike in demand across key categories created short-run stockouts (Mussell et al., 2020). According to Hobbs (2020) the food sector in western economies are dominated by a few large supermarket chains with high buying power and a focus on cost efficiencies. The just-in-time approach with low stocks and continuous flows contributes to the efficiency in the food sectors in normal times. However, Hobbs (2020) also argues this approach appears to be less suitable in sudden demand increases. Supply side disruptions include labour shortages due to worker illness, movement restrictions or self-isolation (Hobbs, 2020). Golan et al. (2020) mention the new coronavirus crisis "clearly shows the lack of resilience in supply chains" (p. 222). Hobbs (2020) states "as the pandemic unfolds in the coming weeks and months, much can be learned about how food supply chains respond to the crisis and about strategies to enhance SCRE" (p. 6). Summarising, the current COVID-19 crisis has led to sudden demand increases and supply shortages. It is expected food supply chains need a new approach to deal with these disruptive risks. This research will therefore analyse the responses and the effect of those responses of food supply chains before, during and after the impact of the COVID-19 crisis.

## 2.4 Current literature about supply chain resilience

SCRE is a multidisciplinary concept which has been defined by many authors. Ponomarov and Holcomb (2009) define resilience as "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (p. 131). SCRE develops over time, enabling an organisation to survive and recover from difficulties and to strengthen its capability to make future adjustments (Johnson, Elliott, & Drake, 2013). According to Melnyk, Closs, Griffis, Zobel and Macdonald (2014), SCRE is "the ability of a supply chain to both resist disruptions and recover operational capability after disruptions occur" (p. 129). Furthermore, Pires Ribeiro and Barbosa-Povoa (2018) conducted a framework analysis of SCRE definitions and proposed a simple new definition. The authors mention "a resilient supply chain should be able to prepare, respond and recover from disturbances and afterwards maintain a positive steady state operation in an acceptable cost and time" (p. 116). This new definition is the most relevant and will be adopted in this research as it covers previous stated definitions.

SCRE has a proactive and reactive phase. While proactive is about anticipating and preventing risks by having contingency plans (Pires Ribeiro & Barbosa-Povoa, 2018), reactive is more focused on responding and recovering from risks (Kamalahmadi & Parast, 2016). Research carried out by Wieland and Marcus Wallenburg (2012) shows resilience is composed of either reactive or proactive phases, which is also empirically revealed by Chowdhury & Quaddus (2017). This is In contrary, Kırılmaz and Erol (2017) mention the reactive phase is replaced by the proactive phase, because supply chain managers have begun to focus more on supply chain continuity. However, Norrman and Wieland (2020) mention "there needs to be a balance between proactive and reactive phases" (p. 2). Simba et al. (2017) agrees and states SCRE is not only reactive but also proactive. Furthermore, Conz and Magnani (2019) proposed a conceptual model based on a literature review that indicates proactive and reactive phases are used in a time span to achieve SCRE. Summarising, the literature has different perspectives on the approach of the proactive phase and reactive phase. This research will use the time span of these phases as stated by Conz and Magnani (2019) to investigate how food supply chains handled before, during and after the COVID-19 crisis. The model of Conz and Magnani (2019) is based on a recent extensive literature review. The researcher assumes that the authors have taken all strategies into account of current literature about this topic. Therefore, this research focuses on the strategies provided by (Conz & Magnani, 2019).

Within the proactive and reactive phases, the literature provides many strategies to enhance SCRE. Table 1 provides an overview of SCRE strategies gathered by a systematic literature review mentioned by the following authors: (1) (Kamalahmadi & Parast, 2016); (2) (Chowdhury & Quaddus, 2017); (3) (Jain et al., 2017); (4) (Tukamuhabwa et al., 2017); (5) (Conz & Magnani, 2019); (6) (Hosseini et al., 2019); (7) (Singh et al., 2019). The most common strategies mentioned are agility, collaboration, flexibility, redundancy and technology. These strategies support the strategies provided by Conz and Magnani (2019) with an additional strategy of collaboration. Although market strength and supply chain design are also mentioned three times by a few authors, these are excluded from this research because they are not mentioned in the literature review of Conz and Magnani (2019).

According to Simba et al. (2017), flexibility and redundancy are the main strategies of SCRE. While redundancy focuses on limiting risks and its consequences by keeping reserves such as safety stock and sourcing from multiple suppliers, flexibility ensures quick decision-making, internal communication and fast learning to adapt strategies to changing situations (Conz & Magnani, 2019; Simba et al., 2017). Simba et al. (2017) argues the two strategies flexibility and redundancy are both important, but their applicability in terms of the risk differs.

The authors mention “redundancy is preferable for everyday risks because of high frequency of occurrence and low impact while flexibility is preferable for exceptional risks usually of low probability and high impact which require rapid response” (p. 3). While flexibility focuses on changing organisational structures to adapt to changing environments, agility is about providing a quick response when dealing with turbulences in which the organisational structures and strategies are maintained (Conz & Magnani, 2019). Collaboration is another strategy for resilience which is defined by Kamalahmadi and Parast (2016) as the “ability to work effectively with other entities for mutual benefits” (p. 124) and consists of trust among partners in the supply chain and information sharing which plays an important role before and after a disruption in a supply chain. In the context of supply management, supply chains should invest in strong buyer-supplier relationships to motivate suppliers taking measures to mitigate risks (Simba et al., 2017). According to (Kamalahmadi & Parast, 2016; Pal, Torstensson, & Mattila, 2014), support, internal interaction, external interaction, information sharing, decision making are important aspects for having a collaborative supply chain. This research focuses on the whole supply chain of a Dutch food supply chain. Therefore, collaboration is an additional strategy taken into account in this research.

Table 1: Supply chain resilience strategies in literature

| **SCRE strategies** \ **Author#** | **1** Kamalahmadi 2016 | **2** Chowdhury & Quaddus 2017 | **3** Jain 2017 | **4** Tukamuhabwa 2017 | **5** Conz & Magnani 2019 | **6** Hosseini 2019 | **7** Singh 2019 |
|---|---|---|---|---|---|---|---|
| SCRM culture | X | | X | X | | | |
| Agility (Velocity & visibility) | X | | X | X | X | X | X |
| Collaboration (trust & information sharing) | X | X | X | X | | X | X |
| Flexibility | X | X | | X | X | | X |
| Redundancy | X | X | | X | X | | X |
| Robustness | | X | | | X | | X |
| Market strength (awareness & sensitiveness) | | X | X | | | | X |
| Financial strength | | X | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Supply chain design (criticality/density/complexity) | | X | | X | | | X |
| Adaptability | | | X | | X | | X |
| Sustainability | | | X | | | | X |
| Resourcefulness/Technology | | | X | X | X | | X |
| Supplier development | | | | X | | | |
| Building security | | | | X | | | X |
| Public-private partnership | | | | X | | | X |
| Inventory management | | | | X | | | |

*Notes: Green = Focus strategies of this research; Red = excluded from this research*

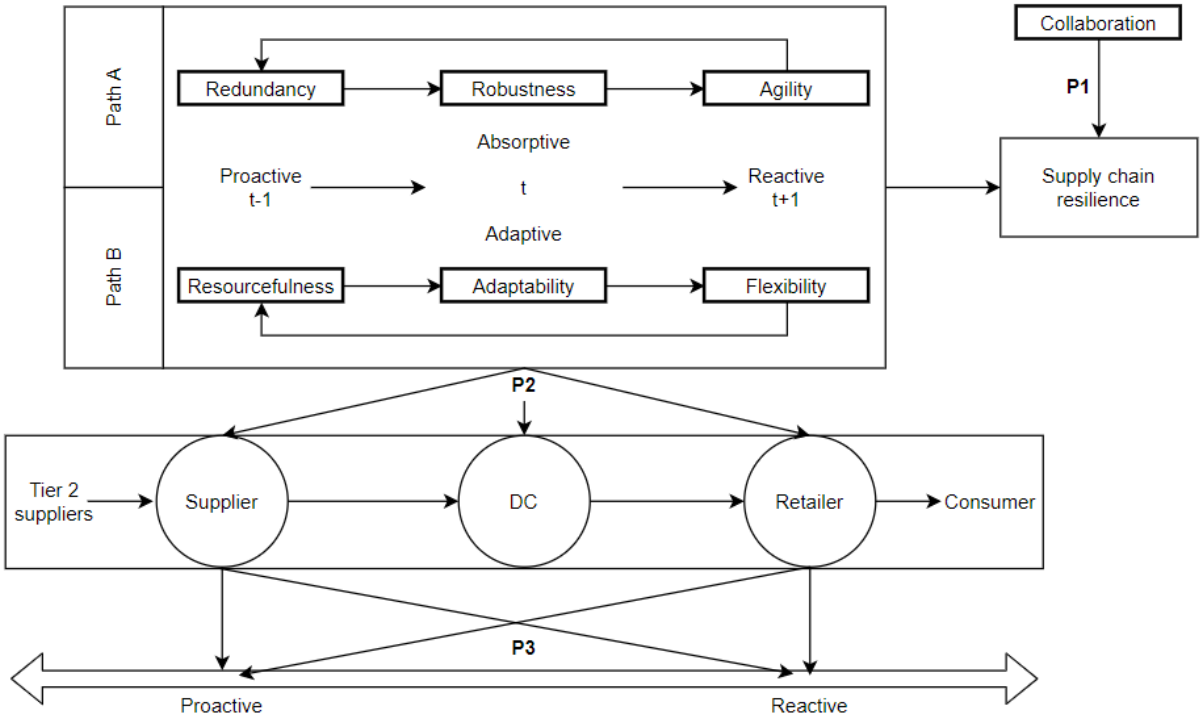
Conz and Magnani (2019) proposed a conceptual resilience framework based on a literature review from articles in the period of 2003 until 2017. This conceptual framework contains two paths with six core strategies for being resilient. Redundancy, robustness and agility are part of the absorptive path and resourcefulness, adaptability and flexibility are part of the adaptive path. Furthermore, the authors indicate that supply chain can be resilient by following either or both paths, which are both equally effective. Based on the strategies in their model and with an additional strategy of collaboration as shown in table 1, a model will be built in this research which explains the phases of being resilient. These strategies will be explained in the next chapter in table 3. Although current empirical research provides insights in SCRE models (Chowdhury & Quaddus, 2017; Conz & Magnani, 2019; Hosseini et al., 2019; Jain et al., 2017; Kamalahmadi & Parast, 2016), articles in the context of a severe shock impacting demand, production and supply at the same time do not yet exist (Mussell et al., 2020). Therefore, based on the literature about SCRE, a protype model will be built in the next section.

## 2.5 Prototype model supply chain resilience

Figure 3 presents the protype model to achieve SCRE derived from the existing resilience models in literature. This model gives the expectation of how SCRE can be achieved. Conz and Magnani (2019) call for empirical studies exploring how knowledge and competences gathered by firms after recovering from a shock, might contribute to the implementation of new abilities useful in preparing for potentially new critical events. The goal of this model is to address this gap and explore its applicability in pandemic situations in which the current COVID-19 crisis will serve as a case study. The model consists of the strategies which are mentioned most in literature, as can be seen in the green marked rows in table 1. The strategies redundancy,

robustness, agility, resourcefulness, adaptability and flexibility from Conz and Magnani (2019) are all considered because their model is based on a recent literature review. This is also often mentioned by other authors as shown in table 1 and therefore reinforces the argument.

Figure 3: Prototype model supply chain resilience strategies




Notes: t-1 = before disruption, t = during disruption, t+1 = after disruption

The strategy collaboration is not specified by Conz and Magnani (2019) but mentioned often by the other authors in table 1. According to Kamalahmadi and Parast (2016) supply chain risk management with a high interconnectedness cannot be examined without a high degree of collaboration, cooperation and partnerships with entities in the supply chain. In addition, Leat and Revoredo-Giha (2013) state collaboration significantly supports supply chain resilience. Therefore the strategy collaboration is also added to the model and the following proposition is set up:

**Proposition1** A collaborative approach supports supply chain resilience

As mentioned before, it is important to keep a balance between a proactive and reactive approach in a time span before, during and after a disruptive risk occurs. The proactive approach limits risks before they occur (e.g. having multiple sourcing and safety stocks) and the reactive approach requires quick responding to changing environments (e.g. reacting quickly to supply chain disruptions such as material shortages or lead time problems and having responsive

suppliers) (Conz and Magnani, 2019). It is expected that taken into account both approaches play an important role in dealing with demand side and supply side disruptions caused by the coronavirus crisis. The following proposition describes the expected relationship of the variables from path A and path B proposed in the protype model:

**Proposition2** Individual Dutch food supply chain partners can synchronise resilience if there is a balance in strategies from the proactive to reactive phases before, during and after a pandemic.

Literature (Mojtahedi & Oo, 2017; Wieland & Marcus Wallenburg, 2012) states it is crucial that supply chains have a holistic approach in proactiveness and reactiveness to limit risks and recover from the impact. When suppliers and buyers are only reactive, this may lead to the ripple effect, increased costs and waste. Mismatches in the proactive and reactive approach between suppliers and buyers lead to frustration and dissatisfaction with the supply chain partner because of lack of process alignment or feeling less return on investment (Lettice, Wyatt, & Evans, 2010). Table 2 illustrates an overview of the proactive and reactive approaches upstream and downstream supply chains.

Table 2: Proactive versus reactive upstream and downstream supply chain

| | | **Upstream (Suppliers)** | |
|---|---|---|---|
| | | **Reactive approach** | **Proactive approach** |
| **Downstream (Buyers)** | **Proactive approach** | Unattractive supplier (Lettice et al., 2010) | Effective risk management (Wieland & Marcus Wallenburg, 2012) |
| | **Reactive approach** | Ripple effect, costs, waste (Mojtahedi & Oo, 2017) | Unattractive buyer (Lettice et al., 2010) |

Although the previous proposition explains that individual supply chain partners should have a combination of proactive and reactive approach, it is assumed that within a whole supply chain the focus should be proactively to achieve effective risk management. Therefore, the following proposition describes the expected difference in proactive or reactive approach by the upstream and downstream supply chain partners:

**Proposition3** Only a proactive approach will lead to effective risk management within supply chains.

# 3 Research Methodology: Case study

In this chapter the research methodology will be explained which refers to how, why, where, what and from whom data and information are obtained to answer the central research question.

## 3.1 Research design

This research reacted to the need for more empirical research into food SCRE during pandemics. The literature calls for empirical studies to make food supply chains resilient during pandemics (Huff et al., 2015). The author of this master thesis is interested in how Dutch food supply chains respond to a pandemic and about strategies used in the supply chain during the current COVID-19 crisis to achieve SCRE. To get insight in the response and used strategies throughout the food supply chain, a case study approach would be suitable (Flyvbjerg, 2006). A case study enables an in-dept analysis of complex, real-life phenomena which could result into new insights (Eisenhardt & Graebner, 2007). However, disadvantages may entail that qualitative studies lack trustworthiness due to small sample sizes and use of variables to statistically test relations meaning the research is not likely to be generalisable (Rahman, 2016). Nevertheless, this research used a descriptive qualitative design, because this provided detailed information from the respondents' perspectives and experiences on the main topic (Neergaard, Olesen, Andersen, & Sondergaard, 2009). This qualitative case study used a deductive approach in which the theoretical proposed model of SCRE is supported, amended or rejected by the respondent's perspectives.

## 3.2 Literature review approach

The objective of the literature review was to gain existing information about supply chain risk management, characteristics and the potential impact of COVID-19 and SCRE. This section gives an overview of the conducted literature review. The database Scopus is used to identify usable articles, because this source contains peer-reviewed journals, can filter articles in a systematic way with special functions and is easy accessible for students from the University of Twente. Additionally, search engine Google Scholar is used to supplement more relevant information. Appendix A presents an overview of the key words and methods to distinguish relevant and irrelevant articles for this research. SCRE strategies was the first theme which was searched for to answer the research question with the available literature. After the initial hits, the articles have been automatically filtered on years (past 5 years), area (mainly business management) and articles in journals. The articles were sorted on "cited by highest" and "most

recent" to make sure the most cited and recent articles were considered in this research. The outcomes of the articles have been manually judged and selected on title, abstract and content which provided SCRE strategies. This ensures the most relevant articles were used in the research. Concluding, the quality and the relevance of the articles are assessed through a structured literature review approach.

## 3.3 Case study

This research used a case study for one case company because it will investigate the whole supply chain which is time consuming, more cases would not be realistic in a master thesis research. The consequence of this is that it would be inappropriate to suggest the findings are representative to the average Dutch food supply chain. Its generalisability is not strong. To make such a generalisation, a research with a more diverse and wider population should be conducted. With this case study, insight in the response and used strategies throughout the food supply chain are gathered but also how the supply chain is operating and interacting with different entities. In addition, the coronavirus crisis impacts not only single organisations, but the whole supply chain. It is expected that resilience is created when taking into account the whole supply chain (Sá, Miguel, Brito, & Pereira, 2019). Thus the whole supply chain should be investigated. The unit of analysis of this research are Dutch food supply chains and the unit of observation is the case company. This case study serves as a validation of a supply chain resilience model with current literature about this topic by empirically exploring supply chain resilience. Within this case study, the strengths and weaknesses of the case are studied to gather new insights for other supply chains. Managing supply chains is important to minimise the ripple effect, but also potential supply side shocks as a cause of pandemics such as labour shortages, disruptions to transportation and cross-border disruptions (Hobbs, 2020) and maintain business performance, productivity, revenues and service levels (Tang, 2006). Furthermore, a case study enables an in-dept analysis of complex, real-life phenomena which could result into new insights (Eisenhardt & Graebner, 2007). This research used a explorative qualitative design, because this provides detailed information from the respondents' perspectives and experiences on the main topic. The respondents in the case are easy approachable because the researcher works at the distribution centre of the food supply chain. A limitation of one case is that other similar food supply chain in the Netherlands could be operating differently. However, investigating one entire supply chain may offer valuable new insights in this specific context.

## 3.4 Operationalisation

This section provides an operationalisation of the key elements and theory of the prototype model used in this research. This enables the process of defining a clear measurement method to correctly explore the effects of the phenomenon. Table 3 provides an operationalisation of the theoretical elements. The strategies are explained with a definition from current literature and complemented with indicators derived from surveys. The indicators are used to give a direction to the coding process and the set-up of the interview protocol.

Table 3: Operationalisation

| **Approach** | **Strategy** | **Operationalisation** | **Indicator** |
|---|---|---|---|
| Proactive | Redundancy | Limiting risks and its consequences by keeping reserves such as safety stock and sourcing from multiple suppliers (Conz & Magnani, 2019). | Alternative strategies for decision making ability (Pal et al., 2014) |
| | | | Multi-channel distribution or retailing facility (Pal et al., 2014) |
| | | | Parallel processes/manufacturing facilities (Pal et al., 2014) |
| Absorptive | Robustness | Resist shocks by preventing and reducing the effects of variables that can make a firm vulnerable in its operating environment (Conz & Magnani, 2019). | Multiple sourcing (Hosseini et al., 2019) |
| | | | Lean management (Pal et al., 2014) |
| Reactive | Agility | Providing a quick response when dealing with turbulences in which the organisational structures and strategies are maintained (Conz & Magnani, 2019). | Responsive suppliers (Hosseini et al., 2019) |
| | | | Response rapidly to random events (Hosseini et al., 2019) |
| | | | Suppliers with multiple skills (Pal et al., 2014) |
| Proactive | Resourcefulness | Capability to accumulate different diversified assets and resources (technological, organisational and human) (Conz & Magnani, 2019). | Technology (Pal et al., 2014) |
| | | | Material (Pal et al., 2014) |
| | | | Human (Pal et al., 2014) |
| Adaptive | Adaptability | | Rerouting (Hosseini et al., 2019) |

| | | | |
|---|---|---|---|
| | | Capability to adjust the firm's response and to adapt internal processes to changing external conditions (Conz & Magnani, 2019). | Backup supplier (Hosseini et al., 2019) |
| | | | Raw material substitution (Hosseini et al., 2019) |
| Reactive | Flexibility | Capability of implementing rapid decision-making processes, quick internal communication and fast learning so as to quickly adapt routines and strategies to changing conditions (Conz & Magnani, 2019). | Introducing new products (Hosseini et al., 2019) |
| | | | Demand driven (Hosseini et al., 2019) |
| | | | Quick reallocation of orders to alternate suppliers (Hosseini et al., 2019) |
| Collaboration | | Ability to work effectively with other entities for mutual benefits (Kamalahmadi & Parast, 2016) | Information sharing (Kamalahmadi & Parast, 2016) |
| | | | Trust (Kamalahmadi & Parast, 2016) |
| | | | Internal interaction (Pal et al., 2014) |
| | | | External interaction (Pal et al., 2014) |
| | | | Decision making (Pal et al., 2014) |
| | | | Support (Pal et al., 2014) |

## 3.5 Population and sampling design

The unit of analysis for this research is are Dutch food supply chains. The unit of observation are Company X and their suppliers. Company X is a Dutch supermarket chain in the food retail branch and has its headquarter in Velp, the Netherlands ( Company X, 2020). Company X was founded in 1891 by factory workers whom started small shops offering provisions (Company X, 2020). In the sixties, the first supermarket was launched where cooperation between the retailers was required to gather a strong market position (Company X, 2020). Nowadays, Company X employs 4500 workers and has over 300 supermarkets (Company X, 2020). In 2019, Company X generated customer revenues of 1,5 billion (Company X, 2019). Company X currently has a market share of 4,2% and strives to achieve growth through a responsible and sustainable supply chain (Company X, 2019). Since the author of this research works at Company X, the case of Company X is a convenient sample. As mentioned before, the implication of this is that it would be inappropriate to suggest the findings are representative to the average Dutch food supply chain. The respondents are chosen in a systematic way based on

their knowledge, experience and function to cover all aspects of the supply chain of Company X including supermarkets, distribution centres and suppliers. The respondent profiles are shown in table 4.

Table 4: Respondents profile

| **Respondent pseudonym** | **Job title** | **Years of experience** | **Link in supply chain Company X** | **Time duration** |
|---|---|---|---|---|
| R1 | Head Office | 10 | Distribution centre | 28:44 |
| R2 | Head Warehouse Operations | 26 | Distribution centre | 44:07 |
| R3 | Head Supply Chain Replenishment + Manager Replenishment & Master Data | 8 | Headquarter | 47:30 |
| R4 | Manager Logistics | 14 | Headquarter | 50:42 |
| R5 | Assistant Branch Manager | 3 | Competitor X | 28:50 |
| R6 | Branch Manager | 12 | Retailer A | 24:07 |
| R7 | Branch Manager | 5 | Retailer B | 23:57 |
| R8 | Customer Development Manager | 14 | Supplier A | 30:23 |

To explore the responses and used strategies, an adequate amount of interviews need to be investigated. According to Galvin (2015), data saturation in qualitative studies is achieved after 12 interviews. The interviews are semi-structured because this enabled the researcher to ask follow-up questions as well as getting more information about specific topics (Adams, 2015). This research held 8 interview with several managers from the different upstream and downstream supply chain entities. Although the plan was to hold interviews with the top management of Company X, this research focused on middle management because of a lack of time from the top management. Therefore, this research struggled with finding strategies taken at the top level of the case company which may lead to an incomplete picture of the case company. While many responses came from the downstream partners (e.g. headquarter, distribution centre and supermarkets), there was a lack of responses from the upstream partners (e.g. suppliers). An internal document that contains all suppliers from Company X was gathered from the Supply Chain Manager. The suppliers producing the most sold products during the coronavirus crisis where approached by the researcher, because it was assumed these suppliers had more challenges to become resilient. In total, 15 to 20 suppliers where contacted from which 2 suppliers responded. From these 2 suppliers only one was interviewed, because the

other supplier did not want to share business sensitive information with third parties. A theoretical data saturation approach was chosen which means the researcher stopped taking interviews when there was no additional crucial data to be gathered. The observation of the same strategies over and over again led to an empirical confidence.

## 3.6 Data collection and analysis

The interview protocol composed of questions is based on the three segments, (1) opening; (2) middle and (3) concluding, of Galetta (2013) and can be found in Appendix B. The questions within the interview protocol are verified with the supervisor on completeness, suitability as well as proper duration. The interviews are taken face-to-face at the respondents' offices or through teams meetings. In approaching the respondents, the researcher made phone calls, followed by an email with the interview protocol. A convenient day, time and location was arranged through these phone calls and emails. Each interview started with an introduction of the interviewer, the objective of the research and interview, clarification of anonymity and confidentiality and the request to record the interview. The input derived from the interviews are transcribed, checked and verified with the respondents. Thematic analysis is used to analyse the data in this research. The coding is supported with the program ATLAS.ti9 which supports qualitative research analysis by generating a quick overview of codes. The process of coding is based on Rowley's (2012) method of using themes, topics and codes. The program works through linking codes to parts of texts. The researcher first determined the themes to focus on, which are impact, taken strategies and the results of these strategies as these themes are relevant to answer the research question. Subsequently, topics were allocated to the themes in which the variables from the model were taken into account. Thereafter, the text from the transcriptions was coded on the basis of the themes. In the end, overarching codes were used to ensure the researcher was able to create an overview and adequately summarise the data. The interview questions and the coding process are structured based on the operationalisation of the protype model (see table 3).

## 3.7 Reliability and validity

Measures to ensure the reliability and the validity of this research are taken. The reliability of this research was supported through a specific description of the research method which enables the replicability of this research by future researchers. The research design is supported with an interview protocol. The questions in this protocol were provided to the respondents before the interview. The validity of this research was ensured by adapting previous empirical works in

the field of SCRM and SCRE. Moreover, expert interviews were used to gather data and member checking was used by providing respondents a copy of the transcribed notes from the recordings which were verified. The data gathering was verified by the supervisors of this research. Finally, data triangulation was used to support the validity meaning the obtained data was looked at from different perspectives (Carter, Bryant-Lukosius, Dicenso, Blythe, & Neville, 2014). This research used a systematic literature review, internal documents, online publications and semi-structured interviews.

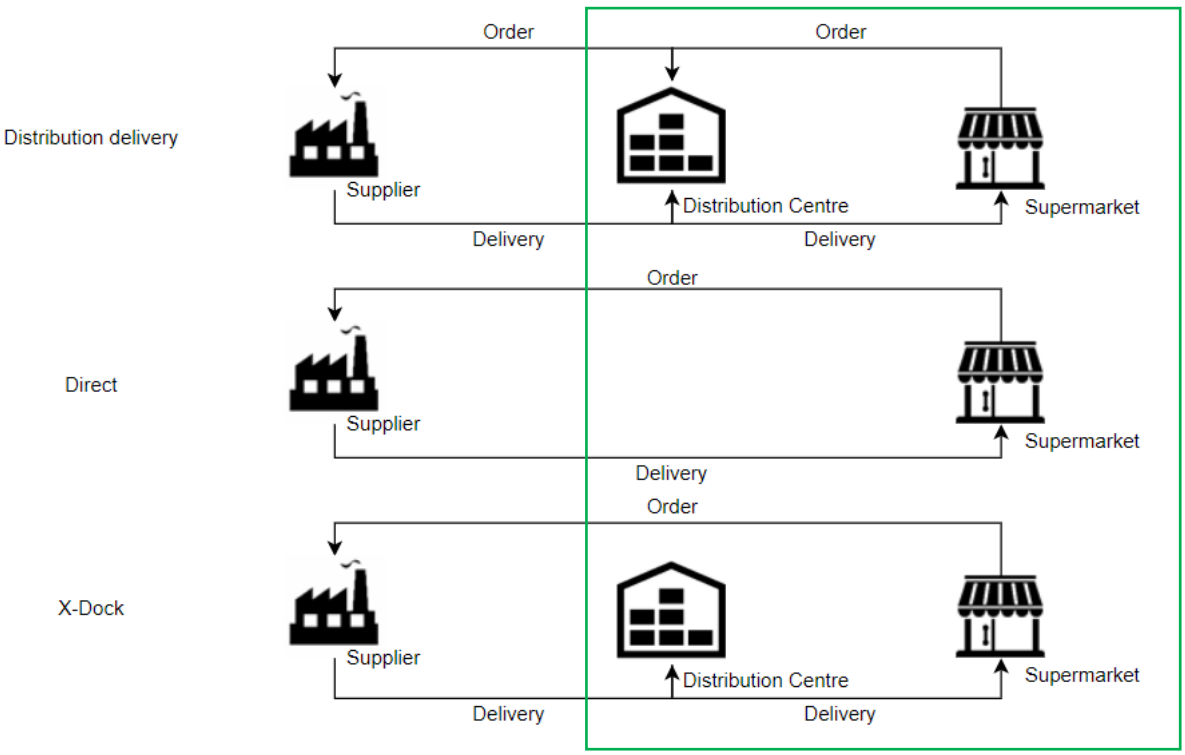
# 4 Results

In this chapter the results are presented including an overview of the supply chain of Company X, the impact of the coronavirus on their supply chain, taken strategies before, during and after the pandemic, the remaining findings and the validation of the proposed model.

## 4.1 Description of the supply chain process of Company X

Figure 4 presents the supply chain process of Company X, which consists of three main flows, namely DC (distribution centre) delivery, direct delivery and X-dock delivery. The first flow is applicable for most products such as fruit, vegetables, dairy and groceries. Here the supermarket orders at the DC and the DC orders at the suppliers. Thereafter, the products are stored at the DC before delivery to the supermarkets. The second flow is direct delivery from the supplier to the supermarket, which is used for the delivery of fresh bread for example. The third flow is called X-Dock, or cross-dock. In this flow the supermarket also orders directly at the supplier, but the products are delivered to the DC in-between before they are delivered to the supermarket. This is applicable for products with a short shelf life such as meat, fish, pre-cut fruit and cake.

Figure 4: Supply chain process of Company X




*Notes: Green = Part of Company X*

Company X has multiple suppliers that are responsible for delivering products either directly to supermarkets or indirectly via the distribution centres. Company X has two distribution centres which are charged with receiving, storing and expediting products. There are over 300 supermarkets responsible for offering the products to the end consumer. As summarised by Distrifood (2019) in 2019, the market share of Company X (3.7%) is relatively small to the big competitors X (34.9%), X (21%), X (6.5), but also less than discounters X (10.7%) and X (5.9%). Their service office and specifically the supply chain department is responsible for servicing the supermarkets. Furthermore, Company X is part of the purchasing organisation Company Y that is responsible for purchasing products for 14 supermarket chain members.

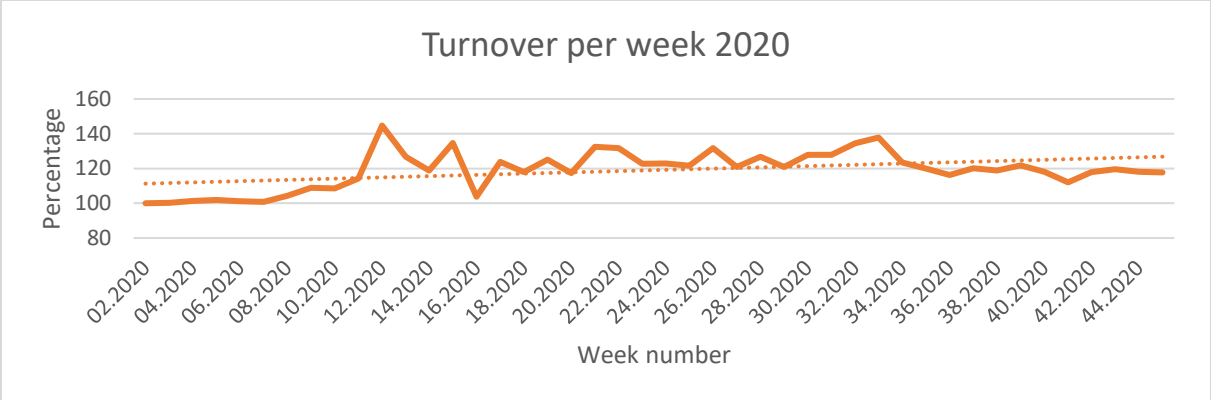
## 4.2 The impact of COVID-19 as crisis and transformation

The coronavirus has caused several negative impacts on the entire supply chain of Company X. The supermarkets had to cope with a sudden increase in demand, especially toilet paper, cleaning products and products with a long shelf life such as rice and pasta. This increase led to out of stock shelves in the supermarkets. *"It was completely looted. Toilet paper was all looted. Pot vegetables had run out, all the flour.. you name it. It was all gone" (Branch manager Supermarket A).* However, both branch managers mentioned the problems only lasted in the first few days of the demand peak. The distribution centre became less productive because of all the measures taken to ensure distance was kept between employees: *"Employees from the order-pick department had to wait for each other, which is fine. But it really had an impact on our productivity" (Head Warehouse Operations).* According to the Supply Chain Manager the suppliers had increased lead times as he claims that *"they increased their lead time from 3 to 5 days or more so they had more time to plan".* Furthermore, the coronavirus led to factory closures. According to the Customer Development Lead of supplier X, some of their factories were closed: *"For example our plant in North-Italy has not been able to deliver for two months".* The supply chain partners reacted to the sudden demand increase by obtaining additional safety stocks. This led to additional stocks and storage costs downstream from supermarkets to suppliers, which is also explained as the ripple effect. The DC Head Operations claims that *"the supply planners ordered more"* and the Logistic Manager mentioned that *"so we responded by taking extra stock".* Additionally the costs increased as the Logistics Managers claims that *"the costs increased with 6 to 7 per cent".*

Although the coronavirus crisis impacted the supply chain negatively, it also made the supply chain discover that certain processes became better or more efficient. First of all, the increased demand led to an increase in turnover. Figure 5 illustrates the turnover per week from

the start of 2020. Based on the figure it can be seen there was a demand peak in week 12, which was the start of the coronavirus period in the Netherlands. The overall turnover increased from week 12 until now on average with approximately 15 per cent, meaning the organisation made profits because the increase in turnover cover the increase in costs which was approximately 6 or 7 per cent according to the Logistics Manager. Supplier X also profited by this crisis *"there are only two or three suppliers that have profited within fast-moving consumer goods and we are one of them. Cleaning products have just gone fast and we happen to be in that industry" (Customer Development Lead)*. Moreover, according to the branch managers the supply chain of Company X had less trouble with stock availability and was impacted less than the bigger competitors because of their smaller customer base leading to less logistical problems. This is in line with an analysis from (Jansen, 2020) published in Distrifood which claims that supermarkets with a higher floor productivity (e.g. the turnover per square meter) had a lower turnover increase during the coronavirus crisis compared to supermarkets with a lower floor productivity. Their research indicates this is due to the fact that customers prefer to visit quiet supermarkets. In addition, the assistant-branch manager of a competitor claims that they work as much as possible with just in time (R5). This indicates that less stocks were hold by competitors while having more logistical problems. Company X also had an positive impact on society by donating volume surpluses to charities and providing new employment opportunities.

Figure 5: Turnover per week 2020




Furthermore, according to the Logistics Manager, the coronavirus crisis also improved collaboration and trust among supply chain partners as he pointed out that *"we contacted suppliers more frequently which improved our collaboration"* and that *"trust improved among the supply chain partners because you depend on each other"*. Finally, the coronavirus crisis resulted in a new chapter of pandemics in the risk-assessment of Company X to prevent similar

disruptions (R4). Summarising, taking all those aspects into account it seems that the impact of the coronavirus crisis on the supply chain of Company X was negative by out-of-stocks due to increased sales, decreased productivity, increased lead times, plant closures, the ripple effect and increased costs. However, the impact was also positive as it led to an increase in turnover, increased collaboration and trust, prepared the supply chain for future pandemics and positively impacted society. Besides, the small supply chain size of Company X ensured more availability and turnover compared to the bigger competitors.

## 4.3 A collaborative approach as driver for supply chain resilience

This section analyses **Proposition1:** A collaborative approach supports supply chain resilience. The different perspectives of the supply chain partners on collaboration indicate that the most important aspects are: support, interaction, information sharing and decision making. The results of the perspectives of the supply chain partners on the collaboration variable are explained below.

**Support**

Support of supply chain partners was mentioned by both downstream buyers and upstream suppliers, but also local support and support from friendly competitors. Upstream support was pointed out by the Logistics Manager and Head Warehouse Office in which the distribution centre was accommodating more with their suppliers: *"We have become more accommodating with suppliers regarding delivery times.. because they are in the same situation as we are (R1)".* According to the Supply Chain Manager one of the suppliers became understaffed on the customer development department leading to a loss in their overview of product availability. The supply chain department of Company X responded by liaising with that supplier. Moreover, they linked a transport company who normally delivered to the catering industry to one of the suppliers that could not arrange their own transport. Upstream support to the retail partners was mentioned by the Customer Development Lead of supplier X: *"we ensured the products were distributed proportionately per customer and per location.* This is also the case for the distribution centre as the Head Warehouse Operations stated: *"We are always service oriented towards the supermarkets and see them as customer.. during unforeseen situations we always try to switch and think along" (R2).* Both the Logistics Manager and Head Warehouse Operations mentioned there was local support from catering wholesalers: *"when the catering industry closed, we immediately contacted local catering wholesales, so we could help their employees for temporarily work at our distribution centre during the time they were closed"*

*(R4)*. Finally, the Supply Chain Manager and Logistics Manager stated there is also support from friendly competitors within the purchasing organisation Company Y: *"We have agreements with our purchasing organisation members to not let each other fall"(R3).*

**Interaction**

Although internal interaction was mentioned by the supply chain partners, external interaction could be improved downstream. The branch managers are satisfied with the external interaction upstream in the supply chain: *"when for example some products could not be delivered, you were informed in time about it"*. In addition, the Supply Chain Manager claims that *"from the beginning of the coronaperiod there was a lot of contact with these suppliers. Sometimes almost daily and sometimes even more often than daily, to ensure you get what you need"*. On the contrary, the Customer Development Manager of supplier X pointed out that the purchasing organisation Company Y was less preferred to collaborate with, because of their focus on cost efficiency rather than collaboration (R8).

**Information sharing**

According to the Logistics Manager the information flow is transparent and provided quick "we follow the supermarket turnover from hour to hour. *When I see a demand increase of 23 per cent higher than the week before, we immediately contact the supermarkets to gather information about which products caused the additional turnover, what happened? Based on that we respond directly to the suppliers that there is a sudden increase in the sales"*. The Supply Chain Manager pointed out his department tracked the products in the supermarkets that were sold a lot: *"what we did is track the product groups that were sold a lot in the supermarkets. Based on that we made adjustments, so that you are actually a bit faster than when you would do it a day later".* An automatic system called Forecast and replenishment is used that automatically sends data from supermarket to distribution centre. According to the Supply Chain Manager this system is only applicable for the distribution centre and supermarkets and thus not directly transferred to the suppliers. As mentioned before, supplier X pointed out that the purchasing organisation Company Y was less preferred to collaborate with (R8).

**Decision making**

The Supply Chain Manager mentioned the decision for offering certain products was based on the availability of the suppliers, meaning there was collaborative decision making: *"By asking*

*a lot more about which products the suppliers had available, so we can adjust the orders and order more from the available products" (R3).* Furthermore, it seems decisions at the head quarter are taken in combination with top management and middle management as the Masterdata Manager stressed out that *"the management tells us that there is a problem, but we figure out the best solutions with our expertise to solve the corona related problems".*

Concluding, this research indicates the internal cooperation within the organisation is well performed, but lack in external cooperation with suppliers. It seems that the purchasing organisation Company Y is more cost driven than collaboration driven, which has a negative effect on mitigating risks together with suppliers. No negative effects were found from the buyer's perspective as all managers claimed that the collaboration even improved due to the coronavirus crisis to ensure continuation of production flows from suppliers to customers. From the supplier's perspective however, the collaboration was less preferred because of the buyer's focus of on cost efficiency rather than collaboration. Nevertheless, due to the support, interaction, information sharing and collaborative decision making, it seems the supply chain has shown to recover from the coronavirus crisis by collaborating with the supply chain partners. Thus the following proposition is supported.

**Proposition1** A collaborative approach supports supply chain resilience.

## 4.4 Strategies mainly taken during the crisis

This section analyses **Proposition2:** Individual Dutch food supply chain partners can synchronise resilience if there is a balance in strategies from the proactive to reactive phases and **Proposition3** Only a proactive approach will lead to effective risk management within supply chains.

Several strategies have been conducted by the supply chain partners of Company X to cope with the coronavirus crisis disruptions. In this section the taken strategies before, during and after the coronavirus crisis mentioned by suppliers, distribution centre and supermarkets are explained. The two paths mentioned by Conz and Magnani (2019) seem to be both applicable in this case study because the supply chain partners quickly responded to deal with the coronavirus crisis by maintaining (agility) as well as adapting (flexibility) their structures and strategies. The strategies of the two paths are combined and explained below per time frame: proactive, absorptive/adaptive and reactive. Table 5 provides an overview of the strategies taken

by the supply chain partners in each variable of path A and path B. The paths and variables are explained below.

Table 5: Results overview strategies path A and path B for involved supply chain partners

| Supply chain link | Path A | | | Path B | | |
|---|---|---|---|---|---|---|
| | **Proactive t-1 (redundancy)** | **Absorptive t (robustness)** | **Reactive t+1 (Agility)** | **Proactive t-1 (Resourcefulness)** | **Adaptive t (Adaptability)** | **Reactive t+1 (Flexibility)** |
| Supermarkets | No plans | - Safety stock | - Quick response | No plans | - Human availability<br>- Technological availability | - Introduce new products |
| Distribution Centre | No plans | - Safety stock<br>- Additional storage and sufficient transportation<br>- Global sourcing<br>- Small batch trade | - Corona crisis team<br>- Quick response | No plans | - Human availability<br>- Technological availability<br>- Rerouting<br>- Backup suppliers<br>- Product substitution | - Focus on key products<br>- Introduce new products<br>- Suppliers deliver whole pallets |
| Suppliers | No plans | - Safety stock<br>- Additional storage | - Quick response | No plans | - Excess plant capacity and production facility<br>- Backup suppliers<br>- Product substitution | - Focus on key products<br>- Extend production lines<br>- Cost reduction by less tv-commercials |

### 4.4.1 Proactiveness before coronavirus crisis

Interestingly, the supply chain partners did not have plans prepared for pandemics in general. The Branch Managers pointed out *"I do not think we had plans ready to prepare for this situation" (R6)* and *"we have plans for fire and threats etcetera. And for disasters.. no. For corona we did not have any plans, I think no-one had. It is usually for the things that could logically occur (R7)".* This shows the supermarkets were not prepared for the coronavirus crisis. From the distribution centre side the same can be stated as the Logistics Manager stressed out that *"we have a risk inventory explaining what to do in case of fire, threats you name it.. but that did not contain a chapter about pandemics. Why? I have not even heard of the word until early 2020".* Although he did point out that they did followed the situation before it came to the Netherlands: *"when we had the first signs that is was spreading from China to Italy, we*

*responded by looking at which products were hoarded in Italy, such as toilet paper".* Yet it seems to be more reactive than proactive because no concrete plans were ready to use. In addition, the Supply Chain Manager stressed out that *"usually before Christmas we prepare months in advance to ensure as much spreading as possible by pushing extra volumes from distribution centres in the supermarkets*" but that *"the corona crisis effected everything at the same time and everything had to go through in one go, which led to a bullwhip through our chain"*. When looking upstream from the supplier's perspective, the Customer Development Manager claims that *"it is not that we had preventive actions 4 months before corona. To be honest, it took us by surprise"* and that *"we did take several measures, but it was mainly reactive*".

Hence it can be stated both downstream and upstream supply chain partners did not act proactively before the coronavirus crisis. While actions were taken to reduce the impact, no concrete plans and preventive forecasts were ready to anticipate adequately before the disruptions occurred. Regarding the variables "redundancy" and "resourcefulness" which are part of proactiveness in the proposed model, it seems the supply chain partners did not have strategies ready before the crisis had taken place. The strategies were taken during the virus to mitigate the effect of the crisis. Therefore, these variables are taken out of the model.

### 4.4.2 Absorptive/adaptive during coronavirus crisis

As mentioned before, the supply chain partners have taken several strategies during the coronavirus crisis to mitigate the impact on their supply chain including 1) safety stock increases, 2) additional storage and transport, 3) rerouting, 4) global sourcing, 5) small batch trade, 6) increase personnel, 7) technological availability, 8) backup suppliers, 9) product substitution, 10) Excess plant capacity and production facility.

- First of all, obtaining **safety stocks** and additional margins to ensure supermarkets can meet the high increase in demand was highlighted by multiple managers from the downstream and upstream supply chain partners. Although having safety stocks is part of proactiveness, the stocks were obtained during the crisis and not before. The Logistics Manager pointed out that high demand products were never unavailable because of their stock availability: *"Toilet paper has never been scarce. Nowhere. However, because we anticipated directly, we were one of the few supermarket supply chains that always had stock available".* The Branch managers of the supermarkets had the same opinion about gathering additional stocks: *"I filled all the shelves entirely full for products with a long shelf life" (R6*). The Customer Development Lead of supplier X claims that *"the safety*

*stocks on raw materials were significantly increased on pumps"* and that *"finished goods on hand soap was increased on stock".*

- Secondly, the organisation rented **additional storage and transport** and **rerouting** on distribution side and suppliers to handle the surpluses. The Supply Chain Manager pointed out that *"we had to store the batches that we purchased abroad in additional locations because it was too much to handle all at once"*. In addition, the Logistics Manager mentioned *"we had to rent extra area to store the stocks"*. Furthermore, he also pointed out they made sure sufficient means of transport were available which was necessary to travel the products from distribution centre to the supermarkets: *"Supermarkets were supplied additionally, some supermarkets even twice on one day to ensure the stocks were refilled timely".* The supermarket did not need additional storage as the Branch Manager claims *"the received products immediately went into the store. You do not really keep stocks, actually almost nothing"(R6).* The supplier also purchased additional space to store additional stocks by manage the overflow (Customer Development Manager). Additionally, the Head Warehouse Office pointed out that rerouting of trucks was used by *"transferring overflow of trucks to other routes within the distribution centre".*
- The strategies **global sourcing** and **buying small batches** were used to obtain products that could be offered to the customers as an alternative. The Supply Chain Manager claims that *"we have a two-man department for small batches. They searched and purchased alternatives for products we had trouble with"* and *"they bought these batches from abroad".* Thus, the organisation was able to keep delivering during the crisis to the customers with alternative products for an most likely additional costs.
- Several managers pointed out that the **increasing personnel** was necessary during the crisis. Not only did they obtain more personnel, but also broadly skilled employees, use of experience and keeping key personnel present was mentioned. Several managers from distribution side mentioned they scaled up the number of employees to meet the high demand. The Logistics Manager pointed out *"we obtained additional employment agencies to ensure that there will be sufficient personnel in case of a massive outbreak in the distribution centre".* Additionally, The Branch Manager of supermarket B explained that he had no issues with personnel unavailability *"schools were closed, so all pupils had plenty of time to work" (R7)*. Furthermore, the Head Warehouse Operations claims that *"our employees are broadly trained so they can function also at other departments when necessary".* The Branch Manager of supermarket A stressed

out that his own experience helped to make adequate decisions: *"I have been working here my whole life from when I was 16 years old, well after some time you will get a feeling for something" (R6).* In addition, the Supply Chain Manager pointed out that *"we made a lot of decisions based on experience. You know what goes wrong and can go wrong, so that gives direction to where you have to focus on".* Lastly, the Supply Chain Manager claims that *"we made sure the crucial personnel from the supply chain department, head of DC orders, head of supermarket orders and master data were always physical present at office to quickly respond when necessary, but also to be able to discuss better together".*

- Some of the managers pointed out that the supermarkets and distribution centre have an integrated **automated order system** that uses near real-time data to detect increases and decreases in customer demand. The Branch Manager of supermarket A pointed out that *"when a lot of products are purchased by customers, the system immediately generated a higher order. And then we wait if it is available on the distribution centre".* However, the Branch Manager of supermarket B claims that "*the order system follows a certain historical trend. It cannot anticipate on such a quick increase as during the hoarding week".* The Supply Chain Manager stressed out that *"sales reports and out-of-stock reports helped us the most to tweak forecasts from the supermarkets to anticipate on the high increased demand"*. Hence, due to the use of the automated order system and tweaking forecasts by the supply chain department, the organisation was able to respond quick to situation.
- Obtaining **backup suppliers** by both suppliers and buyers. The Customer Development Manager of supplier X stressed out that *"multiple new external suppliers were attracted"*. Additionally, the Supply Chain Manager claims that *"in case a supplier could not deliver, we searched for other suppliers to purchase the products"*.
- Several managers mentioned they focused on using product and raw material **substitutions**. For example, the Customer Development Manager of supplier X pointed out *"you are offering other kind of packages on the market. Instead of 300ml bottles, you offer 500ml to get more out of it".* The Supply Chain Manager stressed out that *"we had problems with the packages of eggs coming from abroad. The suppliers had.. well there was increased demand for these packages, so they could not produce everything and there were more border controls so that took longer than usually. Hence they focused on neutral packages."*. This shows alternatives were used during the crisis to meet demand as much as possible.

- Lastly, the supplier made use of **excess plant capacity and production facility** to keep up with the increased demand. The Customer Development Manager from supplier X stressed out that *"we increased the plant capacity from the current plants for hand soap*" and that *"when a plant in Italy closed, we upscaled production to other plants in Europe".*

Concluding, the supply chain partners have taken several strategies during the coronavirus to mitigate the impact of the crisis on their supply chain. Regarding the variables of the model "robustness" and "adaptability", this research could not determine which taken strategies are suitable for each variable. Therefore, this research merged the variables into adaptive/absorptive as the phase of handling during the crisis.

### 4.4.3 Reactiveness after coronavirus crisis

Conz and Magnani (2019) describes reactiveness as the responding to bounce back or recover from a disruption to return to a stable state after an event. While agility is about providing a quick response where the organisational structures and strategies are maintained, flexibility is about adapting routines and strategies to changing conditions (Conz & Magnani, 2019).

The supply chain partners have taken multiple reactive strategies including 1) quick responding, 2) corona crisis team, 3) introduce new products, 4) focus on key products, 5) responsive suppliers.

- Firstly, **quick responding** was mentioned by two managers. The Branch Manager of supermarket B pointed out that *"we immediately responded to increases in particular product groups. So I think we were timely with signalling environmental changes".* In addition, the Logistics Manager stressed out that *"in the corona period... for example for toilet paper it was a bit first come, first served and that is why we did well by responding quick and coming first"*. This shows the organisation was able to respond quick to bounce back from the unavailability from key products.
- Secondly, a **corona crisis team** was set up by the distribution centre to handle all corona related issues. According to the Head Warehouse Operations they *"created a corona crisis team which was very active the first half year by coming together every day and sharing information between distribution centre and all supermarkets".* By setting up this team the organisation showed they were able to adapt to changing conditions.
- Several manager stressed out **new products were introduced** to meet the demand for scarce products. For example, the Supply Chain Manager claims that *"we purchased*

*products which are normally not in our product range just to meet the demand as much as possible"*. Both Branch Managers verified this statement: *"we have had different products with uhm.. different labels other brands etcetera" (R7*).

- **Focus on key products** was another mentioned reactive strategy. The Customer Development Manager pointed out that *"in a plant in Italy that produces fabric softener, which was not in demand, we converted a part of the production to produce more liquid soap"* and that *"yes we absolutely had to cut in our product range. We tried to protect the in demand products by discontinue the less in demand products"*. The Supply Chain Manager stressed out that *"when you have high volumes or important products, you give additional focus on these key products because there might a possibility they won't go across the whole chain"* and "*we focused on product groups that had increased sales in the supermarkets. Based on that we were able to quickly adjust"*. Furthermore, he also mentioned that some suppliers were back on regular performance afterwards, but some were not: *"suppliers that cut in the product range bounced back earlier to their regular performance than suppliers that tried to deliver all products"*. This shows cutting in product range and only producing key products that had increased sales was a good strategy to recover from the disruption afterwards.
- Finally, it seems the supply chain had **responsive suppliers** as the Supply Chain Manager claims that *"many suppliers delivered only whole pallets instead of only pallet layers, because that was easier and quicker to process"*. Additionally, the Customer Development Manager of supplier X pointed out that they "*decided to make more production lines in other plants"* and that they *"cut costs by stopping television commercials in quartile 2 of 2020"*.

Hence, the supply chain partners have shown to be able to respond quick to bounce back from the disruption. Regarding the variables of the model "agility" and "flexibility", it seems both variables could be applied to the case. However, this research could not specifically define the difference between agility and flexibility within the case study. Nevertheless, it seems that agility could be applicable to the supply chain because of their quick responding while the organisational structures were maintained.

Although there was no balance in strategies from proactive to reactive phases, it still seems the supply chain of Company X have proved to be resilient. Nevertheless, this entailed additional costs which may have been prevented with a proactive approach that could ensure the continuation of production flows instead of searching for alternative products. Moreover,

the size of the company seems to have a moderating effect, because the smaller the organisation, the less issues raised. The following proposition is supported. Although the supply chain partners have shown resilience with only reactive strategies, this entailed additional costs, waste and the ripple effect that may have been prevented with both a proactive and reactive approach.

**Proposition2** Individual Dutch food supply chain partners can synchronise resilience if there is a balance in strategies from the proactive to reactive phases

Furthermore, the downstream as well as the upstream supply chain partners both seem to have used a reactive approach to tackle the coronavirus crisis meaning there was an alignment. Although a proactive approach may have prevented the supply chain from additional costs, waste and the ripple effect, it seems the supply chain of Company X reacted quickly to disruptions to ensure the continuation of production flows from suppliers to customers. However, as mentioned in the literature review, a holistic approach from proactive to reactive should be applied to achieve effective risk management within supply chains. This case study indicates that reactiveness also leads to supply chain resilience. Therefore, the following proposition is not supported. Both a proactive and reactive approach should be used to effectively manage supply chain risks.

**Proposition3** Only a proactive approach will lead to effective risk management within supply chains.

However due to limited collected data, this analysis is not representative enough to determine the significance and thus may not be generalisable.

## 4.5 Remaining findings

The current coronavirus crisis led to lessons learned for the supply chain of Company X including the need of contingency plans, ensuring independency and strategic collaborating with external partners. First of all, the lack of contingency plans of the supply chain partners resulted in a less resilient supply chain than it could have been. According to Pavlov, Ivanov, Pavlov and Slinko (2019), contingency plans are strategies created to limit risks before a disruption and executed during the disruption to achieve supply chain resilience. In the model of this research this is expressed as resource reservations which results in redundancy and usage of available resources which results in resourcefulness. According to Conz and Magnani (2019) this includes having safety stocks and multiple sourcing. The Logistics Manager mentioned the management compiled a plan as preparation for future pandemics. Nevertheless, having these

contingency plans beforehand could have prepared the supply chain to be more resilient during the current coronavirus crisis. Therefore, this can be seen as a learning moment for supply chains. From supplier side the Customer Development Manager pointed out that *"we learned from this crisis by ensuring availability of volumes and ingredients in multiple facilities so we can act quicker in the future"*. Additionally, from buyer side the Supply Chain Manager stressed out *"we had to look for alternatives for the products we had problems with*". This shows that both buyer and supplier lacked multiple sourcing. Although having multiple sources for products increases costs, it enables organisations to prevent supply chain risks.

Secondly, being independent from other supply chain partners to continue to deliver was mentioned by a few managers. The Logistics Manager claims *"we were no longer dependent to our suppliers, so we were able to supply our supermarkets"*. The supplier stressed out *"we should try to reduce the dependency on only supplier as much as possible by having for example 3 suppliers"* (R8). The Logistics Manager also claims that they *"have to be prepared timely and have more safety stocks"*.

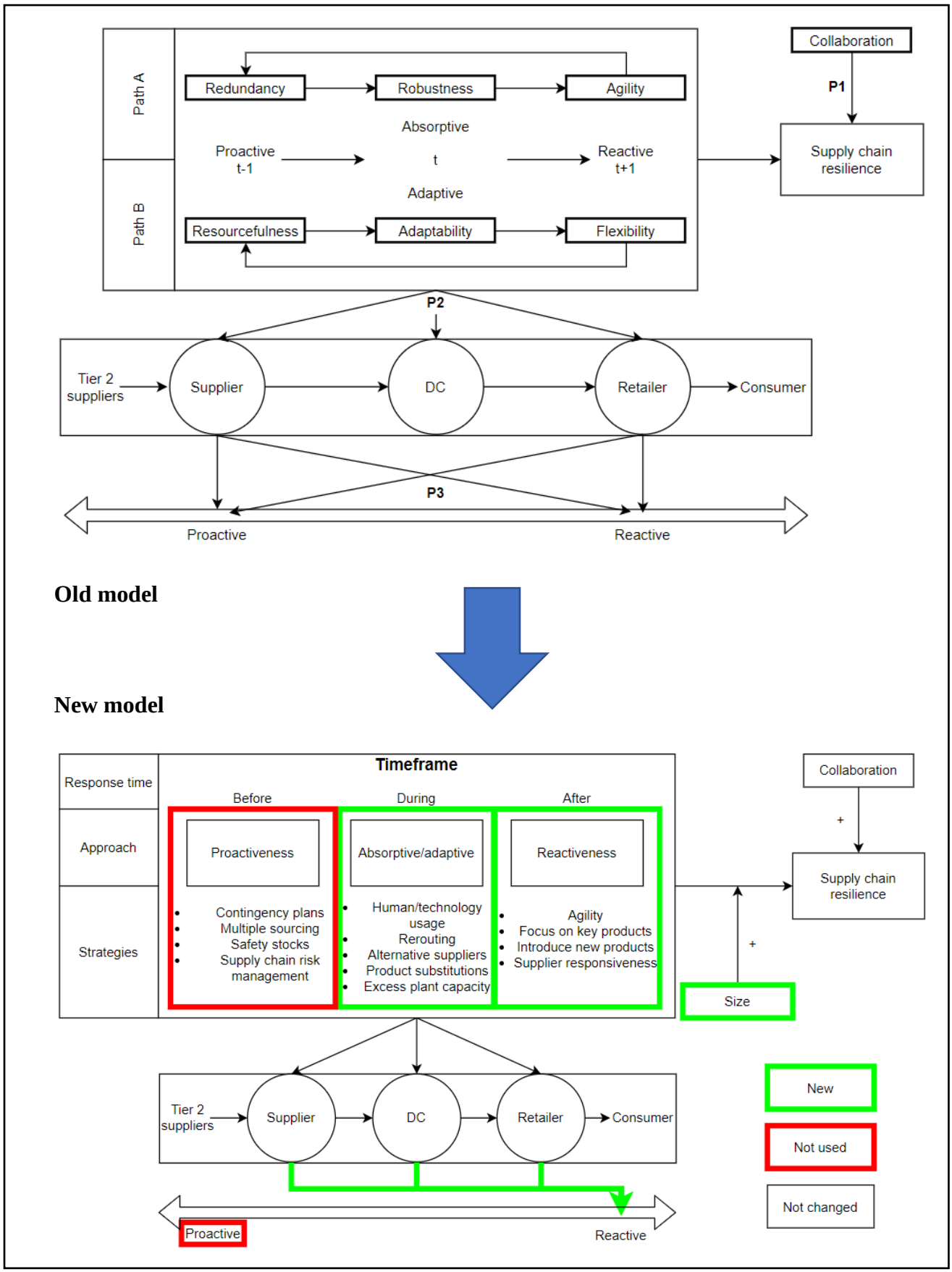
Finally, Company X as organisation collaborated internally well between distribution centres and supermarket and also with other industries such as the catering industry, but it seems external collaboration with suppliers could be improved. The Customer Development Manager from supplier X mentioned they prefer to work with the competitor because they are more collaborative. The purchasing organisation Company Y is seen as cost driven instead of collaborative: *"Company Y says, if you cannot deliver, you get a fine. My response is than hello the entire world cannot deliver from plants, people get ill, hello we are doing the best we can... that is another way of working together" (R8*). The purchasing organisation should strive for strategic partnerships with suppliers to reduce risks and achieve joined competitive advantage.

## 4.6 Supply chain resilience model is amended

Based on a systematic literature review, a supply chain resilience model was drafted. This model is validated with a real life case study of one Dutch food supply chain and seems to be applicable in times of a pandemic. The model is amended with used strategies by the case company per time phase as shown in figure 6. Although the supply chain of the case company was absorptive/adaptive during the crisis and reactive after the peak by responding quick to changing environments, the supply chain lacks proactiveness which could have prepared the supply chain for such disruptions to reduce costs, lead times and quality of products. Furthermore, the size of the supply chain organisation compared to other supply chains in the market seems to have a moderating effect. The smaller the food supply chain organisation is,

the less turnover is generated compared to competitors, the less demand increases and supply shortages there are. Finally, collaboration seems to have a positive effect on supply chain resilience. Several supply chain partners pointed out that collaboration was a key driver in responding quick to the disruption. Regarding the proactive variables “redundancy” and “resourcefulness”, it seems the supply chain partners did not have strategies ready before the crisis had taken place. The strategies were taken during the virus to mitigate the effect of the crisis. Therefore, these variables are taken out of the model. Regarding the variables of the model “robustness” and “adaptability”, this research could not determine which taken strategies are suitable for each variable. Therefore, this research merged the variables into adaptive/absorptive as the phase of handling during the crisis. Regarding the variables of the model “agility” and “flexibility”, it seems both variables could be applied to the case. However, this research could not specifically define the difference between agility and flexibility within the case study. Nevertheless, it seems that agility could be applicable to the supply chain because of their quick responding while the organisational structures were maintained.

Figure 6: Transformation old to new supply chain resilience model amended with strategies



# 5 Discussion and conclusion

### Key findings

From the analyses conducted before, it can be concluded that the coronavirus crisis impacted the supply chain of Company X negatively by out-of-stocks due to increased sales, decreased productivity, increased lead times, plant closures, the ripple effect and increased costs which is in line with recent literature (Hobbs, 2020). However, the results also show the supply chain was impacted positively as it led to an increase in turnover, increased collaboration and trust among supply chain partners and prepared the supply chain for future pandemics, meaning the resilience of the supply chain increased.

Furthermore, it was expected that a collaborative approach supports supply chain resilience (proposition1). Collaboration in buyer-supplier relationships is important to work effectively for mutual benefits before and after a disruption in the supply chain (Kamalahmadi & Parast, 2016) and therefore supply chains should invest in strong buyer-supplier relationships to stimulate suppliers taking risk mitigating measures (Simba et al., 2017). According to recent literature (Kamalahmadi & Parast, 2016; Pal et al., 2014), support, internal interaction, external interaction, information sharing and decision making are important aspects for having a collaborative supply chain. The different perspectives of the supply chain partners on collaboration indicate that the most important aspects used in this case are: support, interaction, information sharing and decision making. Results reveal that although from the downstream supply chain perspective the internal and external cooperation was performed well, from upstream perspective it can be concluded there is a lack in collaboration with suppliers. It seems that the purchasing organisation Company Y was more cost driven than collaboration driven during the coronavirus crisis, which has a negative effect on mitigating risks together with suppliers. Hobbs (2020) stated that while focussing on cost efficiencies in the food sector in normal times, this approach is less suitable in sudden demand increases such as the current pandemic. The purchasing organisation of Company X should therefore adjust their approach from cost efficiency to collaborative in times of pandemics.

Regarding the second proposition, it was expected that food supply chains can be resilient when using a balance from the proactive approach to the reactive approach as shown in figure 3. Conz and Magnani (2019) proposed a conceptual model based on a recent literature review that indicates proactive and reactive phases are used in a time span before, during and after a crisis to achieve supply chain resilience. Results from the case study show that the supply chain of Company X has acted mainly reactive during the coronavirus crisis to mitigate the

negative impact as well as responding quick to bounce back to the normal state before the crisis.

The third proposition described only a proactive approach will lead to effective risk management within supply chains. Mojtahedi and Oo (2017) mentioned that a holistic approach from proactive to reactive among these partners is best suited to achieve effective risk management, while only using the reactive approach may lead to the ripple effect, increased costs and waste. Mismatches in the proactive and reactive approach between suppliers and buyers lead to frustration and dissatisfaction with the supply chain partner because of lack of process alignment or feeling less return on investment (Lettice et al., 2010). The results from this case study show both downstream and upstream partners acted only reactively during the coronavirus crisis which led to the ripple effect, increased costs and waste. However, as mentioned before by Hobbs (2020), cost efficiency is less important during pandemics. Meeting customer demand and collaborating with supply chain partners is more important in such a time to ensure the continuation of products.

Coming back to the research question on how Dutch food supply chains should synchronise supply chain resilience before, during and after the current COVID-19 crisis, it can be concluded through this qualitative exploratory research that food supply chains can achieve resilience by a collaborative, proactive, absorptive/adaptive and a reactive approach. It seems that internal collaboration within organisation as well as external collaboration with suppliers and supermarkets is a key driver for supply chain resilience. Before a pandemic, contingency plans such as having multiple suppliers and safety stocks should be implemented and ready in order to be prepared for disruptions. Organisations that have contingency plans ready and execute the plans during a disruption can limit the impact of the risks. To get out of the disruption and bounce back to the regular performance, quick responding is necessary. Furthermore, this research claims there is strong evidence that supply chain "size" is a moderating variable in supply chain resilience context. In line with this assumption, there is also a consensus among the respondents that because of their small size food supply chain, achieving resilience was easier.

**Limitations**

A big limitation in this research was the focus on only one food supply chain in the Netherlands. Eight managers participated in the interviews, which constitutes a small sample. It is acknowledged that disruptions of supply in one industry in the food supply chain will most likely result in demand changes to others. However, due to limited time this research only considered one Dutch food supply chain. This Dutch food supply chain is relatively small

compared to its competitors. Therefore, it would be inappropriate to suggest the findings are representative to the average Dutch food supply chain. Although this research provides interesting insights in an entire food supply chain, its generalisability is not strong. To make such a generalisation, a research with a more diverse and wider population should be conducted. Finally, the amount of data collected was limited due to a lack of time from top management, a lack of responses from suppliers and unwillingness to share business-sensitive information with third parties. Therefore, finding respondents was extremely difficult. Despite these limitations, the researcher is confident that this research laid a path for the development of supply chain resilience models and has provided direction for future research on the concept of supply chain resilience during pandemics.

**Theoretical implications**

This case study makes a theoretical contribution toward enhancing supply chain resilience for food supply chains during pandemics. Five most important strategies are identified including 1) Multiple sourcing, 2) Safety stocks, 3) Collaboration, 4) Agility, 5) Focus on key products. These strategies should be used by food supply chains before, during and after a pandemic to prevent, mitigate and bounce back from pandemic disruptions. The old model proposed in this research based on a literature review was amended. The variables “redundancy” and “resourcefulness” were not used by the case company to prevent supply chain risks. The variables “robustness” and “adaptability” could not be determined in this research and are therefore merged into adaptive/absorptive which entails several taken strategies. From the variables “agility” and “flexibility”, only agility was used by the case company as they quickly responded to changes to recover from the disruptions while organisational structures were maintained. Furthermore, this research indicates “supply chain size” as a moderating effect. A smaller food supply chain as shown in this case study seems to be impacted less by pandemics.

Regarding proposition1, this research states collaboration within supply chains is a key driver to achieve supply chain resilience. The case company used support, interaction, information sharing and collaborative decision making to recover from the coronavirus crisis by collaborating with the supply chain partners. Regarding proposition2 it can be stated that individual supply chain partners should use a balance in the proactive and reactive approach. Although the case company has shown resilience during the coronavirus crisis by only the reactive approach, this entailed additional costs, waste and the ripple effect. A proactive approach may had prevented these unnecessary conditions. Regarding proposition3 this

research indicates that supply chains should use both a proactive and reactive approach to be resilient during pandemics.

**Practical implications**

This research also makes two practical contributions for the case company towards synchronising supply chain resilience before, during and after pandemics. First of all, Company X should use contingency plans, including multiple sourcing and having safety stocks, to prevent supply chain risks and reduce its vulnerability. Subsequently, although the internal collaboration was well performed and even was improved due to the coronavirus crisis according to several managers, the external collaboration with suppliers should be focused on. From the suppliers' perspective, the purchasing organisation was focused more on cost efficiency than on collaboration. Strategic partnerships with suppliers could help to achieve competitive advantage and reduce supply chain risks during pandemics. Although this research analysed specifically one Dutch food supply chain, it can also be adapted by other food supply chains. However, other supply chains may have different conditions such as size and therefore the strategies may not be applicable to all supply chains.

**Future research**

This research provides a set of future research directions that could help in developing a more rigid understanding of supply chain resilience during pandemics:

- Future research could test the findings in this research with a larger sample, in which the supplier's perspective is more elaborated on.
- The difference between the definitions supply chain risk management and supply chain resilience need to be distinguished because this was not well defined in literature.
- It is recommended that future studies on this topic focus on testing the relationship between the variables in the proposed model through quantitative studies. This enables the use of larger sample sizes to statistically test the relations in order to make the research generalisable. This also entails applying well defined indicators to the variables. Although indicators were assigned to the variables in this research, this research claims there seems to be overlap in some variables such as that the indicator "internal communication" seems to be part of both collaboration and flexibility. To understand the effect of collaboration on supply chain resilience, more cases regarding collaboration internally and externally in supply chains should be researched in the future.

- Controlling the moderating variable “size” was not possible in this research. Future studies could focus on the effect of size on the relationship between the variables in the model on supply chain resilience.
- Respondents in this research also stressed out that organisations should become less dependent on their suppliers in large impact disruptions such as a pandemic, which could be considered in future research.
- The decision between single or multiple sourcing during pandemics is an important topic to discover. This research assumes having multiple suppliers reduces risks during disruption. On the other hand, having strategic partnerships with suppliers is also important, which may not be possible when having many suppliers. Therefore, future research could investigate the effect of multiple versus single sourcing on supply chain resilience in the food industry during pandemics.
- According to the Supply Chain Manager, suppliers that only focused on producing the key products during the pandemic were able to achieve their regular performance earlier than suppliers that focused on producing all products. Some suppliers are still not on their regular performance. Future researchers could validate this statement by investigating and comparing the performance level before and after a pandemic of several suppliers.
- Finally, future research could focus on preferred customer status as driver for supply chain resilience. Food supply chains that are preferred by suppliers, could be more resilient because of access to supplier’s resources. This may lead to food supply chains becoming more collaborative to achieve joined competitive advantage.

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# Appendix A: Literature review approach

| **Keyword** | **Initial hits** | **Automatically filtered on:** | | | | **Used articles** | **Search key** |
|---|---|---|---|---|---|---|---|
| | | Years (hits) | Area (hits) | Articles in journals | Sorted on: | | |
| "Supply chain resilience" (in article title) | 173 | 2016 – 2020 (120) | Business, Management and Accounting (75) | 56 | Cited (by highest) | 8 | TITLE ( "supply chain resilience" ) AND (PUBYEAR > 2015) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( SRCTYPE , "j" ) ) AND ( LIMIT-TO ( SUBJAREA , "BUSI" ) ) |
| "Food supply chains" (in article title) | 1039 | 553 | 195 | 140 | Cited (by highest) | 5 | TITLE ( "food supply chains" ) AND (PUBYEAR > 2015) AND ( LIMIT-TO ( SUBJAREA , "BUSI" ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( SRCTYPE , "j" ) ) |
| "Pandemic" AND "supply chains" | 97 | 2016 – 2020 (59) | Business, Management and Accounting, Engineering, Environmental Science (26) | 19 | Cited (by highest) | 3 | TITLE-ABS-KEY ( "pandemic" AND "supply chains" ) AND (PUBYEAR > 2015) AND ( LIMIT-TO ( SUBJAREA , "ENVI" ) OR LIMIT-TO ( SUBJAREA , "ENGI" ) OR LIMIT-TO ( SUBJAREA , "BUSI" ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( SRCTYPE , "j" ) ) |
| "Supply chain risk management" (in article title) | 303 | 2016 – 2020 (130) | Business, Management and Accounting (85) | 50 | Cited (by highest) | 12 | TITLE ( "Supply Chain Risk Management" ) AND (PUBYEAR > 2015) AND ( LIMIT-TO ( DOCTYPE,"ar" ) ) AND ( LIMIT-TO ( SUBJAREA,"BUSI" ) ) AND ( LIMIT-TO ( SRCTYPE,"j" ) ) |

# Appendix B: Interview protocol

1 Establish a comfort level and explain purpose of the research

- Introduction of researcher and appreciate the interviewee's time for this interview.
- Explain the purpose of the research
- Explain the objective of this interview
- Confidentiality, permission to record this interview.

2 What is your function and what are you responsible for?

Part1: Internal organisation

*Opening segment: Describing the case and exploring subject*

3 Could you tell me something about the processes in your company?

4 What was the impact of corona on your company?

*Middle segment: Exploring aspects more deeply*

5 How is the collaboration (among departments) within your company?

6 Explain model

6a What strategies does your company take to prevent long-term risks?

6b What strategies does your company take to minimise the impact of corona?

6c To what degree does your company respond quickly to short-term disruptions to go back to the old situation?

*Concluding segment: Exploring outcomes of strategies*

7 What are the results of these strategies?

Part2: Supply chain

*Opening segment: Describing the case and exploring subject*

8 Could you tell me something about your supply chain processes?

9 What was the impact of corona on your supply chain?

*Middle segment: Exploring aspects more deeply*

10 How is the collaboration with other supply chain members?

11a What strategies does your supply chain partners take to prevent long-term risks?

11b What strategies does your supply chain partners take to minimise the impact of corona?

11c To what degree does your company respond quickly to short-term disruptions to go back to the old situation?

*Concluding segment: Exploring outcomes of strategies*

12 What are the results of these strategies?

13 Closure:

- Do you have any questions/remarks regarding this interview?
- Do you want to be informed about the results?
- Thank the interviewee for their time and cooperation