Master's degree thesis

LOG950 Logistics

Supply Response to Low Probability, High Impact Events - The Case of Covid-19

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Preface and acknowledgements

This master thesis marks the end of our five years as students at Molde University College. As a general requirement of the two-year *Master of Science in Logistics* program, this thesis was conducted between October 2020 and May 2021.

In over a year, we have lived in and experienced the vast magnitudes of the covid-19 virus. Our inspiration for writing this thesis arose from our eagerness to investigate how Norwegian companies and their supply chain operations have been affected and responded to the pandemic. Hence, the foundation of our thesis was contrived.

We would like to express our deepest gratitude to our proficient academic supervisor Deodat Edward Mwesiumo for answering our many questions, providing constructive feedback, and partaking in fruitful discussions. This thesis would not be the same without your valuable insights and excellent guidance.

Finally, we wish to thank all companies and informants who have spent some of their time participating in our research. Your experiences and views from the past year have been essential for us to acknowledge the relationship between supply chains and pandemics.

Molde, May 25th, 2021

Anette Utvær & Martin Orheim

Abstract

Increased international trade and an extensive focus on cost reduction leave the supply chain prone to disruption risks. The novel covid-19 virus has caused severe global consequences and affected supply chain operations. Consequently, adaptations have been required for focal companies to perform under uncertain conditions in the best possible way. Yet, there is a lack of research on low probability, high impact (LPHI) risk events, and hence, this research seeks to close existing research gaps within the field.

This research aims to explore how focal companies can respond to LPHI risk events and related impacts on the purchasing and supply functions. By using Covid-19 as a cornerstone, the research first examines companies' impacts, responses, and preparedness across different industries. Secondly, suggestions for improving the response to LPHI events are presented.

The research was conducted through a multiple-case approach. Data were collected from semi-structured interviews with supply chain professionals from each of the eight case companies applied. Additionally, reviews of web pages and relevant documents supported the empirical data.

The findings of this paper reveal several impacts and challenges, response measures, and elements of preparedness among the examined cases. All these factors are dependent on company characteristics, whereas some are also dependent on industry characteristics. The main findings show that (1) the major impacts and challenges are demand changes, supply scarcity, supplier opportunism, volatile prices, delivery limitations, and ineffective forecasting, (2) responses taken concerns sourcing approaches, buyer-supplier interactions, and purchasing strategies, and (3) preparedness is due to SCRM and buyer-supplier relationships. Based on our findings and present literature and theories, we present specific suggestions for improving the response to LPHI events: collaboration, multi sourcing, and redundancy are the foremost measures focal companies should practice in uncertain conditions caused by LPHI events. The potential outcomes are increased priority, reduced opportunism, improved forecasting, access to goods, and reduced lead time. Overall, the study contributes to both theoretical- and managerial implications. In addition, further research possibilities are identified.

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List of abbreviations

BOM	Bill of Materials
HoReCA	Hotels, Restaurants, and Catering
LPHI	Low Probability, High Impact
RCT	Relational Contract Theory
RQ	Research Question
SCM	Supply Chain Management
SCRes	Supply Chain Resilience
SCRM	Supply Chain Risk Management
SCV	Supply Chain Visibility
TCE	Transaction Cost Economics
TCT	Transaction Cost Theory

Table of contents

1.0 Introduction

This chapter presents the background of this thesis and the relevance of our study. Additionally, the research objective and corresponding research questions are clarified, and finally, the thesis structure is presented.

1.1 Background of the thesis

In late December 2019, an unidentified pneumonia virus in Wuhan was reported by the Chinese government, known as covid-19 or coronavirus (SARS CoV-2). The virus has, since its outset, spread rapidly across continents and was declared as a pandemic on the 11th of March 2020 (World Health Organization 2020). The implementation of comprehensive countermeasures, including lockdowns and closed borders, has decreased international trade and triggered disruptions to global supply chains (Sharma et al. 2020).

In general, most businesses possess developed risk management strategies to identify possible disruption risks and related impacts. Mitigation plans are adjusted to expected outcomes, and accordingly business initiates prevention measures to reduce the exposure of the identified disruption risks (Le Merle 2011). Despite this, companies worldwide have and are still experiencing severe impacts from the covid-19 pandemic. Covid-19 has, compared to other disasters, yielded vast consequences such as stressful ripple effects triggering a mismatch between supply and demand. What separates this event from others is that the impacts apply to all parts of the global supply chain across various industries. In other words, global supply chains are subject to the enormous pressure that affects the operation and results (Butt 2021).

Responses and impacts are varied, but governments and businesses will probably evaluate the measures taken in the aftermath. Initial indications advocate that companies' responses have been effective and helpful, whereas other responses are the opposite (Sarkis et al. 2020). Some people argue that the pandemic came "out of the blue," which coincides with Nicholas Taleb (2015) characteristics of black swan events; *"First, it is an outlier, as it lies outside the realm of regular expectations because nothing in the past can convincingly point to its possibility. Secondly, it carries an extreme impact. Third, in spite of its outlier status,*

human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable" (Nicholas Taleb 2015).

However, others claim that warnings and knowledge existed but have been disregarded. A variety of events in the past decade have indicated the damage a virus can provide, i.e., the Swine Flu in 2009 and the Ebola epidemic in West Africa in 2014. Yet, the area of pandemic preparedness is indigent and must receive enlarged consideration in the future. According to Le Merle (2011), most businesses spend time and effort on the risks they most frequently encounter, such as risks concerning regulations, appropriate accounting, or ethical issues. By prioritizing common risk areas of compliance, LPHI events are harder to identify and, thus, less prioritized (Le Merle 2011). It is impossible to predict the future, but the previous events indicate that viruses will continue to emerge in the future, and ignorance can be fatal. Thus, it is crucial to establish a better response system and to be prepared for that type of disruption risk (Gates 2018).

1.2 Research objectives- and questions

1.2.1 Research objectives

Throughout this thesis, our main objective is to explore how focal companies can respond to LPHI risk events with a specific focus on the purchasing and supply functions. The covid-19 pandemic is used as a cornerstone as we investigate the impacts and challenges, responses, and preparedness of various companies that have experienced the pandemic's magnitude. Based on empirical data from a multiple case approach, supported by pertinent theories and literature, we aim to provide suggestions for improving response measures to future LPHI events. A subsequent intention is to identify patterns of impacts, response, and preparedness across different industries.

1.2.2 Research questions

Based on our overall objective for this thesis, three research questions are formulated to grasp essential factors that may contribute to a comprehensive understanding of the topic and thereby achieve fruitful insights to our further suggestions.

RQ1: How has covid-19 impacted the purchasing and supply functions of focal companies?

The first research question is a prerequisite to answering the two remaining questions and achieving our research objective. Types of impacts and severeness may determine how companies decide to respond, which is assumed to vary among industries. Additionally, the level of preparedness may also influence the impact companies encounters related to purchasing and supply.

RQ2: How have focal companies responded to impacts of covid-19 on purchasing and supply?

In relevance to the former, this question aims to yield knowledge about the actions executed by companies. These answers permit us to draw links between the type of impact and type of response. Subsequently, we can investigate if impacts and responses are coherent and thereby agree or provide recommendations based on parallels. Also, the outcome related to the response to impacts contribute to our interpretation of the effect.

RQ3: To what extent have focal companies been prepared for covid-19 impacts on purchasing and supply?

This question is significant because the level of preparedness may have a considerable influence on how companies are impacted. It may be exceedingly challenging to prepare for the outcome of an LPHI event such as covid-19. However, if a company has established predetermined strategies, this can contribute to take rapid actions. Thus, the response may be accurate and successful. On the other hand, less preparedness may lead to disproportionate impacts such as ripple effects and more extensive response measures.

1.2.3 Structure of the thesis

This thesis is organized into eight chapters: introduction, literature review, theoretical foundation, methodology, findings and analysis, discussion, and conclusions. Each chapter consists of related subchapters. *Chapter 1* lays the foundation of this thesis by presenting its background and introducing the research objective along with our research questions. In *Chapter 2*, we took a deep dive into existing literature and identified relevant concepts and gaps. *Chapter 3* outlines the theoretical foundation, including TCT, RCT, and Chaos Theory. *Chapter 4* describes the research methodology and justification of our methodological

choices. *Chapter 5* presents the empirical findings deriving from conducted interviews with the case companies, in addition to an aggregated analysis. In *Chapter 7*, our findings are discussed and coupled with extant theories, and our suggestions are illuminated. Lastly, in *chapter 8,* the thesis is summarized, theoretical- and managerial implications presented, and limitations and further research suggestions are presented.

1.2.4 Relevance of the study

Several researchers have already contributed with literature on covid-19 through the lenses of SCM. However, there are remaining aspects yet of being examined. The relevance of this study can be justified from three perspectives.

First, the covid-19 pandemic has proved to cause massive disruptions to global supply chains. Thus, investigating the various impacts and possible response measures may contribute to a holistic understanding of how to manage forthcoming LPHI events.

Second, we have identified gaps in current research on covid-19 and its relations to supply chains. Among them are the need for collecting up-to-date empirical evidence, and that few are comparing industry characteristics. Existing research gaps are further elaborated in chapter "2.2.4. Gaps". Our study will shed light on the gaps and try to fill them.

Third, pandemics and LPHI risk events are likely to keep occurring in the future. Thus, research on this topic may generate vital knowledge.

"We need a clear road map for a comprehensive pandemic preparedness and response system, because lives, in numbers too great to comprehend, depend on it" - (Gates 2018)

2.0 Literature review

This chapter is twofold. Firstly, the background of the field includes literature on supply chain management (SCM) and supply chain risk management (SCRM). Secondly, a systematic literature review on covid-19 and SCM is conducted.

2.1 Background of the field

2.1.1 Supply Chain Management

The term SCM has experienced increased interest over the last couple of decades. The term arose in the late 1980s and has evolved into such a prominent topic that it is difficult to find a periodical on distribution, customer relationship, or transportation without bumping into an article about SCM or related topics (Hugos 2018, Mentzer et al. 2001). Furthermore, Waters (2007) states that SCM has achieved its popularity from people arguing that logistics is too narrow and does not properly include SCM. This is confirmed by Hugos (2018) who claims that before the 1980s, businesses used terms such as logistics or operation management. Carter (2011) conveys that researchers have taken advantage of theories from similar disciplines such as economics, management, and sociology and integrated them into SCM.

Mangan et al. (2012) define SCM as *"the management, across and within a network of upstream and downstream organizations, of both relationships and flows of material, information, and resources. The purposes of SCM are to create value, enhance efficiency, and satisfy customers.*

Mentzer et al. (2001) defined it as *"the systemic, strategic coordination of the traditional business functions and tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole."*

Both definitions are focusing on the coordination and management of business functions within and across businesses. Where Mangan et al. (2012) specify value creation, enhanced efficiency, and satisfied customers as a purpose, Mentzer et al. (2001) has a broader view and explains it simply by highlighting the improvement of the long-term performance of the company and the supply chain.

Literature from the SCM discipline lays the foundation for our literature review. It provides the readers a principal understanding of the structure in a supply network and the objective

of a supply chain. Further, this knowledge and information make it possible to scrutinize our research questions properly.

2.1.2 Supply Chain Risk Management

Global supply chains require highly coordinated flows of goods and are often connected with a degree of uncertainty (Manuj and Mentzer 2008). Competitive pressure and demanding customers have led to various trends such as outsourcing, just-in-time, lean, and reduced product life cycle. In other words, companies encounter increased exposure to supply chain risks (Fan and Stevenson 2018).

Albastroiu and Felea (2013) emphasize that supply chain risk is the number one reason why companies have enhanced their ability to be more flexible and adaptive. Moreover, they highlight that supply chain practices such as outsourcing and lean production have contributed to smoothing operations. However, this leads to decreased margins and, thus, vulnerability in the chains. We distinguish between two types of risk, namely internal and external risk. The internal risks arise from operations within an organization, whereas the external risks arise from interactions with its environment, hence, external to the supply chain. Risk can be defined by the following equation, which applies to both internal and external risk,

Supply chain risk = Probability of disruption x Impact (Albastroiu and Felea 2013)

There are several dimensions of SCRM. Tang (2006) highlights operational risks and disruption risks as two important dimensions. Operational risks deal with intrinsic uncertainty in demand, supply, costs, and other internal risks. On the other hand, disruption risks address great disruptions created by natural and man-made disasters and are generally connected with severe consequences (Tang 2006). Furthermore, disruption risks are highly unpredictable according to (Prieskienis 2021), and caused by: *"1) natural catastrophes, such as hurricanes, earthquakes, floods by 2) man-made threats, such as terrorist attacks, labour strikes or by 3) epidemic outbreaks, pandemics."* Due to the combination of unpredictability and irregularity these occurrences are hard to identify, hence categorized as LPHI events (Prieskienis 2021). As figure 1 illustrates, pandemics fall under the LPHI classification.

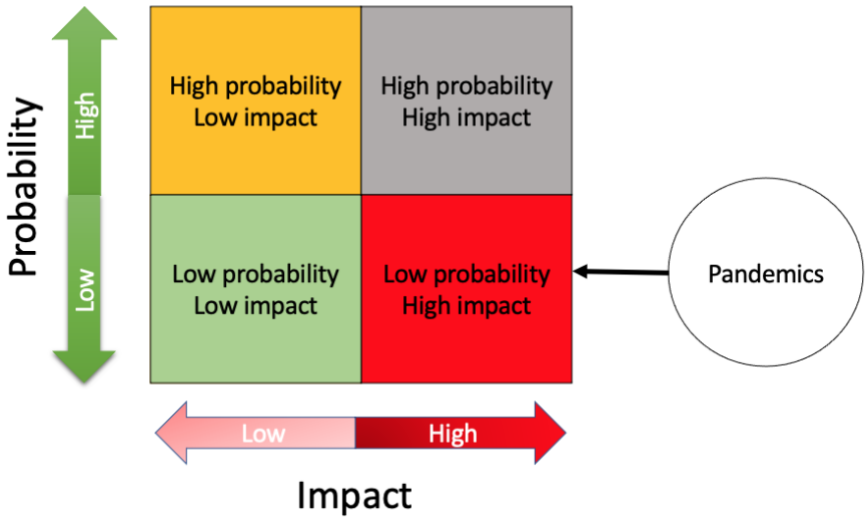

Figure 1: Risk probability/impact matrix (own production)

Researchers are yet to agree on a definition of SCRM from a conceptual perspective. Concerning the theoretical perspective, it is not clear how theories have been utilized in extant literature to further understand the concept of SCRM. Additionally, knowledge about risk is closely related to narrow functional disciplines such as purchasing and IT services. Still, there is an overall lack of a coherent framework that consolidates all activities in the supply chain (Fan and Stevenson 2018). Further, Sodhi, Son, and Tang (2012) confirm this by saying that SCRM is at a nascent stage and, thus, an appealing topic for researchers. That said, Fan and Stevenson (2018) have formulated the following definition of SCRM,

"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."

This definition reflects on both the nature of risk management and a familiar understanding of SCM, which provide the pathway to SCRM and the objectives of SCRM (Fan and Stevenson 2018).

2.2 Review of literature on SCM and covid-19

In this chapter, review of relevant literature is conducted and discussed. Examining papers on covid-19 in a supply chain context provides us knowledge on existing research and lays the foundation for further discussion. A systematic literature review is consequently conducted to identify patterns in methods, findings, and gaps across numerous peer-reviewed publications.

The systematic approach is preferred as it differs from traditional reviews by its aspiration to minimize bias in the literature (Tranfield, Denyer, and Smart 2003). Additionally, unlike traditional studies, systematic reviews are undertaken according to a detailed plan or method (Gough, Oliver, and Thomas 2017). This sort of literature review originates from medical sciences but has become a vital contributor to fostering knowledge within various academic fields (Durach, Kembro, and Wieland 2017). Jesson, Matheson, and Lacey (2011) explain the systematic literature review as *"a review with a clear stated purpose, a question, a defined search approach, stating inclusion and exclusion criteria, producing a qualitative appraisal of articles."* Based on those defined principles, we have examined literature with respect to the following predetermined assumptions: covid-19 has negatively affected supply chains, and fundamental concepts within SCRM will frequently occur in accordance with mitigation of covid-19 impacts. The following sections respectively present our review process, findings, and gaps.

2.2.1 Review process

Pawson (2002) encourages researchers to embrace a large scope of articles to determine the value of the article while conducting the review. Other researchers also support this and discuss the impact journal rankings have on the dispersion of publications within supply chain management (Durach, Kembro, and Wieland 2017). We decided to employ two online search engines, Google Scholar and Oria. These databases were deemed sufficient due to their coverage of all major publisher venues such as Springer, Wiley, ScienceDirect, and Emerald. Furthermore, we decided not to restrict our search to any specific journal in the database search. With assistance from our supervisor, the search terms "supply chain" and "covid-19" were selected to obtain relevant results. These search terms are relatively open and provide a significant number of articles. Nevertheless, the covid-19 outbreak is a recent

phenomenon, and research within the field is limited, which justifies these broad and inclusive search terms.

Inclusion criteria are outlined and based on the standard quality assessment criteria proposed by Kmet, Cook, and Lee (2004). Inclusion criteria encompass relevant title, abstract, study design, sufficient objective, conclusions supported by the results, and lastly, they must be peer-reviewed. Moreover, "The Cars Checklist for Evaluating Research Sources" has been utilized as an additional measure to secure reliable information. CARS is an acronym for four important attributes: credibility, accuracy, reasonableness, and support (Calkins and Kelley 2007). Articles retrieved have been exclusively from the English language, and Harris et al. (2014) argue that positive findings are more likely to be published in literature written in English. The collection of articles is from 2020 and 2021, and the collection of articles was stopped in January 2021. In conclusion, our search resulted in 40 perused articles where a selection of those fulfilled our predetermined inclusion criteria and are included in the literature review. Table 1 summarizes our review process.

Table 1: Summary of review process

Research protocol	Detail's description
Search engines	Oria and Google Scholar, two portals for material gathered from several databases
Publication-type	Peer-reviewed journal articles
Language	Only English publications were considered in the research process
Date range	Due to limitations, the range considered is 2020-2021 (period of covid-19 presence)
Search fields	Titles and keywords
Search terms	"Covid-19 + Supply Chain"
Criteria for inclusion	Pertinent title, abstract, study design, appropriate objective and conclusion supported by the result. Additionally, they must be peer-reviewed.
Criteria for exclusion	Does not meet our predetermined inclusion criteria, not peer-reviewed

2.2.2 Findings

The examination of selected articles has provided us an overview of pertinent topics. Hence, we have found it sensible to allocate each article across three relevant themes addressed in the literature: the impacts of covid-19 on supply chains, resilience, and visibility.

Throughout the literature review, supplemental publications are applied whenever sensible, e.g., when a concept or theory needs further investigation beyond what is said in an article or when earlier publications are used to validate present literature.

2.2.2.1 Impact of covid-19 on supply chains

Pandemics are specific kinds of disruption risks (Ivanov 2020a) and have in recent times exposed vulnerability in supply chains through the ongoing coronavirus (Fonseca and Azevedo 2020, Sharma, Adhikary, and Borah 2020, Veselovská 2020).

Present studies reveal several types and degrees of implications caused by the coronavirus, affecting both upstream and downstream supply chain processes. We experience a consensus among authors regarding how diverse industries have been affected and what may be expected in a future aspect. In our compilation of literature, the current situation has also been compared to former remarkable occurrences to put the scope of impact into perspective.

As of May 2021, over 166 million are confirmed infected, and about 3.5 million confirmed deaths from the virus (World Health Organization 2021). Those numbers substantiate why available publications allude to covid-19 as one of history's most momentous events on the global economy and supply chains (Belhadi et al. 2021, Fonseca and Azevedo 2020, Ivanov 2020a). Disturbing both supply and demand, the world faces a setback equal to or even worse than the financial crisis in 2008/2009. The ongoing pandemic is also labeled as the primary health crisis since the outbreak of influenza after World War II (Fonseca and Azevedo 2020).

Absent links between supply chain parties are causing material shortages and delivery delays that negatively affect revenue and productivity, with lean and globalized supply chains turning out to be specifically prone to epidemics. The immediate and vast impact of

disruption risks on supply chain networks is the precursor of simultaneous disruption propagation, referred to as ripple effects (Ivanov 2020a). Such effects occur when a disruption cascades downstream and propagates within the supply chain, engendering negative impacts on supply chain performance (Dolgui, Ivanov, and Sokolov 2018). Consistent with Queiroz et al. (2020), ripple effects are strong annoyances to supply chains amid the pandemic, stimulated by concurrent disturbances and insecurities in demand and supply.

China´s position in global trade has been reflected in numerous publications, e.g., Belhadi et al. (2021), Cai and Luo (2020), Queiroz et al. (2020), and Shahed et al. (2021). The abovementioned studies denote it as a decisive factor that the outbreak origins from China precisely.

Emphasizing manufacturing supply chains, Cai and Luo (2020) assert that the initial impact of the pandemic contains two phases. Firstly, the virus forced production stops in China. Hence, export operations were affected, and the global supply of raw materials and spare parts diminished. Due to the incessant global spread of the virus, the second phase comprises enormous implications on supply and demand in manufacturing supply chains. Countermeasures like lockdown, travel and transportation stop, and other comprehensive restrictions have coerced plants to shut down in heavily influential countries in the global supply of manufactured goods. Cai and Luo (2020) pinpoint four initial impacts on manufacturing supply chains, namely interrupted production of raw material and spare parts, unsatisfied demand (due to setbacks in logistics), increased risk of bankruptcy, and enlarged fluctuation of supply and demand.

Correspondingly, Belhadi et al. (2021) refer to the high dependence of China as a supply chain partner as a root for the expanded economic spillovers to less-affected parts of the world. The authors elucidate how the virus has caused damage to both manufacturing- and service industries based on the automobile and airline industry. Their principal findings state through performance metrics how costly covid-19 has been. The automobile industry faced effects related to supply chain disruptions and manufacturing shutdowns, whereas shortage of working capital and sales accounted for the airline consequences.

For example, due to preventive actions such as border restrictions and quarantine schemes, airline companies have been forced to minimize their flight operations. As a result, this has caused drastic numbers of job losses and triggered ripple effects affecting the hotel business. Moreover, there are plenty of stakeholders directly involved in airline supply chains, and the likes of goods transportation, airline manufacturing, and tourism are touched by the decrease in flight operations (Belhadi et al. 2021). An estimation performed by the International Air Transport Association indicates a loss of between $63 billion and $113 billion in revenue for global air carriers solely in 2020 (Chowdhury et al. 2020)

Belhadi et al. (2021) found that the automobile industry should acquire localized supply sources and apply advanced industry 4.0 technologies as mitigation strategies. Common to both the automobile- and airline industries is the need for Big Data Analytics to provide real-time information on supply chain activities to identify covid-19 challenges. Finally, they acknowledge cooperation among supply chain stakeholders as a necessity.

The findings of a simulation-based analysis conducted by Ivanov (2020a) uncover four factors that may determine the impacts of covid-19 on supply chain performance: timing of closing and opening of facilities at different supply chain echelons, lead time, epidemic propagation rapidity, and both upstream- and downstream disruption duration. Furthermore, the author posits that the impacts of pandemic outbreaks on supply chains heavily depend on the globally supplied product type (Ivanov 2020a).

Investigating the impacts on supply chains has enabled us to recognize the scope of covid-19. As mentioned earlier in this section, both the supply and demand sides are affected. However, most significant for our case is understanding how ripple effects may affect the purchasing and supply functions of organizations, which will help compare and understand our own gathered data.

2.2.2.2 Resilience

One central concept within supply chain management is resilience. This term refers to the ability to resist disruptions and recuperate performance (Ivanov 2020b). Due to increased disruptions in global supply chains, resilience has aroused interest and become vastly important in this domain (Chowdhury and Quaddus 2017).

Resilience is frequently mentioned in conjunction with covid-19, as the extraordinary magnitude of the coronavirus is challenging the resilience of global supply chains (Golan, Jernegan, and Linkov 2020). From the papers on covid-19 and supply chains, an extended definition is found in El Baz and Ruel (2020), where Supply Chain Resilience (SCRes) is explained as "*a complex, collective, adaptive capability of organizations in the supply network to maintain a dynamic equilibrium, react to and recover from a disruptive event, and to regain performance by absorbing negative impacts, responding to unexpected changes, and capitalizing on the knowledge of success or failure"*. Implementing solid strategies and actions for resilience is claimed to be necessary for supply chains to withstand the previously expounded ripple effects (Queiroz et al. 2020). Nevertheless, complications arise concerning covid-19 as a new phenomenon, resulting in limited empirical data on how global supply chains may turn resilient against it (Belhadi et al. 2021).

However, resilience is not a novel and unambiguous concept. Ponomarov and Holcomb (2009) declare the concept of resilience as multidimensional and multidisciplinary by being both a subject of research within developmental psychology and ecosystems and also a subject of interest in risk management and supply chain management. This provides us the standard definition of resilience in ecological sciences: *"the ability for an ecosystem to rebound from a disturbance while maintaining diversity, integrity, and ecological processes"* (Pettit, Fiksel, and Croxton 2010). For the latter interpretation that relates to our context, a unique definition is lacking, and various contributions in defining the concept exist (El Baz and Ruel 2020).

Christopher and Peck (2004) have turned away from disputed academic definitions and rather sworn to a dictionary-based definition espousing ecological science. Hence, they define resilience as *"the ability of a system to return to its original state or move to a new, more desirable state after being disturbed*". Furthermore, four principles are presented that underpin how supply chains can enhance resilience:

(1) Resilience should be designed into and prioritized in supply chains.
(2) A high level of collaboration between supply chain entities is required to mitigate risks.
(3) Being agile is important to react quickly to unpredictable events. Visibility and velocity are seen as key elements of agility.

(4) Risk management culture within organizations will enhance resilience.

Understanding the supply chain network is a precondition for SCRes. Comprehension can be achieved through mapping, which may help identify bottlenecks like long lead times, single sources of supply, poor visibility, and detectible risks (Christopher and Peck 2004).

Supply chain collaboration can be described as *"two or more companies sharing the responsibility of exchanging common planning, management, execution, and performance measurement information"* (Min et al. 2005). Consistent with Barratt (2004), a "collaborative culture" involves several elements, including trust, mutuality, exchange of information, openness, and communication.

Belhadi et al. (2021) assert that supply chain collaboration may function as proactive and reactive strategies. Through their study on supply chain resilience during covid-19, informants have declared the necessity of strong relationships, collaboration, and mutual goals with key suppliers. The authors conclude that industries have a unique opportunity to redefine business operations by building sustainable, agile, and resilient operations, only to be possible through high levels of coordination and collaboration.

Another pre-requisite for SCRes is supplier selection strategies (Christopher and Peck 2004, Kahiluoto, Mäkinen, and Kaseva 2020, Sheffi and Rice Jr. 2005). Consistent with Sheffi and Rice Jr. (2005), building redundancy or flexibility can bolster resilience. Supporting that claim, Christopher and Peck (2004) say that *"the strategic disposition of additional capacity or inventory at potential "pinch points" can be extremely beneficial in the creation of SCR"*. Of importance is balancing the cost of superfluous inventory/capacity against the probability of a disruption (Christopher and Peck 2004). Thus, with safety stocks, one must be cautious not to go from a "just-in-time" to a "just-in-case" strategy.

Procurement is pointed out as one of five fundamentals of flexibility by Sheffi and Rice Jr. (2005). Specifically, flexibility depends on applying the correct corporate-supplier relationship to one's procurement strategy. Hence, a single supplier strategy requires deep relationships and cooperation. If a disruption causes problems for the sole supplier, the company relying on it may be left without vital resources. Contrariwise, multiple sourcing

demands less focus on relationships, as the risk of losing out on supply is spread out (Sheffi and Rice Jr. 2005).

In the same path, Kahiluoto, Mäkinen, and Kaseva (2020) illuminate the supply base role of resilience, but rather by addressing diversity. In social-ecological systems, resilience is considered a central determinant (Folke 2006). Kahiluoto, Mäkinen, and Kaseva (2020) put the diversity concept into the supply chain context. More precisely, their findings support that *response diversity* is a crucial determinant of resilience and that such diversity can reduce or avoid the trade-offs between redundancy and efficiency. By contrast to *type diversity*, which generally comprehends any diversity of suppliers, *response diversity* is explained as *"diversity within a functional group or purchase category, in their responses to the changes, variabilities, and uncertainties, which are most critical to their function".* Simply said, balancing supply among suppliers that responds differently to disruptions safeguards one by that some suppliers offering the same function may continue to deliver during or after a disruption (Kahiluoto, Mäkinen, and Kaseva 2020).

A majority of the papers reviewed contain, to different extents, some elements of resilience. SCR is of vastly importance in risk management theory. To that end, concerning our incentives with this thesis, we incorporate SCRes literature to gain an in-depth understanding of the concept. The supply and purchasing elements of resilience are of particular interest due to our upstream supply chain emphasis.

2.2.2.3 Visibility

Consistent with Cai and Luo (2020), the necessity of end-to-end visibility has been punctuated due to adverse effects caused by the coronavirus pandemic. This claim is acknowledged in Belhadi et al. (2021) by interviewees from the automotive- and air industries declaring the lack of real-time visibility across supply chains as a major weakness during the outbreak. Correspondingly, Taqi et al. (2020) point out that organizations ought to practice high visibility levels to counter unforeseen risks.

Supply chain visibility (SCV) is commonly associated with information sharing within supply chains (Waters 2007). Barratt and Oke (2007) propose that information sharing is an activity with visibility as the outcome and define SCV as the extent to which parties within

a supply chain have access to or share information considered as suitable for operations, and also considered to be mutually beneficial (Barratt and Oke 2007). SCV is understood as heavily connected to the practicality of exchanged information. Such information should be valuable and expressive (Caridi et al. 2014). Brandon-Jones et al. (2014) have indicated the importance of visibility as a forerunner to risk reduction. It supports risk identification, and its absence can generate new risk events. The following is stated in their publication: *"We suggest that an improved supply chain visibility capability may reduce both the probability and impact of a supply chain disruption and therefore lead to enhanced robustness and/ or resilience."*

Sharing information among supply chain partners is seen as the fundament of improved visibility within supply chains (Christopher and Lee 2004). With visibility comes reduced uncertainty and reduced risks connected to supply chain activities (Holcomb, Ponomarov, and Manrodt 2011). Achieving SCV requires both market-level and partner-level information types, according to Williams et al. (2013). The first relates to conditions in aggregate demand and supply a at market level, as requirements and availabilities. Partner-level information is distinguished by being either downstream or upstream related. Whereas downstream information incorporates data regarding sales, demand forecasts, and customer inventory levels, upstream information relates to supplier inventory, lead-time, shipment data, and distribution network inventory levels (Williams et al. 2013).

2.2.3 Areas for future research

Covid-19 is a recently occurred event, and not unexpectedly, this has affected published literature concerning the subject. Regarding our literature search, researchers have especially been struggling with scarcity of empirical data and ensuring valid results due to the short time between the outbreak and today. Consequently, this affects how the research questions have been addressed.

The Covid-19 pandemic has evolved into a new but highly relevant research topic, and a handful of researchers have investigated the situation from different perspectives. Fonseca and Azevedo (2020) expound that their research contains an inherent limitation due to a lack of empirically quantitative data to support their recommendation, and collection of empirical evidence is recommended for future research. This is supported by Black and Glaser-Segura

(2020) who state that risk mitigation practices during a pandemic are limited. It requires further research to handle the coordination of preparing and executing a pandemic strategy. Moreover, Al-Mansour and Al-Ajmi (2020) explain that all available data in the paper is archival data due to the unavailability of published scientific research papers relating to the integrated effects that covid-19 has brought to businesses globally, and this should be investigated more in-depth. Suggestions for further research areas are in many papers due to the lack of obtained empirical data. It is evident that the collection of empirical data is an area for future research.

The short period between the outbreak and today is a critical element in several of the papers. Some researchers point out that future research is necessary to verify the results and findings. In the paper written by Nakat and Bou-Mitri (2020) about covid-19 and the food industry, they argue that the consumer purchasing behavior changed due to covid-19 and could lead to a competitive advantage for the industry. This might be the case. Nevertheless, it has to be tested in the aftermath.

Furthermore, forecasting and planning during a pandemic were the focus area in the paper by Nikolopoulos et al. (2021). He clarifies that the data may not be reliable due to being collected during the pandemic. The results might be different with data collected after the pandemic by using the same methods. In light of this, the findings need to be tested after the pandemic is over. Both Veselovská (2020) and El Baz and Ruel (2020) managed to gather primary data where the first author conducted a survey with 211 international companies from four central European countries.

In contrast, the latter surveyed a random sample of 3411 companies in France. Similar to the abovementioned papers, the findings need to be tested to achieve verifiable facts to the research question. Veselovská (2020) states that the success of measures taken cannot be precisely quantified as the research is conducted in the early stages of covid-19. She recommends that the adequacy of each response should be measured after a certain period to provide correct findings regarding the success or failure of companies' responses. For the case of El Baz and Ruel (2020), longitudinal data required for studying causality over a more extended period were not available at that time. With this in mind, it is noticeable that some topics require additional research in the aftermath.

2.2.4 Gaps

Scrutinizing the 40 papers has enabled us to identify gaps in research on supply chains and the covid-19 pandemic. In light of recommendations for further research as described above, it is imperative to acquire empirical data from companies that have faced the consequences of covid-19. Among the articles collected, only half of the papers were based on primary sources such as interviews or surveys.

Furthermore, a few researchers have distinctly focused on the similarities and differences between disparate industries on supply chains and covid-19. An exception is Woong and Goh (2020), who examined ten companies from five industries through a case study approach. However, the research is based on secondary sources, including financial statements and press releases, and not primary data gathered from supply chain professionals.

Our thesis exclusively focuses on upstream activities, more precisely, purchasing and supply. Additionally, our study aims to present a model based on our results. None of the selected articles have the same point of view, and our thesis will provide value to a subject exposed for the scarceness of research. Besides all the considerations mentioned above, our research is carried out later into the pandemic. The companies interviewed have more understanding and knowledge concerning the impact and consequences of the covid-19 pandemic. All things considered, our research will cover a gap in the literature regarding the type of measures that prevent disruption in the supply chain due to low probability, high impact (LPHI) events, such as covid-19.

3.0 Theoretical foundation

This section presents three theoretical frameworks that provide lenses through which SCM and covid-19 can be viewed. The theories provide perspective and the basis for explaining the choices and actions taken by supply chain actors.

3.1 Transaction Cost Theory

Transaction costs occur from transactions: when goods or services are transferred across technologically separable interfaces (Williamson 1981). Such transactions function as the basic units of analysis in Transaction Cost Economics (TCE), also known as Transaction Cost Theory (TCT), an idea commonly associated with Oliver Williamson´s contributions to the field (Verbeke et al. 2013, Wever et al. 2012). Williamson´s TCT is an intersection of economics, law, and organizational theory and proposes that economic efficiency and minimization of transaction costs is dependent on a firm´s governance structure and contracting decisions (Chiles and McMackin 1996, Verbeke et al. 2013). Additionally, TCT is used in conjunction with outsourcing decisions (Wever et al. 2012). The decision between make-or-buy is taken concerning a transaction cost economizing motivation (Williamson 2008).

In TCT, there are two underlying behavioral assumptions of transactions: *bounded rationality* and *opportunism* (Williamson 1981). Bounded rationality is *"behavior that is intendedly rational but only limited so"* which in TCT context refers to incomplete contracts due to the limited cognitive competence of actors to specify changes in circumstances before transactions (Wever et al. 2012, Williamson 1996). The limited capacity of organizations and individuals to process information is due to the undeniable amount of uncertainty existing in a transaction (Hallikas, Virolainen, and Tuominen 2002).

Defined as *"self-interest seeking with guile"* (Williamson 1996), opportunism comprehends a strategic behavior from actors that seek to achieve advantages by exploiting the counterpart in a transaction (Wever et al. 2012). This tactical action may be referred to as behavioral uncertainty or supplier uncertainty and results from the potential of ex ante or ex post opportunism at the expense of the exchange partner (Sutcliffe and Zaheer 1998). As Hallikas, Virolainen, and Tuominen (2002), the possibility of opportunism increases when applying a small number of partners and an independent relationship.

TCT calls on three dimensions when describing transactions: asset specificity, uncertainty, and frequency (Williamson 2008). Asset specificity is one of the main drivers of contracting decisions (Wever et al. 2012) and refers to *"a specialized investment that cannot be redeployed to alternative uses or by alternative users except a loss of productive value"*

(Williamson 1996). Transaction-specific investments contain tangible and intangible assets personalized to a specific relationship. Due to peculiarity, specific assets generate bilateral dependence and contractual dangers (Buvik 2002). The difficulty of re-deploying without loss of productive value makes continuity preserving governance for transaction-specific assets significant (Williamson 2008).

From a supply chain disruption perspective, the uncertainty aspect of TCT is particularly pertinent. Uncertainty is the unforeseen fluctuations in the circumstances surrounding a transaction (Grover and Malhotra 2003) and, consistent with Williamson (2008), the source of disruptions to which adaption is required.

According to Sutcliffe and Zaheer (1998), the disaggregation of uncertainties did not occur early, but rather in more recent TCT literature. They furthermore specify that Williamson adapted Koopmans categorization of primary (absence of knowledge about states of nature, e.g., natural events uncertainty) and secondary (absence of knowledge about the actions of other economic actors) uncertainties (Sutcliffe and Zaheer 1998).

From TCT literature, we acknowledge that uncertainty is commonly distinguished by being behavioral or environmental (Grover and Malhotra 2003, Sutcliffe and Zaheer 1998, Wang 2002, Williamson and Ghani 2012). The first comprises difficulties of determining loyalty to contractual agreements and evaluating performance in light of the aforementioned opportunistic behavior (Wang 2002). Also known as external uncertainty, the latter uncertainty is understood as the volatility of a firm's environment (Anderson and Gatignon 1986). Environmental uncertainty constitutes several distinct dimensions (Buvik 2002). As Grover and Malhotra (2003) claim, such uncertainty may be reflected in constructs like environment unpredictability, technology, and demand variety.

Uncertainty has become a central concept within a various organization- and strategy theories. This emerges in the publication of Sutcliffe and Zaheer (1998) who draw on previous literature on the relationship between uncertainty and vertical integration to conceptualize three distinct types of uncertainty: primary, supplier, and competitive. Their explanation of primary uncertainty is obtained from the view of Koopmans and Williamson, comprising the states of nature. Likewise, supplier uncertainty is adapted from the behavioral uncertainty, rooting from the already defined behavioral assumption of

opportunism. Their novel contribution is, however, *competitive uncertainty,* which by the authors is described as uncertainties *"arising from the actions of potential or actual competitors, which may be either "innocent" or "strategic"* (Sutcliffe and Zaheer 1998). Figure 2 shows the relationship between primary-, supplier-, and competitive uncertainty.

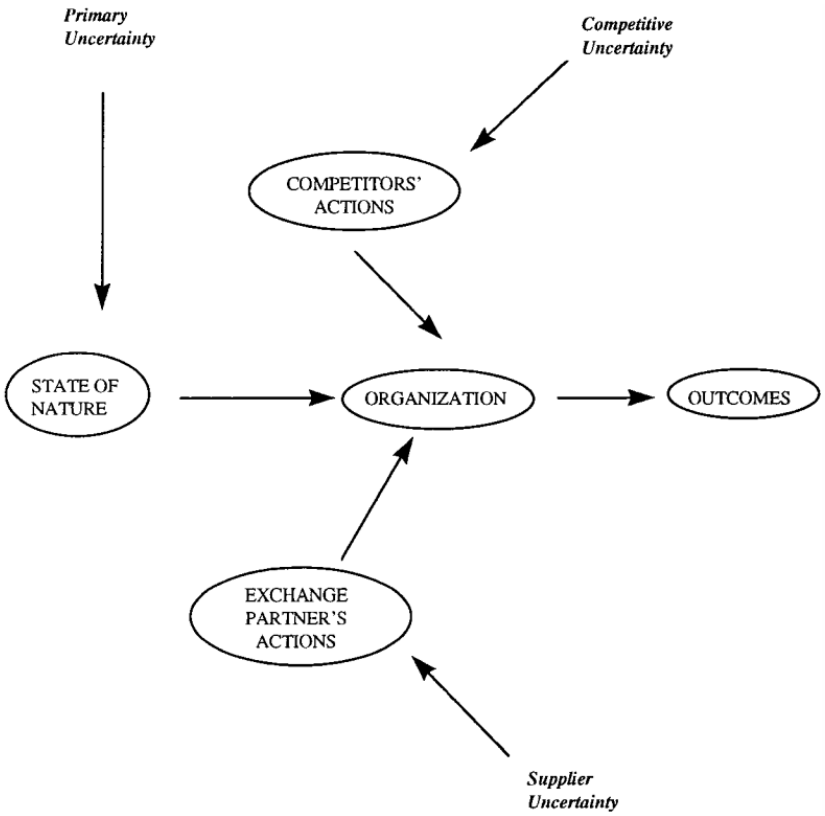

Figure 2: Sources of uncertainty (Sutcliffe and Zaheer 1998)

Exchange partners may be suppliers and buyers, and to this end, uncertainties may affect transactions between them. It is commonsensical to conclude that primary/environmental uncertainty fits our research problem concerning LPHI risk events. Nevertheless, our view is that all the accounted-for uncertainty forms may qualify as determinants for the response to unlikely events. For instance, ripple effects from the coronavirus can increase supplier uncertainty in terms of the shortage of raw materials. Also, competitive uncertainty can potentially arise due to competitors´ maneuvers when trying to achieve competitive advantages by securing priority on critical goods from suppliers.

TCT is concerned with the governance of contractual relations (Williamson 1993). The inter-firm level of "complete" contracts reflects a desire by exchange partners to decrease transaction costs. A definition of "feasible" completeness is that *"a contract is more*

complete than another if it gives a more precise definition of the transaction and of the means to carry it out". A contract is complete if it stipulates how to perform transactions in every imaginable case (Saussier 2000). However, not all transactions fit classical contracting. Contracts under uncertain surroundings make complete presentation prohibitively costly if not impossible, as numerous future contingencies that require adaptations cannot be predicted at the outset, and suitable adaptations may not be apparent until conditions materialize (Williamson 1979). Because it is difficult to have complete contracts that address all uncertainties, relational contracting is crucial, as discussed in the next section.

3.2 Relational Contract Theory

Macaulay (1963) describes two distinct elements for contracts, *"(a) Rational planning of the transaction with careful provision for as many future contingencies as can be foreseen, and (b) the existence or use of actual or potential legal sanctions to induce performance of the exchange or to compensate for non-performance".* The logic behind Relational Contract Theory (RCT) is the existence of non-legal sanctions that makes fulfilling commitments convenient for parties. Consequently, contracts may persist being incomplete without triggering opportunism (Carson, Madhok, and Wu 2006).

RCT is commonly recognized through Ian Macneil's contributions. Macneil (1973) distinguishes discrete contract transactions from relational contracts by that it is solely the latter that incorporates whole personal relations, extensive communication, and substantial elements of non-economic personal fulfillment. His distinction derives from three characteristics of nonprimary and primary relations: (1) participants in primary relations interact as unique, and response is non-transferable to other persons, (2) interaction is deep and extensive in primary relations, while nonprimary relations are restricted to formal, and public approaches of communication, and (3) one enters into primary relations to achieve personal development, security, and well-being (Macneil 1973).

Trust as a relational norm is fundamental in relational exchanges (Carson, Madhok, and Wu 2006). The definition of trust provided by Mayer, Davis, and Schoorman (1995) is frequently applied in the literature, stating that trust is *"the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular*

action important to the trustor, irrespective of the ability to monitor or control that other party". Vulnerability denotes that something of importance is lost (Mayer, Davis, and Schoorman 1995), which appropriately relates to our study by the idea of companies losing out on critical goods because of covid-19.

Jeffries and Reed (2000) say that empirical evidence appears of trust being both cognitive- and affect-based. The cognitive dimension of trust is based on predictability, past behavior, dependability, and fairness and reflects on competency and the obligation to perform. Affect-based trust regards caring and concern for the exchange partner's welfare, as there exists a mutual view of the value in a relationship.

RCT provides important perspectives to LPHI events, as relationships and trust between companies and suppliers are heavily tested due to unpredictable circumstances. In that context, Carson, Madhok, and Wu (2006) investigated the efficiency of contractual and relational governance in limiting opportunistic behavior is volatile (operationalized as frequency and unpredictability of environmental change) and ambiguous (the degree of uncertainty in perceiving the environmental state irrespective of its change over time) conditions. They found that trust plays a vital part in both governances as protection against opportunism. Additionally, relational contracts tend to be effective in volatile environments. Conversely, the effectiveness is limited by ambiguity, and thus, its impediments against opportunistic behavior diminish (Carson, Madhok, and Wu 2006).

Trust-based relational exchanges are often considered substitutes for complex contracts. According to Poppo and Zenger (2002), many argue that formal contracts emasculate trust, thus, encouraging opportunistic behavior, which is to be avoided through such contracts. Their paper provides several substantiated claims to this view, for instance, that *"trust reduces transaction costs by 'replacing contracts with handshakes'"* , "*informal self-enforcing agreements which rely on trust and reputation 'often supplant' the formal controls characteristic of formal contracts",* and *"some firms discourage the use of an elaborate contract because it 'indicates a lack of trust and blunts the demands of friendship, turning a cooperative venture into an antagonistic horsetrade'"*.

Despite this, Poppo and Zenger (2002) hypothesized that the clearly articulated terms, remedies, and processes of dispute resolution in formal contracts, combined with the

flexibility, solidarity, bilaterality, and continuation in relational norms, may stimulate the confidence of cooperation in exchanges. Their findings indeed illustrate a complementarity between relational governance and contractual complexity due to their unique origins. Relational norms increase per the degree of contract customization, and greater contractual complexity correlates to greater extents of relational governance. The authors state that *"customized contracts specify contingencies, adaptive processes, and controls likely to mitigate opportunistic behavior and thereby support relational governance. However, customized contracts do not guarantee the intent of mutuality, bilateralism, and continuance when conflict arises"*. These boundaries are complemented by relational governance by developing continuance and entrustment of mutual agreements (Poppo and Zenger 2002).

3.3 Chaos Theory

Globalization has prominently impacted organizations worldwide, and today's marketplace is increasingly volatile and dynamic, resulting in market pressure and small margins. Moreover, uncertainty in supply and demand has garnered awareness after recognizing the substantial impact on the supply chain performance (Wilding 1998a). To reduce uncertainty, organizations seek to find patterns in customer behavior and demand. However, it is exacting to recognize a pattern under certain conditions, bringing us to chaos theory. Mason (2006) argues that traditional management approaches are inappropriate in turbulent and demanding environments such as natural disasters, financial recession, political instability, or war. Hence, organizations require new methods from other sciences, such as chaos theory.

Chaos theory was pioneered by Edward Norton Lorenz and is the study of dynamic systems that are both complex and nonlinear (Levy 1994). According to Glenn (1996), chaos theory examines systems denoted as "*erratic fluctuations, sensitivity to disturbances and long term unpredictability"* (Glenn 1996). The term chaos is applied as a metaphor to describe how a minor change can be amplified to have a considerable effect on the system, the so-called "butterfly effect." This refers to a butterfly flapping its wings which further leads to tiny changes in the atmosphere, leading to significant crises (Wilding 1998b). An example is the Eyjafjallajökull eruption in Iceland in 2010. An ash cloud interrupted the global aviation industry and resulted in preeminent consequences for the industry and significant disruption for both businesses and individuals worldwide depending on the transportation mode.

Hence, organizations should seek to become resilient against unpreventable crises (Speakman and Sharpley 2019).

The system's equation of motion must be nonlinear to achieve a system to exhibit chaos. Nonlinear equations differ from linear in the sense that all linear equations are analytically solvable, whereas nonlinear equations are not. Moreover, linear systems are composed of equal pieces that can be taken apart, and when you put them together again, the pieces add up. In comparison, it is generally impossible to solve nonlinear systems, and they cannot be added together again. This deviates from standard practice, where mathematicians and physicists often solve nonlinear problems by employing approximations that reduce them to a linear problem (Kantemnidis 2016). Additionally, its ability to demonstrate how a simple set of deterministic relationships can create patterned yet unpredictable outcomes is notable attainment of chaos theory (Levy 1994).

Chaos theory and supply chain

Levy (1994) states that traditional approaches derived from microeconomic have evaluated firm behavior and competitive outcome, emphasizing equilibrium. In comparison, chaotic systems do not hit a stable balance due to the nonlinearity. As a matter of fact, chaotic systems cannot at any time pass through the state more than once. Consequently, it is complicated with long-term planning and forecasting under such environments. Despite the instability and unpredictability, it is possible to identify an order even in chaotic systems. If the condition at time "t" is known, it is possible to calculate "t+1" in a deterministic system. Hence, short-term forecasting is feasible. Thus, in the case of extreme weather such as hurricanes, floods, and tornadoes, we can perceive what conditions lead to their occurrence in addition to the frequency, although the exact time and place are unspecified (Levy 1994). All things considered; chaotic systems can provide helpful information because it traces repetitive patterns.

The application of chaos theory in times of crisis is believed to have a positive effect because it can assist business managers in handling turbulent environments better, hence increasing their survival rate. Le Nguyen and Kock (2011) propose the following model (figure 3) to manage a chaotic environment caused by crises.

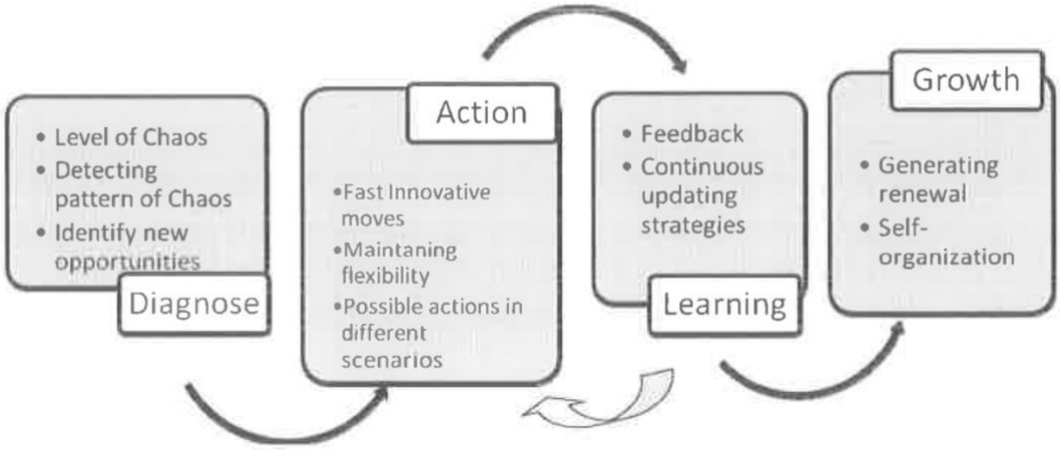

Figure 3: Processing model for firms to cope with chaos (Le Nguyen and Kock 2011)

1. Diagnosis – the degree of chaos is necessary to recognize since this determines the strategy required. Subsequently, the firm can govern chaotic environments and identify patterns, thus acknowledging new opportunities.
2. Action – traditional strategies might be improper during a crisis, and fast, innovative moves are beneficial even though it is associated with risk. This must be weighed against the consequences of taking a risk compared to wait. Chaotic environments are often connected to uncertainties, and if the firm manages to be flexible, this is considered a competitive advantage.
3. Learning – Feedback and continuous evaluation of strategies are necessary measures concerning rapid response, as suggested in step 2. If the outcome from the response taken in step 2 is positive, the firms continue, but if it is negative, the firm needs to reconsider the action taken and update their strategy. Although firms yield positive outcomes for their first-mover strategy, it is crucial to continuously revisit and modify strategies due to the turbulent environment.
4. Growth – it is essential to constantly renew their operations and strategies to cope in a chaotic environment. This also provides opportunities and quickly adapt to new situations (Le Nguyen and Kock 2011)

Due to the characteristics of a supply chain with several echelons, the impacts are divided on several forces (Stapleton, Hanna, and Ross 2006). Hence, it can be difficult for managers to guide the firm through turbulent environments and at the same time accomplish preferred results. Nevertheless, a manager who continuously deals with transformation and change is more prepared to tackle a chaotic environment successfully. Furthermore, this requires a

cultural shift rather than explicit defining objectives and giving orders (Dolan, Garcia, and Auerbach 2003).

According to Stapleton, Hanna, and Ross (2006) chaos theory emphasizes strategic relationships between the different parts in a supply chain because small changes in the SC network may drastically impact other actors in the SC. Furthermore, this relationship is crucial regarding effective and rapid communication when changes are required. It is also highlighted that an accurate and long-term planning approach is preferable because this reduces necessary adjustments (Stapleton, Hanna, and Ross 2006). In comparison, Wilding (1998a) asserts that long-term planning is very demanding in turbulent environments and emphasizes that if long-term plans are constructed, they need to be examined regularly. Also, the supply chain must be managed as a complete network even though it consists of several echelons (Wilding 1998a).

4.0 Research methodology

The purpose of this chapter is to provide a detailed review of the methodological decisions made during our research. We differentiate between methods and methodology to include both the practical and philosophical issues connected to research and to furnish equal emphasis on both (Kirsch and Sullivan 1992). Sedlmair, Meyer, and Munzner (2012) draw parallels to cooking when describing the difference between method and methodology. Methods are like ingredients, and methodology is the recipe. Said more formally, methods are techniques or procedures to gather evidence, whereas methodology is the choice of strategy, process, and plan of action that settle the specific method. To obtain the most relevant results, it is important to have an explicit, disciplined, and systematic approach (Mohajan 2018).

Intending to achieve the best results in our research, we have complied with all the stages in the research onion model presented by Saunders et al. (2019). The research onion consists of six layers and illustrates the different elements that could be included when conducting a research.

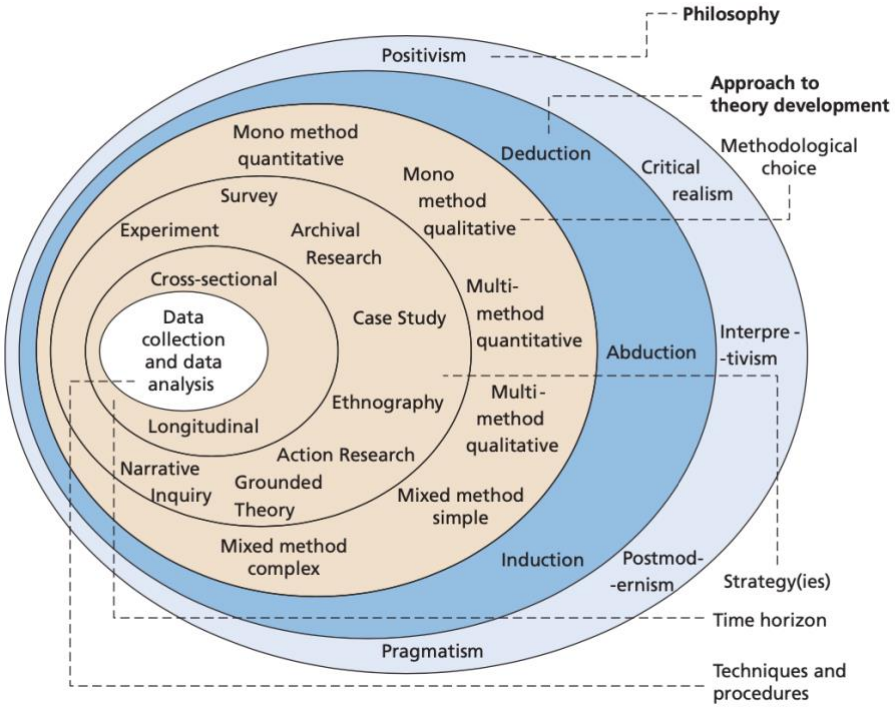

Figure 4: The research onion (Saunders et al. 2019)

4.1 Philosophical direction

The way we understand and apply theory is fundamentals for how research is carried out and the study's outcome. However, apart from theoretical orientation, research is influenced by philosophical assumptions, which are necessary to ensure that your research provides valid claims. All researchers are underpinned by philosophical assumptions that substantially influence the practice of research and the conclusions drawn from data collection and analysis (Bell, Bryman, and Harley 2018).

Ontology and epistemology are the two main philosophical paradigms within research philosophy. They are linked to theory development and the best way to conduct research based on predetermined assumptions (Wahyuni 2012). Ontology relates to questions about reality and what assumptions researchers have concerning the world and how it operates. Ontology is divided into two aspects, objectivism and subjectivism. Firstly, objectivism portrays the existence of social actors in a meaningful reality compared to social actors who discuss their own existence. Secondly, subjectivism is related to social phenomena where social actors are assumed to have a conscious existence. Subjectivism is often associated with constructionism which perceives reality as socially constructed (Saunders, Lewis, and

Thornhill 2012). Constructivism asserts, according to Bryman (2001) *"that social phenomena and their meanings are continually being accomplished by social actors. It implies that social phenomena and categories are not only produced through social interaction but that they are in a constant state of revision".* In other words, reality is perceived differently depending on social actors. In our qualitative research, we assume that humans and their roles as social actors are two different things. Hence, we take a constructionism stance.

Epistemological assumptions emphasize how knowledge is created, acquired, and communicated (Scotland 2012). Firstly, research with a philosophy of positivism prefers data collections concerning a reality that can be observed. Secondly, realism is what we review as reality unrelated to the human mind. Thirdly, interpretivism argues humans and their role as social actors are two different things that are vital to acknowledge. This draws attention to the inequality between research that encompasses people instead of objects (Saunders, Lewis, and Thornhill 2012). Concerning epistemology, we take an interpretive position following the abovementioned explanation.

4.2 Approach to theory development

Review of existing theory is an important task to accomplish during theory development, yet the relationship between theory and empirical research can be viewed differently. In general, two approaches lead to attaining new knowledge, *deductive* and *inductive* reasoning (Spens and Kovács 2006). A deductive research approach begins with identifying a relevant theoretical framework before suggesting a hypothesis which is tested, and finally, creating new knowledge. This approach progresses from a general view to a more specified view, and people typically associate the method with scientific inquiry (Blackstone 2018).

With an inductive approach, the procedure is reversed, and researchers move from a specific view to a more general perspective. Said in another way, the process begins with data collection and development of a hypothesis before taking a step back to get a bird´s eye view of the observations. After that, the researcher evaluates the existing theoretical framework. Coupled with patterns in accumulated data, they acquire new knowledge (Blackstone 2018).

In addition to deductive and inductive research approaches, researchers can also deploy the abductive approach (Saunders et al. 2019). Whereas deductive and inductive approaches move from theory to data or the opposite way, abduction can be perceived as a combination of the deductive and inductive approaches.

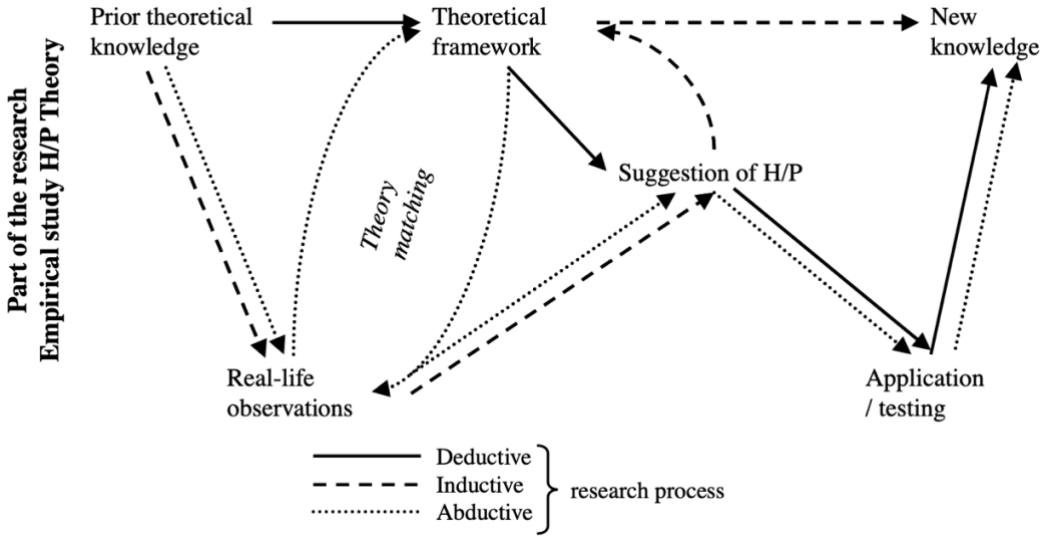

Figure 5: Three research approaches (Spens and Kovács 2006)

In our research, take an inductive approach which apt with our philosophical stance of interpretivism. Due to its origin from social science, the deductive approach does not consider how research objects interpret the social world. By contrast, this is one of the strengths of the inductive approach. The human aspect is important to provide differing sight of our research, substantiating our inductive approach. Furthermore, an inductive approach is suitable for investigating a small sample, which harmonizes with our research design and strategy (Saunders et al. 2019).

4.3 Research design

Creswell and Plano Clark (2011) define research design as the *"procedures for collecting, analyzing, interpreting and reporting data in research studies."* In other words, it is the overall plan for connecting the research problems with empirical research. There are three types of research design: exploratory, descriptive, and explanatory. Firstly, exploratory research contains a study of a new phenomenon and tries to understand and assess the situation in a new light. Secondly, descriptive studies aim to provide an understanding of a

situation, person, or event in addition to convey how things are related to each other. Thirdly, explanatory research explains why phenomena occur and predict future occurrences (Yin and Campbell 1994).

Due to our research questions, an exploratory research design is the most suitable because we can explore a covid-19 which is a relatively new phenomenon. This decision agrees with the rest of our methodological choice concerning philosophy, research approach, sampling, and data collection.

4.4 Research strategy

It is essential to have a strategy to achieve the goal of our research. As the name implies, a research strategy is defined as a plan for how a researcher should organize and carry out their research to obtain valid answers to their research questions. Moreover, it is the methodological link between the philosophical underpinnings, the approach utilized, and methods for data collection and analysis of data. There exist several possible strategies, and the choice is often associated with quantitative or qualitative research. Nevertheless, specific strategies are not considered superior or inferior to any other (Saunders, Lewis, and Thornhill 2012).

Our primary focus during the selection of research strategy was to address and answer our research questions fully. The strategy needs to enable a comprehensive understanding of the subject, and with regards to our research questions, we found it necessary to acquire information from several industries and companies. Hence, the most suited approach was conducting a case study that also supports our philosophical and inductive approaches. A case study is defined as *"an empirical method that investigates a contemporary phenomenon (the case) in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident" (Yin 2018).* Moreover, a case study approach is appropriate when your research questions are concerned with *why* and *how*, and this corresponds with the formulation of our research questions. Since we have collected data from several companies, our study is categorized as an embedded multiple case study, meaning that we examine several cases consisting of several units (Yin 2018). Additionally, the multiple case study design is preferable because it can provide stronger and more powerful evidence and strengthen the findings from your research than a single

case study design where only one case is being studied. To that end, the empirical background may be substantial, and our odds of conducting a good case study are increased (Yin 2018).

In addition to the case study design, we have utilized the grounded theory strategy to analyze collected data. Mixing features from different strategies may be more time-consuming, but it can be beneficial to take advantage of complementary strengths (Neuman 2014). All things considered, a multiple case study design coupled with the constant comparative method from grounded theory provides us an advantageous base for this thesis.

4.5 Sampling

Sample selection is considered vital for the ultimate quality of research. Hence, clarifying the sampling strategy is appropriate (Coyne 1997). In our context, we denote sampling as the choice of type and quantity of cases included for examination.

According to Marshall (1996), there are three extensive ways for sample selection in qualitative research, convenience sample, theoretical sample, and judgment sample. The first strategy involves selecting the most accessible sample. Even though the approach is effortless and time-efficient, convenience sampling may not provide data with sufficient quality and credibility. Theoretical sampling means that theories are developed from emerging data and the selection of a new sample for elaboration. However, the most typical technique is judgmental sampling, also referred to as purposive sampling. Here the sample is actively selected by researchers based on their judgment in order to generate data suitable for the research questions (Marshall 1996).

A central benefit of purposive sampling is its ability to focus on persons with particular characteristics that suit one's research (Etikan 2016). This constitutes our choice of a purposive approach, as we consider speaking with supply chain professionals as the most productive way of achieving desired data on our research problem.

Because our strategy encompasses a multiple-case design, a significant determination to achieve generalizability concerns how many cases to include (Ellram 1996). Additionally, time consumption is an important factor that must be considered due to the in-depth

investigation approach of cases. As said by Ellram (1996), *"...multiple case design should be used to either predict similar results among replications, or to show contrasting results, but for predictable, explainable reasons. In most situations, six to ten cases should provide compelling evidence to support or reject an initial set of propositions"*. To this end, we found a selection of two companies representing four different industries adequate, resulting in eight case companies. This provided us both similarity and variability at the same time, in addition to a relatively large but not excessively time-consuming sample size (Eisenhardt 1989). A more detailed description of each case follows in the subsequent section.

4.6 Presentation of cases

This section presents and describes the eight cases applied in this study. An overview of each company is displayed in Table 2 and further elaborated below. Real company names have been replaced by fictions to keep companies anonymous. Due to the same reason, documents and web pages used in this section have intentionally been omitted.

Table 2: Case descriptions

Company name	Industry/ sector	Informant(s)
Health Services	Healthcare	Economic counselor
MedProvider	Healthcare	Supply chain manager x 2
FishFeed AS	Seafood	Group Sourcing manager
Happy Salmon	Seafood	Logistics director
Wholesale Group	Grocery	Procurement manager
Grocery King	Grocery	CEO Bergen and procurement manager
LightMaker	Manufacturing	Corporate logistics manager
Cool Solutions	Manufacturing	Supply chain manager

4.6.1 Health Services

Health Services is one of in total five health associations within the western region of Norway. Employing around 13 000 people, it provides special healthcare services to individuals across a sizeable area. The company has no sole supply chain but rather several that fall under inbound, internal, and outbound supply. Hence, it is characterized by abundant logistical operations. Regarding inbound supply and procurement, Health Services operates with eleven defined supply chains limited to different parts of the business and based on product categories. Both category management and just-in-time are central strategies exploited within the associations' procurement mechanism.

Health Services has over 3000 suppliers ranging from small to large and are both national and international. In general, their suppliers have fixed contracts with a range of 4-8 years, and due to Heath Service´s size, they don´t have a one-to-one dialogue with suppliers. They have employed a just-in-time strategy, and usually, price and quality are the prime factors regarding the selection of suppliers.

Due to their industry, Health Services has a comprehensive SCRM strategy inherent in the company, both on an operational and strategic level. They operate with category strategies within procurement that dictates how procurement should be administered.

4.6.2 MedProvider

MedProvider is a leading pharmacy chain store. Their 3500 employees run 430 physical stores are in addition to an online shop. Generally, their supply chain begins with placing a purchase order to their supplier before receiving the product at their central warehouse. All products are distributed directly from the main warehouse to the physical stores, except for the northern part of Norway. As for physical stores and customers in the north, goods are stored intermediary at a minor warehouse to retain 24 hours lead time. Goods are delivered three times a week, justified by forecasting based on inventory and point of sale.

The products supplied by MedProvider entail both merchandise and prescription articles acquired from roughly 500 suppliers. Its product assortment is believed to be between 17 000 to 18 000 items, where the largest share of it (90%) is obtained from suppliers

localized in foreign countries. Due to regulations in the industry, risk management is always considered and evaluated at both strategic and operational levels. As far as medicine is concerned, regulations correspond with the Counterfeiting Directive (GDP) and Code of Conduct.

4.6.3 Fishfeed AS

Fishfeed AS is a dedicated manufacturer within the seafood industry. The company employs for approximately 1500 people. With headquarters located in Aarhus, Denmark, and globally widespread production sites, the company follows and evolves along with the growing branch of aquaculture. The company delivers feed to around 45 divergent species in 80 countries worldwide. They operate with a traditional value chain where raw materials are procured, the products prepared, and lastly sold to the customers.

As a part of general risk diversification, the company contracts numerous suppliers, 670 in number. Most of Fishfeed AS acquirements are imported goods globally, apart from some domestic marine production as fish oil and fishmeal. A fundamental principle of Fishfeed AS is long-term contracts with suppliers, ensuring safety and a trustful customer-supplier relationship. Risk management is articulated in the company, including areas such as ethics, sustainability, and sourcing. Suppliers are picked wisely, and sourcing is always according to risk assessment procedures that emphasize traceability, food safety, quality, environmental contract, and in concordance with the code of conduct.

4.6.4 Happy Salmon

Happy Salmon has a long history within the seafood industry. They are considered a leading global seafood company with feed, farming, and sales & marketing as their core areas. With a total of 12 200 employees, products are distributed to approximately 70 countries where Europe comprises 69% of the sales. Their value chain is fully integrated from roe to plate.

There are variations in Happy Salmon´s relationship with suppliers. Their relationships are mainly transactional, but long-term relationships are established with critical suppliers. They have approximately 20-30 indispensable suppliers within transportation, emphasizing aviation, and about 100 minor suppliers who provide goods and services.

Concerning SCRM, the company adheres to the COSO enterprise risk framework with attention to four main risk areas: operational risk, strategic risk, and reporting risk. Hence, Happy Salmon is continuously trying to identify and mitigate risk in diverse areas.

4.6.5 Wholesale Group

Wholesale Group is a sizeable grocery wholesaler with roughly 3000 employees. They operate both within the B2B and B2C markets. The company possesses 13 regional warehouses and two central warehouses with 30 000 articles. Additionally, Wholesale Group is a vast carrier having approximately 600 trucks and an efficient transportation network, delivering goods across the country every day.

The supply chain starts by receiving goods from their suppliers before the commodities are transferred from central warehouses to regional warehouses where the goods get compiled. Lastly, commodities are distributed to customers consisting of gas stations, restaurants, and grocery stores.

Wholesale Group is a subsidiary of a preeminent concern within the grocery industry. Like Happy Salmon, risk management has emerged from the COSO Enterprise Risk Management framework and addresses strategic and operational risks. Solid risk management plans are developed and in coherence with prior experiences. Adapting to those plans is vital for the company.

4.6.6 Grocery King

Grocery King is a large grocery chain, providing groceries to people on a national basis. The company´s headquarter is centrally localized, with 12 regional offices in addition to 6 distribution terminals, they have a broad reach.

Grocery King is a subdivision of a larger organization. It is responsible for supplying 84 stores within a specific range of western Norway. Grocery King contracts 242 suppliers, and most of the incoming supply is distributed directly from the company's suppliers, mainly based on customer demand forecasting. Grocery King appreciates a strong relationship with

suppliers, especially in terms of external suppliers where competition among grocery actors exists. Prior to the covid-19 pandemic, Grocery King focused exclusively on internal risks such as accidents, fire, downtime, and other financial risks.

4.6.7 LightMaker

LightMaker is a prominent manufacturer of lighting solution. The company has more than 2400 employees in numerous European countries. Their operations are divided into three core divisions: Professional Building Solutions (PBS), Global Marine Offshore (GMO), and Sourcing Production and Logistics (SPL). The SPL division is responsible for logistics activities such as procurement, warehousing, and distribution through eight different locations in Europe and China. In short, their supply chain begins with receiving goods from suppliers before the production starts in different plants. Their products are categorized according to an ABC matrix, which directs the lead time and point of delivery. Finished products are subsequently distributed either through the central warehouse or directly to the customer.

Suppliers of raw materials are everything between local actors with low lead-time to vast suppliers in China. They have approximately 1650 suppliers, whereas 170 of the supplier's accounts for 80% of the consumption. Hence, their focus is on these 170 suppliers. LightMaker´s affiliation to risk management has evolved into a vital focus area in the company over the last years.

4.6.8 Cool Solutions

Cool Solutions has expanded into being a leading supplier of refrigeration technology to the maritime sector. The company is divided into two core departments, where one is recognized for their ice systems embracing ice machines, ice plants, and ice slurry systems. The other specializes in heating and cooling of seawater and manufacture systems for vessels and heat systems for fish farming.

Cool Solutions procures goods worldwide. A large share is from Europe and the US, but with origin in the East. Goods procured consist of both finished products in addition to raw materials used in production. They are an industrial company and have a substantial

production in-house, including welding, assembly of pipes, a compilation of diverse parts, etc. After completion, a large share is sold to Norway, yet roughly 50% are transported worldwide, mainly to South America and the Eastern countries.

The company has 1400 suppliers, whereas a couple of hundreds are of importance. The relationship with suppliers can be categorized as primarily transactional, yet the relationship is good. The supplier network consists of both insignificant suppliers that are easy to replace and suppliers that are more incorporated with contracts containing agreements where suppliers store inventory on behalf of Cool Solutions. Regarding SCRM, they are always trying to secure supply and avoid delays.

4.7 Data collection

Data are facts and figures gathered for records or statistical investigations and are distinguished by being either qualitative or quantitative (Adams, Khan, and Raeside 2014). Whereas quantitative data comes in numerical form (Jacobsen 2018), the qualitative method generates descriptive data – written or verbal words and observable behavior (Taylor, Bogdan, and DeVault 2016).

In our research, we prefer a qualitative approach to attain empirical evidence on supply response to covid-19. Qualitative research aims to describe and elucidate experience as it is lived and constituted in awareness (Polkinghorne 2005). We deem that speaking with persons that have experienced the impacts of covid-19 on purchasing and supply on close range will generate sufficient data and fits our objective better than a numerical survey would possibly do.

There are mainly two sources of data in research, primary and secondary data (Adams, Khan, and Raeside 2014). Primary data is the original data collected for a specific research problem. By collecting our own data, we can adjust the operationalization of the theoretical constructs, the research design, and the strategy of data collection to fit our research questions, thus ensuring that the collection will provide us valid empirical evidence (Hox and Boeije 2005). We do not apply secondary data in our study. The following section presents our selected method to gather primary data.

4.7.1 Primary data: interviews

The main strategy we chose for collecting primary data was interviewing. According to Gill et al. (2008), interviews provide a deep understanding of social phenomena and are suitable in cases where little is known. Recognized as a prevalent method of collecting qualitative data (Hox and Boeije 2005), research interviews have their purpose of investigating individuals' views, experiences, beliefs, and motivations on particular matters (Gill et al. 2008). More specifically, semi-structured interviews were conducted with relevant informants from the case companies. A semi-structured interview consists of predetermined themes but at the same time allows the respondent to answer freely and elaborate (Jacobsen 2018). Our interview process comprised four main steps.

Firstly, we contacted the desired companies through a template e-mail containing information about the research and our preferences regarding the job role of interviewees. Most of the companies responded to the e-mail, except for a couple reached by phone and afterward sent the information. Through these conversations, interview terms such as date, duration, and setting were agreed upon.

In the second step, we provided a prearranged interview guide for each company. An interview guide indicates topics and their sequence and predetermined questions depending on the particular interview design (Kvale 1996). Our guide consists of queries made in collaboration with our supervisor and is specified to fit the research purpose. They are carefully thought out to avoid shortcomings in the data. We made a conscious decision to provide the questions a week ahead of the interview point so that the companies had plenty of time to prepare and thereby give us the best answers possible. The interview guide applied for all cases is displayed in Appendix A.

Moreover, we conducted interviews with all the companies between February 10th and February 25th. Although predetermining one hour, some interviewed exceeded, while some lasted a little shorter.

Due to infection control restrictions that made physical attendance impossible, we conducted all interviews were through IP telephony. Despite potential drawbacks related to impersonality, virtual interviews allowed us to be efficient and conduct several interviews

over a shorter time (Adams, Khan, and Raeside 2014). We applied both Zoom and Microsoft Teams based on the preferences of our interview objects. Equally, these applications support audio and video communication, eliminating the lack of bodily and facial expressions as one obtains by physical presence. Altogether, we found virtual interviews non-problematic, as restrictions have familiarized us with the "virtual everyday life."

Audiotape recording was used during the interviews for documentation and to avoid loss of data. The last step was to transcribe all the recorded interviews. Transcriptions are quite time-consuming activities but of importance. Converting the recorded material into text contributes to overview and simplifies the analysis process (Kvale 1996). In total, all interviews amounted to 40 348 words, which corresponds to 71 pages of transcriptions.

4.7.2 Primary data: documents and webpages

As an additional primary data source, we have reviewed documents, web pages, and relevant news articles to gather background information about each case company. According to Bowen (2009), such information provides indications of conditions that may affect our studying phenomena.

4.8 Data analysis

When interviews are conducted and the raw data transcribed into text, one must prepare the data for analysis. A familiar approach and the one we have applied during our data analysis are the *constant comparative method* from the grounded theory. This is an inductive process where different codes are employed to categorize and compare the textual data (Strauss and Corbin 1990). By applying this approach, it is possible to identify patterns and themes in gathered data. Furthermore, this systematic method pays attention to the variation in different circumstances of a social phenomenon, and *"the objective is to reveal important concepts, processes, and the overarching professional experiences between the case organizations"* (Wahyuni 2012).

Coding in qualitative studies is a helpful technique to interpret the collected data and assign different labels to an essence-capturing part, which represents a vital topic of each category of data (Saldaña 2021). We have followed the three phases applied in grounded research

which consist of *open coding, axial coding,* and *selective coding*. The first phase involves breaking down sizeable textual data into smaller parts, and the aim is to grasp the core idea of each part, followed by generating a code to describe it. Moreover, the assignment of the codes can relate to either concept or category that denotes a phenomenon (Kaiser and Presmeg 2019). To give an example:

"During the pandemic, our company has been negatively affected[1] *, and the turnover has decreased by 20%*[2] *.Additionally, we have experienced a decline in production capacity*[3] *and our capacity was 10% lower compared to 2019".*

In this quotation, we have identified essence-capturing words related to our research questions and assigned them a code from 1 to 3, where our interpretation of the codes is explained below.

Negative impact[1]

Decreased turnover[2]

Decline in production capacity[3]

The second phase, axial coding, involves investigating the relationship between the different codes that have been picked out in the open coding process. Furthermore, this phase links the separate codes into new categories based on relevancy towards each other and represents a stronger code (Kaiser and Presmeg 2019). As illustrated below, code 1a represents both reductions in turnover and a decline in production capacity at case companies.

Reduction in turnover AND decline in production capacity[1a]

Lastly, selective coding integrates the different categories that have been identified and developed into one cohesive core category. This phase is quite similar to axial coding. Still, it is organized on a more abstract level. By reflecting on the different codes elaborated in the open coding and axial coding process, it is possible to determine the theme or problem. Thus, we can fully understand our textual data and connect the relevant pieces in order to answer our research questions (Kaiser and Presmeg 2019, Saldaña 2021). An overview of the coding process follows below.

I. Impacts of the covid-19 pandemic

a) Reduction in turnover AND decline in production capacity

1. *Negative impact*
2. *Decreased turnover*
3. *Decline in production capacity*

4.9 Cross-case and cross-industry analysis

A Cross-case analysis can be described as *"a research method that facilitates the comparison commonalities and differences in events, activities, and processes that are the units of analyses in case studies"* (Khan and VanWynsberghe 2008). In this research, the analysis is conducted from both cross-case- and cross-industry aspects.

Figure 6 illustrates our mindset of how we approached the analysis.

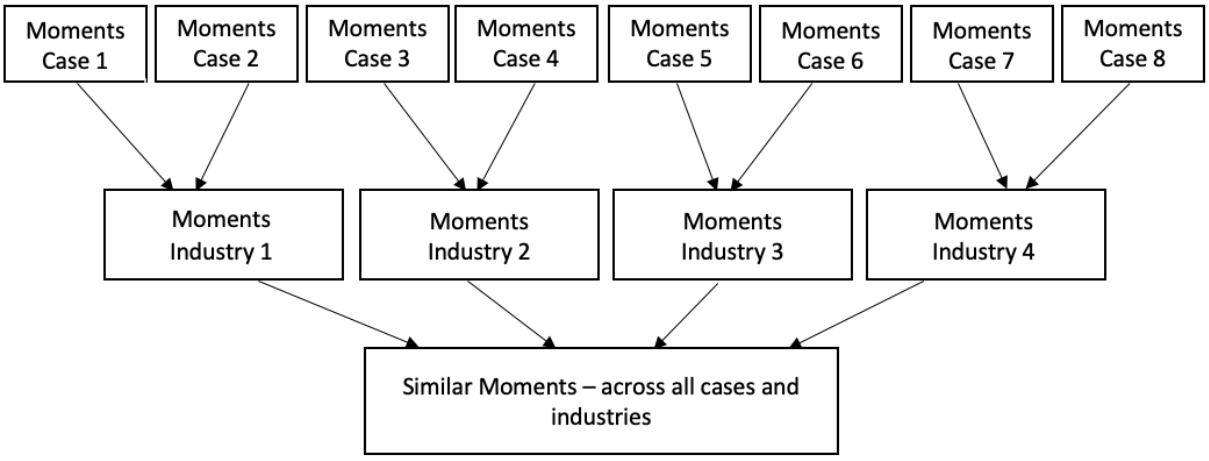

Figure 6: Cross-case and cross-industry analysis approach (own production)

4.10 Research quality

Validity and reliability are vital aspects of credibility and trustworthiness in research. Meticulous emphasis on these elements may secure quality and tip the balance in favor of good research (Brink 1993).

4.10.1 Validity

Validity encompasses the accuracy and trustfulness of findings in scientific research. To terminate research valid, it must produce results reflecting on what actually exists by applying methods that measure a study's intention (Brink 1993). Yin (2018) points out three tests for validity that support establishing quality, namely construct validity, external validity, and internal validity.

Construct validity

Construct validity is expounded as *"identifying correct operational measures for the concept being studied"*. Regarding case studies, construct validity can be gained from three explicit approaches: multiple sources of evidence, chain of evidence, and draft review by key informants (Yin 2018).

Triangulation is a central element of construct validity and involves the principle of multiple sources to substantiate evidence (Ellram 1996). By combining interviews with one or two information providers per case, and company web page/document review, we argue that we partly fulfill a triangulation.

Maintaining a chain of evidence relates to allowing readers insight into the paper from initial research questions to conclusions (Ellram 1996, Yin 2018). Drafts of this paper were continually provided to our academic supervisor, who critically reviewed our process from start to finish. Adjustments were made in conjunction with suggestions obtained from the external review, which ensured data validation. Additionally, every respondent was handed the finished transcriptions from their respective interviews to ensure that the written data corresponding to what they had said. This satisfies Yin (2018) assertion that the findings in one’s case study conclusion undoubtedly are based on the identical evidence obtained from the data collection stage.

External validity

External validity is the extent to which findings are justifiably applicable outside the immediate study (Brink 1993).

Case studies have received criticism for lack of generalizability. According to Ellram (1996) and Riege (2003), external validity may be increased by replicating case studies. Generalization was discussed in the sampling section, stating that we from eight cases across two sectors both achieve identical and contrasting results. This implies both literal replication (similar) and theoretical replication (dissimilar) (Yin 2018).

Internal validity

Riege (2003) describes internal validity as *"the establishment of cause-and-effect relationships".* Furthermore, the author refers to credibility as the corresponding construct to internal validity, which relates to the approval of informants' findings (Riege 2003). This does, however, in our opinion, constitute the same function as elements from construct validity. From the literature on qualitative studies, we find that internal validity solely concerns explanatory or casual studies (Ellram 1996, Yin 2018). For our exploratory design, internal validity as a quality measure is irrelevant and consequently not considered.

4.10.2 Reliability

A fourth quality test concerns the reliability of a study (Yin 2018). Consistent with Riege (2003), reliability comprises that other researchers will achieve similar findings as long as the study procedures remain consistent. The general necessity of reliability concerns documentation of procedures followed in one´s research, intending to minimize errors and bias (Yin 2018).

In terms of the abovementioned requirements, we aimed to increase reliability by meticulously describing every theory and strategy employed in our study. Every decision was made from the cooperation between both students to eliminate individual favoritism.

During interviews, we recorded all interviews, and thereafter verbatim transcribed them. The same interview guide was applied for all cases and is attached to the paper. However, an important remark we used a semi-structured approach. This may influence the chances of obtaining precisely the same evidence, as some interviewees spoke freely beyond the written questions.

5.0 Findings and analysis

This chapter presents our findings derived from primary data and framed in a case-by-case structure. Thereafter follows an analysis on both cross-case and cross-industry levels to profoundly identify similarities and variabilities in companies' impacts of, response to, and preparedness of the covid-19 pandemic.

5.1 Findings

5.1.1 Health Services

Due to their business, Health Services faced severe and substantial impacts compared to other industries. Our informant explains that they were not prepared for a pandemic, and the inventory of equipment for infection control and protection was as good as absent. Securing supply has usually not been an area of concern, but this was a critical when the covid-19 virus spread globally. Health Services' inventory level was estimated to last one day based on the prerequisite. Low inventories and just-in-time deliveries coupled with restricted capital were previously associated with low risk. This put Health Services in an exposed position, and they had an extreme shortage of infection control equipment, which was regarded as directly life-threatening. As our informant said,

«Suppliers reported force majeure, and we had to fend for ourselves; there were no conditions in the contract that applied anymore. The message was that employees had to use whatever available to protect themselves, which provide an understanding of how difficult the situation was the first months».

In the beginning, Health Services had to acquire critical medical supplies in all kinds of ways, also from unfamiliar suppliers due to the desperate situation.

«We had to receive equipment from all public institutions in the city and encourage everyone to deliver equipment to us. Additionally, local companies turned around and started the production of infection control equipment. For instance, a local alcohol production facility started producing disinfectant».

There are normally very rigorous regulations in the supply of medical goods, but these regulations were down prioritized, and the only focus was to gather infection control equipment. According to our informant, public procurement laws were pushed aside, which has never happened before. A lot of the procured goods originate from China and other international suppliers, which led to additional delays and challenges. Not to mention that borders closed, there was a halt in exports, and other countries confiscated goods due to their own need. Thus, the government requisitioned a flight that could transport goods directly from China. Subsequently, this has given them new insight into their dependence on China, and suppliers closer to them are considered more secure.

It was not an option to wait for international supply due to their social responsibility and adapting to the situation by rapid response was crucial. Therefore, small order sizes were requested from various companies located in Norway because of the delays with foreign suppliers.

Health Services established procurement offices and structures in one week, and our informant expressed that a lot of resources is spent on these measures. Successively, an emergency stockpile is permanently established and will also be prioritized in the future.
Storage requests were necessary due to their just-in-time philosophy and were carried out early in the pandemic. Another measure that has been organized is the entrance into agreements, either directly or in contingency agreements. Hence, Norwegian suppliers can produce necessary products or reorganize the production to meet their needs.

In Health Services' opinion, Norwegian production is a central part of future risk management strategies and includes the probability of a new pandemic. Additionally, they emphasize that they must improve their overview of vital suppliers. Yet, the pandemic has provided attention to a former project consisting of a centralized procurement department which will provide a holistic view of the supplier network. The informant asserts that warehouses localized in Norway would be beneficial in the future regarding securing supply.

Generally, the conception is that closer suppliers provide more security. However, since they were so dependent on local suppliers, they have a different view of the main criteria regarding suppliers. Above all, Healthc Services is prepared for a similar event in the future with a ton of experiences. An evaluation will also be conducted in the aftermath.

5.1.2 MedProvider

MedProvider has experienced hoarding of products and stockout situations during the period of covid-19. Due to their critical role in society, pharmacy stores have been prioritized and kept open during the period. Some days, the sales corresponded to a regular monthly sale quantity. Their forecasting strategy became inoperable due to swings in demand. Thus, the pressure of acquiring goods as fast as possible has been high and affected the whole supply chain. According to their supply chain managers, the company has faced the highest tops and the lowest bottoms after the lockdown was implemented.

The utilization of foreign suppliers has, according to them, impacted their access to goods. Restrictions (closed borders) led to delays in distribution and demanded products could not reach Norway. Examples of influential supply are infection control equipment from Germany and masks from China. If they could choose, MedProvider would have liked their suppliers to be localized closer to them. However, a challenge in their industry is that some actors have marketing authorization in Norway, which regulates the possibility of domestic production of drugs.

MedProvider's supplier relationship is characterized as good, as both parts in the value chain share the same desire to make products available to end customers. Consequently, this makes cooperation easy, which ensures that it receives its necessary deliveries during the pandemic. MedProvider maintains weekly contact with their suppliers regarding stockouts and access to products. As a proactive action, they kept dialogues with different actors that could provide equivalent products as their regular suppliers in stockout situations. They also focused on obtaining information as soon as possible from their suppliers if disruptions occurred further behind in the supply chain. When asked if they would like to adjust something related to supplier relationship, the interview objects call for more transparency, as they stated the following:

"There is a need for more transparency. A more transparent value chain would make it better for all actors in the value chain."

The company points out several factors that have triggered their procurement impacts of the pandemic. Existing agreements on distribution and production disappeared, and long-term

supplier relationships were interrupted as MedProvider was less vital than larger competitors in the global market. Hence, they have managed to obtain some new suppliers that could provide equivalent articles as those lost. However, pharmacies operate in a strongly regulated industry, which influences their risk management strategies. They cannot simply pick and choose everything available, so the situation forced MedProvider to assess suppliers more meticulously against the requirements.

In general, risk management is always considered and evaluated at both strategic and operational levels, and adaptions were made in accordance with virus disruptions. Usually, the emergency stockpile does not receive a lot of attention. This quickly changed, and that area demanded to be managed more appropriately. More solid routines within warehousing have been initiated. They even started a valuable collaboration with other medicine wholesalers. The informants assert that a specific emergency plan was not developed before the virus outbreak, even though some instructions and mapping of critical departments existed. MedProvider claims that more precise instructions will receive further attention in the future, based on the experience gained from this disruption. Overall, the company believes it was prepared organizational but in a reactive way.

5.1.3 Fishfeed AS

When Norway went in lockdown, Fishfeed AS emphasized whether suppliers could deliver goods or not. A majority of the pandemic consequences of Fishfeed AS emerged from ripple effects. In that context, China is particularly mentioned due to its influential position in the supplier network of Fishfeed AS. Inland borders closed, which prevented transportation of goods to the port and prevented exportation out of the country. As said by the informant, the problem with lockdown in China is the country's position in the supply of additives and raw materials needed for production. There exists some production in Norway, but still not sufficient to cover the requirements. Furthermore, India made some implications for Fishfeed AS due to the collapse in its society.

The interviewee provided a clear illustration of how the ripple effect may interrupt processes:

"We had suppliers producing bioethanol, used in our bi-products, who experienced negative margins because people did not drive their cars."

Such ripple effects lead to volatility in raw material prices, which again affects the procurement of Fishfeed AS. Generally, the company sources raw material based on the stock exchange, which was impossible due to markets crashing. Buying cheap raw materials became problematic with a lack of liquidity in the market. Safeguarding received more attention, so the company started buffering as they monitored the situation in China in December 2019. The closed borders made Fishfeed AS try to obtain as much as possible from a buffer storage in Europe.

As stated in the case descriptions, Fishfeed AS applies numerous suppliers as general risk diversification, primarily based on price and capability of delivery. The sourcing manager utters that during covid-19, procuring from separate continents was prioritized due to the uncertainty around outbreak areas. One fear the company had was related to the supplier's ability to deliver, but they eventually realized that this mainly did not rise as a problem.

A good customer-supplier relationship has played a vital part in the pandemic and ensured safety and trust. The company has only experienced opportunistic behavior from a sole supplier that is no longer a part of the picture. A key factor of healthy collaboration has been weekly conversations and meetings with suppliers. Furthermore, the informant calls attention to supplier performance; suppliers have done well during the period and generated income. Thus, operating with actors performing well has eased the cooperation. They usually appreciate long-term relationships and see this as an advantage. During covid-19, however, it has been necessary to adjust contract terms due to the rapidly changing circumstances. Currency clauses have lacked from contracts, resulting in force majeure in contracts with transportation firms. As a response, shorter time-horizon contracts have been bought, incorporating provisions for prevention if a disruption occurs. Fishfeed AS has also adjusted exposure geographically by, for instance, becoming less dependent on India and instead increase focus in Brazil and Nordic countries, solely to achieve safety concerning raw material access.

On a general basis, Fishfeed AS leans towards having closer suppliers. Their sourcing manager stipulated that this is based on sustainability and not potential future risk events.

He furthermore indicates this as a possibility, as factories are set to be built in nearby countries like Sweden, Denmark, and Finland.

Altogether, the informant claims that the acquirement of goods has run approximately equal to normal. Nevertheless, covid-19 has instigated effects and triggered changes in their risk management priorities. Risk management is generally seen as a critical element in the raw material operations of Fishfeed AS. There are no specific measures against unlikely events, as they rather focus on adapting circumstances operational. The informant does not believe a written strategy would have worked due to the uncertainty of the pandemic's extent.

5.1.4 Happy Salmon

In general, the seafood industry is exposed to risk due to the characteristics of products, but Happy Salmon never imagined the scope of impacts from covid-19. Happy Salmon has experienced both SARS and bird flu in addition to earthquakes in Asia. Consequently, plans have been prepared to manage such events. Also, they put an effort in rapid response regarding critical factors such as securing air freight capacity. This required immediate decisions, and as our informant stated:

«The hardest part was to make decisions without enough information and visibility about the future. You have to make decisions on a weaker basis, and it has been more unforeseen circumstances than we are used to».

Nevertheless, covid-19 had a minimal impact on the procurement of goods and services, but the informant emphasizes that it has been an exceptionally demanding year. As the informant asserted,

«I have worked within the industry for a long time, and this has been the toughest I have been involved in.»

The industry has struggled with vigorously reduced margins which leads to more focus on price. The price is stipulated in the market, and during covid-19, the market priced Happy Salmon´s product differently, and this amendment had the most considerable impact on Happy Salmon. Also, delays at borders and uncertainty regarding air freight were impacts

they experienced. Still, Oslo airport played an important role, and they managed to place all their goods, although it has been incredibly demanding.

Opportunistic behavior was something that occurred from time to time. Still, the informant asserts that long-term and valid relationships were a primary reason for why they acceptably tackled the situation. Notably, the relation to the aviation companies became one of the most important relations concerning the covid-19 pandemic. While the demand in the HoReCa market nearly disappeared, the grocery market turned out to be necessary to sell the salmon and avoid waste. The grocery market compensated for 20-25% of sales. Despite this, Happy Salmon experienced a net demand decline of 15% and consequently negatively impacted price.

Their industrial background has affected the risk culture compared to many of its competitors within the industry. Therefore, risk management has always been an integrated part of the company with sound systems regarding this area. The company has operated with a comprehensive risk management strategy that applies to all stages in the chain, yet without a specific consideration concerning pandemics. Generally, the risk management approach has been driven by the management with a focus on best practice, sharing of best practice, and copying between departments. Happy Salmon perceives how important a supplier can be before engaging in a partnership with a long-term contract and mutual commitments. A part of their business philosophy is to avoid situations where the supplier comes into possession of more power than the company.

The informant claims that pandemic or similar events will be considered in the future, especially concerning suppliers. The covid-19 pandemic has shown that solid and long-term relations are crucial to be prioritized in such situations. Additionally, it appears that communication is a key element to respond successfully.

5.1.5 Wholesale Group

Wholesale Group operates in an industry defined as critical for the society, which has received few boundaries during the pandemic. Yet, the company has been affected in its acquirement of groceries.

In the early stages, Wholesale Group underwent hoarding in stores. Yeast was a highly demanded product and forced them to procure from European suppliers as Norwegian producers could not deliver. What was in one perspective positive, hoarding increased their turnover by several hundred percent overnight. The grocery market has later stabilized at 20%. Contrarily, closed restaurants eliminated the company's turnover in that particular market. Due to unpredictability in demand, Wholesale Group claims that forecasting has been highly challenging.

Correlated to increased grocery sales is the need for higher quantities of goods, which has been challenging to attain due to restrictions and ripple effects. Closed borders and lockdowns have influenced the import of, for instance, rice from Vietnam and pasta from Italy, as those deliveries have been delayed. Toilet paper has been problematic to attain due to competition from Swedish and Danish competitors. When obtaining goods from specific locations has been unmanageable, the company sources from other parts of the world. Regarding multi-sourcing, Wholesale Group has commonly had several alternatives to their typically acquired products, either from diverse suppliers or from their own brands.

Wholesale Group has cooperated a lot with their suppliers during the hectic times. The relationship is close and did not notably change due to the circumstances. As said by their procurement manager:

"For us, it is important to trade with proper suppliers that we can trust…I find the suppliers very cooperative."

According to the informant, only a couple of new suppliers tried to be opportunistic, but it was nothing noteworthy.

Several measures connected to procurement have been based on tight collaboration with suppliers. They have attempted to provide suppliers predictability on future requirements based on forecasting on a retail-grocery level to meet demand variations. Sharing forecast information is the responsibility of their own coordination group that works closely towards suppliers.

Moreover, meetings regarding critical products have been held on a detailed level. The company has been proactive by keeping in touch with foreign grocery stores that have experienced hoarding to identify empty-running products. Additionally, safety stocks have been built up based on data from their suppliers. Even though it is solely the responsibility of suppliers, Wholesale Group participated in sourcing alternative packaging as certain products lacked packaging from closed borders.

As a part of general risk management, the company applies written, rehearsed strategies. When the pandemic hit, they managed to react quickly and make use of the predetermined plans. The interview object indicates the importance of establishing emergency groups and maintaining good communication throughout the organization.

A fire that broke out in one of their storages four years ago is a weighty reason for their risk management priorities. Wholesale Group claims to be prepared if another similar incident is to occur. Their informant utters that strategies are designed in cooperation with other important actors in the country. He affirmed that food is a prerequisite for people.

5.1.6 Grocery King

Grocery King buys most of its products directly from suppliers. During the pandemic, access to goods has been limited because of numerous factors, such as infection at factories, closed borders, and vast competition.

The interview objects representing Grocery King describes the first week of Norwegian lockdown as hopeless. Due to hoarding, they were forced to deliver approximately 90% more than what is expected. A positive effect of has been an increase of 20% in turnover. Contrary, obtaining sufficient quantities have been complicated, as the company claims that goods have been lacking from suppliers everywhere. Grocery King has worked hard to acquire enough goods but has not succeeded in every area.

When asked about multi-sourcing, the company gave an interesting response:

"Several suppliers are used with regards to fresh meat. On dry goods, however, we do not believe it is profitable to apply multiple suppliers."

Although the interviewees did not have exact numbers on it, they indicated that a large share of their suppliers is foreign. This negatively affected their supply of goods during the pandemic because of closed borders and suppliers who struggle to catch up on their backlog from lockdown. They exemplify this by mentioning troubles with closed borders in Italy that prevented them from attaining pasta. Additionally, they have strived to obtain products from China. Norwegian suppliers have also faced unfortunate situations with their delivery capability as they often require imported raw materials. This illuminates the ripple effect, as one problem occurs at a particular spot in the supply chain and subsequently cascades upstream.

In response to the situation, Grocery King has implemented several measures related to supply. They claim to have been good at adjusting and sourced temporary replacement products. Furthermore, they reacted quickly to stockouts and tried to obtain large quantities. As forecasting became difficult due to unpredictability, their overall strategy was to secure as many products as possible. However, Grocery King was not always prioritized as much as their competitors, as some actors have preferential rights among suppliers. Some suppliers were nevertheless fair. When competitors have escalated, the company has worked on achieving higher priority both locally and nationally.

Yet, the interview objects claim that their relationship with suppliers is good, which has been crucial in obtaining Grocery King's share of products. They furthermore state that collaboration is vital and that the focus between Grocery King and suppliers has been to keep in pace and help each other out. When procuring from external suppliers and not their own, keeping in touch and communicating has been extra significant.

The company asserts that covid-19 has affected their risk management, and they have become more conscious of the risk management field. Before the pandemic, risks such as downtime, freezer failure, and fires have been emphasized. If downtime in a terminal happens, they have action plans for goods distribution. Their informants claim that risk is not an unfamiliar word for the company and that risk mitigation strategies exist.

Overall, Grocery King is satisfied with its handling of the pandemic. Particularly collaboration and shared decision-making is considered essential.

5.1.7 LightMaker

The covid-19 pandemic has affected LightMaker in several ways. Our informant mentions increased prices of goods, delays, insecurity, and variations in demand, a decline in production and sales which led to a 20% decrease in turnover. LightMaker was afraid of stockouts due to the uncertain situation, leading to increased orders and consequently increased inventory. A safety stock has been established. Yet, this entails storing of goods for an extended period, which is a direct cost.

They did not restructure their operations when covid-19 occurred, but they were fast to implement measures such as reducing capacity while adapting to the current market situation. The informant emphasizes that they managed to purchase components through an existing network, and above all, the result was satisfying, although their profitability was less than expected.

Suppliers are considered significant partners, and according to our informant, the relationship with their suppliers is strong and will continue to be strong. Nevertheless, there are differences in their relationships with suppliers, where some are closely integrated, while others are easy to replace. Their suppliers are mostly international suppliers, which has impacted LightMaker during covid-19. First and foremost, LightMaker receives many deliveries from China and eastern countries, where the price increased by 300%. It has been discussed if suppliers should be localized closer to their production facilities.

«In general, the wage level is higher in Europe compared to China or eastern countries. But it is not the only price that is important. Factors such as lead time and reduced need for storage in addition to knowledge and service are also important factors. Nevertheless, it has to be a positive calculation».

LightMaker has also experienced opportunistic behavior where a «covid-19 surcharge» has been added to the price. This surcharge is introduced because covid-19 has led to a more expensive value chain and our informant claim that everyone is eager to cover their expenses. This has made LightMaker aware of the importance of having a clear and precise contract.

LightMaker emphasizes that the identification of risk in different areas is important within their company. Risk management has increased considerably over the past years, and all parts of the company focus on identifying risk areas. However, external disruption risk has not been the prime concern. Light Maker's SCRM strategy dealt with more probable risks, and pandemics have been considered force majeure and are not included in their SCRM strategies. Our informant asserts that covid-19 has changed their practice and prioritization of SCRM. They have also observed that single components with few suppliers are more exposed to risk. Thus, measures will be taken within this area, e.g., finding alternative suppliers. However, the challenge with changing suppliers for some products is that they must change the Bill of Materials (BOM).

«*By changing the BOM, we must test the new products, and a pretty huge document flow is connected to the switch between one supplier to another. This work is very time-consuming, and thus, it is not that easy to change suppliers quickly. Additionally, the value chain must be robust before changing suppliers*».

LightMaker has not yet taken a comprehensive evaluation of impacts and measures, but this will be conducted in the aftermath. However, our informant claim that future risk management strategies will include pandemics; thus, solid plans are in place when it occurs again.

5.1.8 Cool Solutions

Our informant from Cool Solutions does not assume that their industry has been more affected than others, yet he points out several impacts affecting the procurement department after the covid-19 outbreak. They encountered delays in deliveries that consisted of 2-3 weeks. According to Cool Solutions, keeping a solid overview upstream in the value chain was essential to avoid further delays. Moreover, they faced some difficulties regarding purchasing, and therefore, new contracts have been initiated. Expansion of inventory, securing supply, and determining lead time were imperative to have in the agreement. Also, Cool Solutions renegotiate agreements with an extended payment period, e.g., from 30 days to 60 days.

Approximately 50% of the suppliers are localized in foreign countries, which impacted the company. Firstly, alternatives of transportation decreased while the prices increased. Secondly, prices of goods were elevated due to exchange rates, and thirdly, increased lead time. On the grounds of this, Cool Solutions will juggle between different suppliers and preferably with additional locations to scatter the risk on geography or alternative value chains. Through the past year, Cool Solution researched the supplier more closely to ensure that delays were under control, and they recognize the value of a long-term relationship, especially in light of covid-19.

It was critical to keep decent liquidity during the pandemic, and as a measure, Cool Solutions were ready to withhold payment to suppliers with delayed deliveries. According to our informant, the uncertain situation presented challenges with opportunistic behavior. Some products increased in price without any logical reason, which was suspected of adding some percent to the supplier. Additionally, Cool Solutions felt that the suppliers enticed them to make earlier decisions or order more products. To some extent, they let them be persuaded due to the fear of delays. However, it turned out that it was not reality, and they could safely have waited. Nevertheless, they ensured that the inventory level was high enough but agrees that it is more important to be closely connected with suppliers and have a long-term view. Our informant explains that this was discussed prior to the pandemic, but the past year reminded them of the importance.

Cool Solutions are currently establishing new procedures, and in light of the covid-19 pandemic, risk management has been reinforced. Furthermore, risk management and minimization of risk are important and central parts of upcoming plans. Their focus is always to avoid disruptions and delays in their supply chain. Generally, they have one core supplier in different areas, but they try to have at least two suppliers available to maintain their power position. As our informant states,

«*It has been positive with several suppliers, both to ensure delivery and to compare prices…this contributed to avoiding acceptance of price increase during the covid-19 pandemic immediately*».

Our informant from Cool Solutions felt that they were not prepared for the severe impacts covid-19 had across the world, and specific risk evaluations were not prepared. Furthermore, covid-19 has made them realize the importance of including such events in future risk management. Nevertheless, Cool Solutions don´t think it will be any drastic changes in future strategies. Still, they admit that they have obtained a couple of insights regarding the relationship to suppliers and how it can be improved to tackle these events better.

5.2 Analysis

5.2.1 Impacts and challenges

Our findings propose that there are several ways companies' purchasing and supply have been affected. Additionally, large variations are related to the extent of impacts, as some companies have come out better than others. Figure 7 presents a conceptual model illustrating the main impacts of the pandemic on purchasing and supply. The vertical arrows point out impacts due to industry characteristics, while the arrows at the right side display the reason (R) for each impact. The analysis follows.

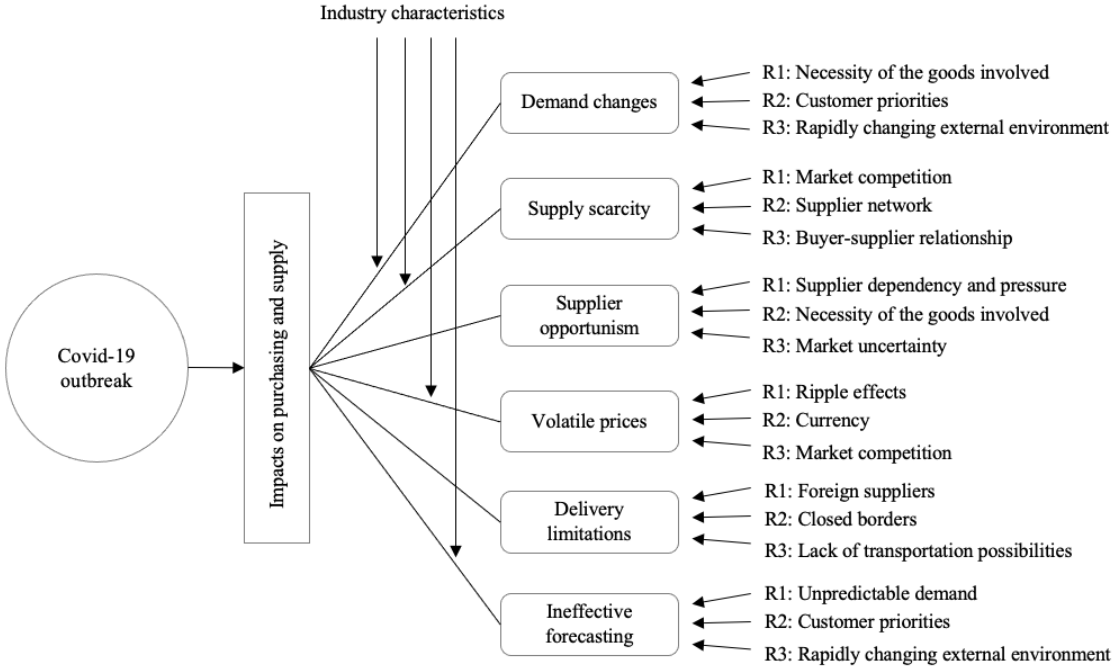

Figure 7: Covid-19 main impacts on purchasing and supply

Demand changes

Demand changes are noteworthy impacts of covid-19. Some focal companies have experienced an increase, e.g., Health Services and Grocery King, whereas others' demand has increased and fluctuated. A tendency is that goods characterized as critical to the society, such as groceries, medicines, and medical equipment, are particularly demanded in uncertain conditions caused by pandemics. Hoarding has been a triggering factor for changes in demand and has happened due to the rapidly changing external environment, goods necessity, and customer priorities.

On the contrary, focal companies operating with low prioritized goods in pandemics logically encounter lower demand. Happy Salmon and LightMaker prove to be pertinent examples, who respectively sell seafood and lightning solutions.

Supplier opportunism

Five of eight companies have encountered opportunistic tendencies from some of their suppliers. Nevertheless, the likes of MedProvider, Wholesale Group, and Happy Salmon were not dependent on these suppliers and thereby avoided further negative consequences. The gathered data points out supplier dependency, goods necessity, and market uncertainty as the foremost reasons for opportunism during covid-19.

Market uncertainty leads to reduced margins, and suppliers seemingly try to regain lost income by acting opportunistically. A visible pattern suggests that specific businesses are more exposed to opportunism than others. Both manufacturing companies were affected - one in terms of misleading information and the other by a suddenly added "covid-19" surcharge.

The parallels are that both companies were affected due to goods necessity; Their end products need specific components, and changing suppliers are demanding due to vast document flows and the obligation of changing BOM.

Supply scarcity

During the pandemic, having priority among suppliers seems beneficial. Some companies have not procured their desired goods volumes because they have been considered less important than others.

Our data suggests a correlation between supply scarcity and buyer-supplier interactions. Companies with more integrated buyer-supplier relationships tend to achieve higher priorities and thereby be less affected by a supply shortage.

Lower supply possibilities augment the need for comprehensive supplier networks. Health Services, for instance, applied local suppliers as they could not attain sufficient quantities. In addition, multi sourcing can mitigate the risk of supply scarcity. An important aspect is that firms with increased demand are more likely to struggle in obtaining enough goods, with the opposite for low demand.

Volatile prices

Volatile prices tend to result from several factors. Commonly, the cost of goods adjusts in line with demand. However, covid-19 has caused fluctuating demand through market competition and ripple effects, two generators of price volatility.

Additionally, trading with foreign suppliers concerns a minor risk for focal companies in terms of altered currency, which specifically occurred as a problem for Fishfeed AS. The same company did also experience a clear instance of how ripple effects may influence market prices. One of their suppliers lost a large income generator from a totally different industry which negatively affected the transactions of FishFeed AS.

Delivery limitations

Limited delivery capabilities are a common determinator regardless of company or industry, where utilization of foreign suppliers seems to be the main reason. Gathered data outlines delivery limitations as apparent during the first weeks of the pandemic and can fairly be expressed as an outcome of closed borders, which in turn connects to foreign suppliers. Resulting from this is delays in supply and higher lead times.

A general halt in the transportation market and uncertain circumstances generated a high request for transportation, which negatively affected transport access. Cool Solutions pinpoints that limited transportation options were incoherent to enlarged prices.

Ineffective forecasting

Unpredictable surroundings make it challenging for focal firms to predict the future tense. The findings show that forecasting with unpredictable demand is challenging, and companies apply various strategies to cope with it. Examples are Fishfeed AS, LightMaker, and Cool Solutions, who increased the order sizes to avoid postponing production. Still, this entails added inventory costs. In comparison, escalation in demand of critical goods prevented Health Services, Grocery King, MedProvider, and Wholesale Group from storing. This provides a significant indication that customers prioritize differently during uncertain environments. With a rapidly changing environment, the companies have less time to forecast, and decisions must sometimes be taken without the appropriate information.

Industry characteristics

Similarities and variabilities of impacts across industries emerge from the analysis. From the conceptual model, four impacts are outlined as industry dependent, namely demand changes, supply scarcity, volatile prices, and ineffective forecasting

Our data indicate that companies within healthcare and grocery are the most impacted by demand changes. These changes consist of a vast demand increase, and the main reason is their critical role in societies. Customers perceive their products as indispensable, which leads to a high request for products. On the contrary, companies within the manufacturing- and seafood industries experienced demand that was either reduced or fluctuating.

A clear distinction emerges from our data regarding the impact of supply scarcity. Closely linked to high demand, the healthcare- and grocery industries were undoubtedly most affected by lessened supply. Grocery companies witnessed hoarding shortly after the Norwegian government instigated lockdown, whereas the companies in the healthcare industry strived to obtain enough goods from a combination of its highly demanded goods and services and a lack of enough suppliers

Companies within the manufacturing- and seafood industry were impacted by volatile prices caused by ripple effects, market competition, and currency, e.g., elevated exchange rates. The data posit that companies with low demand are more affected by volatile prices, where a minor price increase can significantly impact the revenue. This is also related to ineffective forecasting, where the impact has a relevant effect on costs. If the company orders a higher quantity than necessary which does not match the demand, it can cause high inventory holding costs. The industries categorized as critical are also impacted by ineffective forecasting, as their high and fluctuating demand makes future predictions challenging, if not impossible.

In summary, our findings provide a clear distinction between the four case industries. The healthcare- and grocery industries, referred to as critical for societies, differs from the rest due to the goods and services involved in their business. Supply scarcity has been the foremost impact on the industries in question. On the other hand, however, the manufacturing- and seafood companies are primarily concerned with impacts related to increased costs.

5.2.2 Responses

Response correlates with impacts, and thus, how companies have responded depends on their respective consequences of the pandemic. The way companies have responded is influenced by newly implemented measures as reactions to the pandemic and their degree of preparedness. The latter is elaborated in the next section. Figure 8 presents a conceptual model elucidating how companies responded to the pandemic and the reason justifying their actions.

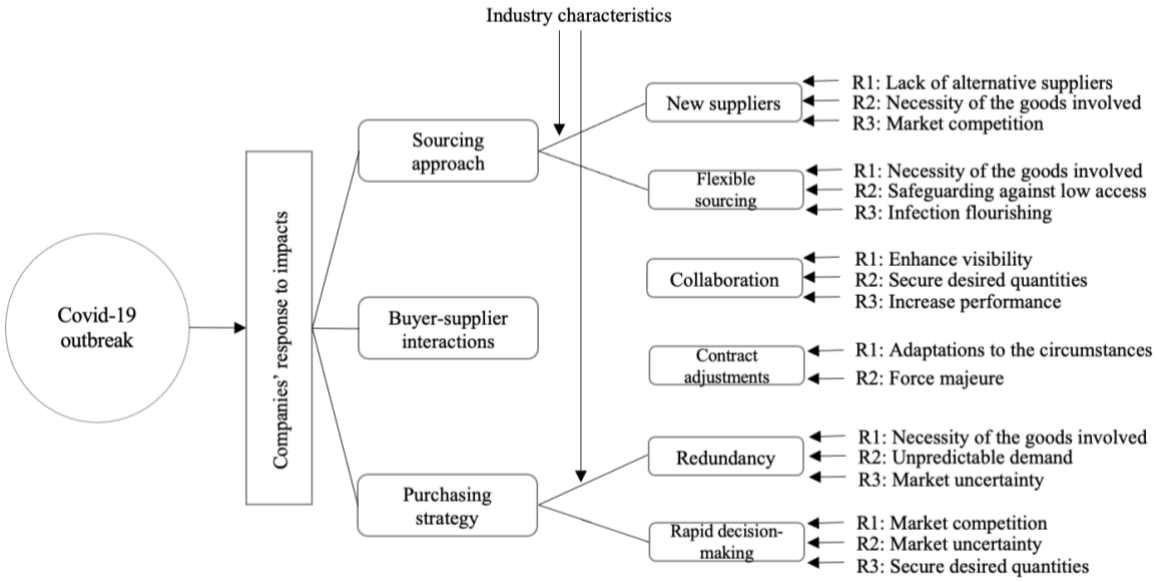

Figure 8: Responses to covid-19 impacts on purchasing and supply

Sourcing approach

Sourcing during covid-19 is tailored to fit the circumstances. As the conceptual model displays, sourcing as a response is characterized by utilizing new suppliers and sourcing flexibility.

Companies applying multiple sourcing across diverse geographical locations possess the opportunity to juggle between suppliers. Consequently, one can achieve a sort of assurance against low goods accessibility, a situation that may arise from effects like infection flourishing in imperative supplier areas. Prominent examples are the strategy of procuring from separate continents (Fishfeed AS and Wholesale Group) or the geographical risk diversification of Cool Solutions.

Conversely, if such a possibility does not exist, the data pinpoints the approach of contracting new suppliers as a tendency in the absence of alternative suppliers. Our findings also expose a parallel between the acquisition of critical, highly demanded goods, market competition, and the requirement of new sources. Both the cases of Health Services and MedProvider substantiates this propensity. The former was forced to attain certain products from unacquainted suppliers due to the extreme need for medical equipment. At the same time, the latter saw its need to acquire from new sources because of low priority, hence losing suppliers. Both companies are generally affected by strong industry regulations, hindering the abundance of supply sources of particular goods.

Equivalently, contracting new suppliers and sourcing flexibility responses are justified through the necessity of the goods involved.

Buyer-supplier interactions

Our findings propose that interactions between companies and suppliers are mostly based on tighter collaboration and contractual adjustments with respect to pandemic commotions.

There is a consensus among our cases that collaboration through shared decision-making and information, communication, and refined relationships is crucial for three main reasons: to secure demanded quantities, increase visibility, and enhance customer and supplier performance. Prominent examples are MedProvider, Grocery King, and Wholesale Group. They all specifically assert their high valuation of mutual buyer-supplier information and cooperation in helping each other out during the turbulent period. Generally, all three collaboration factors connect, as increased visibility through information-sharing exposes the explicitly demanded quantities, which augments both the suppliers' and buying organizations' delivery performance. Already existing buyer-supplier relationships are seen as an aspect of preparedness, which consequently is accounted for in that respective section.

Our data denotes a few contractual modifications required in uncertain environments, mainly due to needed adaptations and force majeure. Contractual conditions were changed by introducing clauses to respond to volatile currency (Fishfeed AS) and expansion of inventory (Cool Solutions). Generally, the findings imply a difficulty to include unpredictable contingents in contractual outsets.

Purchasing strategy

From the conceptual model, organizations' purchasing strategies involve redundancy and rapid decision-making.

Increased order sizes and safety stocks connect, and most of our examined organizations have taken a minimum of one of these measures. Logically, the data elucidate a tendency that companies facing high demand (Health Services, MedProvider, Wholesale Group, and Grocery King) seek to procure higher quantities and build up stocks. Equally, low-demand organizations expand their inventory level, but rather due to uncertainties in future goods

access and market unpredictability (Fishfeed AS, LightMaker, and Cool Solutions). Hence, the justification of buffering derives from high and unpredictable demand and uncertainty in future markets.

Rapid decision-making tends to be more significant for certain companies compared to others. Typically, organizations encountering demand increase, e.g., Health Services and Grocery King, were forced to react quickly to ensure supply. Logically, Health Services, who provide necessary treatment to human lives are seemingly most reliant on making quick decisions during pandemics.

Industry characteristics

The conceptual model specifies three responses relying on the nature of industries: acquisition of new suppliers, buffering, and rapid decision-making.

Our data imply that companies within healthcare are the ones most concerned with the acquisition of new suppliers. This is mainly because during a pandemic, medical equipment has understandably proven to be highly demanded. As a result, firms within that industry have either lost suppliers to competitors or demanded more goods than their suppliers could possibly deliver.

About buffering, a clear distinction emerges, as the healthcare- and grocery industry had to procure in accordance with their growing demand for critical goods. Manufacturing- and seafood organizations, with low demand, may prioritize to buffer up as protection against the unpredictable ripple effects of covid-19. Thus, our data posit that organizations within "society critical" industries require more frequent attainment of high quantities during pandemics. This implies two aspects of "product necessity": (1) the necessity of certain goods for organizations to enable the production of their products, and (2) the necessity of certain goods for end-customers during a pandemic.

As with the abovementioned responses, similarities between healthcare and grocery companies also apply to rapid decision-making as a response due to the fact that both of these industries had high and fluctuating demand. However, the findings point out organizations providing services within healthcare as the ones most needy to make quick decisions during pandemics, which sensibly is because of the virus's danger to human life.

5.2.3 Preparedness

Our data indicate variable levels of preparedness across cases and diverse ways of being prepared. Factors differentiating levels of preparedness tend to root from SCRM emphasis, buyer-supplier relationships, and redundancy.

In general, companies do not contemplate pandemics and related external risk events in their SCRM. Instead, our data propose that risks assessed within organizations are based on past experiences and the degree of probability for a risk's appearance within the respective business of an organization. Thus, most cases approached a more reactive way of preparedness by implementing measures directly to impacts (the abovementioned responses).

Based on SCRM emphasis, our findings nevertheless show that predetermined action plans intended for other risk types may contribute to preparedness for pandemics. The example of Wholesale Group validates this, as a specific prior risk event, namely fire, and predetermined action plans prepared following that experience made them better equipped for covid-19 impacts. Happy Salmon, who experienced minimal procurement impacts, also possesses plans for handling external risks. Contrarywise, deriving from our transcripts, the other cases did not share the common assertion and nor made use of predetermined strategies to combat the pandemic. Despite the prior lack of pandemic focus, a large portion of the case companies avows that pandemic-related risks will receive more attention in future SCRM procedures due to the likeliness of similar occurrences in the time ahead.

In addition to SCRM, buyer-supplier relationships can be denoted as a factor of proactivity. Our data confirm this link, but at the same time implies that good supplier relationships do not necessarily improve preparedness, as it is contingent on market competition. As competition arises among organizations encountering demand increases, buyer-dependency is a vital factor in the acquisition of goods in competitive markets. This assertion is mentioned explicitly by both MedProvider and Grocery King, who both were considered less impressionable on suppliers compared to other actors. On the other end of this scale, companies possess high priority among suppliers (Happy Salmon and LightMaker). The companies in question operate with long-term buyer-supplier relationships. Compared to other cases, the latter mentioned organizations integrates and consolidates suppliers. None

of these organizations' procurement was explicitly affected, and hence, our gathered data imply that long-term relationships and integration may augment priority.

Our data suggest that redundancy seems to have low consideration among companies, logically because of inventory holding costs. As already elaborated, a majority of the cases buffered up inventory as a reaction to the virus outbreak, while, for example, Health Services, with their JIT strategy and critically high demand, would have benefitted from an already established safety stock to be prepared.

Whereas data on "impacts" and "response" tell us a lot about the significance of operating in respective industries during pandemic-related disruptions, we could not determine many similarities or variabilities of preparedness between separate industries. Few distinctive SCRM methods were identified across industries, and neither customer-supplier relationship as response measure tended to clearly distinguish healthcare, seafood, grocery, and manufacturing. As elaborated in this section, the extent of preparedness emerges from case-to-case rather than industry-to-industry.

5.2.4 Chapter summary

In this chapter, we have presented and analyzed our empirical findings. As a short summary, our findings propose that most parallels can be drawn among industries described as "critical for the society", e.g., healthcare and grocery. This propensity is because during pandemics, such industries provide critical products and services to societies.

The most significant findings are accounted for in table 3 and 4, illustrating impacts and challenges and responses respectively.

Table 3: Overview of findings on impacts and challenges

Case	Impacts and challenges
Health Services	Demand changes, supply scarcity, delivery limitations, ineffective forecasting.
MedProvider	Demand changes, supply scarcity, delivery limitations, supplier opportunism, ineffective forecasting.

Fishfeed AS	Demand changes, volatile prices, delivery limitations, ineffective forecasting.
Happy Salmon	Demand changes, supplier opportunism, delivery limitations
Wholesale Group	Demand changes, supply scarcity, supplier opportunism, delivery limitations, ineffective forecasting.
Grocery King	Demand changes, supply scarcity, delivery limitations, ineffective forecasting.
LightMaker	Demand changes, supplier opportunism, volatile prices, delivery limitations, ineffective forecasting
Cool Solutions	Demand changes, supplier opportunism, volatile prices, delivery limitations, ineffective forecasting.

Table 4: Overview of findings on responses

Case	Responses
Health Services	New suppliers, flexible sourcing, redundancy rapid decision making.
MedProvider	New suppliers, flexible sourcing, collaboration, redundancy, rapid decision making.
Fishfeed AS	Contract adjustments, redundancy, flexible sourcing.
Happy Salmon	Collaboration, rapid decision making
Wholesale Group	Collaboration, flexible sourcing, buffering, rapid decision making.
Grocery King	Collaboration, flexible sourcing, buffering rapid decision making, redundancy.
LightMaker	Redundancy, rapid decision making, collaboration
Cool Solutions	Contract adjustments, flexible sourcing, redundancy

6.0 Discussion

This research seeks to provide knowledge on how focal companies can manage disruptions risks characterized with LPHI, and thus, contribute to filling the existing gap within this area. As a pillar, we have examined the impacts and challenges, response, and preparedness of eight case companies with respect to the covid-19 pandemic. This chapter discusses our findings through the perspective of our research questions and evaluates them against existing knowledge.

6.1 How has covid-19 impacted the purchasing and supply functions of focal companies?

We have identified six prominent covid-19 impacts on focal companies' purchasing and supply function from our sample. Our data reveal that the magnitude and species of impacts are disparate and dependent on both company- and industry characteristics.

In light of this event as a medical disease, it is logical to recognize the health care industry as one of the most affected. Additionally, the grocery industry is seen as a critical contributor to society since food is a prerequisite for people. We argue that the health care- and grocery industries are comparable in which LPHI events may cause disruptions. As we elaborated in the analysis, the two aspects of "product necessity" are either that a product importantly contributes to the production or are vital for end-customers in everyday life during pandemics. The abovementioned industries involve the latter aspect.

Industries facing lower demands are most certainly manufacturers of non-important goods in pandemics. We thereby share the interpretation of Ivanov (2020a) that pandemic impacts are heavily dependent on the type of product supplied.

Overall, the pattern tells us that impacts of pandemics, and potentially LPHI risks in general, are decided by the significance of an industry's contributions during risks with specific characteristics.

Price volatility occurs from a combination of ripple effects and the use of foreign suppliers. Our empirical evidence harmonizes with Queiroz et al. (2020), who found that ripple effects triggered by covid-19 are strong annoyances to supply chains. One of our cases provided a prominent example:

"We had suppliers producing bioethanol, used in our bi-products, who experienced negative margins because people did not drive their cars."

This shows that the actions of actors totally irrelevant for companies may suddenly become very relevant. Ripple effects are very much comparable to the "butterfly effect" from Chaos theory. The example above fits the idea that minor changes can cause considerable effects on the whole system (Wilding 1998b)

In terms of foreign sources, price volatility results from fluctuating exchange rates when trading with international suppliers. Limitations in delivery also emerge from foreign supply sources, as closed borders hinder global exportation of goods. Thus, both price volatility and delivery limitations can be substantiated to an assertion that firms ought to avoid the use of foreign sources. In practice, however, this will be a problematic achievement for several reasons, e.g., raw material accessibility and prices.

Additionally, scarcity of supply can be viewed due to demand increase coupled with a single supplier strategy. It can therefore be argued that multi sourcing may prevent this impact, which, contrary to the elaboration above, can be viewed as corroboration for the need of foreign suppliers.

From TCT, uncertain environments are said to increase the likelihood of opportunistic behavior (Williamson 1996). This is reaffirmed from our findings, as companies independent of industry faced opportunistic tendencies from suppliers. Deriving from our interviews, organizations requiring specific components to their production (manufacturing companies) are the ones asserting to be most affected by opportunism during covid-19. Hence, opportunism in pandemics results from few sources and asset specificity, which concur with recognized TCT ideas (Buvik 2002, Hallikas, Virolainen, and Tuominen 2002).

6.2 How have focal companies responded to impacts of covid-19 on purchasing and supply

Sourcing approach

Sourcing approaches include selection, structure, and utilization of companies' supplier networks. Our findings elucidate that acquisition of new suppliers, or sourcing flexibility depends on both case- and industry characteristics; therefore, how organizations choose to respond is conditional to their respective impacts. Existing literature denotes supplier selection as a key determination for SCRes (Christopher and Peck 2004, Kahiluoto, Mäkinen, and Kaseva 2020, Sheffi and Rice Jr. 2005), and we can undoubtedly stand behind this implication. Our data suggest so, and especially the idea that flexibility may bolster SCRes (Sheffi and Rice Jr. 2005). Buying organizations engaging multiple suppliers of similar goods (multi sourcing) are more resistant to upstream supply chain disruptions that can cause accessibility problems due to the existing possibility of switching between suppliers. Flexibility as risk mitigation also corresponds to Chaos Theory and the model of Le Nguyen and Kock (2011), affirming that being flexible can engender competitive advantages in uncertain environments.

From our sample, a pattern suggests that contracting new suppliers is significant within industries operating with critical products. We previously defined two aspects of product necessity: the necessity of certain goods for organizations to enable the production of their products and the necessity of certain goods for end-customers during a pandemic. For "new suppliers" as a response, the latter interpretation applies in this particular case (pandemics). Thus, we argue that healthcare organizations respond by employing new sources due to (1) vastly high demand and (2) industry regulations that complicate multi sourcing.

Buyer-supplier interactions

Buyer-supplier interactions as a response to the pandemic's impacts concern buyer-supplier collaboration and contractual adjustments in accordance with the environment. We share the proposition of Belhadi et al. (2021) that collaboration functions as both proactive and reactive risk mitigation strategies. We argue that the higher the level of buyer-supplier collaboration is prior to disruptions, the greater probability exists for focal firms to be resilient against lack of supply. In this way, proactive collaboration is seen as a factor of preparedness. If the present degree of collaboration is absent, companies should focus on

enhancing it by reacting to disruptions. Both the proactive and reactive aspects of collaboration are needed for focal firms to achieve priority and also to increase the performance of both exchange parties through mutual information-sharing.

By sharing information, supply chain parties provide increased visibility. Our findings fit with the assertion that visibility contributes to reduced uncertainty, consequently reducing the probabilities and impacts of supply chain disruptions (Brandon-Jones et al. 2014, Holcomb, Ponomarov, and Manrodt 2011). With respect to pandemics and risk events causing similar disruptions, we consider a lack of SCV as problematic for focal companies' attempt to avoid shortcomings in supply. Visibility may, for instance, provide real-time information on customer buying trends both globally and locally and hence give indications for what and how much to procure.

Contractual adjustments between buyer and suppliers during covid-19 (introduction of clauses tailored to environmental changes) supports the view of Williamson (1979) that not every transaction fits complex contracts because abundant future contingencies are unpredictable at the outset, and appropriate adaptations may not be apparent until conditions materialize. As adaptations were required for a selection of cases, our study, in harmony with Poppo and Zenger (2002), exposes the importance of combining transaction-based agreements with relational aspects.

Some of our case companies expressed their gratitude to buyer-supplier cooperation and mutual business desires as contributors to receiving demanded quantities. From RCT, this corresponds to affect-based trust. The companies in question were not exposed to opportunism. Carson, Madhok, and Wu (2006) found that precisely trust plays a significant part in limiting opportunism in volatile and ambiguous environments.

An important remark from our findings is that exchanges during pandemics also is decided due to other considerations, such as companies' priority compared to rivals and the extent of how ripple effects may have affected one's suppliers. Even though complementing relational- and transactional contracts certainly will diminish opportunistic behavior, we cannot entirely exclude the chances in uncertain surroundings.

Purchasing strategies

Purchasing strategies require alterations following the uncertain environment emerging from pandemics. Our empirical evidence reveals the necessity of building redundancy for focal firms during pandemics. However, the magnitude of redundancy is industry dependent. As we explained in the analysis, some companies buffer up due to high demand from end-customers (necessity of certain goods for end-customers during a pandemic), while others increase order quantities as a protection against the uncertain (necessity of certain goods to enable production). Christopher and Peck (2004) expound that the disposition of additional inventory or capacity at "pinch points" may be enormously beneficial in creating SCRes. However, balancing the cost of superfluous inventory/capacity against the probability of a disruption to occur is important. Thus, companies must be aware not to go from JIT to "just-in-case".

We argue that some focal firms nevertheless must consider a partly "just-in-case" strategy. Our study revealed the problematic combination of JIT and high demand of critical goods in pandemics through the case where a buying organization within healthcare (critical industry) employed JIT and encountered extreme demand increases. Hence, both our data and SCR concepts make us contend that the level of buffering should be decided from a cost-benefit consideration due to industry characteristics.

6.3 To what extent have focal companies been prepared for covid-19 impacts on purchasing and supply?

Preparedness relates to SCRes and the ability for organizations to resist disruptions. In our sample, we find various levels of preparedness and diverse ways of being prepared. The extent of preparedness emerges from case-to-case rather than industry-to-industry. Our empirical data does not evidently distinguish preparedness factors across healthcare, seafood, grocery, and manufacturing. However, among cases, SCRM emphasis and buyer-supplier relationships are common denominators of preparedness level, while redundancy apparently has a reactive focus.

All our examined cases practice SCRM, commonly based on risk types and probability with respect to their respective business operations. However, one particular company exposed

the importance of assessing external and unlikely risk events and thus familiarizing the organization with relevant procedures. Even if entirely correct measures are hard to predict due to uncertainties, earlier experiences and predetermined SCRM-plans prove to be anyway beneficial as preparations for pandemic disruptions. We consequently agree with the conception of SCRes that resilience should be designed into and receive priority in supply chains and that integrated SCRM culture will enhance resilience within organizations (Christopher and Peck 2004).

The role of buyer-supplier relationships in preparedness plays its part through collaboration and enhancing priority. As we elaborated in RQ2, the higher the level of buyer-supplier collaboration is prior to disruptions, the greater probability exists for focal firms to prepare themselves. We propose that implementing Barratt (2004)'s collaborative culture of trust, mutuality, information exchange, openness, and communication between focal companies and key suppliers may improve collaboration before risk occurrences and subsequently enhance preparedness for both the buying and selling organization.

Generally, covid-19 appears to be a lesson learned for focal firms, as our data shows the desire to evaluate and elaborate on own performance during the pandemic. Along with our sample, we agree that one should build on both the positive and negative experiences obtained, which corresponds to the two last points in Le Nguyen and Kock (2011)'s model of managing chaotic environments, learning, and growth. The fact that focal firms now have stood in it provides them an opportunity to become more prepared in forthcoming disruption risks.

6.4 Suggestions for improving response to LPHI events

Grounded from the recognized supply impacts and response measures to covid-19, we will in this section propose suggestions that in our viewpoint embrace the foremost elements worth considering for managers to implement in order to manage LPHI risks. We believe our findings justifiably can be generalized to fit other disruption risks due to the pandemic's manifold impacts and large scope.

Recommendations derive from a combination of our own gathered data and what is already specified in current theories and research. Figure 9 presents a conceptual model including proposed response maneuvers with corresponding features, along with achievable outcomes. An elaboration follows.

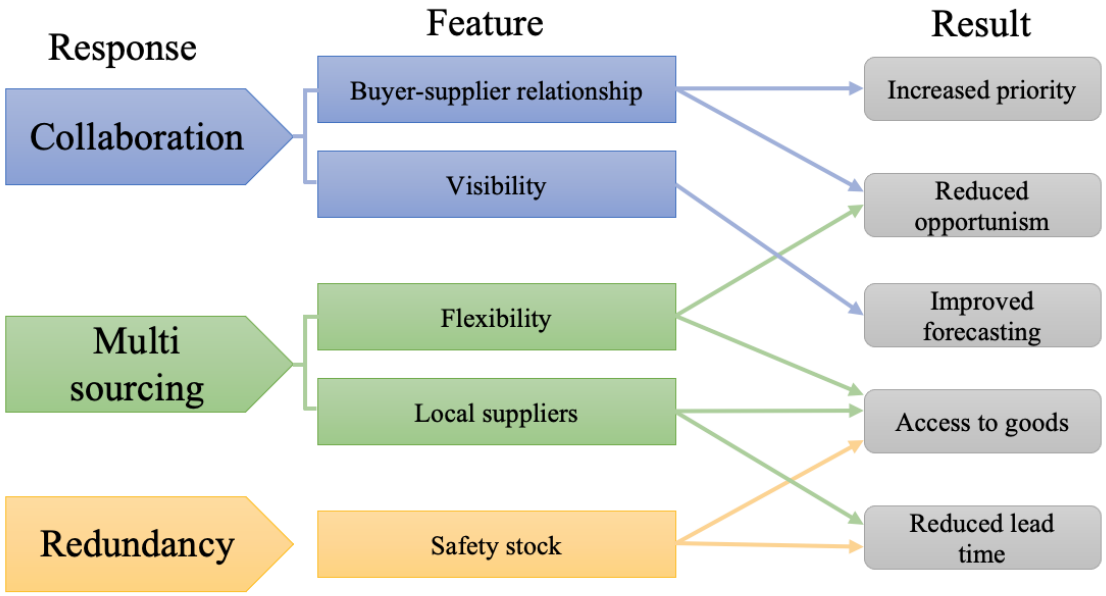

Figure 9: Response improvement suggestions

Collaboration

Collaboration is acknowledged as a prominent response measure amongst our studied cases, previous research, e.g., Belhadi et al. (2021) and SCRes literature, e.g., Christopher and Peck (2004). In our view, this recognition is not unwarranted. We can justify this contention for two main reasons, namely that collaboration both has proactive and reactive aspects, and its features cover the response to numerous disruption risk impacts on purchasing and supply.

Focal firms should do their utmost to establish strong or enhance already existing collaborative relationships with key suppliers. Firstly, collaboration bolsters buyer-supplier relationships (via trust, mutuality, exchange of information, openness, and communication (Barratt 2004)). From our empirical evidence, we conclude that mutual decision-making, shared goals, and good communication are essential interactions for companies to increase their priority among suppliers. Priority improves the possibility of obtaining desired quantities and species of goods. Additionally, the chances of supplier opportunism diminish

under better relationships, mainly due to the aspect of trust. This supports the findings of Carson, Madhok, and Wu (2006), that trust to avoid opportunism is significant in volatile conditions.

Secondly, collaboration may amplify SCV through information-sharing (Barratt and Oke 2007, Christopher and Lee 2004). Deriving from our findings, fluctuating demand complicates long-term predictions. SCV proves to partly solve the forecasting difficulties in uncertain circumstances. Thus, detailed information shared between supply chain actors can illuminate buying patterns, hence provide short-term estimates.

Multi sourcing

We also argue that implementing multi sourcing may be a worthy consideration for managers. Possessing the opportunity to obtain goods from multiple sources proves to be advantageous in circumstances caused by pandemics. Chaos Theory understands flexibility as a generator for competitive advantages in uncertain environments (Le Nguyen and Kock 2011), a view that we support based on what we have found in this study. Multiple suppliers provide flexibility in form of the opportunity to switch between sources if necessary (e.g., due to infection flourishing or closed borders). Risk diversification through sourcing flexibility can, for instance, be achieved by either (1) sourcing from diverse geographical locations or (2) balancing supply across suppliers applying different response strategies (response diversity), as elaborated by Kahiluoto, Mäkinen, and Kaseva (2020).

From TCT, we recognize that sourcing from few suppliers increases the possibility of generating opportunism (Hallikas, Virolainen, and Tuominen 2002). Indeed, if a company engages several supply sources, it can change focus to other suppliers if facing opportunistic tendencies from a particular source.

As a third alternative of sourcing, we argue that procuring from nearby suppliers should be a decision-variable for focal companies. Local sources provide advantages like shorter lead times and reduced delivery limitations from closed borders. However, acquiring from local sources may not be cost-effective; therefore, we believe that whether to choose local suppliers or not is due to a cost-benefit decision. If a disruption risk trigger extensive needs for products or services provided by an organization, local suppliers should be considered to reduce the odds of supply shortage (e.g., health care companies during pandemics).

Redundancy

A final suggestion for improvement comprises an implementation of redundancy to avoid shortcomings in inventory. Safety stocks appear to provide critical support for focal companies operating in industries heavily affected by escalating or fluctuating demand. Additionally, not being able to predict forthcoming consequences of disruption risks activates the desire of companies to buffer up. Hence, our data harmonize with the views of Christopher and Peck (2004) and Sheffi and Rice Jr. (2005) that augmented capacity or inventory is significant for building SCRes.

Excessive stock levels may, however, simply just lead to higher inventory holding costs for other organizations. Nevertheless, we argue that most managers should consider redundancy independent of the industry type, but the extent of redundancy ought to be decided on industry characteristics. Specifically, valuating assets based on importance in addition to a cost-benefit evaluation should provide sufficient indications on whether companies should implement safety stocks.

7.0 Conclusions

This chapter presents a summary of the research and reflects on theoretical- and managerial implications. Additionally, research limitations and suggestions for further research are accounted for.

7.1 Research summary

The main objective of this thesis has been to explore how companies can respond to LPHI supply disruption risks by using the covid-19 pandemic as a cornerstone. To do so, we investigated the impacts and challenges to purchasing and supply, response measures, and preparedness of eight companies from four distinct industries. Deriving from empirical data and applied theories, we have provided specific suggestions to how managers may improve organizations' response to risks causing uncertain conditions.

RQ1 – How has covid-19 impacted the purchasing and supply functions of focal companies?

There are numerous impacts and challenges to focal firms' purchasing and supply. Our research exposes similarities and variabilities between cases and distinct industries. The main impacts identified are presented in a conceptual model and include demand changes, scarcity of supply, opportunistic behavior, volatile prices, delivery limitations, and ineffective forecasting.

Companies operating in industries defined as "critical for the society", e.g., healthcare and grocery, tend to encounter similar impacts, mainly due to the criticality of the goods and services involved in their business operations. Overall, demand changes, scarcity of supply, volatile prices, and ineffective forecasting are considered industry dependent impacts.

RQ2 – How have focal companies responded to impacts of covid-19 on purchasing and supply?

Response correlates with impacts, meaning that companies logically respond in coherence with their respective consequences and challenges.

A conceptual model is presented, illustrating the response of companies and the reasons justifying their actions. The foremost response measures taken involve sourcing approaches (new suppliers and flexibility), buyer-supplier interactions (collaboration and contractual adjustments), and purchasing strategies (redundancy and rapid decision making). Some responses, i.e., acquisition of new suppliers, redundancy, and rapid decision-making, are engaged due to industry characteristics, primarily because of product necessity. Hence, we presented two aspects of product necessity: (1) the necessity of certain goods for organizations to enable the production of their products, and (2) the necessity of certain goods to end customers during a pandemic.

RQ3 – To what extent have focal companies been prepared for covid-19 impacts on purchasing and supply?

Preparedness is determined from SCRM emphasis, buyer-supplier relationships, and redundancy. The latter, however, tends to be given less focus in preparations, as safety stocks are implemented as a direct response to sudden demand escalations. Our data cannot determine many similarities or variabilities of preparedness between different industries;

therefore, the extent of preparedness emerges from case-to-case rather than industry-to-industry.

Generally, companies do not contemplate pandemics in their SCRM. Nevertheless, our findings show that predetermined action plans intended for other risk types may contribute to preparedness for disruption risks. Additionally, long-term relationships and integration may augment priority, which bolsters preparedness by increasing companies' chances of obtaining desired acquisitions.

Response improvement suggestions

We propose that collaboration, multi sourcing, and redundancy are the foremost response measures managers ought to consider implementing in uncertain circumstances caused by LPHI disruption risks:

- Increased priority may be achieved through collaboration.
- Both multi sourcing and collaboration reduce the risk of opportunism.
- Visibility (reached through collaboration) improves forecasting.
- Features of multi sourcing and redundancy increase goods accessibility and reduces lead time.

However, we affirm that certain measures may not fit every company and its business operations, thereby must be evaluated from an industry characteristic- and cost-benefit aspect.

7.2 Theoretical implications

The empirical data in this thesis were collected over a year into the pandemic's outset. It thereby contributes to filling the gap of absent empirical evidence identified from nascent stage literature on covid-19 and SCM. In addition, this research provides extensive support to pertinent SCRM concepts and contributes to TCT, RCT, and Chaos Theory.

Concerning SCRes, we reaffirm collaboration, flexibility, and redundancy as central contributors to increasing resilience and SCRM following present research, e.g., Barratt (2004), Christopher and Peck (2004), and Sheffi and Rice Jr. (2005). Additionally, this study

demonstrates that increased SCV through shared information provides overview, hence supports supply chain actors in identifying risks and areas for improvement.

A mutual denominator in Chaos theory and SCRes is that both address strategic relationships (collaboration) in changing environments. Consistent with Stapleton, Hanna, and Ross (2006), Chaos theory suggests that such relationships are significant when effective and rapid communication is needed. We can certainly approve this idea, as this study has uncovered the importance of a collaborative culture with trust, mutuality, information exchange, openness, and communication between focal companies and key suppliers (Barratt 2004).

Our research validates the view of uncertain environments as a triggering factor to opportunistic behavior. We also recognize that sourcing from few suppliers increases the possibility of opportunism, thereby concurring with TCT literature (Hallikas, Virolainen, and Tuominen 2002). Indeed, engaging numerous supply sources can enable companies to focus on other suppliers if facing opportunistic tendencies from a particular source.

Opportunism may also decrease by affect-based trust, a central element of RCT (Jeffries and Reed 2000). Our research shows the difficulty of complete contracts to address uncertainties and that complementation between transaction- and relational aspects are necessary during pandemics and uncertain conditions (Poppo and Zenger 2002, Williamson 1979).

7.3 Managerial implications

This thesis provides several findings worth considering for managers to combat forthcoming disruption risks. The findings apply to SC focal firms beyond our sample and various industries.

As mentioned, this research is conducted at a late stage in the pandemic. Hence, the findings provide up-to-date information on the experiences and views of supply chain actors that have stood in the middle of the disruptions.

Managers can adopt our conceptual model for response enhancement to guide them in the right direction when deciding response approaches. The first consideration is that

collaboration should be the core priority for companies seeking to improve performance in uncertain conditions. By building collaborative buyer-supplier relationships, SCV augments (positive to forecasting), opportunism diminishes, and goods accessibility increases.

Another practical implication is that flexibility tends to be beneficial in uncertain environments and should therefore be considered. Flexibility can, like collaboration, decrease opportunism chances and increase the possibility to obtain desired goods. Whether to employ local suppliers should be decided from a cost-benefit evaluation.

Concurring to SCRes literature, redundancy bolsters a company's resilience and preparedness. If the need exists, excessive inventory seems to be advantageous when combatting impacts from covid-19. Managers ought to only consider redundancy extent based on company and industry characteristics, thereby from a cost-benefit view.

In light of Christopher and Peck (2004) view, SCRes should be incorporated in supply chains, and an SCRM culture within organizations will increase SCRes. This research shows that case- and industry characteristics determine pandemic impacts. We thereby encourage focal firms to assess external disruption risks ahead and tailor their SCRM based on respective covid-19 impacts.

7.4 Limitations and suggestions for further research

Although this study provides lenses through which companies can respond to LPHI risk events causing uncertain circumstances, there are noteworthy limitations. Hence, this section provides suggestions for areas that beneficially can be further investigated.

Firstly, this research predominantly addresses impacts and corresponding responses to upstream supply chain disruptions. For future research, it would be valuable to examine further supply chain mechanisms to achieve a more holistic vision of the relationship between SCM and pandemics.

Third, a larger sample would upsurge the possibility for generalization. Even if our sample covers various case characteristics across four industries, expanding the sample from two

to, for example, four companies per industry may provide variabilities in terms of, for instance, different company sizes, thereby include an additional aspect.

Fourth, the cases included in this research are predominantly from production industries (except Health Services). Bearing in mind the vast impediments of covid-19 to service-providing companies, it would be interesting to go more in-depth on the service industry, for instance, by investigating transportation or HoReCa firms.

Fifth, the semi-structured interview approach can influence the chances of obtaining consistent empirical data, as some interviewees spoke freely beyond the written questions. This slightly limits the reliability of this thesis.

Lastly, our conceptual model on response improvement is not a solution but rather a parameter to which companies may use to manage disruption risks. There are many diverse factors that influence companies during pandemics, and the most important consideration is to tailor SCRM strategies to fit one's respective characteristics.

References

Adams, John, Hafiz T. A. Khan, and Robert Raeside. 2014. *Research Methods for Business and Social Science Students*. New Delhi: SAGE Publications.

Al-Mansour, Jarrah F, and Sanad A Al-Ajmi. 2020. "Coronavirus' COVID-19'-Supply Chain Disruption and Implications for Strategy, Economy, and Management." *The Journal of Asian Finance, Economics, and Business* 7 (9):659-672.

Albastroiu, Irina, and Mihai Felea. 2013. "An Introduction to Supply Chain Risk Management: Definitions and Theories Perspective." *Valahian Journal of Economic Studies* 4:57-64. doi: https://search.proquest.com/docview/1540957416?accountid=40814.

Anderson, Erin, and Hubert Gatignon. 1986. "Modes of Foreign Entry: A Transaction Cost Analysis and Propositions." *Journal of International Business Studies* 17 (3):1-26. doi: 10.1057/palgrave.jibs.8490432.

Barratt, Mark. 2004. "Understanding the meaning of collaboration in the supply chain." *Supply Chain Management: An International Journal* 9 (1):30-42. doi: 10.1108/13598540410517566.

Barratt, Mark, and Adegoke Oke. 2007. "Antecedents of supply chain visibility in retail supply chains: A resource-based theory perspective." *Journal of Operations Management* 25 (6):1217-1233. doi: https://doi.org/10.1016/j.jom.2007.01.003.

Belhadi, Amine, Sachin Kamble, Charbel Jose Chiappetta Jabbour, Angappa Gunasekaran, Nelson Oly Ndubisi, and Mani Venkatesh. 2021. "Manufacturing and service supply chain resilience to the COVID-19 outbreak: Lessons learned from the automobile and airline industries." *Technological Forecasting and Social Change* 163:120447. doi: https://doi.org/10.1016/j.techfore.2020.120447.

Bell, Emma, Alan Bryman, and Bill Harley. 2018. *Business research methods*: Oxford university press.

Black, Stephanie, and Daniel Glaser-Segura. 2020. "Supply Chain Resilience in a Pandemic: The Need for Revised Contingency Planning." *Management Dynamics in the Knowledge Economy* 8 (4):325. doi: 10.2478/mdke-2020-0021.

Blackstone, Amy. 2018. "Principles of sociological inquiry: Qualitative and quantitative methods."

Bowen, Glenn A. 2009. "Document Analysis as a Qualitative Research Method." *Qualitative Research Journal* 9 (2):27-40. doi: 10.3316/QRJ0902027.

Brandon-Jones, Emma, Brian Squire, Chad W. Autry, and Kenneth J. Petersen. 2014. "A Contingent Resource-Based Perspective of Supply Chain Resilience and Robustness." *The journal of supply chain management* 50 (3):55-73. doi: 10.1111/jscm.12050.

Brink, H. I. L. 1993. "Validity and reliability in qualitative research." *1993* 16 (2):4. doi: 10.4102/curationis.v16i2.1396.

Bryman, Alan. 2001. *Social research methods*. Oxford: Oxford University Press.

Butt, Atif Saleem. 2021. "Strategies to mitigate the impact of COVID-19 on supply chain disruptions: a multiple case analysis of buyers and distributors." *The International Journal of Logistics Management* ahead-of-print (ahead-of-print). doi: 10.1108/IJLM-11-2020-0455.

Buvik, Arnt. 2002. "Hybrid governance and governance performance in industrial purchasing relationships." *Scandinavian Journal of Management* 18 (4):567-587. doi: https://doi.org/10.1016/S0956-5221(01)00030-6.

Cai, Min, and Jianwen Luo. 2020. "Influence of COVID-19 on Manufacturing Industry and Corresponding Countermeasures from Supply Chain Perspective." *Journal of*

Shanghai Jiaotong University (Science) 25 (4):409-416. doi: 10.1007/s12204-020-2206-z.

Calkins, Susanna, and Matthew R. Kelley. 2007. "Evaluating Internet and Scholarly Sources Across the Disciplines: Two Case Studies." *College Teaching* 55 (4):151-156. doi: 10.3200/CTCH.55.4.151-156.

Caridi, Maria, Antonella Moretto, Alessandro Perego, and Angela Tumino. 2014. "The benefits of supply chain visibility: A value assessment model." *International Journal of Production Economics* 151:1-19. doi: https://doi.org/10.1016/j.ijpe.2013.12.025.

Carson, Stephen J, Anoop Madhok, and Tao Wu. 2006. "Uncertainty, opportunism, and governance: The effects of volatility and ambiguity on formal and relational contracting." *Academy of Management journal* 49 (5):1058-1077.

Carter, Craig R. 2011. "A CALL FOR THEORY: THE MATURATION OF THE SUPPLY CHAIN MANAGEMENT DISCIPLINE." *Journal of Supply Chain Management* 47 (2):3-7.

Chiles, Todd, and John McMackin. 1996. "Integrating Variable Risk Preferences, Trust, and Transaction Cost Economics." *The Academy of Management Review* 21:73. doi: 10.2307/258630.

Chowdhury, Md Maruf H., and Mohammed Quaddus. 2017. "Supply chain resilience: Conceptualization and scale development using dynamic capability theory." *International journal of production economics* 188:185-204. doi: 10.1016/j.ijpe.2017.03.020.

Chowdhury, Md Tarek, Aditi Sarkar, Sanjoy Kumar Paul, and Md Abdul Moktadir. 2020. "A case study on strategies to deal with the impacts of COVID-19 pandemic in the food and beverage industry." *Operations Management Research*. doi: 10.1007/s12063-020-00166-9.

Christopher, Martin, and Hau Lee. 2004. "Mitigating supply chain risk through improved confidence." *International Journal of Physical Distribution & Logistics Management* 34 (5):388-396. doi: 10.1108/09600030410545436.

Christopher, Martin, and Helen Peck. 2004. "Building the Resilient Supply Chain." *International Journal of Logistics Management* 15:1-13. doi: 10.1108/09574090410700275.

Coyne, Imelda T. 1997. "Sampling in qualitative research. Purposeful and theoretical sampling; merging or clear boundaries?" *Journal of advanced nursing* 26 (3):623-630.

Creswell, John W., and Vicki L. Plano Clark. 2011. *Designing and conducting mixed methods research*. 2nd ed. ed. Los Angeles: Sage.

Dolan, SL, Simon Garcia, and A Auerbach. 2003. "Understanding and managing chaos in organisations." *International journal of management* 20 (1):23-35.

Dolgui, Alexandre, Dmitry Ivanov, and Boris Sokolov. 2018. "Ripple effect in the supply chain: an analysis and recent literature." *International Journal of Production Research* 56 (1-2):414-430.

Durach, Christian, Joakim Kembro, and Andreas Wieland. 2017. "A New Paradigm for Systematic Literature Reviews in Supply Chain Management." *Journal of Supply Chain Management* 53. doi: 10.1111/jscm.12145.

Eisenhardt, Kathleen M. 1989. "Building Theories from Case Study Research." *Academy of Management Review* 14 (4):532-550. doi: 10.5465/amr.1989.4308385.

El Baz, Jamal, and Salomée Ruel. 2020. "Can supply chain risk management practices mitigate the disruption impacts on supply chains' resilience and robustness? Evidence from an empirical survey in a COVID-19 outbreak era." *International*

Journal of Production Economics:107972. doi: https://doi.org/10.1016/j.ijpe.2020.107972.
Ellram, Lisa M. 1996. "The use of the case study method in logistics research." *Journal of Business Logistics* 17 (2):93-138.
Etikan, Ilker. 2016. "Comparison of Convenience Sampling and Purposive Sampling." *American Journal of Theoretical and Applied Statistics* 5:1. doi: 10.11648/j.ajtas.20160501.11.
Fan, Yiyi, and Mark Stevenson. 2018. "A review of supply chain risk management: definition, theory, and research agenda." *International journal of physical distribution & logistics management* 48 (3):205-230. doi: 10.1108/ijpdlm-01-2017-0043.
Folke, Carl. 2006. "Resilience: The emergence of a perspective for social–ecological systems analyses." *Global Environmental Change* 16 (3):253-267. doi: https://doi.org/10.1016/j.gloenvcha.2006.04.002.
Fonseca, Luis Miguel, and Américo Lopes Azevedo. 2020. "COVID- 19: outcomes for Global Supply Chains." *Management & Marketing. Challenges for the Knowledge Society* 15 (s1):424-438. doi: https://doi.org/10.2478/mmcks-2020-0025.
Gates, Bill. 2018. "Innovation for pandemics." *New England Journal of Medicine* 378 (22):2057-2060.
Gill, Paul, Kate Stewart, Elizabeth Treasure, and Barbara Chadwick. 2008. "Methods of data collection in qualitative research: interviews and focus groups." *British dental journal* 204 (6):291-295.
Glenn, James E. 1996. "Chaos Theory: The Essential for Military Applications."
Golan, Maureen S., Laura H. Jernegan, and Igor Linkov. 2020. "Trends and applications of resilience analytics in supply chain modeling: systematic literature review in the context of the COVID-19 pandemic." *Environment Systems and Decisions* 40 (2):222-243. doi: 10.1007/s10669-020-09777-w.
Gough, David A., Sandy Oliver, and James Thomas. 2017. *An introduction to systematic reviews*. Second edition. ed, *Systematic reviews*. Los Angeles: SAGE.
Grover, Varun, and Manoj K. Malhotra. 2003. "Transaction cost framework in operations and supply chain management research: theory and measurement." *Journal of Operations Management* 21 (4):457-473. doi: https://doi.org/10.1016/S0272-6963(03)00040-8.
Hallikas, Jukka, V-M Virolainen, and Markku Tuominen. 2002. "Understanding risk and uncertainty in supplier networks--a transaction cost approach." *International Journal of Production Research* 40 (15):3519-3531.
Harris, Joshua D., Carmen E. Quatman, M.M. Manring, Robert A. Siston, and David C. Flanigan. 2014. "How to Write a Systematic Review." *The American Journal of Sports Medicine* 42 (11):2761-2768. doi: 10.1177/0363546513497567.
Holcomb, Mary C, Serhiy Y Ponomarov, and Karl B Manrodt. 2011. "The relationship of supply chain visibility to firm performance." Supply Chain Forum: An International Journal.
Hox, Joop, and Hennie Boeije. 2005. "Data collection, primary versus secondary." *Encyclopedia of Social Measurement* 1. doi: 10.1016/B0-12-369398-5/00041-4.
Hugos, Michael H. 2018. *Essentials of Supply Chain Management, Essentials series*. Newark: Newark: John Wiley & Sons, Incorporated.
Ivanov, Dmitry. 2020a. "Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case." *Transportation Research Part E: Logistics and Transportation Review* 136:101922. doi: https://doi.org/10.1016/j.tre.2020.101922.

Ivanov, Dmitry. 2020b. "Viable supply chain model: integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 pandemic." *Annals of Operations Research*. doi: 10.1007/s10479-020-03640-6.
Jacobsen, Dag Ingvar. 2018. *Hvordan gjennomføre undersøkelser? : innføring i samfunnsvitenskapelig metode*. 3. utg. ed. Oslo: Cappelen Damm akademisk.
Jeffries, Frank L., and Richard Reed. 2000. "Trust and adaptation in relational contracting." *Academy of Management. The Academy of Management Review* 25 (4):873-882.
Jesson, J., L. Matheson, and F.M. Lacey. 2011. *Doing Your Literature Review: Traditional and Systematic Techniques*: SAGE Publications.
Kahiluoto, Helena, Hanna Mäkinen, and Janne Kaseva. 2020. "Supplying resilience through assessing diversity of responses to disruption." *International Journal of Operations & Production Management*.
Kaiser, Gabriele, and Norma Presmeg. 2019. *Compendium for early career researchers in mathematics education*: Springer Nature.
Kantemnidis, Dimitrios. 2016. Chaos Theory and International Relations.
Khan, Samia, and Robert VanWynsberghe. 2008. "Cultivating the under-mined: Cross-case analysis as knowledge mobilization." Forum: Qualitative Social Research.
Kirsch, Gesa, and Patricia A Sullivan. 1992. *Methods and methodology in composition research*: SIU Press.
Kmet, Leanne M, Linda S Cook, and Robert C Lee. 2004. "Standard quality assessment criteria for evaluating primary research papers from a variety of fields."
Kvale, Steinar. 1996. *Interviews : an introduction to qualitative research interviewing*. Thousand Oaks, Calif: Sage.
Le Merle, Matthew. 2011. "How To Prepare For A Black Swan." *Strategy + business magazine* (64).
Le Nguyen, Huu, and Sören Kock. 2011. "Managing SMEs' Survival from Financial Crisis in a Transition Economy: A Chaos Theory Approach." *Journal of General Management* 37 (1):31-45. doi: 10.1177/030630701103700103.
Levy, David. 1994. "Chaos theory and strategy: Theory, application, and managerial implications." *Strategic Management Journal* 15 (S2):167-178. doi: https://doi.org/10.1002/smj.4250151011.
Macaulay, Stewart. 1963. "Non-contractual relations in business: A preliminary study." In *Stewart Macaulay: Selected Works*, 361-377. Springer.
Macneil, Ian R. 1973. "The many futures of contracts." *S. Cal. l. Rev.* 47:691.
Mangan, John, Chandra Lalwani, Tim Butcher, and Roya Javadpour. 2012. *Global Logistics & Supply Chain Management*. 2. ed. Chichester, West Sussex: John Wiley & Sons, Ltd.
Manuj, Ila, and John T. Mentzer. 2008. "GLOBAL SUPPLY CHAIN RISK MANAGEMENT." *Journal of Business Logistics* 29 (1):133-155. doi: 10.1002/j.2158-1592.2008.tb00072.x.
Marshall, Martin N. 1996. "Sampling for qualitative research." *Family Practice* 13 (6):522-526. doi: 10.1093/fampra/13.6.522.
Mason, Roger B. 2006. "Coping with complexity and turbulence-an entrepreneurial solution." *Journal of Enterprising culture* 14 (04):241-266.
Mayer, Roger C., James H. Davis, and F. David Schoorman. 1995. "An integrative model of organizational trust." *Academy of Management. The Academy of Management Review* 20 (3):709.
Mentzer, John T., William DeWitt, James S. Keebler, Soonhong Min, Nancy W. Nix, Carlo D. Smith, and Zach G. Zacharia. 2001. "DEFINING SUPPLY CHAIN

MANAGEMENT." *Journal of Business Logistics* 22 (2):1-25. doi: https://doi.org/10.1002/j.2158-1592.2001.tb00001.x.
Min, Soonhong, Anthony S. Roath, Patricia J. Daugherty, Stefan E. Genchev, Haozhe Chen, Aaron D. Arndt, and R. Glenn Richey. 2005. "Supply chain collaboration: what's happening?" *The International Journal of Logistics Management* 16 (2):237-256. doi: 10.1108/09574090510634539.
Mohajan, Haradhan Kumar. 2018. "QUALITATIVE RESEARCH METHODOLOGY IN SOCIAL SCIENCES AND RELATED SUBJECTS." *Journal of Economic Development, Environment and People* 7 (1):23-48. doi: http://dx.doi.org/10.26458/jedep.v7i1.571.
Nakat, Zeina, and Christelle Bou-Mitri. 2020. "COVID-19 and the food industry: Readiness assessment." *Food control*:107661.
Neuman, W. Lawrence. 2014. *Social research methods : qualitative and quantitative approaches*. 7th ed.
Pearson new international edition. ed. Harlow: Pearson.
Nicholas Taleb, Nassim. 2015. "The black swan: The impact of the highly improbable." *Victoria* 250:595-7955.
Nikolopoulos, Konstantinos, Sushil Punia, Andreas Schäfers, Christos Tsinopoulos, and Chrysovalantis Vasilakis. 2021. "Forecasting and planning during a pandemic: COVID-19 growth rates, supply chain disruptions, and governmental decisions." *European journal of operational research* 290 (1):99-115.
Pawson, Ray. 2002. "Evidence-based Policy: The Promise of `Realist Synthesis'." *Evaluation* 8 (3):340-358. doi: 10.1177/135638902401462448.
Pettit, Timothy J, Joseph Fiksel, and Keely L Croxton. 2010. "Ensuring supply chain resilience: development of a conceptual framework." *Journal of business logistics* 31 (1):1-21.
Polkinghorne, Donald E. 2005. "Language and meaning: Data collection in qualitative research." *Journal of counseling psychology* 52 (2):137.
Ponomarov, Serhiy Y., and Mary C. Holcomb. 2009. "Understanding the concept of supply chain resilience." *International Journal of Logistics Management* 20 (1):124-143. doi: http://dx.doi.org/10.1108/09574090910954873.
Poppo, Laura, and Todd Zenger. 2002. "Do formal contracts and relational governance function as substitutes or complements?" *Strategic management journal* 23 (8):707-725.
Prieskienis, Adrijus. 2021. "Information value for disruption management in supply chains." University of Twente.
Queiroz, Maciel M., Dmitry Ivanov, Alexandre Dolgui, and Samuel Fosso Wamba. 2020. "Impacts of epidemic outbreaks on supply chains: mapping a research agenda amid the COVID-19 pandemic through a structured literature review." *Annals of Operations Research*. doi: 10.1007/s10479-020-03685-7.
Riege, Andreas M. 2003. "Validity and reliability tests in case study research: A literature review with "hands-on" applications for each research phase." *Qualitative Market Research* 6 (2):75-86. doi: http://dx.doi.org/10.1108/13522750310470055.
Saldaña, Johnny. 2021. *The coding manual for qualitative researchers*: sage.
Sarkis, Joseph, Paul Dewick, Joerg Stefan Hofstetter, and Patrick Schröder. 2020. "Overcoming the Arrogance of Ignorance: Supply-Chain Lessons from COVID-19 for Climate Shocks." *One Earth* 3 (1):9-12. doi: https://doi.org/10.1016/j.oneear.2020.06.017.

Saunders, Mark, Philip Lewis, Adrian Thornhill, and Alex Bristow. 2019. ""Research Methods for Business Students" Chapter 4: Understanding research philosophy and approaches to theory development." In, 128-171.
Saunders, Mark N. K., Philip Lewis, and Adrian Thornhill. 2012. *Research methods for business students*. 6th ed. ed. Harlow: Pearson.
Saussier, Stéphane. 2000. "Transaction costs and contractual incompleteness: the case of Électricité de France." *Journal of Economic Behavior & Organization* 42 (2):189-206. doi: https://doi.org/10.1016/S0167-2681(00)00085-8.
Scotland, James. 2012. "Exploring the philosophical underpinnings of research: Relating ontology and epistemology to the methodology and methods of the scientific, interpretive, and critical research paradigms." *English language teaching* 5 (9):9-16.
Sedlmair, Michael, Miriah Meyer, and Tamara Munzner. 2012. "Design study methodology: Reflections from the trenches and the stacks." *IEEE transactions on visualization and computer graphics* 18 (12):2431-2440.
Shahed, Kazi Safowan, Abdullahil Azeem, Syed Mithun Ali, and Md Abdul Moktadir. 2021. "A supply chain disruption risk mitigation model to manage COVID-19 pandemic risk." *Environmental Science and Pollution Research*. doi: 10.1007/s11356-020-12289-4.
Sharma, Amalesh, Anirban Adhikary, and Sourav Bikash Borah. 2020. "Covid-19′s impact on supply chain decisions: Strategic insights from NASDAQ 100 firms using Twitter data." *Journal of Business Research* 117:443-449. doi: https://doi.org/10.1016/j.jbusres.2020.05.035.
Sharma, Manu, Sunil Luthra, Sudhanshu Joshi, and Anil Kumar. 2020. "Developing a framework for enhancing survivability of sustainable supply chains during and post-COVID-19 pandemic." *International Journal of Logistics Research and Applications*:1-21. doi: 10.1080/13675567.2020.1810213.
Sheffi, Yossi, and James B Rice Jr. 2005. "A Supply Chain View of the Resilient Enterprise." *MIT Sloan Management Review* 47 (1):41-48.
Sodhi, ManMohan S., Byung-Gak Son, and Christopher S. Tang. 2012. "Researchers' Perspectives on Supply Chain Risk Management." *Production and operations management* 21 (1):1-13. doi: 10.1111/j.1937-5956.2011.01251.x.
Speakman, Mark, and Richard Sharpley. 2019. "A chaos theory perspective on destination crisis management: Evidence from Mexico."
Spens, Karen M., and Gyöngyi Kovács. 2006. "A content analysis of research approaches in logistics research." *International Journal of Physical Distribution & Logistics Management* 36 (5):374-390. doi: 10.1108/09600030610676259.
Stapleton, Drew, Joe B. Hanna, and Jonathan R. Ross. 2006. "Enhancing supply chain solutions with the application of chaos theory." *Supply Chain Management: An International Journal* 11 (2):108-114. doi: 10.1108/13598540610652483.
Strauss, Anselm, and Juliet Corbin. 1990. *Basics of qualitative research*: Sage publications.
Sutcliffe, Kathleen M, and Akbar Zaheer. 1998. "Uncertainty in the transaction environment: an empirical test." *Strategic management journal* 19 (1):1-23.
Tang, Christopher S. 2006. "Perspectives in supply chain risk management." *International journal of production economics* 103 (2):451-488.
Taqi, Hasin, Humaira Ahmed, Sumit Paul, Maryam Garshasbi, Syed Mithun Ali, Golam Kabir, and Sanjoy Paul. 2020. "Strategies to Manage the Impacts of the COVID-19 Pandemic in the Supply Chain: Implications for Improving Economic and Social Sustainability." *Sustainability* 12:9483. doi: 10.3390/su12229483.

Taylor, Steven J., Robert Bogdan, and Marjorie L. DeVault. 2016. "Introduction to qualitative research methods : a guidebook and resource." In. Hoboken, New Jersey: Wiley.
Tranfield, David, David Denyer, and Palminder Smart. 2003. "Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review." *British Journal of Management* 14:207-222. doi: 10.1111/1467-8551.00375.
Verbeke, Alain, Alain Verbeke, Liena Kano, and Liena Kano. 2013. "The transaction cost economics (TCE) theory of trading favors." *Asia Pacific journal of management* 30 (2):409-431. doi: 10.1007/s10490-012-9324-6.
Veselovská, Lenka. 2020. "Supply chain disruptions in the context of early stages of the global COVID-19 outbreak." *Problems and Perspectives in Management* 18:490-500. doi: 10.21511/ppm.18(2).2020.40.
Wahyuni, Dina. 2012. "The research design maze: Understanding paradigms, cases, methods and methodologies." *Journal of applied management accounting research* 10 (1):69-80.
Wang, Eric TG. 2002. "Transaction attributes and software outsourcing success: an empirical investigation of transaction cost theory." *Information Systems Journal* 12 (2):153-181.
Waters, C. D. J. 2007. *Supply chain risk management : vulnerability and resilience in logistics*. Edited by Logistics The Chartered Institute of and Transport. London: Kogan Page.
Wever, Mark, Nel Wognum, J. Trienekens, and Simon Omta. 2012. "Supply Chain-Wide Consequences of Transaction Risks and Their Contractual Solutions: Towards an Extended Transaction Cost Economics Framework." *The Journal of Supply Chain Management* 48. doi: 10.1111/j.1745-493X.2011.03253.x.
Wilding, Richard. 1998a. "The supply chain complexity triangle: uncertainty generation in the supply chain." *International Journal of Physical Distribution & Logistics Management*.
Wilding, Richard D. 1998b. "Chaos theory: implications for supply chain management." *The International Journal of Logistics Management* 9 (1):43-56.
Williams, Brent D., Joseph Roh, Travis Tokar, and Morgan Swink. 2013. "Leveraging supply chain visibility for responsiveness: The moderating role of internal integration." *Journal of Operations Management* 31 (7):543-554. doi: https://doi.org/10.1016/j.jom.2013.09.003.
Williamson, Oliver E. 1979. "Transaction-Cost Economics: The Governance of Contractual Relations." *The Journal of Law and Economics* 22 (2):233-261. doi: 10.1086/466942.
Williamson, Oliver E. 1981. "The Economics of Organization: The Transaction Cost Approach." *ajs* 87:548. doi: 10.1086/227496.
Williamson, Oliver E. 1993. "Transaction Cost Economics and Organization Theory." *Industrial and Corporate Change* 2 (2):107-156. doi: 10.1093/icc/2.2.107.
Williamson, Oliver E. 1996. *The Mechanisms of Governance*. Cary: Cary: Oxford University Press, Incorporated.
Williamson, Oliver E. 2008. "OUTSOURCING: TRANSACTION COST ECONOMICS AND SUPPLY CHAIN MANAGEMENT*." *Journal of Supply Chain Management* 44 (2):5-16. doi: https://doi.org/10.1111/j.1745-493X.2008.00051.x.
Williamson, Oliver, and Tarek Ghani. 2012. "Transaction cost economics and its uses in marketing." *Journal of the Academy of Marketing Science* 40 (1):74-85. doi: 10.1007/s11747-011-0268-z.

Woong, Jia, and Shao Hung Goh. 2020. *Supply Chain Risk Management Strategies in the Face of COVID-19*.
World Health Organization. 2020. "Listings og WHO's response to COVID-19." Last Modified 28/12/20, accessed 24/05/21. https://www.who.int/news/item/29-06-2020-covidtimeline?fbclid=IwAR1uPaX7x0cr6uPZc09QywNq6qkx9MFZn0lSQDSWtJ0sf-cunR4KU9y7Bgs.
World Health Organization. 2021. "Coronavirus disease (COVID-19) pandemic." Last Modified 03/08, accessed 03/09. https://www.who.int/emergencies/diseases/novel-coronavirus-2019?gclid=Cj0KCQiA1pyCBhCtARIsAHaY_5fGHp3Z2fsgPYRZ7FPPmWjqACCW-G7R-lLtg1us5UchPYn49AeRWDkaApz6EALw_wcB.
Yin, R.K., and D.T. Campbell. 1994. *Case Study Research: Design and Methods*: SAGE Publications.
Yin, Robert K. 2018. *Case study research and applications : design and methods*. 6. utgave. ed. Los Angeles: SAGE.

Appendices

Appendix A: Interview-guide

Interview guide

General questions

1. Can you briefly describe your business and the type of work you perform?
2. Can you describe the company´s supply chain?

Risk Management

1. To what extent have risk management been prioritized prior to covid-19?
2. Has covid-19 changed the practice and prioritization of risk management within the company? If yes, how?
3. What type of measures have been executed to minimize the consequences of the pandemic?
4. Have you prepared any measures to handle future occurrences categorized as low probability for it to occur, yet high impact if it occurs? If yes, what type of measures?
5. In your opinion, do you think your industry is more affected by events such as covid-19 compared to other industries?
6. Did you have a specific risk management strategy prior to covid-19? If yes, what type of risk did it advocate? If no, why?

Contracts/Supplier relationships

1. What type of relationship do you have with your suppliers? Do you think this relationship will change due to the pandemic?
2. Did the relationship with your suppliers affect the impacts of covid-19? If yes, how?
3. How did covid-19 affect the company´s ability to purchase goods and services?
4. Did you need to change supplier contract terms following the covid-19 outbreak?
5. Did the company operate with multi sourcing before the covid-19 outbreak? Subsequently, did this have any impact?
6. Among your suppliers, how many are foreign? Did foreign suppliers affect your purchasing and supply?

Covid-19

1. What was the company's immediate challenges or concerns when the covid-19 virus evolved into a pandemic?
2. What measures were taken to adjust following the covid-19 outbreak, and how long did it take to adjust?
3. Which experiences have you obtained from the covid-19 pandemic?

Appendix B: Table of examined publications on covid-19 and SCM

Table 5: Examined literature on covid-19 and SCM

	Title	Author(s)	Journal
1.	A case study on strategies to deal with the impacts of COVID-19 pandemic in the food and beverage industry	Md. Tarek Chowdhury, Aditi Sarkar, Sanjoy Kumar Paul, and Md. Abdul Moktadir	Operations Management Research
2.	Agriculture supply chain risks and COVID-19: mitigation strategies and implications for the practitioners	Rohit Sharma, Anjali Shishodia, Sachin Kamble, Angappa Gunasekaran & Amine Belhadi	International Journal of Logistics Research and Applications
3.	Applications of industry 4.0 to overcome the COVID-19 operational challenges	Mr Shashank Kumar, Dr Rakesh D. Raut, Dr Veibhav S. Narwane and Dr Balkrishna E. Narkhede	Diabetes & Metabolic Syndrome: Clinical Research & Reviews
4.	A supply chain disruption risk mitigation model to manage COVID-19 pandemic risk	Shahed Kazi Safowan, Azeem Abdullahil, Ali Syed Mithun, and Moktadir Md. Abdul	Environmental Science and Pollution Research
5.	Can supply chain risk management practices mitigate the disruption impacts on supply chains' resilience and robustness? Evidence from an empirical survey in a COVID-19 outbreak era	Jamal El Baz and Salomée Ruel	International Journal of Production Economics
6.	Coronavirus 'COVID-19' - Supply Chain Disruption and Implications for Strategy, Economy, and Management	Jarrah F. Al-Mansour and Sanad A. Al-Ajmi	Journal of Asian Finance, Economics and Business
7.	COVID-19 and the food industry: Readiness assessment	Zeina Nakat and Christelle Bou-Mitri	Food control
8.	COVID-19 Global Pandemic: Impact on Management of Supply Chain	Rakesh Kumar and R.S. Mishra	International Journal of Emerging Technology and Advanced Engineering

9.	COVID- 19: outcomes for Global Supply Chains	Luis Miguel Fonseca and Américo Lopes Azevedo	Management & Marketing. Challenges for the Knowledge Society
10.	Covid-19 impact on international trade	Kirti Srivastava	Perspectives on Business Management & Economics
11.	Covid-19′s impact on supply chain decisions: Strategic insights from NASDAQ 100 firms using Twitter data	Sharma, Amalesh, Anirban Adhikary, and Sourav Bikash Borah	Journal of Business Research
12.	Developing Strategies to Improve the Performance of the Resilient Supply Chain (RSC) to Rise Back from Post Covid-19	Dishanthi N. Kahaduwa and Dushanthi D. Lokuge	13th International Research Conference General Sir John Kotelawala Defence University
13.	Forecasting and planning during a pandemic: COVID-19 growth rates, supply chain disruptions, and governmental decisions	Nikolopoulos, Konstantinos, Sushil Punia, Andreas Schäfers, Christos Tsinopoulos, and Chrysovalantis Vasilakis	European journal of operational research
14.	Impact of COVID-19 on logistics systems and disruptions in food supply chain	Sube Singh, Ramesh Kumar, Rohit Panchal and Manoj Kumar Tiwari	International Journal of Production Research
15.	Impact of COVID-19 on the food supply chain	Serpil Aday and Mehmet Seckin Aday	*Food Quality and Safety*
16.	Impacts of epidemic outbreaks on supply chains: mapping a research agenda amid the COVID-19 pandemic through a structured literature review	Queiroz, Maciel M., Dmitry Ivanov, Alexandre Dolgui, and Samuel Fosso Wamba	Annals of Operations Research
17.	Implications of COVID-19 Pandemic on the Global Trade Networks	C.T Vidya and K.P. Prabheesh	Emerging Markets Finance and Trade
18.	Influence of COVID-19 on Manufacturing Industry and Corresponding Countermeasures from Supply Chain Perspective	Min Cai and Jianwen Luo	Journal of Shanghai Jiaotong University (Science)
19.	Investigating the effects of COVID-19 and public health expenditure on global supply chain operations: an empirical study	Xuanlong Qin, Danish Iqbal Godil, Muhammad Kamran Khan, Salman Sarwat, Sadaf Alam and Laeeq Janjua	Operations Management Research

20.	Lessons Learned from the COVID-19 Pandemic Exposing the Shortcomings of Current Supply Chain Operations: A Long-Term Prescriptive Offering	Guiyang Zhu, Mabel C. Chou and Christina W. Tsai	Sustainability
21.	Managing supply chain uncertainty by building flexibility in container port capacity: a logistics triad perspective and the COVID-19 case	Dawn Russell, Kusumal Ruamsook, and Violeta Roso	Maritime Economics & Logistics
22.	Manufacturing and service supply chain resilience to the COVID-19 outbreak: Lessons learned from the automobile and airline industries	Amine Belhadi, Sachin Kamble, Charbel Jose Chiappetta Jabbour, Angappa Gunasekaran, Nelson Oly Ndubisi and Mani Venkatesh	Technological Forecasting and Social Change
23.	Measuring the impact of COVID-19 on stock prices and profits in the food supply chain	Julia Höhler and Alfons Oude Lansink	Agribusiness
24.	Panic buying: An insight from the content analysis of media reports during COVID-19 pandemic	S.M. Yasir Arafat, Sujita Kumar Kar, Vikas Menon, Charanya Kaliamoorthy, Srijeeta Mukherjee, Angi Alradie-Mohamed, Pawan Sharma, Marthoenis Marthoenis and Russell Kabir	Neurology, Psychiatry and Brain Research
25.	Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case	Dmitry Ivanov	Transportation Research Part E: Logistics and Transportation Review
26.	Responding to COVID-19 Supply Chain Risks—Insights from Supply Chain Change Management, Total Cost of Ownership and Supplier Segmentation Theory	Remko van Hoek	*Logistics*
27.	Ripple effect in the supply chain network: Forward and backward disruption propagation, network health and firm vulnerability	Yuhong Li, Kedong Chen, Stephane Collignon and Dmitry Ivanov	European Journal of Operational Research

28.	Strategies to Manage the Impacts of the COVID-19 Pandemic in the Supply Chain: Implications for Improving Economic and Social Sustainability	Taqi, Hasin, Humaira Ahmed, Sumit Paul, Maryam Garshasbi, Syed Mithun Ali, Golam Kabir, and Sanjoy Paul	Sustainability
29.	Supply chain disruptions in the context of early stages of the global COVID-19 outbreak	Lenka Veselovská	Problems and Perspectives in Management
30.	Supply Chain Management for Extreme Conditions: Research Opportunities	Manmohan S. Sodhi and Christopher S. Tang	Journal of Supply Chain Management
31.	Supply Chain Manipulation, Misrepresentation, and Magical Thinking During the COVID-19 Pandemic	Christopher L. Atkinson, Clifford McCue, Eric Prier, and Allison M. Atkinson	The American Review of Public Administration
32.	Supply Chain Resilience in a Pandemic: The Need for Revised Contingency Planning	Stephanie Black and Daniel Glaser-Segura	Management Dynamics in the Knowledge Economy
33.	Supply Chain Risk Management Strategies in the Face of COVID-19	Jia Yi Woong and Shao Hung Goh	Proceedings of the 11th Annual International Conference on Industrial Engineering and Operations Management Singapore, March 7-11, 2021
34.	Supply chain sustainability: learning from the COVID-19 pandemic	Joseph Sarkis	International Journal of Operations & Production Management
35.	The Impact of the Covid-19 Pandemic on the Supply Chain of Agricultural Products	Kamola Mukhamedjanova	Asian Journal of Technology & Management Research
36.	The Supply Chain Disruption Framework Post COVID-19: A System Dynamics Model	Deepankar Sinha, Virupaxi Bagodi and Debasri Dey	Foreign Trade Review
37.	Trends and applications of resilience analytics in supply chain modeling: systematic literature review in the context of the COVID-19 pandemic	Golan S. Maureen, Laura H. Jernegan and Igor Linkov	Environment Systems and Decisions

38.	Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak	Dmitry Ivanov and Alexandre Dolgui	International Journal of Production Research
39.	Viable supply chain model: integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 pandemic	Dmitry Ivanov	Annals of Operations Research
40.	Sustainability of supply chains in the wake of the coronavirus (COVID-19/SARS-CoV-2) pandemic: lessons and trends	Ana Beatriz Lopes de Sousa Jabbour, Charbel Jose Chiappetta Jabbour, Martin Hingley, Eliseo Luis Vilalta-Perdomo, Gary Ramsden and David Twigg	Modern Supply Chain Research and Applications