



# Master's degree thesis

**LOG950 Logistics**

**Are organizations prepared for managing potential upstream supply chain risks in the future? A case study of Norwegian food-and energy supply chains**

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Ski, 21.05.2023



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## Preface and acknowledgements

This thesis marks the end of my two years as a student at Molde University College.

It was conducted between October 2022 and May 2023 as a part of the *Master of Science in logistics* program.

I would like to express my deepest gratitude to my supervisor Sergei Teryokhin for our many good discussions, for answering my questions, and for giving me constructive feedback along the whole journey.

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Ski, May 21<sup>st</sup>, 2023

Erik Johannessen

## Abstract

The Covid 19 pandemic and the war in Ukraine have developed several upstream supply chain risks in many supply chains globally. Organizations have therefore had to work on their SCRM processes to secure supplies during the recent years. The objective with this research was to find out if the organizations within Norwegian food-and energy supply chains are prepared for managing potential future upstream SC risk consequences by investigating upstream SC risk types- and consequences they have experienced during the period from January 2020 to March 2023, and their current SCRM processes. Differences between the two supply chains have also been examined during the research. A multiple-case study was conducted, and empirical data were collected from semi-structured interviews with SC professionals in six organizations in food- and energy supply chains.

The findings in this paper propose that both supply chains have sufficient current SC mitigation practices considering their recent experienced upstream SC risk consequences. There are only minor differences between the supply chains regarding their experienced upstream SC risk types- and consequences. The food supply chain has a sufficient upstream SC risk identification process, and a moderately sufficient assessment process due to lack of risk matrix in one organization. They could also benefit from stating clear criterias for risk probability- and impact and to use their suppliers more actively to identify and assess upstream SC risks. The energy supply chain has a moderately sufficient upstream SC risk identification- and assessment process due to lack of risk screening in all organizations and lack of risk matrix in one organization. They could also benefit from stating clear criterias for risk probability- and impact and to use their suppliers more actively in risk identification- and assessment. Except from increased inventory which is implemented as a mitigation practice by all organizations, there are large differences in the choice of mitigation practices between the two supply chains. The food supply chain's mitigation practices are mainly the following ones: Supplier/material diversification, Flexibility in production, and Consider more local sourcing. While the energy supply chain's mitigation practices are mainly the following: Order early, Strategic relationship with key suppliers, Sharing of strategic information with key suppliers, and Profit sharing. Despite the mitigation practices being sufficient, the energy supply chain could benefit from considering more local sourcing, and both supply chains could benefit from strategic relationships- and sharing of strategic with key suppliers to a larger extent.

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## List of abbreviations

HSE	Health, Safety, Environment
RQ	Research Question
SC	Supply Chain
SCI	Supply Chain Integration
SCM	Supply Chain Management
SCRM	Supply Chain Risk Management



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## 1.0 Introduction

This chapter first presents the background of this thesis. Further, the research objective and corresponding research questions are clarified before the structure of the thesis is presented. Lastly, relevance of my study is included.

### 1.1 Background of the thesis

As supply chains become longer and more complex, with more outsourcing, shorter product life-cycles, and more globalization, risk management are becoming more important (Alicke and Strigel 2020; Johnsen, Howard, and Miemczyk 2019). The last three years, the world has experienced, and are still experiencing both a global pandemic and a war between Russia and Ukraine. This has created a global supply chain disruption, which has caused many businesses to experience large supply problems (Nikolopoulos et al. 2021). Amongst others there have been a huge shortage of chips used in automobiles, mobile phones and computers (Wu, Zhang, and Du 2021). There have also been additional events such as the blockage of the Suez Canal that delayed much goods being transported between Asia and Europe (Lee and Wong 2021).

Covid 19 was reported by Chinese government in late December 2019. The virus has since then been spread across the world and it reached its peak in January 2021 (Couture et al. 2022). It has caused a huge humanitarian challenge, and disruptions that are incomparable to past events (Kwon 2020). Many authorities have used lockdown and closed borders as a response to the outbreaks (Tardivo, Carrillo Zanuy, and Sánchez Martín 2021). This has impacted supply chains all around the world, especially since Chinese companies is a large contributor to many of them (Shih 2020). It is reported that 94% of companies listed in *Fortune 1000* experienced supply chain disruptions from Covid 19 (Sherman 2020).

In February 2022, Russia invaded Ukraine. This led to a large humanitarian crisis, and the largest refugee challenge in Europe since World War 2 (Jagtap et al. 2022). It has caused a particular disruption in food supply chains as both countries are important agricultural producers. These goods produced in Ukraine are being disrupted from being produced or exported (Jagtap et al. 2022). In addition, most of the western world have imposed extensive economic sanctions on Russia to weaken their economy and prevent further

military aggression (Åslund and Snegovaya 2021). Both these reasons lead to shortage and higher prices of energy, raw materials, and food products. Increase in fuel costs has also increased prices of transport, which again has been transferred to other goods (Halicki 2022).

Supply chain risk management literature suggests several strategies on how to deal with supply chain risks. The recent years' events and development of risks in supply chains forms an interesting object of research for all industries.

## **1.2 Research objectives- and questions**

### **1.2.1 Research objectives**

The objective for this research is to find out if the organizations within Norwegian food- and energy supply chains are prepared for managing potential upstream SC risks in the future.

I will explore the current supply chain risk management process of Norwegian organizations in food supply chains and energy supply chains, and experienced risk types- and consequences that has occurred in the period after the Covid 19 outbreak. I will thereby try to find out how the supply chains have reacted to their recently previous experienced upstream SC risks, to understand if their supply chain risk management process is sufficient to manage potential upstream SC risks in the future. Potential differences between the two types of supply chains also forms an interesting object of research.

I will investigate the upstream supply chain risk types in the period between January 2020 and today, how the upstream SC risks have impacted the organizations, and how their supply chain risk management processes are conducted. The thesis will use a multiple case approach with empirical data supported by relevant literature.

### **1.2.2 Research question**

Based on the research objective for this thesis, I have formulated a research question. The question is comprehensive, but it will help me to provide a better understanding of the topic and to investigate the research objective.

**RQ: How do current supply chain mitigation practices of Norwegian organizations within food-and energy supply chains correspond to the consequences of upstream supply chain risks occurred during the Covid 19 pandemic?**

To answer this question, I will examine the risk types and the consequences the organizations have experienced from upstream supply chain risks during the period from January 2020 to March 2023. I will then research the organizations' current upstream supply chain risk identification-, assessment-, and mitigation practices to get a holistic picture of their supply chain risk management practices.

### **1.2.3 Structure of the thesis**

This thesis is organized into seven chapters: introduction, literature review, research methodology, findings and analysis, discussion, and conclusion. The chapters are further divided into subchapters. *Chapter 1* lays the foundation of the thesis by presenting background information as well as the research objective- and question. *Chapter 2* consists of relevant literature for the thesis, in addition to some theoretical foundation. *Chapter 3* presents the methodological choices of this thesis. *Chapter 4* includes the findings from each of the case companies. *Chapter 5* includes analysis of the findings. In *Chapter 6*, the findings and analysis are discussed and seen in light of the explored literature. *Chapter 7* lastly summarizes the thesis and suggests managerial implications, limitations, and further research.

### **1.2.4 Relevance of the study**

There is an extensive amount of literature about both supply chain risk management and the Covid 19 pandemic, and it's therefore harder to justify the need for even more research about this field and topic. However, it's such an important field and topic because it has affected, and still affects organizations greatly. Organizations also often tend to return back to normal after a major disruptive event, and academia therefore has a responsibility of highlighting the importance of supply chain risk management (Jüttner, Peck, and Christopher 2010).

There are large differences in supply chain risk management practices and experiences of upstream supply chain risks during Covid 19 across supply chains and in different parts of the world. Therefore, research on Norwegian organizations within two supply chains will contribute to the already existing literature. It has already been studied how organizations

have approached challenges faced due to pandemic-related disruptions, but to the best of my knowledge, no existing literature has studied the current supply chain risk management practices and the experienced upstream supply chain risk consequences in Norwegian food supply chains and energy supply chains during the period from January 2020 to March 2023.

Due to its recent occurrence, few studies have taken risks from the war in Ukraine into consideration when studying the impacts of upstream supply chain risks on SCRM processes. Therefore, this thesis provides up-to-date empirical evidence of current supply chain risk management practices and upstream SC risk consequences that can be used to understand how organizations within food- and energy supply chains are prepared to face potential upstream supply chain risks in the future.

## 2.0 Literature review

This chapter presents the relevant literature for the research, which is mostly related to supply chain risk management (SCRM). It starts by presenting some literature on supply chain management (SCM).

### 2.1 Supply chain management

#### 2.1.1 Definition

Supply Chain Management (SCM) is a term that since it was introduced in the 1980's has gained more interests by businesses (D.M. Lambert, Cooper, and Pagh 1998). SCM and logistics management are two terms that are often used interchangeably, but these are not identical in an academical view.

These are some definitions of the term *Supply chain (SC)* that are commonly used in academic literature:

Definition	Authors
"The <u>integration</u> of business processes from end user through original suppliers that provides products, services, and information that add value for customers"	(Lambert, Stock and Ellram 1998, 504)

<p>“The supply chain is the <u>network</u> of <u>organizations</u> that are involved, through <u>upstream</u> and <u>downstream</u> linkages, in the different processes and activities that <u>produce value</u> in the form of products and services in the hands of <u>the ultimate consumers</u>.”</p>	<p>(Mangan and Lalwani 2016, 10)</p>
<p>“A <u>network</u> of connected and <u>interdependent organizations</u> mutually and co-operatively working together <u>to control, manage and improve the flow of material and information</u> from suppliers to end users”.</p>	<p>(Christopher 2016, 4)</p>
<p>“A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even the customers themselves. Within each organization (...) the supply chain includes all functions involved in receiving and filling a customer request.”</p>	<p>(Chopra and Meindl 2016)</p>

Table 1: Definitions of supply chain

From these definitions by Lambert, Stock, and Ellram (1998), Mangan & Lalwani (2016), Christopher (2016), and Chopra and Meindl (2016), we can say that a supply chain is a network of integrated organizations that works together to provide products and services and seeks to manage and improve this flow of material and information to create value for end-customers.

### 2.1.2 Upstream- and downstream supply chains

When studying supply chains, it’s normal to distinguish between upstream-and downstream supply chains. Upstream supply chain means the flow of material on the supply side of the focal company, related to acquiring goods. Downstream supply chain means the flow of material on the customer side of the focal company, related to distributing goods (Jonsson 2008, 9). Figure 1 illustrates this difference with a typical supply chain structure, and the difference between tier 1- and 2 suppliers, which is that second-tier suppliers are the suppliers’ suppliers.

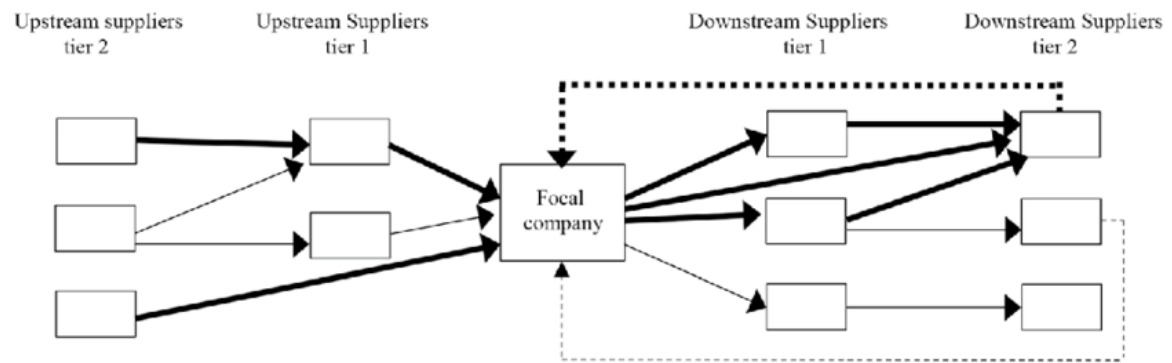


Figure 1: Upstream- and downstream supply chains (De Giovanni and Zaccour 2019)

## 2.2 Supply chain risks

The term “risk” is a very intelligible, yet confusing term, because it’s a multidimensional construct that either can refer to the sources of risk or to the consequences of risk (Jüttner, Peck, and Christopher 2010). A definition of supply chain risks, based on other definitions of “risk” can therefore be “any risks for the information, material, and product flows from original supplier to the delivery of the final product for the end user” (Jüttner, Peck, and Christopher 2010).

Supply chain risks are traditionally split into operational risks and disruption risks.

Operational risks refer to regular interruptions which for instance affects the lead time or demand (El Baz and Ruel 2021). Disruption risks are risks that are unlikely to happen but have a huge impact when they first occur. Examples of disruption risks are man-made threats such as labour strikes and war, and natural catastrophes such as earthquakes, volcano outbreaks, and hurricanes (Hosseini, Ivanov, and Dolgui 2019). Kleindorfer and Saad (2005) presents risks affecting the supply chain design and management as either risks arising from problems of coordinating supply and demand (e.g., inventory control issues and stockout situations), or risks arising from disruption and delay to normal supply chain activities (e.g., natural disasters, civil unrest etc.). They also address the fact that as transportation of goods in supply chains have been given longer routes and shorter clock speeds, there is a larger potential, and less room for upstream supply chain risks.

Christopher and Peck (2004) categorizes risks into five categories: process risks, control risks, demand risks, supply risks and environmental risks. Process risks are risks related to the different value-adding and managerial activities in the firm, such as disruption on equipment and important infrastructure. Control risks are risks arising from the application



or misapplication of the assumptions, rules, systems, and procedures that manages the organization's processes. Demand risks refers to risks related to the uncertainty of customer demand. This may result in the supply not matching the demand, either as a stockout, or as excessive inventory (Sodhi 2005, 72). Both these events are negatively for a company. Supply risks are risks that are associated with sourcing goods from a supplier that leads to the firm being unable to meet customer demand or that causes other threats to customers life and safety (George A. Zsidisin et al. 2004). The last category are environmental risks, that are risks from environmental influences such as directives from the EU (Bogataj and Bogataj 2007).

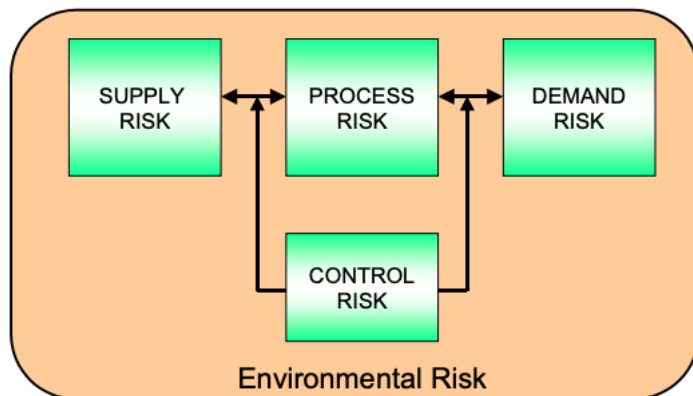


Figure 2: Sources of risks in the supply chain (Christopher and Peck 2004).

Chopra and Sodhi (2004) also presents many potential supply chain risks such as delays, disruptions, forecast inaccuracies, systems breakdowns, intellectual property breaches, procurement failures, inventory problems and capacity issues. They also propose some underlying drivers and mitigation strategies for each of the risks (Chopra and Sodhi 2004). Figure 3 presents the risks categorized by Chopra and Sodhi (2004) and the respective risk drivers.

Category of Risk	Drivers of Risk
<b>Disruptions</b>	<ul style="list-style-type: none"> <li>■ Natural disaster</li> <li>■ Labor dispute</li> <li>■ Supplier bankruptcy</li> <li>■ War and terrorism</li> <li>■ Dependency on a single source of supply as well as the capacity and responsiveness of alternative suppliers</li> </ul>
<b>Delays</b>	<ul style="list-style-type: none"> <li>■ High capacity utilization at supply source</li> <li>■ Inflexibility of supply source</li> <li>■ Poor quality or yield at supply source</li> <li>■ Excessive handling due to border crossings or to change in transportation modes</li> </ul>
<b>Systems</b>	<ul style="list-style-type: none"> <li>■ Information infrastructure breakdown</li> <li>■ System integration or extensive systems networking</li> <li>■ E-commerce</li> </ul>
<b>Forecast</b>	<ul style="list-style-type: none"> <li>■ Inaccurate forecasts due to long lead times, seasonality, product variety, short life cycles, small customer base</li> <li>■ "Bullwhip effect" or information distortion due to sales promotions, incentives, lack of supply-chain visibility and exaggeration of demand in times of product shortage</li> </ul>
<b>Intellectual Property</b>	<ul style="list-style-type: none"> <li>■ Vertical integration of supply chain</li> <li>■ Global outsourcing and markets</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>■ Exchange rate risk</li> <li>■ Percentage of a key component or raw material procured from a single source</li> <li>■ Industrywide capacity utilization</li> <li>■ Long-term versus short-term contracts</li> </ul>
<b>Receivables</b>	<ul style="list-style-type: none"> <li>■ Number of customers</li> <li>■ Financial strength of customers</li> </ul>
<b>Inventory</b>	<ul style="list-style-type: none"> <li>■ Rate of product obsolescence</li> <li>■ Inventory holding cost</li> <li>■ Product value</li> <li>■ Demand and supply uncertainty</li> </ul>
<b>Capacity</b>	<ul style="list-style-type: none"> <li>■ Cost of capacity</li> <li>■ Capacity flexibility</li> </ul>

Figure 3: Supply chain risks and their drivers (Chopra and Sodhi 2004)

This thesis has focused on disruptions and delays as upstream SC risks. There is a difference between disruptions and delays. Delays will often happen because a supplier fails to react on changes in demand. Other reasons for delays can be due to poor performance at the plant of the supplier, much handling and inspection in connection with import and changes between different modes of transport (Chopra and Sodhi 2004). Some consequences of delays can be lost sales, loss of goodwill, and reduced or stop in production (Guiffrida and Jaber 2008). A study from 2010 showed that wholesalers and manufacturers that imported goods focused most on increased inventory costs caused by delays, and the impact delays had on promotions and sales plans (Zhang and Figliozzi 2010).

To best prepare for delays, organizations can increase their capacity and inventory to become more flexible. If the organization holds products of different value, they can choose a solution that takes the product value into account when deciding capacity- and inventory level. High-cost items that have low demand should be more flexible in terms of capacity and inventory, while low-cost, high-demand items could have a less flexible solution that is cheaper for the organization (Chopra and Sodhi 2004). This strategy can also be extended with choice of transport mode based on value of the item, were high-

value items are kept to a minimum in the inventory, and rather transported by air, whereas cheap items are shipped with less expensive transport methods in larger bulks (Chopra and Sodhi 2004).

Disruptions can come in many forms. Common to all of them is that they happen rarely, are hard to predict, and often cause a lot of damage for many parties in the supply chain. Disruptions can often also lead to increased prices, such as has been seen with amongst other container shipping in the aftermath of Covid 19, and prices of electricity during the conflict in Ukraine (Chopra and Sodhi 2004; Placek 2022; NHO 2022).

To cope with disruptions, companies can increase the inventory levels or have excessive suppliers (Chopra and Sodhi 2004). Both these solutions are expensive but might be necessary. If a disruption can be somewhat predicted, increasing inventory in advance can be defended. As with delays, differentiating the strategy between goods can be clever. Products that are expensive to keep in stock or fast-depreciating goods should be acquired by using extensive suppliers, while products that can be kept for a long time without obsoleting or are cheap to keep in stock can use a strategy with additional inventory level (Chopra and Sodhi 2004).

Wilson (2007) mentions natural disasters, labour dispute, dependence on a single supplier, supplier bankruptcy, terrorism, war, and political instability as possible causes for disruptions. These are almost identical to risk drivers for disruptions, presented by Chopra and Sodhi (2004). Wilson also present transportation disruptions as disruptions that arises “when the material flow is interrupted between two echelons in a supply chain, temporarily stopping the transit of these goods, regardless of the source of the disruption”. She argues that transport disruptions, unlike disruptions in general, therefore can be seen as less severe, because they only stop the flow of goods, and not for instance production. However, transport is also said by others to be the most vulnerable part of a supply chain (Stecke and Kumar 2009).

A study of China’s logistics industry from 2010 showed that the respondents’ assumption on what was most likely to cause delays in the supply chain was other factors than transport, such as manufacturing, customs, weather, or supplier-related delays (Zhang and Figliozzi 2010). Of the transport-related delays, transshipment, and loading and unloading

at port was seen as the most likely causes. Shipment by sea was seen as very unlikely to cause any delays.

Ho et al. (2015) performed a comprehensive review of literature on supply chain risk management. They discovered seven types of risks: Macro risk, demand risk, manufacturing risk, supply risk, information risk, transportation risk, and manufacturing risk. Within these types, they mentioned about 120 risk factors, such as natural disasters, war, shorter lifetime of products, global outsourcing, lack of integration with suppliers, port strikes, and currency fluctuations. Supply risk was the most studied risk type, while transportation risk was the least studied. Automotive was the most studied industry, while toy manufacturing was the least. Both food- and energy industries were both studied to a medium extent. Of the individual processes within supply chain risk management, supply chain mitigation was the most studied, and most of the studies were quantitative.

A study of food supply chains after the Covid 19 outbreak discovered that delays occurred mostly due to lack of supply of products, either by suppliers, transporters, or producers (Ferreira et al. 2021). Closing of borders due to Brexit was also seen as a risk driver. Most of the companies studied also experienced that it was difficult to use alternative suppliers, because they could not guarantee for the quality of the products. Another example is that Honda, a Japanese automobile manufacturer that operates plants in Wuhan, reduced the production of automobiles in Japan due to a lack of supplies of parts from China in early March 2020 (Inoue and Todo 2020). Lack of resources has also been mentioned before 2020 as a risk type that can cause disruptions in the supply chain (Stecke and Kumar 2009). Consequences seen on Norwegian businesses during and after Covid 19 due to disruptions and delays are transport challenges, use of alternative products and suppliers, stockouts, increased transportation costs, reduced production (Bø, Hovi, and Pinchasik 2023).

Transportation of goods has been heavily impacted because of Covid 19. Air transport faced a huge passenger air traffic fell and a reduced airfreight capacity between China and Europe to 40% of the original capacity (Tardivo, Carrillo Zanuy, and Sánchez Martín 2021). This increased the price rates for freight flights (Bø, Hovi, and Pinchasik 2023). The closing of border crossings created long queues for trucks, which is the most used transport mode for freight transport in Europe (Commission and Eurostat 2022). The ocean

freight industry experienced a decrease in demand for goods between China and Europe. They therefore reduced the supply of shipping services accordingly (Tardivo, Carrillo Zanuy, and Sánchez Martín 2021). All these transport-and logistic issues has contributed to creating delays and disruptions in supply chains.

Legislations and regulations from governments to prevent the spread of the Covid 19 virus in many countries have also been seen as a reason for delays and disruptions, because it has reduced the amount of goods being transported (Xu et al. 2022). Dohale et al. (2023) found that pandemic disruption risks, together with demand uncertainty were most critical risks from the pandemic and that lockdown caused large issues for all actors of the studied organizations' supply chain. Lafrogne-Joussier, Martin, and Mejean (2023) found that firms that were exposed to Chinese lockdowns experienced a reduction in imports. Lockdown of large cities have a huge impact on supply chains and should therefore be avoided, or held as short as possible (Inoue and Todo 2020).

Epidemics and pandemics had already before Covid 19 caused economic consequences globally, with both SARS and the Bird flu in the early 2000s (Stecke and Kumar 2009). They both created supply chain disruptions, and amongst others, Australia lost about \$1 billion from the SARS without having any diagnosed cases (Australia 2003).

The war in Ukraine impacts the world's economy and supply chains in many ways. First, there are the goods from Ukraine which is disrupted from being produced or exported (Jagtap et al. 2022). Second, there are goods from Russia which are stopped by the sanctions imposed on Russia by the western world. Both these reasons lead to shortages and higher prices of energy, raw materials, and food products. Increase in fuel costs also increases prices of transport, which again are being transferred to other goods (Halicki 2022).

### **2.2.1 Supply chain risk management**

Supply chain risk management can be defined as “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.” (Fan and Stevenson 2018). The term “Treatment” is by many also called mitigation.

The field of supply chain risk management is well established, and has gained more attention the recent years (Johnsen, Howard, and Miemczyk 2019, 216). Many firms choose to take more risk, for example by adopting a lean supply strategy, where most of the activities are outsourced to low-cost countries suppliers (Johnsen, Howard, and Miemczyk 2019, 216). According to Johnsen, Howard, and Miemczyk (2019, 217), firms can’t benefit from opportunities without taking some risk.

Supply chain risk management was often limited to top-tier suppliers before Covid 19 and events disrupting lower-tier suppliers were then often discovered too late. Mapping of the whole supply chain has been proposed as a way to predict and prepare for supply chain disruptions (Zhu, Chou, and Tsai 2020). To be able to classify the risk of the suppliers and products, the mapping should include all suppliers, and the geographical locations of manufacturers plants and factories. Other possible mitigation practices mentioned by the same authors are diversification of suppliers, vertical integration of supply chains, moving manufacturing in-house or closer to home. Sourcing more locally is also something that can be combined with a sourcing strategy that diversifies suppliers. Sheffi (2001) suggests dual sourcing as a strategy with local suppliers to meet demand in case of a disruption, and offshore suppliers for the normal sourcing.

There have been several studies that points out that companies tend to identify and assess the probability and impact of risks but spend less time and resources creating mitigation strategies and managing these risks (Tang 2006b). Rice and Caniato (2003) and George A. Zsidisin, Panelli, and Upton (2000) suggest that this may be because:

- Firms underestimate the risk in the absence of accurate supply chain risk assessment.
- Firms are not familiar with ways to manage supply chain risks.
- With inaccurate estimates of the probability that a major disruption would occur, many firms find it difficult to perform cost/benefit or return on investment analysis to justify certain risk reduction programmes or contingency plans.

This was also discovered by van Hoek (2021) who found that the studied firms one year into the Covid 19 pandemic still lacked to mitigate risks from pandemic, and that several of the risks had increased in severity.

Er Kara, Oktay Fırat, and Ghadge (2020) suggests establishing a risk management team which are responsible for the organizations' SCRM process. Jüttner, Peck, and Christopher (2010) presents four different strategies companies can undertake in order to mitigate risk. These are *avoidance*, *control*, *co-operation*, and *flexibility*. *Avoidance* involves avoiding products, suppliers, or geographical markets that has an uncertain supply. *Control* involves mitigation practices that seek to control the risk, such as vertical integration, increased inventory, excess capacity in production and transport, as well as entering requirements into contracts with suppliers. *Co-operation* refers to joint efforts to improve supply chain visibility and understanding, to share risk-related information, and to prepare supply chain continuity plans. *Flexibility* involves mitigation practices for increasing the responsiveness of organizations with specific practices such as postponement, multiple sourcing, and localised sourcing. Flexibility have often been given lower priority than cost reductions, particularly in global supply chains (Jüttner, Peck, and Christopher 2010). The different strategies are presented in table 2.

<b>Avoidance</b>	• Dropping specific products/geographical markets/supplier and/or customer organizations
<b>Control</b>	• Vertical integration
	• Increased stockpiling and the use of buffer inventory
	• Maintaining excess capacity in productions, storage, handling and/or transport
	• Imposing contractual obligations on suppliers
<b>Co-operation</b>	• Joint efforts to improve supply chain visibility and understanding
	• Joint efforts to share risk-related information
	• Joint efforts to prepare supply chain continuity plans
<b>Flexibility</b>	• Postponement
	• Multiple sourcing
	• Localized sourcing

Table 2: Overview of mitigation strategies (Jüttner, Peck, and Christopher 2010)

### 2.2.2 Supply chain risk management process

Many researchers have discussed how to deal with risks. Most of them include the steps of first identifying the risks, then assessing them, before creating strategies to mitigate them (Kern et al. 2012). The assessment often includes both estimating the likelihood of a risk occurring, as well as the potential economic impact on the businesses, such as presented by Tang (2006b). Several researchers have also included a fourth step in the supply chain risk management process, which is controlling and monitoring the risk in advance (G. A. Zsidisin, Melnyk, and Ragatz 2005; Hachicha and Elmsalmi 2014; Fan and Stevenson

2018; El Baz and Ruel 2021). It has also been discovered that these steps will affect a supply chain's resilience positively (El Baz and Ruel 2021).

### *Risk identification*

Risk identification is the first step in the SCRM process and involves trying to find all potential risks that are relevant for a business. It is necessary to be able to later assess and determine a strategy for it (Fan and Stevenson 2018). The two main things that are done in risk identification are scanning for new potential threats and classifying the already identified risks (Kern et al. 2012). The risk identification should be done in a such way that it uses the company's resources efficiently. This is done by focusing around already existing sources of risks as well as the company's most vulnerable and critical areas regarding supply of material. A such operation requires knowledge about critical components, processes and suppliers (Kern et al. 2012). Several tools have been developed to identify risks, but most of them are only applied either by researchers or practitioners. According to Fan and Stevenson (2018), the only tool applied by both groups seems to be the cause-effect diagram, also known as Ishikawa diagram or a fishbone diagram. This diagram shows the relationship between risks and their respective causes (Lin and Zhou 2011).

Chopra and Sodhi (2004) presents that managers should make sure that the company has a common understanding of their supply chain risks, and that this can be achieved through "stress testing". The first step of stress testing involves identifying the most important suppliers, customers, plant capacity, distribution centres and shipping lanes, as well as possible sources of risks.

### *Risk assessment*

Risk assessment is the second step in the SCRM process, and involves evaluating the likelihood of a risk occurring, and the impact it will have if it occurs (Kern et al. 2012). It aims to prioritize the risks according to this evaluation, which is important to determine the strategy to deal with the risks (El Baz and Ruel 2021). This is done by providing in-depth information about the risks, which can contribute to avoiding it, reducing the likelihood and impact, in addition to coming up with a mitigation strategy (Kern et al. 2012).



The wanted result from risk assessment is a classification and prioritization of all relevant risks, which can be achieved by graphical illustration (Kern et al. 2012). A risk matrix can be a such example that is the most popular for both researchers and practitioners (Fan and Stevenson 2018). A risk matrix is a tool used to classify risks based on the probability of the risk occurring and the impact it has if the risk occurs (Jonsson 2008, 391). The number of squares in the matrix varies. Jonsson (2008) includes four squares (2x2), dividing the probability and impact into two categories: Low and high. Khan, Christopher, and Burnes (2008) divides the probability into remote, possible, and likely, and impact into manageable, major and critical. They thereby include nine squares (3x3) in their matrix. The most critical risks are the ones that have a high likelihood and a high impact, while the opposite applies for the least critical risks (Jonsson 2008, 391).

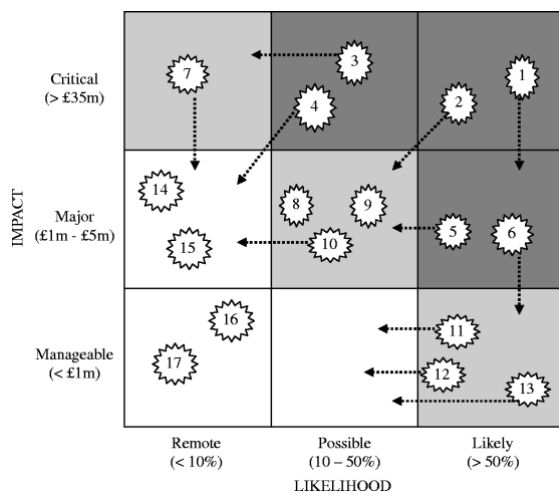


Figure 4: Example of a risk matrix (Khan, Christopher, and Burnes 2008).

The stress test of Chopra and Sodhi (2004) also involves assessing the potential impacts and the company's preparedness to create a foundation for prioritizing where the focus on risk mitigation should be.

### *Risk mitigation*

The third step in the SCRM process is risk mitigation. Risk mitigation is about reducing both the likelihood and impact of a risk to an acceptable level (Fan and Stevenson 2018). This is essential for a company in order to survive disruptions, but despite this, 95% of *Fortune 500* companies are not prepared to manage an unexperienced disruption (Alpaslan and Mitroff 2003). Risk mitigation can either be done proactively, through mitigating the risk before it occurs, or reactively by creating contingency plans for dealing with the event (El Baz and Ruel 2021). It is not expected from the supply and purchasing practitioners to

predict all potential risk, but to create strategies to mitigate the most likely events (Johnsen, Howard, and Miemczyk 2019, 217).

The last step of Chopra and Sodhi's (2004) stress test is to come up with strategies to mitigate the discovered risks, and they suggest "tailoring" to achieve this. Tailoring involves customising the strategies by doing a trade-off between the risk, and the cost of mitigating it. They suggest the following rule-of-thumb: "When the cost of building a reserve is low, reserves should be decentralized. When the cost is high, reserves should be pooled. If the level of risk is low, focus on reducing costs. If the risk is high, focus on risk mitigation." (Chopra and Sodhi 2004). Risk pooling means centralizing inventory to deal with demand variance at the individual retailers, to reduce costs and risk (Schmitt et al. 2015). Chopra and Sodhi (2004) also suggests diversifying the sourcing strategy based on the risk and value of the goods. Products with low margins and low forecast risks should be sourced from a cheaper supplier with higher efficiency, while products with high value and high risks should be sourced from a more responsive supplier that can be more costly.

Tang (2006b) mentions economic supply incentives as a possible mitigation practice. He explains that organizations can provide economic incentives for their suppliers to ensure having a stable supply base by establishing and maintaining alternative suppliers, in case of disruptions. The practice involves sharing a financial risk with the supplier(s), by for instance committing to a minimum order quantity. Pakdeechoho and Sukhotu (2018) suggests that a higher level of incentives in the supply chain increases the supply chain collaboration.

Various risks may benefit from separate strategies based on their predictability and criticality. Chopra and Sodhi (2004) presents seven different mitigation approaches, and how to choose a tailored strategy in each of them:

1. Increase capacity, by having a low-cost, decentralized capacity for the predictable demand, and centralized capacity for the unpredictable demand.
2. Acquire redundant suppliers for high-volume products, and use a few flexible, centralized suppliers for low-volume products.
3. Increase responsiveness for short life cycle products and focus on costs for commodity products.

4. Decentralize inventory of predictable, low-value goods and centralizing inventory of unpredictable, high-value goods
5. Increase flexibility for low-volume, unpredictable goods and focus on costs for high-volume, predictable goods.
6. Pool or aggregate demand when unpredictability increases.
7. Increase capability for high-value, high-risk goods, and focus on costs for low-value, commodity goods.

Dohale et al. (2022) lists eight different proactive and reactive mitigation strategies:

1. Visibility and transparency, through information sharing
2. Flexibility, to be able to respond to external changes
3. Relationships/Partnerships with suppliers to minimize supplier uncertainty, and get on-time and high-quality deliveries
4. Postponement of parts, as a strategic backup inventory
5. Multiple sourcing and flexible contracts to ensure deliveries
6. Redundancy of inventory
7. Collaboration on research and innovation for gaining knowledge to cope with risks
8. Joint planning and coordination throughout the supply chain to distribute the risk across it.

These two lists of mitigation strategies from different authors, with almost 20 years apart, shows how the approach to mitigate risks have changed in this time. There are still focus on increasing inventory, and having redundant suppliers, but there is much more focus on supply chain relationship, collaboration, and coordinating, as well as transparency. A recent study by Lafrogne-Joussier, Martin, and Mejean (2023) studied French firms sourcing inputs from China in the early period after Covid 19. They found that firms that held more inventory were less affected by the disruption, while geographic diversification didn't seem to mitigate the disruption.

The fact that risks are interconnected makes supply chain risk management more difficult. This is because mitigating one risk may end up with aggravating another one (Chopra and Sodhi 2004; Fan and Stevenson 2018). Kern et al. (2012) also mentions this when saying that it's crucial to understand the factors behind a risk, with a special attention on inter-relatedness of risks and trigger events when performing risk assessment. Figure 4 shows

how mitigation strategies can both decrease and increase different types of risks at the same time. As an example, increasing the inventory reduces the risk related to stockouts, but it increases the risk related to having unnecessary inventory that is costly and might shrink (Chopra and Sodhi 2004). It can therefore be a good strategy in short-terms, but the long term effects must also be identified and taken into consideration (Stecke and Kumar 2009).

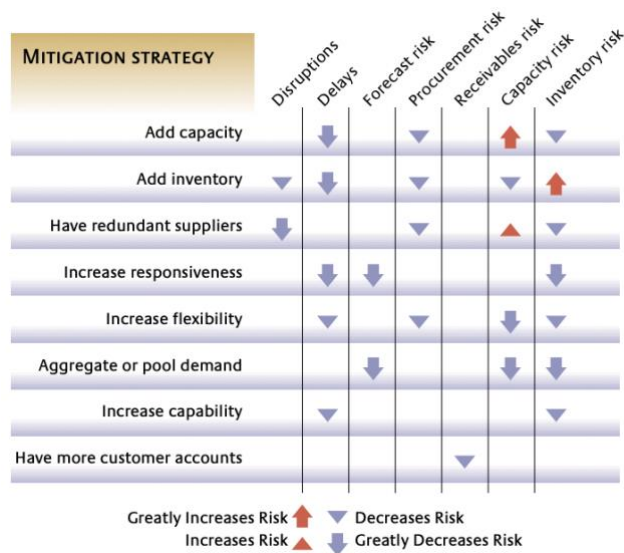


Figure 5: Impact of various mitigation strategies (Chopra and Sodhi 2004).

### Risk monitoring

Risk monitoring is about monitoring to evaluate how the sources of risk are evolving, and if there is a need for changing the strategy (Fan and Stevenson 2018). It has been stressed by many researchers as a way to reduce both frequency and impact of risks. According to Fan and Stevenson (2018), risk monitoring have been less researched and less focused on by practitioners. It's important to monitor the risk, even after it has successfully been mitigated, to follow changes, follow up the effectiveness of the mitigation strategy and to make adjustments if necessary (Kern et al. 2012). Research has shown that a continuous improvement process, which can be achieved through risk monitoring, has a positive impact on supply chain risk identification (Kern et al. 2012). One way to do this is by using the risk matrix devolved in the risk assessment step to determine which risks to monitor more frequently (Qazi and Akhtar 2020).

Even though it has been developed some methodologies to monitor risks, most of them are not developed to monitor supplier risks over time. Research has also shown that most methods are too complex to understand and to implement, needs a huge amount of data, or

are too subjective (Blackhurst, Scheibe, and Johnson 2008). Blackhurst, Scheibe, and Johnson (2008) therefore created a monitoring methodology using a multi-criteria scoring procedure. The methodology mathematically analyzes the risk related to a supplier or critical parts over time and identifies trends. This helps the business to develop proactive strategies.

### **2.2.3 Supply chain integration**

There has been a change in supply chains from firms competing against each other, to supply chains competing against each other (Christopher 2000). This has increased the need for collaboration and integration in supply chains. There are a lot of studies that has proved that companies' performance is affected by the degree of integration, and that integration can enhance the resilience of a company (Liu and Lee 2018).

Kauppi et al. (2016) discovered the importance of combining external supply chain integration (SCI) with supply chain risk management practices as it increases the company's operational performance. They saw that companies facing major disruption risk see the benefit of SCI. In their studies they found that SCI can benefit from risk management practices by decreasing the dependency on suppliers and customers.

Traditionally, firms have used buffer stocks, quoted lead times, excess capacity, and extra suppliers to deal with supply chain risks. As they build up these buffers, it reduces their need for process information from their partners (Kauppi et al. 2016). Other research has turned their focus to SCI in risk mitigation. Tang (2006a) suggests that supply chain risks can be mitigated through coordination and collaboration on four approaches: supply management, demand management, product management and information management. Coordination and collaboration with upstream partners can ensure that the supply of materials happens less risky and more efficiently (Tang 2006a). Close collaboration with suppliers have also been found to enable early and effective risk mitigation (Kern et al. 2012).

A recent study conducted by Bø, Hovi, and Pinchasik (2023) that studied Norwegian food- and pharmaceutical supply chains in the aftermath of Covid 19 stressed the importance of having good and long-term relationships with both upstream- and downstream partners in the supply chain, to be able to handle disruptions.

## 2.2.4 Supply chain relationship

Supply chain relationships can be seen as a continuum between an arm's-length relationship and vertical integration (Harrison et al. 2019, 343). This has been suggested by several well-known economic researchers such as Sako (1992), Lambert (1996), and Williamson (2008). An arm's length relationship is market-based and has a price-focus and a transactional nature, while vertical integration is cemented through ownership and has a collaborative nature.

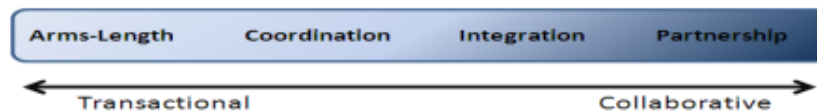


Figure 6: Buyer-supplier relationship continuum (Morsy and Ibrahim 2014).

Supply chain relationships can also be presented as short-term exchanges and long-term exchanges as two opposites, where short-term exchanges involves products or services, information, financial and/or social exchanges, while long-term exchanges involves strategic alignment or long-term sharing of risk and reward between two parties (Johnsen, Howard, and Miemczyk 2019, 102). Bag et al. (2023) suggests maintaining a relationship with alternative suppliers in order to secure supplies in uncertain times.

Resilience, in a supply chain perspective, can be defined as *“the adaptive capability of the SC to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function”* (Ponomarov and Holcomb 2009, 131). A study from Bø, Hovi, and Pinchasik (2023) discovered that strong, long-term, and collaborative relationships with key suppliers tend to increase a firm's resilience and chance of being prioritized, compared to firms with supplier-relationships based on pricing.

## 2.2.5 Transparency

Transparency can be described as when “Information is shared on a selective and justified basis between two organizations” (Lamming et al. 2001). Transparency of information between upstream- and downstream partners in a supply chain is key to success in today's volatile market (Harrison et al. 2019, 321). According to, Christopher and Peck (2004) lack of shared information can increase the total supply chain costs and make them more vulnerable. Communication has been identified as particularly important in global supply chains to control and coordinate operations, and sharing of information can increase the

possibility of anticipating a potential upstream supply chain risk (Stecke and Kumar 2009). By sharing relevant information upstream and downstream in the supply chain, the organizations can make better decisions based on data (Huong Tran, Childerhouse, and Deakins 2016).

van Hoek (2021) found that information sharing increased in the supply chains increased during the first year of Covid 19, and that it had been a key factor for collaboration. It is evident that transparency can be beneficial for all parts of a supply chain, and the whole supply chain in total, but however it have not been seen to reduce uncertainty in transport, because it's hard to control this risk (Du and Jiang 2019).

### **3.0 Research methodology**

This chapter presents the methodological decisions of my research. Both methods and methodology are taken into consideration to pay equal attention to both practical and philosophical issues of research (Kirsch and Sullivan 1992). The terms *method* and *methodology* are frequently interchanged. Kirsch and Sullivan (1992) defines method as "a technique or way of proceeding in gathering evidence". They also define methodology as "the underlying theory and analysis of how research proceeds. The difference between them is often illustrated by referring to the method as the ingredients in a recipe and the methodology as the recipe (Sedlmair, Meyer, and Munzner 2012). In order to obtain an applicable result in a research, Mohajan (2018) argued that it must involve an explicit, disciplined, and systematic approach.

Saunders et al. (2019) introduced a model that can be used as a tool for describing the different stages a researcher must go through to, to develop an effective methodology and an appropriate result. The model is called the 'research onion', and consists of six layers, representing the different stages. Crotty (1998) argues that for your research to be taken seriously, it's necessary to explain the reasons behind your choices. The goal is to design a research project where all the different research elements fit together (Saunders et al. 2019, 131)

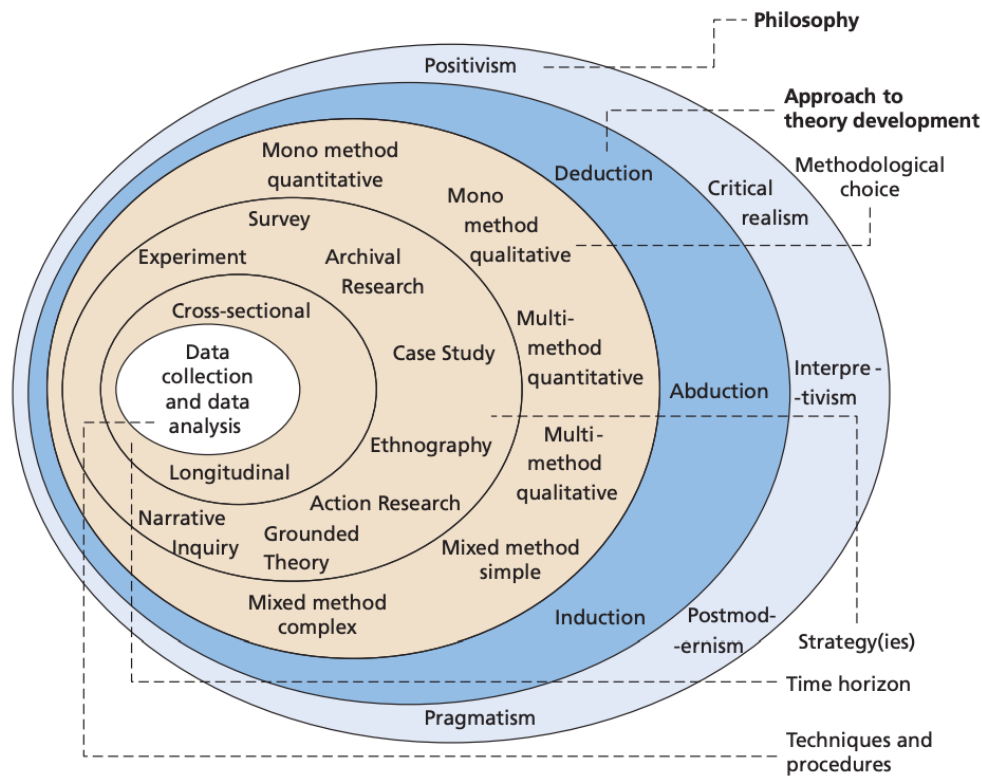


Figure 7: The 'research onion' (Saunders et al. 2019).

### 3.1 Research philosophy

The first layer of the 'research onion' is research philosophy. Research is about developing knowledge on a specific area. This knowledge development will be colored by one's own assumptions about realities experienced in the research (ontological assumptions), about human knowledge (epistemological assumptions), and about how one's own values influence the research process (axiological assumptions) (Saunders et al. 2019, 130).

Ontology and epistemology are the two main types of philosophical assumptions, and they show important differences that influence how researchers think of their research process. These differences may also cause the results to be biased in the researcher's direction.

#### *Objectivism and subjectivism*

Both ontology and epistemology differ between two set of extremes: objectivism and subjectivism. Ontological, objectivism takes the position that "things, such as social entities, exist as a meaningful reality external to those social actors concerned with their existence" (Crotty 1998). Subjectivism, on the other hand, believes that "social phenomena are created through the perceptions and consequent actions of affected social actors" (Saunders, Lewis, and Thornhill 2012, 131). Subjectivists therefore gather opinions and



narratives, and because they are involved in the way they are when collecting data, they acknowledge that their own values can affect the research (Saunders et al. 2019, 137). While objectivism epistemological believes that only observable facts can contribute to acceptable knowledge, and that the obtained data must be law-like generalized, subjectivism emphasizes people's opinions and focus on individuals and contexts (Saunders et al. 2019, 135). Based on these explanations, I believe that I, both ontologically and epistemologically, lean more towards subjectivism.

### **3.1.1 Research philosophies in business and management**

Saunders et al. (2019) further presents five different philosophies from business and management research: Positivism, Realism, Interpretivism, Postmodernism, and Pragmatism. In my research, I follow interpretivism as research philosophy because its better suited for exploring social phenomena in depth.

According to interpretivism, a researcher must understand the different roles humans have as social actors in our everyday life. Each of the roles we and others have, we interpret in accordance with a set of meanings we give to these roles. Interpretivism argues that social science is too complex to be explained by some law-like generalizations such as in natural science, and therefore the researchers must try to understand the world from the research subjects point of view without creating universal 'laws' that applies for everyone (Saunders, Lewis, and Thornhill 2012, 137; Saunders et al. 2019, 149). This philosophy therefore often favors collection of qualitative data (Saunders et al. 2019, 145).

## **3.2 Approach to theory development**

The approach to theory development refers to how the relationship between theory and data is organized in the study. There are three different approaches: deductive, inductive, and abductive.

A deductive approach involves starting with developing a theory from an idea or some hypotheses, often from existing literature, and then designing a research strategy to test this theory. This approach is often used in natural science, where one develops laws that helps to explain phenomena's and predict their occurrence. The theory can be confirmed if

the results correspond to the prerequisites which has been set. An essential characteristic of the deductive approach is to be able to measure the data collected, which makes it most common to use quantitative data and a positivist research philosophy. The results should also be generalizable, and therefore the sample used in the research must be large enough and chosen correctly (Saunders et al. 2019, 153-154).

An inductive approach involves starting by collecting data to explore a phenomenon and then use this to build a theory (Saunders et al. 2019, 153). The theory may be the same as a theory developed with a deductive approach, but the reasoning is different. Induction, in contrast to deduction, is often used in social science where a cause-effect relationship is less fitting. It is more common to collect qualitative data, and the researcher would also most likely follow an interpretive philosophy (Saunders et al. 2019, 155)

Abductive approach involves collecting data to explore a phenomenon, identify themes and explain patterns, to be able to generate a new theory or modify an existing one, which is subsequently tested through additional data collection (Saunders et al. 2019, 153). This can often be done by coming up with a theory that could give an answer to some surprising phenomena (Saunders et al. 2019, 155). An abductive approach combines both a deductive and an inductive approach (Suddaby 2006). In practice, most researchers in the management field use some sort of abduction, because it's very difficult to exclusively use either deduction or induction. Pragmatism, postmodernism and sometimes critical realism are the most common philosophies for this approach (Saunders et al. 2019, 156). The main differences between the approaches are shown in figure 9.

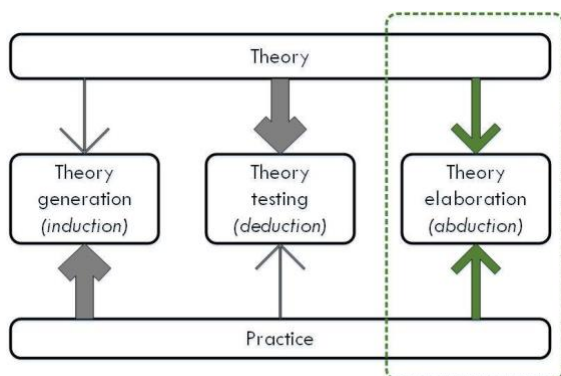


Figure 8: Inductive, deductive, and abductive approaches

In my research, I use an abductive approach because it involves generating explanations to an observed phenomenon and using theory and practice to elaborate theory. It's also well suited to subjectivism and interpretivism as research philosophies.

### **3.3 Research design**

Research design can be defined as "a logical plan for getting from here to there, where here may be defined as the set of questions to be addressed, and there is some set of conclusions about these questions. Between here and there may be found a number of major steps, including the collection and analysis of relevant data." (R.K. Yin 2018, 26). In other words, research design helps to choose the right research questions, the right data to be collected, as well as how the results should be analysed (Philliber, Schwab, and Samloss 1980). The main purpose with the research design is to make sure that the result of the study answers the research questions (R.K. Yin 2018, 26).

An important choice of the research design is whether the research should be quantitative, qualitative, or a combination of the two. Quantitative research design will often be connected to positivism and based on a deductive approach, while qualitative design usually matches with an interpretive philosophy and an inductive or abductive approach (Denzin and Lincoln 2008; Saunders, Lewis, and Thornhill 2012, 163).

R.K. Yin (1994) categorizes research design into three categories: Exploratory, Descriptive, and Explanatory. Exploratory studies seek to study a new phenomenon and understand a situation from a new perspective. Descriptive studies seek to understand a situation, person or event as well as communicating how things are related to each other. Lastly, explanatory studies seek to explain why a phenomena occur, and to predict the occurrence of future phenomena's (R.K. Yin 1994).

In my research, I use a qualitative design, and this matches with my research philosophy and approach to theory development. Based on the research question, my research can be viewed as explanatory because the question seeks to understand how organizations' mitigation practices correspond with their experienced consequences and what the differences between two types of supply chains are.

### 3.4 Research strategy

Saunders, Lewis, and Thornhill (2012, 173) defines a research strategy as “a plan of how a researcher will go about answering her or his research question» and Denzin and Lincoln (2008) emphasizes that it is a connecting methodological link between the research philosophy and the research methods. There are many research strategies that can be deployed. Saunders, Lewis, and Thornhill (2012) presents experiments, surveys, archival research, case studies, ethnographies, action research, grounded theory, and narrative inquiry as research strategies.

This thesis is designed as a case study. There are many definitions of a case study. Common for most of them is that it is about studying the complexity involved in real situations. A detailed definition is given by Simons (2009, 21): "Case study is an in depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, programme or system in a 'real life' context. It is researched-based, inclusive of different methods and is evidence-led. The primary purpose is to generate in-depth understanding of a specific topic (as in a thesis), programme, policy, institution or system to generate knowledge and/or inform policy development, professional practice and civil or community action." R.K. Yin (2018, 9) adds to the description of case studies that the researcher has little or no control over behavioural events when doing the research. According to R.K. Yin (2018, 4), a case study should be done when one has research questions that wants to study and explain a present situation of a social phenomenon, often with questions starting with the words "how" or "why".

When case study is chosen as design, one must determine whether to perform a single case study or multiple case study. A single case study can be used when the case is to test a well-formulated theory, when the case is extreme or unique, or when the phenomenon researched has previously been inaccessible. A multiple case study design can be used to predict similar results among replications or to show contrasting results for reasons that can be predicted (Ellram 1996). Ellram (1996) suggests that six to ten cases should be included to provide convincing evidence. In this thesis I am going to perform a multiple case study with six cases, which should be enough to provide convincing evidence. I chose to perform a multiple case study because this can create better generalizability than a

single case study, and because it creates the possibility to compare two different types of supply chains.

### **3.5 Data collection**

Data are “the facts and figures collected for records or any statistical investigation.”, and they can be either quantitative or qualitative (Adams, Khan, and Raeside 2014, 70). The sources of data may either be primary or secondary, where primary sources are gathered by the researcher himself, while secondary sources have been collected for other reasons, and used by the researcher (Adams, Khan, and Raeside 2014, 70).

To answer my research questions, I’ve chosen a qualitative approach. Qualitative research involves “verbal description of real-life situations”, in contrast to quantitative research which involves “numerical analysis of the relationship between variables” (Silverman 2020, 6). In other words, qualitative research use text whilst quantitative research use numbers. I believe that a qualitative approach is best for this study because this will provide deeper insight into different organizations’ experience of upstream supply chains risks, as well as how they work with risk management, than a quantitative approach would do. I’m also going to collect primary data, as this is the best way to collect data that are tailored to answer my research question (Hox and Boeije 2005).

In the following section, the selected method for gathering primary data is presented. Secondary data has not been used in this study.

#### **3.5.1 Primary data: Interviews**

For the collection of primary data for this research, I chose to perform semi-structured interviews. A research interview is a targeted conversation between a group of people, where an interviewer ask questions and a respondent answers them (Saunders, Lewis, and Thornhill 2012, 372). Semi-structured interviews are common in qualitative research and can be seen as a mix between the two extremes of structured interviews and open-ended interviews (Silverman 2020, 177). In a semi-structured interview, the researcher has some key topics do discuss, and possibly some key questions. The questions or the order of them are not fixed but will vary depending on the organization being interviewed and the flow of the interview (Saunders, Lewis, and Thornhill 2012, 374). It’s also normal to dig deeper

into interesting or unclear answers from the interviewee during the interview (Silverman 2020, 177).

To find the cases for this study, I collaborated with a consulting company specialized in procurement. They helped me by providing contact info for organizations they thought were relevant and interesting for my study. All organizations are current or former customers of them. These organizations were first contacted by the respective customer manager with a short note about the master's thesis and a question if they would be willing to attend an interview. The organizations with a positive answer were then presented for me, together with their contact info. I then contacted them myself to schedule the interview.

Furthermore, the organizations that wanted it were provided a prearranged interview guide in advance. A few of the interviews were conducted without the respondents being sent the interview guide in advance because they were planned and conducted in such a short time, or due to other reasons. An interview guide is used to cover the most important topics of a study, but should only be used as a guideline and not followed strictly (Kallio et al. 2016). The interview guide was created in collaboration with my supervisor and was made to answer the research question. Interview guides from other similar studies were used as inspiration for the questions. Some of the questions included examples either in the prescribed version or in my internal version, to help the respondents come up with relevant examples from their organization. The interview guide was adjusted a little bit for each interview, but the main version is presented in Appendix 1.

All interviews were conducted with supply chain professionals in the different organizations between January 23<sup>rd</sup> and March 1<sup>st</sup>. All of them were conducted digitally through Microsoft Teams with both audio and video communication. This made it easier to carry out the interviews with interviewees located throughout the country, than with physical meetings, enabling more interviews in a shorter time, and with the right personnel. Most of the interviews took approximately one hour, as was prescribed for the interviewees, but some exceeded, while others were some shorter.

To document as much details as possible from the interviews, audiotape recording was used. This was done through an application called *Diktafon* developed by University of

Oslo to record and store the recordings in a safe place. The recording was then used to transcribe all interviews. In this part I followed the advice from Silverman (2020, 115) that one should only transcribe the first one or two interviews fully, and then analyze those to determine which parts of the remaining material that needs to be transcribed fully.

Transcribing is a time-consuming activity, but it is important to create a good foundation for discovering findings and performing the analysis.

### **3.6 Data analysis**

When analyzing the data, I first went through the transcribed data and generated codes for risk types and consequences of upstream SC risks, and the different SCRM processes, including all their mitigation practices. These are also the same areas I examined to answer my research question. The codes were then grouped where this was natural. An example of this grouping is that the codes “Reduced production” and “Stop in production” which were discovered as consequences of upstream supply chain risks were grouped as “Reduced or stop in production”. Coding and creating code groups is a part of *stepwise deductive induction* which is a process presented by Tjora (2021), to analyze qualitative data. An important factor from this process regarding coding, is that the codes should present the essence of the interview, but with less text. Coding have also been presented by several other researchers, such as Saunders, Lewis, and Thornhill (2012). They also distinguish between concept-driven and data-driven categories. Concept-driven means that they are derived from existing theory and literature, whilst data-driven categories are derived from own terms or actual terms used by participants in the data. Almost all terms are used by the participants and are therefore data-driven categories. In my analysis, I also used a form for a correlation matrix with qualitative data to investigate the connections between experienced consequences and currently implemented mitigation practices in the organizations.

### **3.7 Research quality**

Researchers that want their research to be accepted as credible must focus on the research quality. It's impossible to know that the evidence and conclusion of a study is totally correct, it's only possible to reduce the likelihood of being incorrect (Saunders, Lewis, and Thornhill 2012, 192). This is done by having a good research design that promotes reliability and validity.

### **3.7.1 Reliability**

Reliability concerns a research's consistency. Would the results be the same if they were repeated on a different point of time or by a different researcher? (Saunders, Lewis, and Thornhill 2012, 192). R.K. Yin (2018, 43) provides some tactics to ensure reliability in case studies. These are to use a case study protocol, to develop a case study database, and to maintain a chain of evidence. According to Silverman (2020, 93), key factors for ensuring reliability when using interviews are that the questions are understood similarly by the respondents and that the answers can be coded without uncertainty.

To ensure reliability in my research I recorded all interviews and transcribed them myself. The interview guide was revised by my contact person in the consulting company, to make sure that all questions were asked in such a way that they were easy to understand for the respondents. I used the same interview guide for all interviews, but since this was semi-structured interviews, it was slightly adopted and reordered, both before, and during the interviews to have a natural flow and to fit the different organizations. This may have had an impact on the reliability, as questions were open-ended, and the respondents were free to elaborate on what they thought was interesting for the interview (Saunders, Lewis, and Thornhill 2012, 381)

It can be discussed if findings from semi-structured interviews are meant to be reliable as they are a picture of a situation at a certain time and therefore not repeatable. Thus, it's important that the study's research design, choice of strategy and methods, as well as the obtained data are accessible for other researchers, for them to understand the process and potentially reanalyse the data (Saunders, Lewis, and Thornhill 2012, 382).

### **3.7.2 Validity**

Reliability, however, is not enough to ensure good quality. Validity is also necessary and can be divided into three forms: Construct validity, Internal validity, and External validity.

#### *Construct validity*

Construct validity is about identifying the correct operational set of measures, to be sure that the research measures what it is meant to measure (Saunders, Lewis, and Thornhill 2012, 42, 193). The tactics of R.K. Yin (2018) for construct validity are to use multiple



sources of evidence and have key informants review draft case study report. I regularly provided drafts of the thesis to my academic supervisor, who reviewed it and provided feedback. In addition, I let the respondents read through the finished transcription from their interview to fact check it and possibly correct misunderstandings.

### *Internal validity*

Internal validity can only be applied to explanatory or causal studies, and not to exploratory or descriptive studies, as it concerns the causal relationship between two variables (Saunders, Lewis, and Thornhill 2012, 193). For instance, if a researcher concludes why event x leads to event y, without taking an unknown event z into consideration, the internal validity has failed (Saunders, Lewis, and Thornhill 2012, 45). The tactics for internal validity is to do pattern matching, do explanation building, address rival explanations, and use logic models (R.K. Yin 2018, 43). This study takes several factors into consideration when analysing and discussing the data in order to retain internal validity.

### *External validity*

The last form of validity is external validity, and it concerns the research's generalizability. Generalizability concerns the fact that the findings of a study can be applied to other settings (Saunders, Lewis, and Thornhill 2012, 382). R.K. Yin (2018, 46) argues that including "how" and "why" questions can improve the external validity, because this makes the results easier to generalize. R.K. Yin (2018, 43) here suggests using theory in single-case studies and use replication logic in multiple-case studies to ensure external validity in case studies. Bryman (1998) argues that when qualitative research can be related to existing theory, the research study will have a broader theoretical significance, hereby being more generalizable. This research study is related to existing theory about supply chain risk management, which increases the possibility of generalizing the results.

## **3.8 Presentation of cases**

In this section, I will present the cases in this study, which regards six different organizations within two different types of supply chains. These supply chains are food supply chain and energy supply chain. Table 3 shows an overview over the organizations and the supply chain they operate in. The real organization names have been replaced with numbers to ensure anonymity. The same organizations numbers are used throughout the

thesis. The organizations within the food industry formally, according to Classification of Standard Industrial Classification by SSB (2009) belongs to *Manufacturing – Manufacture of food products*. Organization 4 and 6 from the energy supply chain formally belongs to *Mining and quarrying – Extraction of crude petroleum and natural gas*, while Organization 5 in the energy supply chain belongs to *Construction – Other specialized construction activities*. However, they are all part of energy supply chains.

Additionally, two other organizations were interviewed in conjunction with the research for this thesis, but these were omitted because they didn't fit with requirements of the research process. One of the organizations belonged to a health supply chain, and the initial goal was to interview several organizations within this type of supply chain, but due to difficulties in finding relevant organizations that wanted to participate in the research, this did not happen after all. The other company was a company within the energy supply chain, but they were founded in 2020 and have not had active operations with procurement of goods yet. The results from this interview were in collaboration with supervisor concluded to be irrelevant for this research.

<b>Organization</b>	<b>Supply chain</b>
Organization 1	Food supply chain
Organization 2	Food supply chain
Organization 3	Food supply chain
Organization 4	Energy supply chain
Organization 5	Energy supply chain
Organization 6	Energy supply chain

Table 3: Case descriptions

### **3.8.1 Organization 1**

Organization 1 is a large company owned by farmers which operates within several areas related to agricultural production. They have three divisions in their company. Firstly, they have a retail business of around 100 stores with a wide assortment for farmers and consumers. Secondly, they have a machine division that handles the sale and service of machines and equipment for farmers and construction. The third division is the agricultural division that handles all input factors for farmers. They produce concentrates themselves, and resell important input factors to farmers, such as fertilizer.

Organization 1 purchases goods and equipment for direct resale, and raw materials for their own production. In our interview, we had a focus on raw materials for their own production and important input factors for the farmers. I have therefore placed them within food supply chain at the overview. Organization 1 purchases raw materials either directly through the suppliers or through traders and agents that uses several suppliers. The input factors are to a large extent bought directly from the suppliers or through large wholesalers. Their suppliers of raw materials are mostly located in Brazil and China. Otherwise, they source mostly from Europe.

### **3.8.2 Organization 2**

Organization 2 is a producer and provider of emergency food for malnutrition, preparedness, and maritime survival. They have production in Norway, India, and South-Africa and are a part of a larger group that has businesses within many different areas such as shipping and real estate. Organization 2 purchases raw materials, packaging, and transport, and most of their costs, especially in India and South Africa, comes from these. In addition to following some requirements from ISO-standards, some of their customers are large humanitarian organizations that has strict requirements for production and hygiene. This affects their sourcing as it places restrictions on which raw materials and suppliers they can use. All new suppliers must be audited before they can be approved. Their products are therefore quite similar and consists of few raw materials.

All goods purchased for production in Norway is purchased from European suppliers. This is due to legislations which allows them to avoid custom duties in and out of Norway, as they export all their products. For India, they also source mainly locally in India due to legislations, with some exceptions. For South Africa, most of the goods are imported.

### **3.8.3 Organization 3**

Organization 3 is a concern within production and marketing of food for the consumer market. The concern consists of two production businesses. One that produces spread cheese and other toppings, and one that produces dairy products. Today, they have production in Norway, Sweden, Finland, and Great Britain, but the interview focused on their activity in Norway. Most of the products produced in Norway are also distributed within the country.

Organization 3 purchases raw materials, packaging, in addition to some services and transport. Most of their raw materials are sourced from Norway, while their packaging is sourced from Europe. For their most important suppliers, they have a close collaboration and a strategic relationship, while for others they keep an arm's-length distance. As they are a food producer, they have strict requirements they follow in terms of food safety. All new suppliers and products must be tested and approved, which can be time consuming. Therefore, they cannot easily swap suppliers, raw materials, or packaging without there being an already additional supplier of the product, or a backup-supplier ready in the system.

### Food supply chain

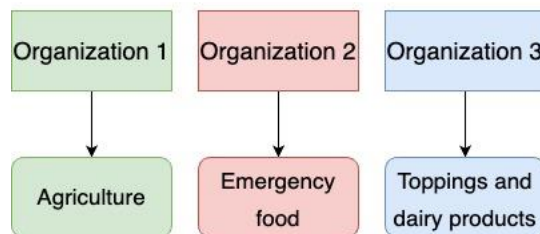


Figure 9: Food supply chain

#### 3.8.4 Organization 4

Organization 4 is a large oil- and gas company that explores for and produces oil and gas on the Norwegian continental shelf. My informant is working within the department drilling and wells, which is the business area that focuses on drilling for the oil and gas, and this interview has therefore been about this part of the company.

Organization 4 purchase mostly services. Only 10-15% of the total cost of a well comes from equipment. There is a lot of equipment that is rented, such as the rigs, and the equipment they use to drill the holes. They also purchase some bulk, such as fluids and mud, that can be reused partly, and oil country tubular goods which is a tube that is installed in the well to prevent it from collapsing. In this interview, we mostly focused on the goods they purchase.

Organization 4 have a clear strategy of having long-term strategic relationships with their key suppliers. They want to build trust with them through transparency and mutual respect. The idea behind this is that one should work seamlessly together to solve issues fast. This means that they not necessarily choose the best or cheapest suppliers, but the ones that fit

them best, gives them priority, and want to work and develop together. These suppliers are often large international companies, but they all have offices in Norway.

### 3.8.5 Organization 5

Organization 5 is a company within the field of ISS (Insulation, scaffold, surface protection) that provides products and services related to maintenance and modification for the oil-and gas industry and some other industries. The services they provide are mostly personnel, and the products they sell are habitats for welding etc., and various insulation products that they either custom make themselves to order or purchase as finished goods from a supplier. This supplier is located in Germany, and Organization 5 have a close integration with them. The goods they purchase to produce habitats and insulation products are steel plates, insulation materials, and a type of tarp. The steel plates are sourced from Norwegian steel wholesalers, and the tarps are sourced from China or UK.

### 3.8.6 Organization 6

Organization 6 is a small to medium sized oil- and gas company that explores for and produces oil and gas on the Norwegian continental shelf. In 2022, they purchased goods and services for over 5 billion NOK from about 1700 suppliers. They purchase a very large range of goods and services to produce the oil, and they also rent services such as vessels and warehouse. 95% of their suppliers are located in Norway, but these suppliers are amongst others sourcing from Europe, Brazil, USA, and China. Organization 6 have a strategy of having a long-term strategic relationship with their most important suppliers.

#### Energy supply chain

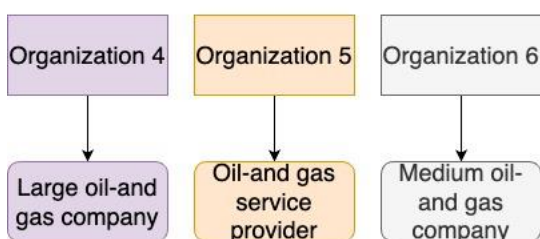


Figure 10: Energy supply chain

## 3.9 Construct measures

In this thesis I mobilize five constructs: Identified upstream SC risks and drivers, Experienced upstream SC risk consequences, Implemented upstream SC risk identification practices, Implemented upstream SC risk assessment practices, and Implemented upstream

SC risk mitigation practices. Most of the construct items were identified through the interviews, but they have a foundation in questions that is largely inspired by questionnaires by Kern et al. (2012) and El Baz and Ruel (2021).

The identified upstream SC risks and drivers can be found in Stecke and Kumar (2009), Inoue and Todo (2020), Ferreira et al. (2021), Tardivo, Carrillo Zanuy, and Sánchez Martín (2021), Dohale et al. (2022), Jagtap et al. (2022), Bø, Hovi, and Pinchasik (2023), and Lafrogne-Joussier, Martin, and Mejean (2023).

The identified consequences from upstream SC risks can to a large extent be found in George A. Zsidisin et al. (2004), Kleindorfer and Saad (2005), Guiffrida and Jaber (2008), Zhang and Figliozzi (2010), and Bø, Hovi, and Pinchasik (2023).

Most of the SC risk identification practices mentioned during the interviews overlap to a large extent with practices recommended by Kern et al. (2012), Zhu, Chou, and Tsai (2020), and El Baz and Ruel (2021).

The mentioned risk assessment practices can to a large extent be found in Klinkle and Renn (2002) and (Fan and Stevenson 2018).

Identified mitigation practices overlap to a large extent with suggestions from Chopra and Sodhi (2004), Tang (2006b), Jüttner, Peck, and Christopher (2010), Pakdeechoho and Sukhotu (2018), Er Kara, Oktay Firat, and Ghadge (2020), and Kumar et al. (2021).

In the next chapter, I will present the findings from the interviews, and then analyze the data obtained.

## **4.0 Findings**

This chapter includes a summary of the findings from each of the six organizations interviewed.

### **4.1 Organization 1**

Organization 1 have been affected by both delays and disruptions, and according to themselves, this has impacted them on a high level the last three years. Covid 19 has been

the main driver, which has brought along delays because of transport- and logistics issues and production delays from suppliers because they lack necessary resources.

The war in Ukraine has also caused some suppliers to reduce or stop production because of increased costs on input factors. This has especially affected their supply of artificial fertilizers because it requires large amount of energy to produce. In addition, they had some suppliers in Ukraine when the war started, but they had alternatives that they could switch to quickly.

Organization 1 have increased their purchase volume at existing suppliers and sourced from other suppliers than usual to secure supply of necessary resources. They have managed to avoid a stop in production of their concentrate, because they have used alternative recipes with substitutes. In addition, they have experienced increased costs as a consequence of more expensive products, increased inventory, and more expensive transport solutions.

Most of Organization 1's suppliers are usually good at informing about potential upstream SC risks, but not all of them. On critical deliveries, Organization 1 have a close follow-up. Their focus on identifying risks now is totally different than before January 2020. It was then much more dependent on the product, suppliers, and the persons working with it. As my respondent says: "One took it for granted that things would roll and go". The last three years they have therefore increased their awareness, systematic, and structure related to risk identification of supply risks.

Organization 1 use a standard ABC-categorizing of suppliers and products. For all products and suppliers that are being classified as strategic or critical, they perform a screening to see if there any possible risks that must be further investigated before they close a deal with a potential supplier or place an order. They then use a risk matrix to prioritize the risks based on their probability and impact, but the impact has a much larger role in their risk matrix. This also creates a foundation for the framework of follow-up for the different purchase orders. They admit that they still have some way to go on systemizing and structuring this, as it at this point is mostly dependent on the different employees how this is done. It will however be prioritized soon as they plan to include supply risks in their contract management system as a part of a total risk mapping of all

suppliers and agreements.

One of the most important mitigation practices Organization 1 has done is to build buffer by increasing their inventory. Before Covid 19 they had worked a few years with reducing their inventories and focus on costs when sourcing. This changed overnight to be about securing supplies. Organization 1 are now considering the possibilities to source more locally, but this is still in the starting pit. They have also had meetings with their suppliers to secure supplies. Organization 1 are actively working with investigating how they can increase the degree of Norwegian resources in the production of concentrate, for instance by replacing Soya from Brazil with Norwegian raw material. The reason for this is both to reduce the supply risk, and because Norwegian authorities has given clear guidance that they want to increase the use of Norwegian input factors in production of Norwegian concentrate. The use of alternative recipes with substitutes makes their production more flexible, and this has been an important factor for Organization 1 to maintain production.

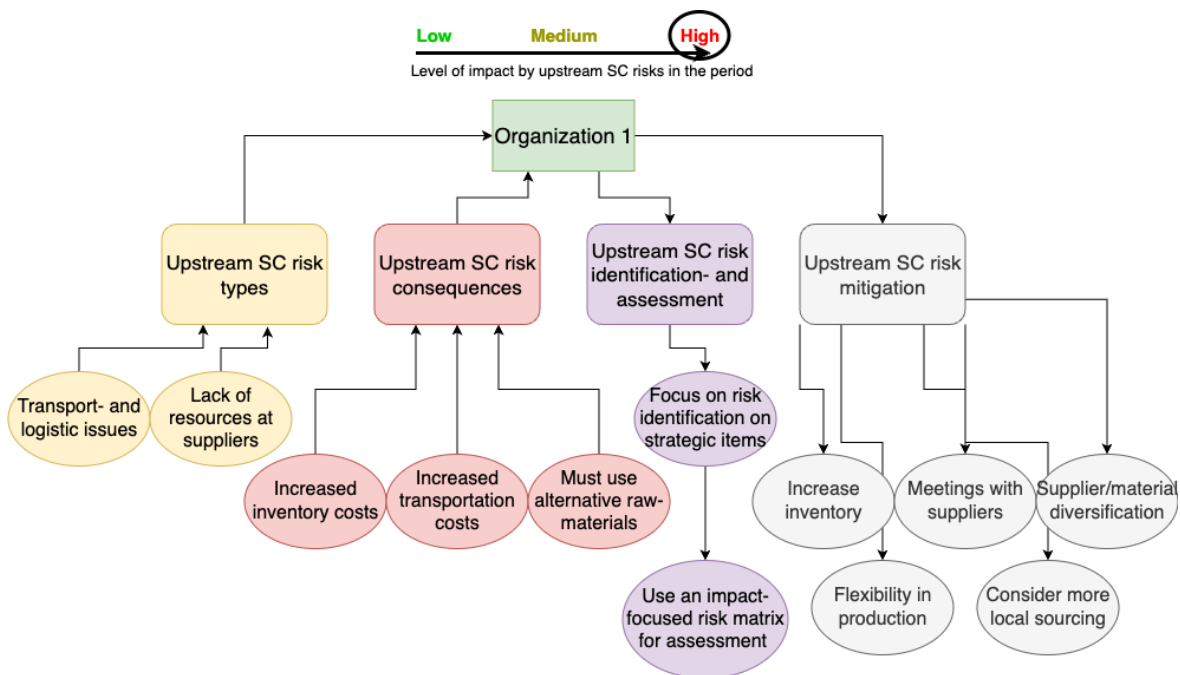


Figure 11: Characteristics of Organization 1

## 4.2 Organization 2

Organization 2 have experienced some delays to their production facility in South-Africa, but not that much in Norway or India. In total, my respondent says that they have been medium affected by disruptions and delays the last three years. The delays in South-Africa came, amongst others, because of closed ports, and they have also experienced other



logistic issues. My respondent did not work for the company when Covid 19 hit the world but says that especially their transport- and raw materials costs increased greatly.

To their production in Norway, they only source from European suppliers, due to legislations which allows them to avoid custom duties in and out of Norway. Legislation in India also forces them to source mainly locally in India. In addition to some delays and already high prices, they have experienced even more increased prices of raw material after the war, especially on cooking oil, sugar, and wheat flour.

As a consequence of delays, they have had to change their production schedules sometimes because they didn't get raw materials as planned. This has made the production sub-optimal, but it hasn't created large problems, because their products have a very long shelf life. This makes their production more flexible, as they can produce products where they have all necessary resources and store the finished goods for a period. They have therefore avoided stop in production.

However, they have had some reduced production at times. In addition, they have had to use alternative suppliers and raw materials that is maybe not their first choice. This is not unproblematic, as they set very strict requirements for food security, partly due to customers' requests. Sometimes, they have had to acquire alternative raw materials in a very short time, because they lacked a raw material they were expecting. This has also been more costly. To secure supplies, they have increased transportation- and inventory costs.

Risk management is generally well incorporated in the company because they work so much with food security. They have a good dialogue with their suppliers, and they have been visiting and auditing them all before closing the deal. This is important for them, and a possible action as they have few suppliers. They also believe that this is one of the key factors for securing supplies in uncertain times. They update their risk matrices within the different areas' multiple times a year and come up with mitigation practices. They have clear criterias for classification of impact and probability of the identified risks.

They have also seen that the use of local suppliers has been a success in India, and they therefore assessing the possibilities of using more local suppliers in South-Africa as well.

They are therefore in a process of building up suppliers to be able to deliver according to the requirements they have.

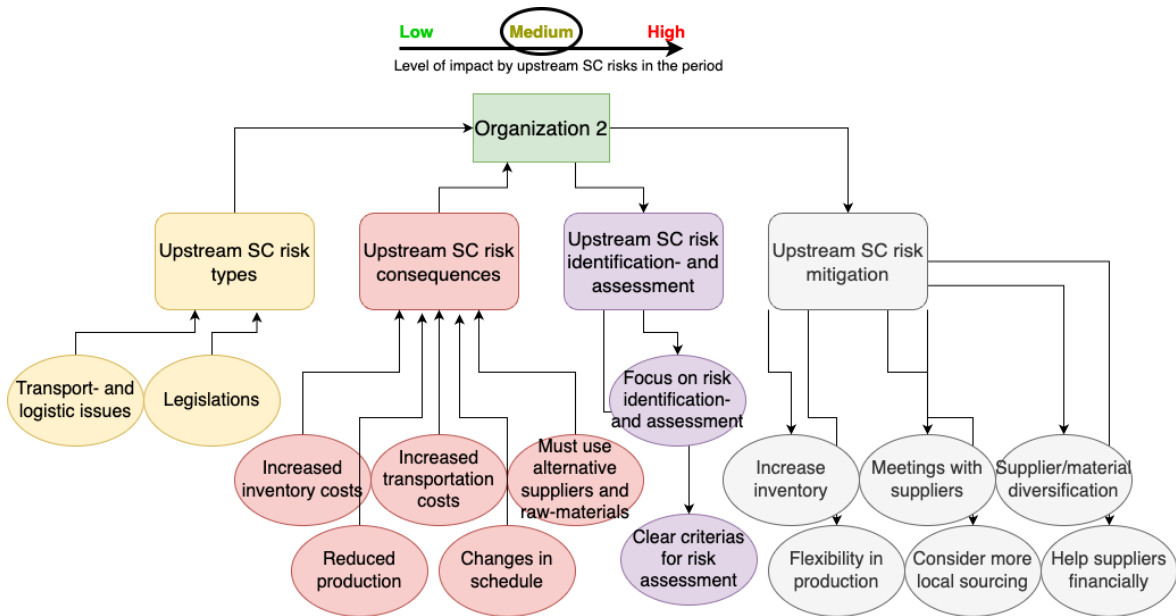


Figure 12: Characteristics of Organization 2

### 4.3 Organization 3

Organization 3 have experienced delays and disruptions on both raw-material and packaging. However, according to themselves, they have only been affected on a low level from these two risks the last three years. In conjunction with Covid 19, they experienced problems with sourcing a product from their supplier, because the supplier lacked a resource from China to produce it. There were also some issues with sourcing packaging during Covid 19 because suppliers' factories were closed down.

One of their packaging is made of aluminum, which has been difficult to obtain because the prices has increased the last years and was further increased when the war in Ukraine began. Their supplier has therefore reduced its production. The transport of packaging was also an issue when the war started because the supplier, located in Slovakia, usually relies on truck drivers from Ukraine. They suddenly had to fight for their country, and the supplier were then left without drivers.

Organization 3 have also experienced that a supplier from Sweden could not deliver a critical raw material for their production of dairy products. This even stopped the production and caused a stockout. Production of these products are much less flexible than the other part of their business because they have a short shelf life due to it being fresh

dairy products. They are also usually sold immediately after being produced, and there is therefore no assigned space for storing them. Prohibition from authorities against using plastic also forced Organization 3 to sell one of their products without a spoon for a period, as the supplier did not come up with any good alternatives. In addition, they have had to use alternative suppliers, or increase their volume at a second supplier of a product. Both the lead times and prices on raw material has increased greatly, and this has forced them to keep a larger safety stock, follow up deliveries more closely, and be much more proactive.

When Organization 3 place an order, they require an order confirmation within three days confirming that the right quantity will be delivered at the right time and price. If there is a discrepancy, they take action straight away. Many of their suppliers are good at informing them about issues further down the supply chain that may lead to delays, and sometimes recommend them to increase lead times on certain products. There are also exceptions to this, and they notice a difference between suppliers they have a strategic relationship with and not. Generally, they try to make sure that their suppliers are dependent on them. For themselves, they search for information in the market, but they mostly discover disruptions and delays when purchasers inform about discrepancy in the order confirmations. They therefore have weekly meetings with purchasers to ensure good communication about supply risk. Organization 3 focuses on identifying potential upstream SC risks in the whole supply chain, both when entering into agreements with new suppliers, and with existing ones.

In case of special events, for instance if a supplier has reported possible delays, they set up frequent meetings with them. When Covid 19 hit the world and when the war in Ukraine started, they had to check all their products weekly to see if they had control, as a consequence of the uncertainty they experienced.

Organization 3 focus mostly on impact of the upstream SC risks when assessing them. The largest consequence is a stockout situation of some of their products that they define as their bestsellers, or products where consumers have no other alternatives. This lay the foundation for prioritizing the sourcing of raw materials and packaging as well.

They use forecasts six months ahead to plan their production. This is something they share with their suppliers, to facilitate that they can inform about potential issues as early as

possible. On some critical products they have a deal with their suppliers that they are keeping a safety stock for them. They also use several suppliers for some of the critical products and have a backup supplier ready if necessary.

Their ERP-system is an active part of their risk mitigation which gives them information about when they need to order raw materials and packaging in order to fulfil their production as planned. The recent years, they have had to increase both lead times and safety stock in the system to secure deliveries.

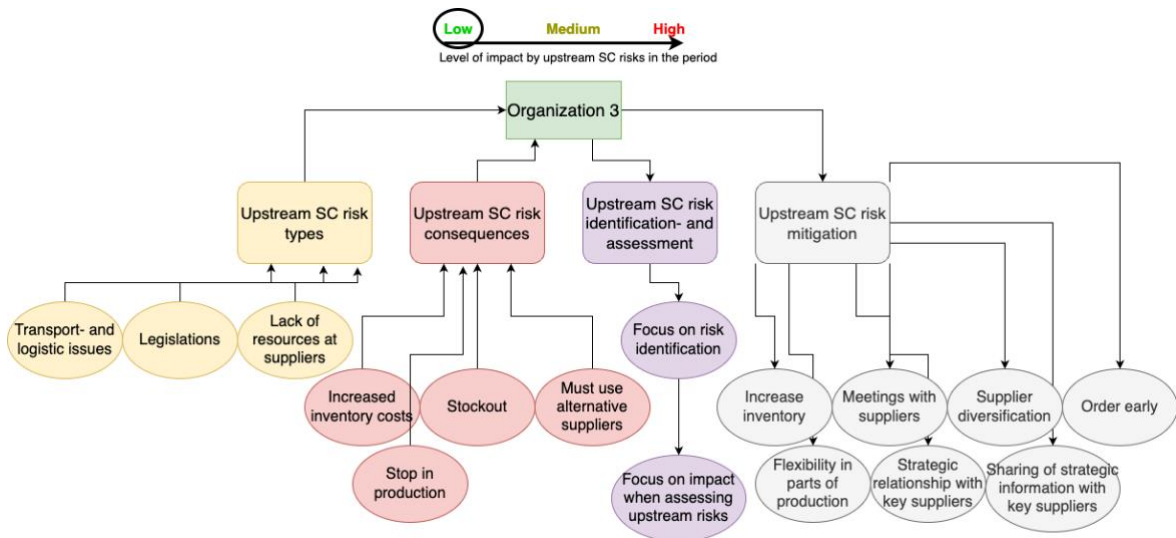


Figure 13: Characteristics of Organization 3

#### 4.4 Organization 4

Organization 4 have experienced few delays, and no disruptions. They have therefore been affected on a low level according to themselves. The few delays they experienced were mainly because of logistical challenges related to Covid 19 and lockdown in China, often also due to long ques for loading and unloading of ships. However, the interviewee believes Organization 4 and other companies within the same industry often were prioritized in these ques because they pay well and handle high-value equipment.

Another interesting mention from the interviewee is that Organization 4 and the rest of the industry had a lower activity than normal in the start of 2020, which may have made things better than they could have been if Covid 19 hit the world at a time of higher activity. To avoid delays, they have had increased costs on some equipment and transport, amongst others air freight. They've also had increased inventory costs.

It's a bit varied how good their suppliers are at informing them about potential disruptions and delays. They have a good dialogue with their key suppliers, especially about items with long lead time. Suppliers of rental goods have a higher incentive to avoid delays and are therefore generally much more used to search for information about potential disruptions and delays in their supply chain. However, some suppliers are too small to have employees working on this all the time. The same suppliers are also often in a position where they can't build up safety stocks of all products. In those situations, Organization 4, in cooperation with the supplier tries to find out if they can help by paying for raw materials etc. This way they can increase the probability of receiving their goods on time.

When Organization 4 assesses an upstream risk, they look at both the consequence and the probability. This is some of the information that they store about the upstream risks in a risk-register. The consequence is mostly based on what the cost of the risk is. They have four categories from a "quickfix" which increases logistic costs etc., to postponed production start, which is the most severe in terms of economy. Probability is determined on a scale of six, from low to high, and is based on market information and information from suppliers.

Organization 4 have worked a lot with risk management the last years and are now working on implementing a risk module with a risk register in their new contract system that is especially focused on delays. At the time of the interview, they currently used an Excel-sheet with the same information, but the plan was to implement the new module in Q1. The excel-sheet includes different types of risks, what equipment and suppliers it affects, possible impacts, probability, as well as mitigating actions and results if mitigated.

An important mitigation practice for Organization 4 is that they order some of their equipment six months earlier than they did before Covid 19. This has increased their inventory costs, but according to the interviewee it is a cheap insurance. However, the rest of the organization have had to change some of their processes to be able to make such early orders possible. There was some unwillingness to change in the beginning, but this has changed slow and steady the last months.

In 2022, Organization 4 created a team that should work with delivery security. This team have since then amongst others sent out questionnaires to all key suppliers with questions about supply risks and had follow-up meetings with them. This has laid the foundation for their risk register. Through this work, they saw the importance of a properly demand structure, as the suppliers are interested in what the organization need, how much they need, and when they need it, to be able to say something about the potential supply risk. They have therefore broken their 5-6 years rig schedule down to component level for each well, and thereby found out approximately what they need to purchase. They are thus having a lot of information about their own demand, that they share with their suppliers. In return they get feedback about their future orders, and when they should order to receive the goods on time. They also use profit sharing as an incentive with some of their key suppliers they have a strategic relationship with, to increase its effectiveness.

They also have their most important supplier in the supply risk team. The supplier is much larger, and more global than Organization 4, and therefore have more information and understanding further down the supply chains. Organization 4 also follows closely possible risks such as geographical problems and supplier situation. They have good control over alternative suppliers, and they also build up suppliers to become quality approved if necessary.

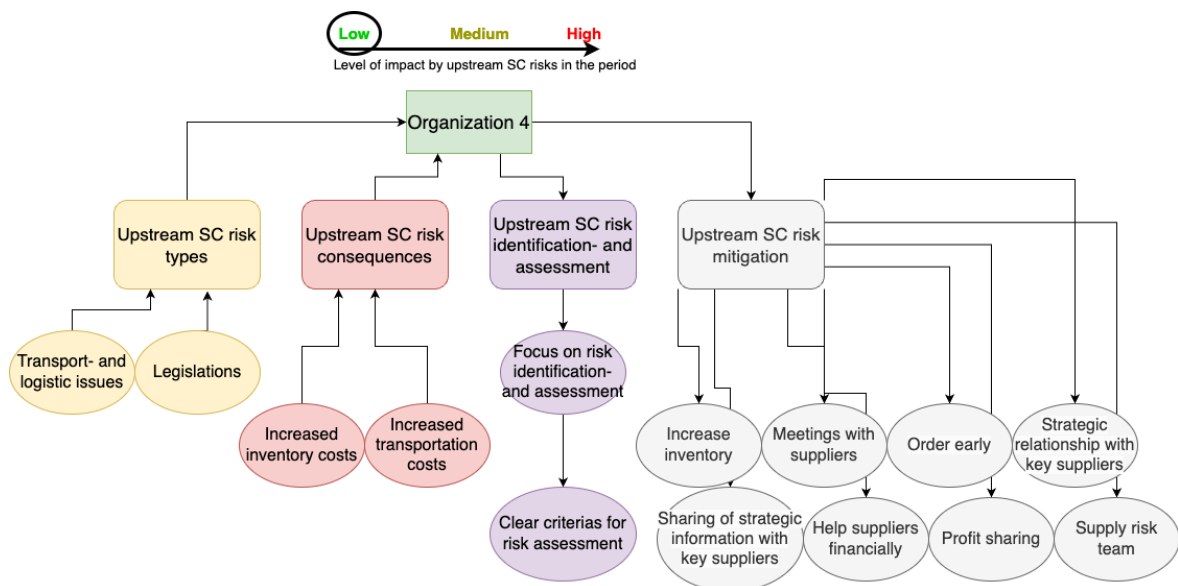


Figure 14: Characteristics of Organization 4

## 4.5 Organization 5

Organization 5 have only experienced delays, not disruptions, and they have been affected on a medium level. The delays have mainly happened because of Covid 19 which caused a

lock down on factories in China and shipping issues around the world. Sometimes the transport costs have been too expensive for the supplier to deliver the goods on time. In addition, Organization 5 had problems sourcing steel plates from Norwegian wholesalers after the war in Ukraine started, because they lacked steel due to the sanctions on Russia.

Organization 5 have had some problems in fulfilling delivery to customers on time because they have lacked resources to complete their production. To try to avoid this, they have had to order larger quantities and earlier than normal, which has increased their inventory costs and affected their liquidity. They have also had to use air freight, both when sourcing, but also on distribution to be able to deliver to their customers on time when they have had a delay on sourcing. Alternative suppliers have also been used, especially on steel. The tarps they purchase are specially designed and produced for them, and it is therefore not easy to use alternative suppliers. One of these suppliers are located in China.

Organization 5 are informed to a small extent by their suppliers about potential disruptions and delays, and they are therefore active in contacting the suppliers themselves. They see a difference between suppliers where they are an important customer in terms of a high purchasing volume, and not. Organization 5 focuses their search for information on critical deliveries, however there is little structure and routines in this. My informant admits that they have discussed that the practice for risk identification of upstream SC risks must be changed, but that not much has been done in practice.

He also says that they have had much more focus on risk identification on services, specifically hiring of personnel. He explains that the consequence of hiring wrong personnel is much larger than having delays on goods delivered. Organization 5 does not use any form of tools to assess supply risk for goods, however they use a risk matrix for assessing and classifying supply risk for personnel in addition to other risk areas, so it's a known tool for them.

Their most important mitigation action is that they have increased their inventory of raw materials and critical products. They have also expanded their list of relevant suppliers and increased the number of suppliers for products where they have had supply challenges the last three years. Organization 5 have the recent years been more transparent with their suppliers about their forecasts and future needs, as an action to reduce the supply risk. In

return, they expect their suppliers to be more proactive and provide information about their situation. They take this with them as a positive action that benefits both parts, and it is something they will continue with.

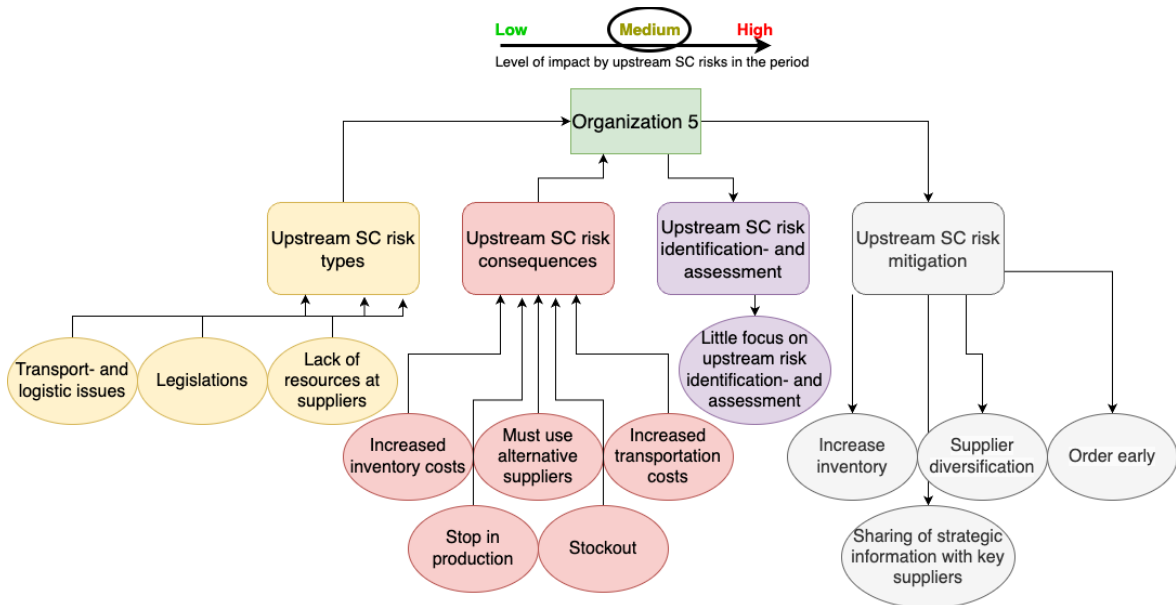


Figure 15: Characteristics of Organization 5

## 4.6 Organization 6

Organization 6 have experienced some delays, but according to themselves, they have been affected on a low level from upstream SC risks during the last three years. Covid 19 had major impacts on delivery. The blockage in the Suez Canal in March 2021 led to a lack of containers in the world which affected them. They have also experienced delays due to the war in Ukraine. For instance, they are sourcing nickel which Russia is a large supplier of. Because of the sanctions against Russia, there has become a shortage that has led to longer lead times and higher prices.

Because of the delays Organization 6 has experienced, they have had to make changes in their activity plans. An example is that they have a large maintenance on each platform every second or third year where other activity is closed for three weeks. In this time, there is a lot that needs to be done, so all essential products must be in place. The recent years they have had to purchase these products earlier and follow up the deliveries more closely to ensure that they receive them in time. They have also had to postpone maintenance of a platform because they were unsure whether they would receive an important component in time.



In the early period of Covid 19 they experienced large uncertainty for themselves and from their suppliers related to supply of materials. For instance, they at some point had to hire additional warehouses to store extra chemicals that are essential in their production. Organization 6 also must buy slots in suppliers' production queue for products with very long lead time. The lead time is so long that they must place an order and pay for the goods long before they know what their budgets will look like and if they will get the approvals they need to drill for oil. Organization 6's warehouse is filled automatically, so the systems need to be updated with the latest information about lead time and safety stock. To ensure this, they have had to have more employees in the warehouse which has increased their inventory costs.

Organization 6 receives information about potential disruptions and delays from their suppliers, but in the start of Covid 19, they had to take the first initiative to the suppliers. They then had to call in meetings and nag the suppliers. However, they now feel that the suppliers have become better at informing them. For smaller orders, the suppliers send an order confirmation with any changes of delivery time. For larger orders, Organization 6 have a dialogue with the supplier. Otherwise, they try to follow the market actively and find out in which areas supply problems may occur.

Risk management is generally well incorporated in the company because they work so much with it in other parts of the organization such as with HSE. They use a risk matrix to assess the different upstream SC risks, and the recent years, upstream SC risks have become a much larger part of this matrix. They use both probability and consequence when assessing, but consequence is probably weighted to a higher degree.

Organization 6 sees the benefit of having a close and strategic relationship with some of their suppliers and believes this has been important for them the last three years. They have also updated their contract strategy to focus more on strategic relationships, partly because of this. My informant says that this is because they are a relatively small company compared to the largest oil-companies. To ensure that they receive priority in deliveries they must have good relationships with their suppliers. Amongst others, they bring the suppliers into the projects early in the process and let them give their opinion. Their contracts also have incentive models with profit sharing which make sure the suppliers earn money as well. This is probably more costly for Organization 6, but they believe it

will pay off overall.

The most important mitigation action for Organization 6 is that they have a close collaboration with their most important suppliers, and in meetings with them, they have upstream SC risks high on the agenda to answer questions such as “Do we get any delays, and what does this mean for our projects?”. The recent years they have followed up their suppliers more closely by visiting their production facilities, and avoiding delays is often the most important when discussing requirements for profit sharing incentives.

Generally, Organization 6 rather prefers to pay a little extra to reduce risk. For instance, they have insured themselves against currency fluctuations. They have also considered to insure themselves with a fixed copper price for a cable they will lay from land to a platform. Since they are such a small company, they are much more exposed to a potential downside from risks. This has always been a strategy for Organization 6, but the recent years they have seen the need for this much clearer.

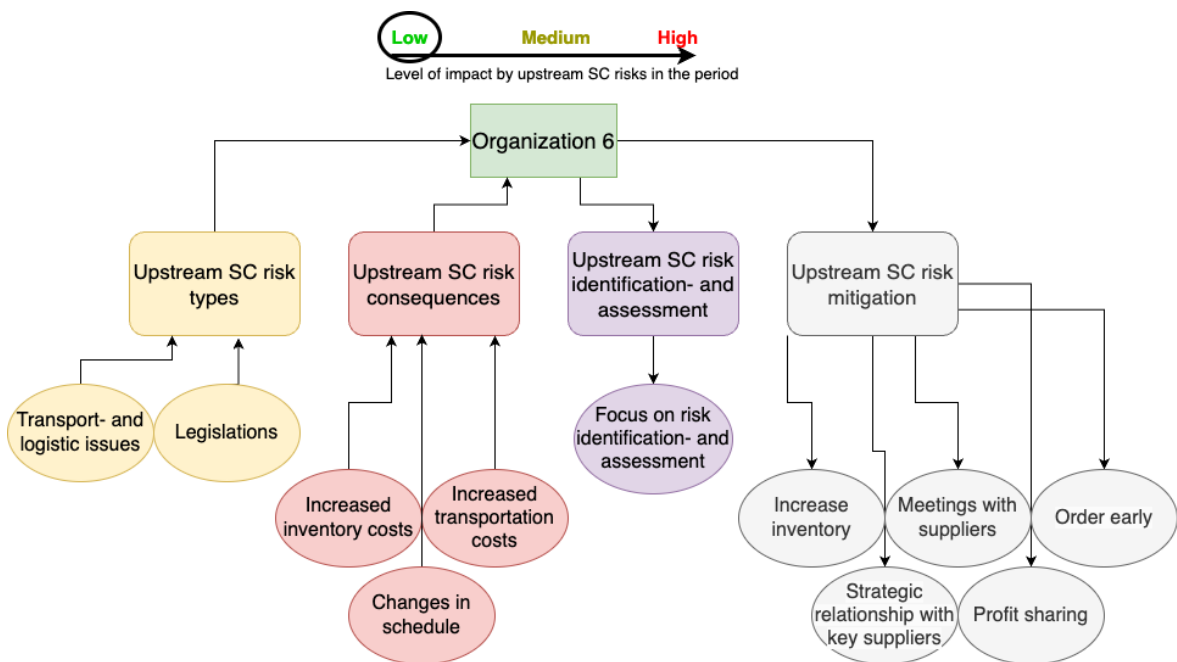


Figure 16: Characteristics of Organization 6

The following chapter includes the analysis of the obtained data. These are analysis of identified types of upstream SC risks, experienced upstream SC risk consequences, implemented upstream SC risk identification-, assessment- and mitigation practices, and the correlation between experienced upstream SC risk consequences and implemented mitigation practices.

## 5.0 Analysis

### 5.1 Identified types of upstream SC risks and their drivers

Based on the interviews, there are essentially three types of identified upstream SC risks that the studied organizations have experienced in the period between January 2020 and when the interviews were conducted in the beginning of 2023. These are:

1. *Transport- and logistic issues*
2. *Legislations*
3. *Lack of resources at suppliers*

The drivers behind these risks also vary. Most of the transport- and logistic issues and legislations come as a consequence of the outbreak of Covid 19 around the world. The war in Ukraine is also a driver because it caused the western world to impose political economic sanctions on Russia. Lack of resources at suppliers has arisen due to both Covid 19 related shortages, and a shortage of some resources due to political economic sanctions imposed on Russia.

#### **Transport- and logistic issues**

All six organizations have experienced disruptions or delays caused by transport- and logistic issues. The organizations vary in where they are sourcing from, and which transport modes are being used, but they have still experienced these issues. The mode of transport that has been impacted the most are water transport, i.e., shipping. Five of the six organizations that experienced transport- and logistic issues mentioned that shipping was the area of problem. The informant in Organization 4 within the energy supply chain mentioned that the reason often was due to long queues for loading and unloading of ships, and that they had used air freight as a substitute for shipping to avoid delays. Organization 6 within the energy supply chain mentioned the blockage in the Suez Canal in March 2021 which led to a lack of containers in the world as a reason for their delays. Organization 3 in the food supply chain do not source any goods by sea, but they experienced that a supplier of packaging located in Slovakia which usually relies on truck drivers from Ukraine were left without drivers when the war started. Organization 5 experienced that their supplier was not able to send the goods due to high transportation costs.

In total, both supply chains have been equally affected by transport- and logistic issues, and there are no large differences in which transport- and logistic issues the two supply chains have experienced.

<b>Transport- and logistic issues</b>	<b>Food supply chain</b>	<b>Energy supply chain</b>
<b>Total organizations</b>	<b>3</b>	<b>3</b>
General shipping-and logistic issues	1	1
Loading and unloading of ships	1	1
Driver shortage	1	0
Lack of containers	0	1
Transportation too expensive for supplier	0	1

Table 4: Reasons for transport- and logistic issues

### **Legislations**

Five of the organizations have mentioned that they have experienced disruptions or delays caused by legislations. Three of them are due to lockdown determined by the authorities, to limit the spread of Covid 19. This stopped the production and transportation of a lot of goods in many countries, especially in China. In addition, authorities in many countries had strict regulations on their borders and sometimes closed their ports. This is something Organization 2 in the food supply chain experienced when they were sourcing for their production in South Africa.

Both Organization 5 and 6 from the energy supply chain have experienced direct upstream SC risks due to political economic sanctions against Russia. In addition, two organizations from the food supply chain have experienced indirect upstream SC risks due to sanctions. This will be elaborated below, in *Lack of resources at suppliers*.

Organization 3 in the food supply chain also experienced that there was a legislation that prohibited plastic, which the spoon for one of their products was made of. The supplier of this spoon didn't find any good alternatives in time, and some of the products were therefore sold without this component.

In total, both supply chains have been almost equally affected by legislations. The energy supply chain has experienced political economic sanctions to a larger extent, but the food supply chain has experienced these sanctions indirectly.

<b>Legislations</b>	<b>Food supply chain</b>	<b>Energy supply chain</b>
<b>Total organizations</b>	<b>3</b>	<b>3</b>
Lockdown	1	2
Political economic sanctions	0	2
Border regulations	1	0
Product prohibition	1	0

*Table 5: Reasons for legislations*

### **Lack of resources at suppliers**

Three of the organizations mention that they have experienced upstream SC risks caused by their suppliers lacking resources. For Organization 1 and 3 within the food supply chain, this can both be explained by Covid 19 related shortage due to legislations or transport- and logistic issues, and by political economic sanctions against Russia.

However, the sanctions have only affected them indirectly, because it has affected some of their suppliers that are heavily dependent on energy or other resources that Russia is a large producer of. These suppliers have therefore incurred higher costs which have meant that they have had to reduce or stop their production. For Organization 5 in the energy supply chain, the lack of resources at suppliers also happened because of political economic sanctions. They experienced that it was difficult to source steel plates because their suppliers lacked steel which was to a great extent sourced from Russia.

In total, the food supply chain has been slightly more affected by lack of resources at suppliers than the energy supply chain.

<b>Lack of resources at suppliers</b>	<b>Food supply chain</b>	<b>Energy supply chain</b>
<b>Total organizations</b>	<b>3</b>	<b>3</b>
Covid 19 related shortage	2	0

Political economic sanctions	2	1
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Table 6: Reasons for lack of resources at suppliers

### Summary table

This table summarizes the number of organizations in each supply chain that has experienced the different upstream SC risk types.

	Food supply chain	Energy supply chain
<b>Total organizations</b>	<b>3</b>	<b>3</b>
Transport- and logistic issues	3	3
Legislations	2	3
Lack of resources at suppliers	2	1

Table 7: Overview of risk types

In the next sub-chapter, I will examine the consequences of the identified upstream supply chain risks on organizations in food- and energy supply chains.

## 5.2 Experienced upstream SC consequences

Based on the data from interviews, six types of consequences experienced because of upstream SC risks can be identified in the period between January 2020 and the interviews in early 2023. These are:

1. *Increased inventory costs*
2. *Must use alternative suppliers and/or materials*
3. *Increased transportation costs*
4. *Reduced or stop in production*
5. *Stockout*
6. *Changes in schedule*

The upstream SC risk consequences that are listed are limited to the ones that the studied organizations have experienced during the period. There is a large number of potential upstream SC risk consequences, but I have concentrated on the ones they have mentioned during the interviews.

### Increased inventory costs

All organizations have experienced increased inventory costs because of upstream SC risks the last three years. The costs come from the fact that the organizations have had to increase inventory volumes due to the recent supply. Most of the organizations mention this consequence as a natural because of the times we live in. Organization 5 from the energy supply chain mention that this has affected their liquidity because they have had to tie up more capital in stock than normal.

### **Must use alternative suppliers and/or materials**

Four of the organizations have had to use alternative suppliers and/or materials. Of these, three are within the food supply chain, and one is within the energy supply chain.

Organization 1 in the food supply chain have used alternative raw materials in one of their recipes to avoid stop in production. Organization 2 from the food supply chain had to acquire some alternative suppliers and raw materials that was not their first choice.

Occasionally they had to source alternative raw materials very quickly because they didn't get the original resources, which is difficult for them as they have strict requirements due to food security. Organization 5 within the energy supply chain had to use alternative suppliers for sourcing steel. They also purchase special designed tarps where it is difficult to use alternative suppliers.

### **Increased transportation costs**

Four of the organizations mention increased transportation costs as one of the experienced upstream SC consequences. Organization 1 in the food supply chain have had to use more expensive modes of transportation to secure deliveries. Organization 4 and Organization 5 from the energy supply chain have also experienced increased transportation costs, occasionally because they've had to use air freight to transport necessary goods.

### **Reduced or stop in production**

Three organizations have had to reduce their production or stop their production. Organization 2 within the food supply chain have experienced reduced production at times because they lack raw material to produce as normal. Organization 3 in the food supply chain experienced that a disruption of a critical raw material stopped their production because they had less flexibility in what they could produce. Organization 5 from the energy supply chain had problems completing some of their production because they lacked essential resources.

## Stockout

Two of the organizations have experienced a stockout situation due to upstream SC risks. Organization 3 within the food supply chain have experienced a stockout in the dairy-production part of the business due to a disruption on a critical component. This production is more dependent on receiving goods on time, as the production have little flexibility due to the short shelf life of the products. Organization 5 from the energy supply chain had production difficulties due to lack of resources and therefore could not fulfill some of their orders.

## Changes in schedule

Two of the organizations mention that they have experienced changes in their schedule due to delays. Organization 2 in the food supply chain had to change their production schedule due to delays of raw materials. This made the production sub-optimal, but it didn't cause large problems due to their production flexibility. Organization 6 from the energy supply chain had to postpone a scheduled maintenance because it was uncertain if they managed to get a hold of an essential component in time.

In total, the food supply chain has had to use alternative suppliers/materials to a larger extent than the energy supply chain. The food supply chain has also experienced slightly more reduced/stop in production. Otherwise, the experienced upstream SC risk consequences are quite similar for the two supply chains.

This table shows a summary of the presented upstream SC risk consequences.

<b>Upstream SC risk Consequences</b>	<b>Food supply chain</b>	<b>Energy supply chain</b>
<b>Total organizations</b>	<b>3</b>	<b>3</b>
Increased inventory costs	3	3
Must use alternative suppliers/materials	3	1
Increased transportation costs	2	2
Reduced or stop in production	2	1



Stockout	1	1
Changes in schedule	1	1

Table 8: Experienced upstream SC risk consequences

### 5.3 Supply chain risk identification- and assessment

To find the correct mitigation practices, one must perform good risk identification, and risk assessment (Fan and Stevenson 2018). This section will present the upstream SC risk identification- and assessment practices of the studied organizations. This step is necessary because it may help to explain the appropriateness of the mitigation strategies developed and the extent to which every organization is affected if risks occur. This research does not include the step of monitoring, which is included in the SCRM process by some researchers. This is a conscious choice that is made in collaboration with my supervisor because it can be argued that risk monitoring corresponds to risk identification, and that a loop of the three included processes is a sufficient total SCRM process.

#### Upstream SC risk identification

Both the food supply chain and the energy supply chain are following the news and market closely, and mostly have suppliers that are good at informing about risks. For Organization 5 in the energy supply chain, their only way to identify upstream SC risks are by following the news and market. All organizations within the food supply chain perform risk screening or auditing of new suppliers, but none of the organizations within the energy supply chain does it. This could be a source to risk because they don't identify potential upstream supply chain risks. The upstream SC risk identification process is sufficient for the food supply chain because most of them perform several upstream SC risk identification practices. The process is only moderately sufficient for the energy industry, because they have implemented some of the practices, but there are still practices they lack to implement.

Both supply chains mostly neglect to analyze second-tier suppliers or further down the supply chain. The only organizations that perform this are Organization 3 in the food supply chain and Organization 4 in the energy supply chain. Organization 3 in the food supply chain are also, together with Organization 6 in the energy supply chain the only organizations that use order confirmations from their suppliers actively to identify potential disruptions or delays.

The following table shows different practices of the two supply chains' upstream SC risk identification process that are mentioned during the interviews.

<b>Upstream SC risk identification practices</b>	<b>Food supply chain</b>	<b>Energy supply chain</b>
<b>Total organizations</b>	<b>3</b>	<b>3</b>
Follow news and the market closely	3	3
Suppliers are good at informing about risks	3	2
Performs risk screening or auditing of new suppliers	3	0
Analyzes second-tier suppliers and further down the SC	1	1
Use order confirmations from suppliers to identify delays/disruptions	1	1

*Table 9: Upstream SC risk identification practices*

### **Risk assessment of upstream SC risks**

The most common tool when assessing risks is a risk matrix that assesses both the impact and the probability of a risk occurring. Four of the organizations use this tool to assess upstream SC risks: Organization 1 and 2 from the food supply chain, and Organization 4 and 6 from the energy supply chain. Organization 3 from the food supply chain only take the consequence of a risk into consideration when assessing it, while Organization 5 from the energy supply chain do not have any known risk assessment practices for upstream SC risks.

Organization 2, 4, 5 and 6 mention that they have well implemented risk management practices for other risks than upstream SC risks. Organization 2 have a strict procedure for maintaining food safety, while Organization 4 and 6 have good routines for HSE. Organization 5 has a well incorporated risk management practice when it comes to hiring of personnel, and use a risk matrix for this, but they do not use it when sourcing goods.

Both Organization 2 and 4 stated clear criterias for classification of both risk probability- and impact, and Organization 4 also mention that they have included suppliers with a strategic relationship in a supply risk team to benefit from their information, knowledge,

and competence when assessing risks. They have also asked their most important suppliers to come up with potential risks in their upstream supply chain and assess those risks.

The risk assessment process for upstream SC risks is moderately sufficient for the food supply chain, because two of them use a risk matrix, but none of the other listed risk assessment practices are implemented by more than one organization at the time. The risk assessment process for upstream SC risks is also moderately sufficient for the energy supply chain because several organizations use a risk matrix, but the rest of the assessment practices are implemented by a maximum of one organization.

This table shows different practices of the two supply chains' supply chain risk assessment process, which is the second step of the supply chain risk management practice.

<b>Risk assessment practices of upstream SC risks</b>	<b>Food supply chain</b>	<b>Energy supply chain</b>
<b>Total organizations</b>	<b>3</b>	<b>3</b>
Risk matrix (or similar) with impact and probability	2	2
Well implemented risk management practices for other risks than upstream SC risks	1	3
Clear criterias for risk probability- and impact	1	1
Let suppliers risk assess themselves	0	1
Collaboration with strategic partners	0	1
Assess only impact of supply risks	1	0

Table 10: Supply chain risk assessment practices

In the next sub-chapter, I will present the mitigation practices implemented by the organizations in food- and energy supply chains to mitigate upstream SC risks.

## **5.4 Upstream supply chain risk mitigation**

The analysis of interview data has revealed the following 11 mitigation practices:

1. *Increased inventory*
2. *Meetings with suppliers*
3. *Supplier/material diversification*
4. *Order early*

5. *Strategic relationship with key suppliers*
6. *Sharing of strategic information with key suppliers (transparency)*
7. *Flexibility in production*
8. *Consider more local sourcing*
9. *Help suppliers financially*
10. *Profit sharing*
11. *Supply risk team*

Most of the mitigation practices are mentioned by the organizations during the interviews, but *Flexibility in production* is borrowed from literature because it was not mentioned by any of the organizations during the interviews, but it was discovered as a mitigation practice when analyzing the data (Dohale et al. 2023). The rest of the mitigation practices can nevertheless also be found in existing literature (Chopra and Sodhi 2004; Tang 2006b; Jüttner, Peck, and Christopher 2010; Pakdeechoho and Sukhotu 2018; Er Kara, Oktay Firat, and Ghadge 2020; Kumar et al. 2021).

The different mitigation practices will later be used in a correlation matrix together with experienced consequences. I will therefore also present which of the upstream SC risk consequences the different mitigation practices possibly can mitigate.

### **Increased inventory**

*Increased inventory* is a traditional mitigation practice that has been suggested by several researchers in the field for a long time (Chopra and Sodhi 2004; Dohale et al. 2022). It is performed by all six organizations, and it is an effective practice that possibly can mitigate all listed consequences the organizations have experienced, except increased inventory costs. With an increased inventory, organizations have more flexibility and can therefore avoid using alternative suppliers or materials. They can also avoid having stockouts or having to make changes in their production or schedule. Increased transportation costs can also be avoided because one avoids the use of more expensive transport methods to obtain products.

### **Meetings with suppliers**

All three organizations within the food supply chain, and Organization 4 and 6 within the energy supply chain have mentioned *Meetings with suppliers* as one of their mitigation

strategies. It's sometimes unclear what information is shared between the organizations and their suppliers in these meetings, but my impression is that it's often of transactional nature, to follow up- and secure deliveries. The choice of which consequences the practice mitigates is based on that it's only shared non-strategic information in these meetings. Such information can possibly help organizations avoid having stockouts, production stops, or changes in schedule. This is the only mitigation practice that some of the organizations have implemented, without it mitigating any of the consequences they have experienced. This applies for Organization 1 in the food supply chain and Organization 4 in the energy supply chain.

### **Supplier/material diversification**

*Supplier/material diversification* is something all organizations in the food supply chain have implemented, but only Organization 5 within the energy supply chain. It is one of the traditional practices that are often mentioned in literature, because it deals with spreading the risk. The practice can mitigate the consequence of increased inventory, as one can possibly reduce the stock, without other consequences such as stockout, production stops, or changes in schedule. These consequences can also be mitigated by this practice.

### **Order early**

*Order early* is closely related to increased inventory, and it's mentioned as a practice by Organization 3 in the food supply chain, and all organizations in the energy supply chain. Ordering early reduces the risk of not receiving goods on time, and thereby the risk of stockout, production stops, or schedule changes. Ordering early can also reduce the consequence of increased transportation costs, as one may avoid alternative, more expensive transport methods at the last minute. This practice is implemented by the same organizations that either have a strategic relationship with their key suppliers or share strategic information with them.

### **Strategic relationship with key suppliers**

*Strategic relationship with key suppliers* is implemented by three of the organizations, and these are the same organizations which states that they have been affected on a low level from disruptions and delays the last three years. The organizations are Organization 3 from the food supply chain, and Organization 4 and 6 from the energy supply chain. The practice is assumed to mitigate all listed consequences, except increased transportation costs. Having a strategic relationship can increase the information flow, and thereby

reduce the uncertainty related to deliveries of goods. It can also mean that the organization is given priority when the supplier is to deliver goods.

### **Sharing of strategic information with key suppliers (transparency)**

*Sharing of strategic information with key suppliers (transparency)* is closely related to having strategic relationships and it mitigates the same risk consequences. It is mentioned by Organization 3 from the food supply chain and Organization 4 and 5 from the energy supply chain. During the interviews, all these organizations addressed the importance of this mitigation practice for creating predictability for them and their suppliers. There are more organizations mentioning sharing of information with suppliers during meetings as a practice, but this is not identified as strategic information by the undersigned. Examples of strategic information are forecasts or other information about future demand (Chu and Lee 2006).

### **Flexibility in production**

None of the organizations mention *Flexibility in production* specifically, but it is borrowed as a mitigation practice from literature and included in the list because it was identified as a relevant mitigation practice at some of the organizations. The three organizations that are listed presents that they have a flexibility in their production through other questions in the interviews. These organizations are all within the food supply chain. Organization 1 changed their recipe so they could use other resources in their production. Organization 2 produced other goods than planned, which was not optimal, but saved them from stopping the production. Organization 3 have a flexible production of spread cheese with large possibilities of storing finished goods. However, they also produce dairy products, and this part of the production is not flexible at all. Having some sort of flexibility in the production can mitigate several of the consequences because the organizations find alternative methods to be able handle upstream SC risks.

### **Consider more local sourcing**

Two organizations are *Considering more local sourcing*. By sourcing more locally, organizations have a shorter route for their goods, and thus less uncertainty (Z. Yin, Guan, and Xiao 2017). They can therefore decrease the transportation costs, hold a lower level of inventory, as well as reduce the possibility of stockouts, production stops or changes in schedule. None of the organizations mentions to have changed permanently to more local suppliers, but Organization 1 and 2 within the food supply chain have considered it.

However, there are large differences in what is considered more ‘local’ for each of the organizations studied. For some of the organizations, this means sourcing from Europe instead of Asia, but for others it means sourcing in Norway instead of Europe.

### **Help suppliers financially**

*Help suppliers financially* is implemented by two organizations. For some of the organizations, the supplier market is limited because there are few suppliers who can deliver the right quality. Both Organization 2 in the food supply chain and Organization 4 in the energy supply chain have experienced this as a problem and are therefore helping potential suppliers financially to build them up to become approved. They thus expand the supplier market, and this practice therefore possibly mitigates the same consequences as diversifying suppliers/materials. It’s also possible to help current suppliers by paying for or taking part of the costs of ordering large volumes of goods. This is something Organization 4 have done with their suppliers, as they are better off financially than some of them.

### **Profit sharing**

*Profit sharing* with key suppliers is implemented by Organization 4 and 6 in the energy supply chain. It is closely related to having a strategic relationship with suppliers, and it can reduce the need for extra inventory or alternative suppliers, as well as the possibility of having a stockout, production stop or changes in schedule because the suppliers get an incentive to perform better, for example by making sure to deliver on time, and delivering the right goods.

### **Supply risk team**

*Supply risk team* is only implemented by Organization 4 within the energy supply chain, and they established it as a consequence of what they had experienced during, and after Covid 19. The team works actively with all steps of the supply chain risk management process to handle risks. A supply risk team is therefore something that can increase the information flow and reduce uncertainty, and thereby mitigate the consequence of stockouts, production stops, or changes in schedule.

<b>Upstream SC risk mitigation practices</b>	<b>Food supply chain</b>	<b>Energy supply chain</b>
<b>Total organizations</b>	<b>3</b>	<b>3</b>
Increased inventory	3	3
Meetings with suppliers	3	2
Supplier/material diversification	3	1
Order early	1	3
Strategic relationship with key suppliers	1	2
Sharing of strategic information with key suppliers (Transparency)	1	2
Flexibility in production	3	0
Consider more local sourcing	2	0
Help suppliers financially	1	1
Profit sharing	0	2
Supply risk team	0	1

Table 11: Upstream supply chain risk mitigation practices

## 5.5 Analysis of upstream supply chain risk mitigation- and consequences

As discussed previously, one mitigation practice can mitigate different risk consequences at the same time. The experienced consequences can therefore raise the question which mitigation practice or practices work best against a specific risk consequence.

I will now present two equal tables for each of the two supply chains, four tables in total. These can be seen as correlation matrixes, but they are not traditional correlation matrices because they include qualitative data instead of quantitative. The first table for each of the supply chains shows the correlation between the previously experienced consequences identified in section 5.2 and the current implemented mitigation practices identified in section 5.4.

If the mitigation practice is assumed to mitigate the respective consequence, the organizations that have implemented the mitigation practice and experienced the



consequence are listed in the matching cell. This assumption is determined by me and have been thoroughly considered based on literature and common knowledge. The black cells means that the risk consequence cannot initially be mitigated by the respective practice. For correlation matrix 1, empty white cells means that the risk consequence can be mitigated by the mitigation practice, but none of the organizations in the supply chain that have experienced the consequence have implemented that practice.

The second table for each of the supply chains shows which of the organizations that have not implemented the mitigation practices that are assumed to mitigate the consequences they have experienced. For correlation matrix 2, empty white cells means that the consequence can be mitigated by the mitigation practice, but all organizations in the supply chain that have experienced the consequence, have implemented the practice.

### **Correlation matrix 1, Food supply chain**

The matrix shows that all organizations in the food supply chain have implemented at least two mitigation practices that mitigates the upstream SC risks they have experienced during the period between January 2020 and today. The SC mitigation practice for the food supply chain is therefore initially sufficient.

For the food supply chain, there at least two organizations that have a match between a consequence they have experienced, and mitigation practices they have implemented for the following practices: Increased inventory, meetings with suppliers, supplier/material diversification, flexibility in production, and local sourcing. There are also only four mitigation practices that are implemented by all three organizations in the food supply chain. These are: Increased inventory, Meetings with suppliers, Supplier/material diversification, and Flexibility in production. Organization 1 is not listed in any of the cells in the column with “Meetings with suppliers”, even though they have implemented the practice, but this is because they have not experienced any of the upstream SC risk consequences it could mitigate in the period between January 2020 and the time of the interview.

There is a match between experienced consequence and implemented mitigation practice in a total of 48 times. Organization 1 stands for seven of these, Organization 2 for 19, and

Organization 3 for 22. Organization 2 and 3 have thereby implemented a lot of mitigation practices that are assumed to mitigate the consequences they have previously experienced.

Mitigation practices	Increased inventory	Meetings with suppliers	Supplier/material diversification	Order early	Strategic relationship with key suppliers	Sharing of strategic information with key suppliers (Transparency)	Flexibility in production	Consider more local sourcing	Help suppliers financially	Profit sharing	Supply risk team
<b>Consequences</b>											
Increased inventory costs			1, 2, 3		3	3		1, 2	2		
Must use alternative suppliers and/or materials	1, 2, 3			3	3	3	1, 2, 3*				
Increased transportation costs	1, 2						1, 2	1, 2			
Reduced or stop in production	2, 3	2, 3	2, 3	3	3	3	2, 3*	2	2		
Stockout	3	3	3	3	3	3	3*				
Changes in schedule	2	2	2					2	2		

Table 12: Correlation matrix 1, Food supply chain

### Correlation matrix 1, Energy supply chain

The matrix shows that all organizations in the energy supply chain have implemented at least two mitigation practices that mitigates the upstream SC risks they have experienced during the period between January 2020 and today. The SC mitigation practice for the energy supply chain is therefore initially sufficient.

For the energy supply chain, there at least two organizations that have a match between a consequence they have experienced, and mitigation practices they have implemented for the following practices: Increased inventory, order early, strategic relationship with key suppliers, and sharing of strategic information with key suppliers. There are also only two mitigation practices that are implemented by all organizations in the energy industry: Increased inventory and order early.

There is a match between experienced risk consequence and implemented mitigation practice in a total of 28 times. Organization 4 stands for six of these, Organization 5 for 15, and Organization 6 for seven. Organization 5 have thereby implemented several mitigation practices that are assumed to mitigate the consequences they have previously experienced.

Mitigation practices	Increased inventory	Meetings with suppliers	Supplier/material diversification	Order early	Strategic relationship with key suppliers	Sharing of strategic information with key suppliers (Transparency)	Flexibility in production	Consider more local sourcing	Help suppliers financially	Profit sharing	Supply risk team
<b>Consequences</b>											
Increased inventory costs			5		4, 6	4, 5			4	4, 6	
Must use alternative suppliers and/or materials	5			5		5					
Increased transportation costs	4, 5			4, 5							
Reduced or stop in production	5		5	5		5					
Stockout	5		5	5		5					
Changes in schedule	6	6		6	6					6	

Table 13: Correlation matrix 1, Energy supply chain

In the section below, I will present the results of the analysis which shows the mitigation practices recommended but not implemented by the organizations in food- and energy supply chains. These results of the analysis are summarized in tables 14 and 15.

### Increased inventory

All organizations have already implemented this mitigation practice and they have therefore gained its benefits.

### Meeting with suppliers

Organization 5 within the energy supply chain have experienced a stockout and a reduced production, but they have not stated to have any meetings with suppliers. Both these consequences could have been mitigated by this mitigation practice because they would then receive more information about current and future orders, and thereby be able to source the necessary goods, for instance by ordering earlier or using an alternative supplier. However, as previously presented, they share strategic information with their suppliers, and it would therefore be natural to believe that they have meetings with them as well.

### Supplier/material diversification

Organization 4 and 6 within the energy supply chain have experienced increased inventory, and Organization 6 have also experienced changes in schedule, but none of them have implemented this practice. At the same time, Organization 4 mentions that they have good control over alternative suppliers. Having a supplier/material diversification

would spread the risk even more and reduce the need for increased inventory. Therefore, they could save inventory costs by diversifying suppliers or materials.

### **Order early**

Organization 1 and 2 from the food supply chain have not implemented this in their risk mitigation despite it being a simple practice that can mitigate several consequences they have experienced. However, ordering earlier means that the organization should know what their future demand is, to avoid products becoming obsolete. It also requires potentially increased inventory, and thereby accompanying inventory costs.

### **Strategic relationship with key suppliers**

Organization 1 and 2 in the food supply chain and Organization 5 from the energy supply chain have experienced several of the matching consequences, but not implemented this practice. Establishment of a strategic relationship with key suppliers also depends on the suppliers' willingness to create strategic partnerships and on the existing power-dependency structure, as strategic relationships must be beneficial for both sides.

### **Sharing of strategic information with key suppliers (transparency)**

Organization 1 and 2 from the food supply chain and Organization 6 in the energy supply chain are repeated as organizations that could benefit from implementing this practice. Organization 6 have stated to have strategic relationships with their key suppliers, and they also let their suppliers be a part of their projects from an early phase. However, they do not have accurate information about their future demand, and they can therefore not share this with their key suppliers. By sharing strategic information with key suppliers, these organizations could reduce uncertainty by increasing their suppliers' predictability.

### **Flexibility in production**

Organization 5 within the energy supply chain have not implemented this practice, but they have experienced several of the matching consequences. By making their production more flexible, they could for example produce alternative products, and thereby avoid a stop in production. Organization 4 could also avoid increased transportation costs from quick, alternative transportation if their production was more flexible. In addition, number 3 in the food supply chain is marked with a star. This is because one part of their

production is very flexible, while the other one is not. The latter is the part of the organization that experienced a stop in production and a stockout.

### **Consider more local sourcing**

Organization 3 from the food supply chain, and all organizations in the energy supply chain have not implemented this practice but have experienced some of the matching consequences. All of them have experienced increased inventory costs. By sourcing more locally, they could reduce their inventory levels, because the goods would have a shorter transportation route and they would perhaps increase their purchasing frequency. Thereby there would be less risk of the goods being disrupted or delayed. Organization 3 already sources very locally with most of their raw materials from Norway, and packaging from Europe. However, the production stop and stockout they experienced once was because of a disruption on a raw material from Sweden. Organization 4 and 6 from the energy supply chain sources mostly from suppliers located within Norway, but much of the goods or raw materials for the goods comes from abroad. Organization 5 from the energy supply chain are particularly vulnerable considering a tarp they source from China which is essential for their production, and not something they can easily purchase from alternative suppliers.

### **Help suppliers financially**

Helping suppliers financially have not been implemented by Organization 1 and 3 from the food supply chain, and 5 and 6 from the energy supply chain. The organizations are in various financial positions, and this may affect the possibility of implementing this practice. It would be most beneficial for the organizations that has a limited supplier market who wants to expand this.

### **Profit sharing**

Profit sharing with key suppliers is particularly effective for companies that depend on getting goods delivered on time to avoid large financial losses in the event of a stop in production, such as Organization 4 and 6 from the energy supply chain. Organizations 2 and 3 from the food supply chain and Organization 5 from the energy supply chain could benefit from implementing this practice, but it depends on the type of business and the goods they are sourcing.

### **Supply risk team**

Organizations 2 and 3 from the food supply chain, and 5 and 6 from the energy supply chain have experienced some of the matching consequences to this mitigation practice but have not implemented the practice. However, this is not a practice that all organizations can afford to use their resources on.

I will now present the second correlation matrix for the food supply chain, and the energy supply chain which shows the mitigation practices recommended but not implemented.

### **Correlation matrix 2, Food supply chain**

The next tables are also correlation matrices, and they are similar to table 12 and 13, but the numbers listed within the white cells now represent the organizations that have experienced the consequence, but not implemented the respective mitigation practice for this consequence.

None of the organizations within the food supply chain have implemented profit sharing or supply risk team, but Organization 1 have not experienced any of the consequences a supply risk team can mitigate. In addition, for the food supply chain, there at least two organizations that have a match between a consequence they have experienced, and mitigation practices they have not implemented for the following practices: Order early, strategic relationship with key suppliers, sharing of strategic information with key suppliers, help suppliers financially, profit sharing, and supply risk team.

There is a match between experienced consequence and lack of implemented mitigation practice in a total of 42 times. Organization 1 stands for nine of these, Organization 2 for 18, and Organization 3 for 15. Organization 2 and 3 therefore lacks to implement a good number of the mitigation practices that are assumed to mitigate the consequences they have previously experienced.

Mitigation practices	Increased inventory	Meetings with suppliers	Supplier/material diversification	Order early	Strategic relationship with key suppliers	Sharing of strategic information with key suppliers (Transparency)	Flexibility in production	Consider more local sourcing	Help suppliers financially	Profit sharing	Supply risk team
<b>Consequences</b>											
Increased inventory costs					1, 2	1, 2		3	1, 3	1, 2, 3	
Must use alternative suppliers and/or materials				1, 2	1, 2	1, 2	3*			1, 2, 3	
Increased transportation costs				1, 2							
Reduced or stop in production				2	2	2	3*	3	3	2, 3	2, 3
Stockout							3*	3	3	3	3
Changes in schedule				2	2	2				2	2

Table 14: Correlation matrix 2, Food supply chain

### Correlation matrix 2, Energy supply chain

None of the organizations in the energy supply chain have implemented flexibility in production and consider more local sourcing, but Organization 6 have not experienced any of the consequences flexibility in production can mitigate. In addition, for the energy supply chain, there at least two organizations that have a match between a consequence they have experienced, and mitigation practices they have not implemented for the following practices: Supplier/material diversification, consider more local sourcing, help suppliers financially, and supply risk team.

There is a match between experienced consequence and lack of implemented mitigation practice in a total of 36 times. Organization 4 stands for four of these, Organization 5 for 23, and Organization 6 for nine. Organization 5 therefore lacks to implement a lot of the mitigation practices that are assumed to mitigate the consequences they have previously experienced.

Mitigation practices	Increased inventory	Meetings with suppliers	Supplier/material diversification	Order early	Strategic relationship with key suppliers	Sharing of strategic information with key suppliers (Transparency)	Flexibility in production	Consider more local sourcing	Help suppliers financially	Profit sharing	Supply risk team
<b>Consequences</b>											
Increased inventory costs			4, 6		5	6		4, 5, 6	5, 6	5	
Must use alternative suppliers and/or materials					5		5			5	
Increased transportation costs							4, 5	4, 5			
Reduced or stop in production		5			5		5	5	5	5	5
Stockout		5			5		5	5	5	5	5
Changes in schedule			6			6		6	6		6

Table 15: Correlation matrix 2, Energy supply chain

## 5.6 Chapter summary

In this chapter, analysis of experienced upstream SC risk types-, consequences, and SCRM practices have been conducted. In addition, mitigation practices applied by six organizations in food- and energy supply chains have been opposed to upstream SC risk consequences. As a conclusion, one can say that there are small differences between the examined two supply chains regarding upstream SC risk types- and consequences, as well as the upstream SC risk identification- and assessment process. However, there are large differences in the pattern between experienced upstream SC consequences and implemented upstream SC mitigation practices. Table 16 shows the most important findings for each of the two studied supply chains.

	<b>Food supply chain</b>	<b>Energy supply chain</b>
<b>Types of experienced upstream SC risks</b>	Transport- and logistic issues, legislations, lack of resources at suppliers	Transport- and logistic issues, legislations
<b>Experienced upstream SC risk consequences</b>	Increased inventory costs, must use alternative suppliers, increased transportation costs, reduced/stop in production	Increased inventory costs, increased transportation costs
<b>Upstream SC risk identification- and assessment practices</b>	Upstream SC risk identification practices are sufficient.  Risk assessment practices of upstream SC risks are moderately sufficient.	Upstream SC risk identification practices are moderately sufficient  Risk assessment practices of upstream SC risks are moderately sufficient.
<b>Mostly implemented upstream SC risk mitigation practices</b>	Increased inventory, meetings with suppliers, supplier/material diversification, flexibility in production, consider more local sourcing	Increased inventory, order early, Strategic relationship with key suppliers, Sharing of strategic information with key suppliers

Table 16: Overview of differences in the two supply chains

## 6.0 Discussion

This research seeks to provide knowledge on supply chain risk management practices, to see if organizations within food- and energy supply chains have implemented practices that are sufficient to manage potential upstream SC risks that may occur in the future. I have investigated upstream SC risk types- and consequences, and SCRM processes of six



organizations. In this chapter, I will discuss my findings by using existing knowledge and literature from the literature review.

## **6.1 How do current supply chain mitigation practices of Norwegian organizations within food-and energy supply chains correspond to the consequences of upstream supply chain risks occurred during the Covid 19 pandemic?**

Based on the analysis conducted in the previous chapter, the following findings on upstream SC risk types-, consequences- and SCRM practices can be highlighted:

1. Both supply chains have sufficient mitigation practices for upstream SC risks.
2. There are minor differences in what upstream SC risk types- and consequences the two supply chains have experienced.
3. The food supply chain has a sufficient upstream SC risk identification process, while the energy supply chains' process is only moderately sufficient, because they lack to perform risk screening or auditing of new suppliers.
4. Both the food supply chain and the energy supply chain have a moderately sufficient assessment process of upstream SC risks because most of them are using a risk matrix to assess impact and probability, but there are other assessment practices they have not implemented.
5. Increased inventory is the most used mitigation practice for both supply chains.
6. Meetings with suppliers is the only mitigation practice that has been implemented by some of the organizations, without it mitigating any of the consequences they have experienced.
7. The food supply chain uses the following mitigation practices to a larger extent than the energy supply chain: Supplier/material diversification, Flexibility in production, and Consider more local sourcing.
8. The energy supply chain uses the following mitigation practices to a larger extent than the food supply chain: Order early, Strategic relationship with key suppliers, sharing of strategic information with key suppliers, and Profit sharing.
9. Within both supply chains, there are unimplemented mitigation practices that could possibly mitigate consequences they have experienced.

This means that both supply chains have mitigation practices that may be sufficient to handle future upstream SC risks, but there are large differences between the risk mitigation practices of the two studied supply chains. At the same time, there are no major differences in the supply chains' experienced upstream SC risk types- and consequences, and only moderately differences in their current upstream SC risk identification- and assessment processes. There are also possible mitigation practices that the studied organizations still could benefit from implementing. There are several possible factors that could influence why. I will discuss some of them below. These findings are important because they give an impression of how the current supply chain risk mitigation practice is at two important types of supply chains in the Norwegian market, and because they show how organizations can improve their SCRM process.

In the next sub-chapter, upstream SC risk types of Norwegian food- and energy supply chains are discussed.

### **6.1.1 Upstream SC risk types**

There are few differences when it comes to the upstream SC risk types the two supply chains have faced. They have mostly been affected by the same risk drivers and risk types, but there are some differences within the different types of risks they have faced with. In addition, the food supply chain has experienced lack of resources at suppliers to a slightly larger extent than the energy supply chain. There may be many possible reasons for this. As presented by Jagtap et al. (2022), food supply chains have been massively impacted in both production and transportation due to the war in Ukraine. As mentioned by some of the organizations, their suppliers have had to reduce their production due to increased prices of power and raw materials. This contributes to the reduction of food products supply. The findings are aligned with a study of food supply chains during Covid 19 which discovered that delays occurred mostly due to lack of supply of products, either by suppliers, transporters, or producers, as well as due to closed borders (Ferreira et al. 2021). The same study pointed out the difficulty for food manufacturers to use alternative suppliers due to strict requirements on food safety, which I also discovered for two of the organizations that are food manufacturers.

All organizations have experienced upstream SC risks due to transport-and logistic issues. This agrees with Kleindorfer and Saad (2005) statement that due to longer transportation

routes, because of production in low-cost countries (Johnsen, Howard, and Miemczyk 2019, 216), organizations are more likely to experience disruptions and delays. However, Organization 3 in the food supply chain who source their raw materials from within Scandinavia experienced a disruption of a raw material during Covid 19. The disruption they experienced were however for one of the few raw materials they sourced outside Norway. This could mean that they could experience such disruptions or delays regardless of their sourcing destination, but it could also mean that as long as they source within Norway, they are less exposed to these upstream SC risks.

Transport issues are also mentioned in other studies after the Covid 19 outbreak as possible reasons for upstream SC risks (Bø, Hovi, and Pinchasik 2023). The finding may however be interesting to see in the light of a study by Zhang and Figliozzi (2010) where the respondents' assumed other factors than transport to be more likely to cause delays. They also assumed that shipment by sea was very unlikely to cause delays, but for many of the organizations that have experienced delays, the goods have been shipped by sea.

Lockdown was the type of legislation most organizations experienced upstream SC risk because of. This is consistent with findings from Dohale et al. (2023) where lockdown caused large issues for all actors of the studied organizations' supply chain.

The next sub-chapter discusses the upstream SC risk consequences found in the studied organizations of Norwegian food-and energy supply chains.

### **6.1.2 Upstream SC risk consequences**

There are only minor differences between the two supply chains when it comes to the experienced consequences from upstream SC risks that has occurred in the period after the Covid 19 outbreak. The two discovered differences between the two supply chains are that the food supply chain has had to use alternative suppliers or materials to a larger extent than the energy supply chain, and that they have experienced slightly more reduced or stop in production.

The food supply chain may have had to use alternative suppliers or materials to a larger extent because they may have a shorter shelf life of their sourced goods, and thereby cannot keep a larger safety stock volume that might depreciate if it remains unused.

Another finding is that Organization 4 and 6 in the energy supply chain have a clear supplier relationship strategy of long-term collaborative relationships, and they therefore perhaps don't need to, or want to use alternative suppliers. Both of these reflections will be elaborated further in the discussion of the mitigation practice "Supplier/material diversification".

The larger extent of reduced or stop in production at the food industry may come from case specific differences, because of the three organizations, one part of Organization 3 from the food supply chain has a make-to-order production strategy, and Organization 5 from the energy supply chain have a mix between a make-to-order, and an engineer-to-order production strategy. A make-to-order strategy means that the goods are made when they are ordered from a customer, while an engineer-to-order strategy means that the goods are custom-made or engineered and that the design phase starts when the order is received. Such strategies make the production less flexible because they cannot produce something else if they do not get the raw materials they need. For Organization 3, this is about the shelf life of the products, and lack of space for storing finished goods. For Organization 5, this is because most of their products are custom-made to fit the customers dimensions. These two organizations are also the two that have experienced a stockout, and it may likely be due to the same reason.

Increased inventory cost is the only upstream SC risk consequence found in all organizations studied. A study from 2010 showed that wholesalers and manufacturers that imported goods were concerned about that upstream SC risks could cause increased inventory costs (Zhang and Figliozzi 2010). Stockouts have only been experienced by two organizations, but it is suggested by several researchers as a possible consequence of upstream SC risks (George A. Zsidisin et al. 2004; Kleindorfer and Saad 2005; Guiffrida and Jaber 2008). It's also a very severe one, and it's considered a critical consequence by both those who have and those who haven't experienced it.

Guiffrida and Jaber (2008) also suggests reduced or stop in production, and loss of goodwill as potential impact from delays. Both reduced production and stop in production have happened to some of the organizations, but none of the organizations mentioned that they had lost goodwill from their customers, even though some of them had a stockout. It might be that the customers have had a better understanding that disruptions and delays

could occur during these times, because it has happened to almost everyone simultaneously.

Bø, Hovi, and Pinchasik (2023) studied Norwegian food and pharmaceutical supply chains during and after Covid 19 and found that use of alternative products and suppliers, stockouts, increased transportation costs and reduced production were consequences the organizations had experienced due to the pandemic. This is consistent with my findings. All these four are included in my list of six consequences. Changes in schedule is not specifically mentioned by any researchers, but it can be compared to reduced production or stop in production. Otherwise, all consequences discovered are mentioned in literature either before or after the Covid 19 outbreak.

In the next sub-chapter, I will discuss the risk identification- and assessment process of upstream SC risks in food- and energy supply chains.

### **6.1.3 Upstream SC risk identification- and assessment**

There are also only minor differences between the two supply chains when it comes to the risk identification- and assessment processes of upstream SC risks for the studied organizations. The upstream SC risk identification process can be seen as sufficient for the food supply chain because all organizations perform several upstream SC risk identification practices. For the food supply chain, food safety is an important area. Therefore, they amongst others perform auditing to ensure that the supplier can deliver according to their required quality. In this way, it's easier for them to find out about potential upstream SC risks, and it also improves their relationship with the suppliers, because they have met each other in person, and they have had a look at the suppliers' facilities.

The upstream SC risk identification process can be seen as moderately sufficient for the energy supply chain. All organizations follow the news and market closely and most of them are well informed from their suppliers about upstream SC risks, but none of them perform risk screening or auditing of new suppliers, and only one analyze second tier-suppliers and further down the supply chain or use order confirmations to identify upstream SC risks. By not performing risk screening of new suppliers, the energy supply

chain potentially misses the opportunity to identify upstream risks that may occur in the SC.

Analyzing second-tier suppliers and further down in the supply chain have only been implemented by Organization 3 in the food supply chain and Organization 4 in the energy supply chain. Instead of implementing a holistic approach of SCRM with all SC actors, the other organizations only focus on SC dyads with their suppliers. They thereby miss several potential upstream SC risks that could occur in their supply chain, and thereby miss the opportunity to assess them, and implement proper mitigation practices customized for the consequences. Mapping of suppliers have been suggested as a possible action to predict and prepare for supply chain disruptions, and to avoid discovering disruptions from lower-tier suppliers too late (Zhu, Chou, and Tsai 2020). This involves obtaining an overview of the entire network of suppliers and their geographical locations. Before the organizations can identify upstream supply chain risks from the whole supply chain, they must have this overview over the supply chain.

The SC risk assessment process is moderately sufficient for the food supply chain. Most of them use a risk matrix to assess the impact and probability of risk occurrence of upstream SC risks, but there are still practices they could implement, such as having clear criterias for impact and probability, and using their suppliers more actively in the risk assessment process. By having clear criterias, it would be easier for the organizations to assess their identified risks more accurately, because the classification would be objective rather than subjective. They could also benefit from their suppliers' knowledge by including them in the risk assessment process.

The SC risk assessment process is also moderately sufficient for the energy supply chain. Most of them use a risk matrix to assess the impact and probability of risk occurrence of upstream SC risks, but as with the food supply chain, most of them still lack to have clear criterias for the impact and probability of upstream SC risks, and to use their suppliers more actively in the risk assessment process.

Bø, Hovi, and Pinchasik (2023) found that the studied organizations in retrospect of experienced upstream SC risks noted that risk assessment should have been more in focus, but that the trade of between cost and benefit must be considered when developing risk

identification- and assessment practices. Even if there is a trade of, the organizations that have not implemented a risk matrix, or only focuses on impact when assessing upstream SC risks, should consider implementing a risk matrix that assesses both probability and impact. This is because, to be able to mitigate risk, one must perform good risk identification and assessment (Fan and Stevenson 2018). It makes it more difficult to determine which mitigation practices to implement when there is little information about potential impact of the risk and its probability to occur. They may end up not mitigating the consequences that are most critical when it comes to both risk probability and consequence, even if they have identified the correct risks.

The next sub-chapter presents a discussion of the identified upstream SC risk mitigation practices of food- and energy supply chains.

#### **6.1.4 Upstream SC risk mitigation practices**

##### **Increased inventory**

In my sample, I find that all organizations have used increased inventory as a mitigation practice against upstream SC risk consequences they have experienced in this period. This is also the only practice that all studied organizations have implemented. There are therefore no differences between the different supply chains when it comes to this practice. This mitigation practice has been suggested by several researchers for a long time, it's simple to implement, and it's something that can mitigate several consequences.

##### **Meetings with suppliers**

Meetings with suppliers is the only mitigation practice that has been implemented by some of the organizations, without it mitigating any of the consequences they have experienced. Organization 1 within the food supply chain, and Organization 4 within the energy supply chain have implemented the practice, but not experienced any of the consequences it could mitigate, which was reduced or stop in production, stockout, and changes in schedule. This does not mean that this mitigation practice is redundant. It could also mean that they have avoided some of these consequences because they have had meetings with their suppliers, or that they have experienced it before the Covid 19 pandemic, and then implemented it.

##### **Supplier/material diversification**

All studied organizations in the food supply chain have implemented supplier/material

diversification, but only one organization within the energy supply chain have done it. Supplier/material diversification may be an alternative to increase inventory or order early where one avoids having products becoming obsolete. Chopra and Sodhi (2004) says that products that are expensive to keep in stock or fast-depreciating goods should be acquired by using extensive suppliers, while products that can be kept for a long time without obsoleting or are cheap to keep in stock can use a strategy with additional inventory level. In the energy supply chain, only Organization 5 have implemented this, even though all organizations in the supply chain could potentially benefit from it. Organization 4 and 6 have however claimed to have a supplier relationship strategy of long-term collaborative relationships. A such mitigation practice could therefore potentially ruin these relationships, and therefore also the mitigation practice of having strategic relationships with key suppliers.

### **Strategic relationships with key suppliers, and profit sharing**

There are more organizations within the energy supply chain which have a strategic relationship with key suppliers. Organization 4 and 6 within the energy supply chain have mentioned that this is a conscious choice as a result of their strategy. They have also both expressed that the consequence of a production stop on a platform is very expensive, and that they would therefore rather pay a little extra to avoid this. These two organizations are also the same that have implemented profit sharing with their suppliers, to increase their motivation for performing well. It's most likely not a coincidence that these are the same organizations.

Neither Organization 2 from the food supply chain nor Organization 5 from the energy supply chain have implemented profit sharing as a mitigation practice. They are both smaller than the other organizations in terms of revenue and are therefore maybe not in a financial position to provide their suppliers with enticing incentives. According to Tang (2006b), providing economic supply incentives for suppliers can ensure a stable supply base for the organization. For Organization 3, sharing profits with key suppliers could also improve the strategic relationship they have with them (Pakdeechoho and Sukhotu 2018).

Only one of the organizations within the food supply chain have strategic relationships with their key suppliers. Of the other two, it is only Organization 2 that have experienced matching consequences that are not experienced by all of them. They have experienced a



reduction in production and changes of schedule. None of them have experienced stockouts. Organization 2 also state to have handled this well, and that both consequences did not cause any large issues. They may therefore not see the same need for and benefit of implementing this mitigation practice.

It is interesting to note that the three organizations that have implemented this practice are also the only three that stated that they had been impacted on a low level from disruptions and delays the last three years.

By building up inventory and using alternative suppliers, organizations reduce the need for information from their suppliers (Kauppi et al. 2016), but other research have argued in favour of integration with suppliers through coordination and collaboration as strategy because it can make supply of materials less risky and more efficiently (Tang 2006a). It can also enhance companies' resilience (Liu and Lee 2018). Having long-term relationships to handle disruptions have also been stressed by relevant, recent research (Bø, Hovi, and Pinchasik 2023).

### **Sharing of strategic information with key suppliers (transparency)**

There are also more organizations within the energy supply chain that share strategic information with their suppliers than within the food supply chain. Organization 3 in the food supply chain and Organization 4 in the energy supply chain both have a strategic relationship with their suppliers and share strategic information with them. Organization 6 in the energy supply chain however does not share strategic information with them. It came out in the interview that this is not because they don't want to share it, but because they do not have all this information themselves. However, they let their suppliers be a part of their projects from an early phase, which might be seen as a form of strategic information sharing. By sharing strategic information with key suppliers, the uncertainty in the supply chain decreases because the suppliers can then make decisions based on data.

Organization 1 and 2 from the food supply chain could also benefit from implementing this mitigation practice. Organization 1 share some strategic information about production and distribution with one of their suppliers that they have a close relationship with, but this is only with one of their suppliers. Organization 2 have stated to have a good dialogue with

their suppliers, but they currently do not share any strategic information with them, which they potentially could benefit from.

Christopher and Peck (2004) says that lack of shared information can increase the total supply chain costs and make the supply chains more vulnerable. Transparency have also been stressed as important because it can decrease the potential for an upstream supply risk. van Hoek (2021) also found that information sharing increased in the supply chains increased during the first year of Covid 19, and that it had been a key factor for collaboration. At the same time, not all organizations could benefit from sharing strategic information. If the demand is very uncertain, which cause forecasts to be inaccurate, such information sharing may be unnecessary. This is also mentioned by Du and Jiang (2019).

Even though transparency can benefit all parts of a supply chain, it may however not reduce uncertainty of transport, according to a study by Du and Jiang (2019). Their argument is that transport risks are too hard to control. This means that it's not certain that the organizations would avoid this particular upstream supply chain risk type. For this mitigation practice it must also be taken into consideration that organizations are often reluctant to share strategic information due to competitive considerations (Tai et al. 2022).

### **Order early**

Order early have been implemented by all organizations within the energy supply chain, but only by one organization within the food supply chain. Ordering early increases the probability of receiving the goods before needed but it also means that products can become obsolete. The organizations should therefore know what their future demand is, to avoid this. This particularly applies to the organizations within the food supply chain. This may be why only Organization 3 in the food supply chain that have implemented it, even though it could potentially mitigate several of the consequences the food supply chain has experienced.

The organizations within the energy supply chain do not have the same issues as the food supply chain regarding shelf life of products. They do not have to take into consideration that products deteriorate. Nor do they have to take into account that the products go out of style. Therefore, this mitigation practice is better suited to this supply chain, and therefore

perhaps answers why all studied organizations in the energy supply chain have already implemented it.

### **Flexibility in production**

The organizations in the food supply chain generally have more flexibility in their production. Organizations with a flexible production can make rapidly changes to their production when experiencing risks (Dohale et al. 2023). Generally, a strategy with a focus on flexibility have been found to be more efficient to prevent supply chain failures (Talluri et al. 2013). As mentioned previously, both parts of Organization 3's production in the food supply chain, and Organization 5's production in the energy supply chain is less flexible due to their supply chain strategies. Particularly for organizations with an engineer-to-order strategy, flexibility has been considered important (Gosling and Naim 2009), and Organization 5 could therefore make their production more flexible to mitigate supply chain risks. Organization 4 in the energy supply chain could also reduce their transportation costs by having a more flexible production as they could avoid expensive alternative transport whenever goods are disrupted or delayed. However, as mentioned previously, the consequence of a production stop is very critical for them, and they are in a position where a slight increase in transportation costs does not affect them very much.

It must also be mentioned that none of the organizations mentioned this mitigation practice, but through the interviews three of the organizations stood out as flexible. Despite this, the others may have a flexible production without this being identified during the interviews.

### **Consider more local sourcing**

There are more organizations within the food supply chain that are considering more local sourcing. By sourcing more locally, the goods have a shorter route that they must be transported, and there are often less changes in transport modes throughout its journey. It's therefore not surprising that more organizations within the food supply chain consider it, as they handle goods that often have a short shelf life. A shorter transportation route would therefore be beneficial for them. However, they need to take into consideration both price levels and accessibility when sourcing more locally because not all food is available in Norway, or Europe because it cannot be grown in that climate. Seasons must also be taken

into consideration, as products that can be grown locally are not always available all year round.

Organization 3 from the food supply chain have not considered more local sourcing, but as previously mentioned, they already source most of their raw materials from within Norway and packaging from Europe. They experienced a production stop and a stockout because they lacked a raw material from Sweden, which might show how important it can be to source locally. Both Organization 4 and 6 from the energy supply chain state that their suppliers are located very locally, but that these often source from abroad. To source more locally, they would thereby have to convince their suppliers to do so. However, these two organizations have a strategic relationship with their key suppliers and are therefore in a position where it's easier for them to influence their suppliers. In addition, since both of them, and Organization 3 have a strategic relationship with their key suppliers, it might decrease the need for even more local sourcing.

Local sourcing is also something that can be combined with diversifying of suppliers. Sheffi (2001) suggests using local suppliers for covering the demand when there is a disruption, and offshore suppliers for the normal sourcing. If the organizations don't want to convert to all local suppliers immediately, this could be an option.

In the next sub-chapter, I will discuss suggestions for improving the upstream SCRM process of food- and energy supply chains, based on the reflections in the discussion.

### **6.1.5 Suggestions for improving the SCRM process of upstream supply chain risks**

The current SC risk mitigation practices of upstream SC risks are sufficient for both supply chains. However, there is still room for improvement. Additionally, the upstream SC risk identification- and assessment process also may benefit from suggestions for improvement in both supply chains.

The mitigation practices implemented by all organizations within the food supply chain are increased inventory, meetings with suppliers, supplier/material diversification, and flexibility in production. These four practices in total mitigates all the listed upstream SC risk consequences. However, the only mitigation practice that mitigates the risk of

increased inventory costs are supplier/material diversification. This is a consequence that all organizations within the food supply chain have experienced. The supply chain could therefore benefit from implementing other mitigation practices that mitigates this upstream SC consequence, such as strategic relationship- or sharing of strategic information with key suppliers, or both. These are mitigation practices that possibly mitigates all risks except increased transportation costs, and that has successfully been implemented by Organization 3 already. In addition, they are mentioned by several researchers as effective mitigation practices (Christopher and Peck 2004; Tang 2006b; Stecke and Kumar 2009; Kauppi et al. 2016; Bø, Hovi, and Pinchasik 2023).

The only mitigation practices implemented by all organizations within the energy supply chain are increased inventory and order early. These two mitigation practices mitigate all listed upstream SC risk consequences except increased inventory costs, which all organizations within the energy supply chain have experienced. They should therefore implement one, or several of the mitigation practices that could mitigate this upstream SC risk consequence. As with the food supply chain, the energy supply chain could also benefit from implementing strategic relationship- and sharing of information with key suppliers. Both these mitigation practices are practices that could work well together with increased inventory and order early because they mitigate the risk consequence that those don't. In addition, consider more local sourcing is the mitigation practice that most organizations in the energy supply chain could benefit from implementing. This is also a mitigation practice that would work well together with increased inventory and order early. Organization 4 and 6 have local suppliers that source offshore, but they also have a strategic relationship with their suppliers and therefore a larger possibility of influencing them to source more locally.

Both supply chains could also improve their SCRM process of upstream SC risks by improving their upstream SC risk identification- and assessment process. The food supply chain already has a sufficient upstream SC risk identification process, but they could benefit from identifying upstream SC risks further down in the supply chain than their first-tier suppliers because it would improve their overview over potential upstream SC risks. They could also benefit from improving their assessment process of upstream SC risks, which is moderately sufficient. To improve it, the most effective measure would be for all of them to start using a risk matrix to assess the different identified upstream SC

risks' impact and probability of occurring. In addition, having clear criterias for classifying impact and probability would make the process easier and more accurate. They could also use their suppliers more actively when both identifying and assessing upstream SC risks, as this would increase their list of potential risks, and give more accurate information which makes the prioritizing of risks easier.

The energy supply chain has a moderately sufficient upstream SC risk identification- and assessment process. Their upstream SC risk identification process could be improved if they started performing risk screening or auditing of new suppliers and started analysing second-tier suppliers and further down in the supply chain. Both these practices would increase their total control of upstream SC risks. Their assessment process would potentially be more effective when improving their upstream SC risk identification process, because they would identify several- and more accurate risks. To improve the assessment process of upstream SC risks additionally, all of them could start using a risk matrix to assess both probability and impact. They could also implement clear criterias of impact and probability and use their suppliers more actively in the risk identification- and assessment process.

Even though most organizations have implemented several mitigation practices, and particularly those who are often mentioned in literature, there are still potential for improvement. This observation is not unique, and has been pointed out by researchers before the Covid 19 outbreak (Tang 2006b), and after. van Hoek (2021) discovered that the studied firms one year into the Covid 19 pandemic still lacked to mitigate risks from pandemic, and that several of the risks had increased in severity. It might be because of lack of knowledge and competence in the organizations. Even though supply chain risk management is a well-established field within supply chain management, it is only the last few years that organizations have really had to deal with supply risk on the scale we have seen recently. Therefore, they might lack the knowledge to what mitigation practices that exists and how they can mitigate different consequences. This is also suggested as a possible reasons by Rice and Caniato (2003) and George A. Zsidisin, Panelli, and Upton (2000). They also suggest that a possible reason is because assessing impact and probability of risks sometimes are difficult to estimate, and that the risks therefore might be underestimated, or the mitigation practices de-prioritized because it's difficult to justify its benefit compared to costs.

## 7.0 Conclusions

This chapter presents the summary of the thesis' research and a reflection on managerial implications. In addition, limitations of the research and suggestions for further research are given.

### 7.1 Research summary

The main objective for this thesis has been to find out if Norwegian organizations within food- and energy supply chains are prepared to mitigate upstream SC risks that may occur in the future. The thesis has studied the current supply chain risk mitigation practices of Norwegian organizations within the food supply chain and the energy supply chain and whether they are sufficient to cope with the consequences they have experienced from upstream supply chain risks in the period during the Covid 19 pandemic. I have explored the risk types- and consequences of upstream SC risks in the period from January 2020 to March 2023, as well as the current SCRM practices of six organizations from two different supply chains. The main conclusions are summarized below.

**RQ - How do current supply chain mitigation practices of Norwegian organizations within food-and energy supply chains correspond to the consequences of upstream supply chain risks occurred during the Covid 19 pandemic?**

The studied food supply chain has a sufficient supply chain mitigation practice as the organizations have implemented at least two supply chain mitigation practices that mitigate each upstream SC risk consequence they have experienced during this period. Their most implemented mitigation practices are Increased inventory, Meetings with suppliers, Supplier/material diversification and Flexibility in production. They have implemented the following mitigation practices to a larger extent than the energy industry: Supplier/material diversification, Flexibility in production, and Consider more local sourcing.

The food supply chain has a sufficient upstream SC risk identification process, and they have a moderately sufficient assessment process of upstream SC risks that could benefit from implementing a risk matrix to assess the impact and probability of risk occurrence of the identified upstream SC risks in all organizations, as well as stating clear criterias for

probability and impact, and using their suppliers more actively when identifying and assessing risks.

The studied energy supply chain has a sufficient supply chain mitigation practice as the organizations have implemented at least two supply chain mitigation practices that mitigate the upstream SC risks they have experienced during this period. Their most implemented mitigation practices are increased inventory and order early, and they have implemented the following mitigation practices to a larger extent than the food industry: Order early, Strategic relationship with key suppliers, sharing of strategic information with key suppliers, and Profit sharing. There are therefore large variations between the two supply chains regarding choice of mitigation practices.

The energy supply chain has a moderately sufficient upstream SC risk identification- and assessment process. They could still benefit from implementing risk screening or auditing of new suppliers and analysis of second-tier suppliers and further down the supply chain in the upstream SC risk identification process. The supply chain could also benefit from all organizations using a risk matrix to assess upstream SC risks, as well as creating clear criterias for assessing impact and probability of upstream risks and using their suppliers more actively in the risk identification- and assessment process.

My empirical cases indicates that within both supply chains there are also unimplemented mitigation practices that could mitigate consequences they have experienced from upstream supply chain risks in the period after Covid 19. More organizations in both supply chains could benefit from implementing strategic relationship with key suppliers and sharing of information with key suppliers, and the energy supply chain could benefit from considering more local sourcing.

## **7.2 Managerial implications**

The findings in this thesis provides numerous implications for practitioners. The results are naturally most relevant for organizations within food supply chains and energy supply chains, but the findings can also be applied to several organizations within different supply chains. This thesis has focused on upstream SC risks, but many of the findings are transferable to other risk types such as demand risks as well. This research is conducted after the outbreaks of a pandemic and war which has meant that many organizations have



had to care about their SCRM process. The findings thereby provide up-to-date information about experienced upstream risks and current SCRM practices.

Practitioners can use the main areas of this research as a framework to examine their own SCRM process. By investigating SC risk types-, consequences, and SCRM processes, organizations can discover if they are prepared for mitigating future potential upstream SC risks.

Other implications are that the SC mitigation strategy is connected to the risk identification- and assessment processes and must therefore be considered in a holistic picture. Risk mitigation strategies are also something that must be carefully considered to cover the most important risks which are the ones that have a high impact or probability, or both.

### **7.3 Limitations**

The whole process of this thesis was completed over a period of 6-7 months. This naturally puts a limit to the research regarding size, depth, and accuracy of the study. Within the energy supply chain, Organization 6 formally belongs to *Construction*, while the two others belong to *Mining and quarrying*, according to Classification of Standard Industrial Classification by SSB (2009). Organization 6 still belongs to the energy supply chain with the two others, but this is a limitation of the study that may influence the results.

As there are only three organizations within each supply chain studied, the conclusions that are drawn may be affected by other factors than studied, such as case specific differences. Within the food supply chain, all cases are food manufacturers. This can give a unilateral picture of the supply chain. It was also not possible to compare whether there are any differences in the research outcomes between small and large organizations, because all organizations except one have over 100 employees and are therefore classified as large according to NHO (n.d).

The use of semi-structured interviews may have influenced the findings from the research as the interviewees spoke freely during the interview and were occasionally given examples that could help them answer the questions. The findings from each organization therefore depends on the informant who attended the interview, their knowledge, and their

understanding of the questions. It was also challenging for the informants to remember details all the way back to before 2020. Some of them also didn't work at the organization at the time and therefore could not answer how the supply chain risk management practice were conducted then. The data may therefore be insufficient or incorrect.

This research has been limited to upstream SC risk types- and consequences, and SCRM practices that are mentioned during the interviews. The analysis therefore lacks several upstream SC risk types- and consequences, and SCRM practices that are mentioned in literature. The organizations may also experience other upstream SC risks in the future than they have experienced during this period. Therefore, their mitigation practices may not be sufficient to mitigate future upstream SC risk consequences even though this is concluded in this thesis.

## **7.4 Suggestions for further research**

There are several suggestions that can be made for further research.

It could be interesting to use the findings to conduct a larger quantitative study with questionnaires to get a broader perspective of other supply chains, and within the already studied supply chains to see if the findings are consistent and can be verified from a larger study. A such study should also include several upstream SC risk types- and consequences, and SCRM practices that are mentioned in literature.

Another suggestion for future research can be to examine the difference between small and large organizations, as organizations' size may affect how extensive SCRM processes they can develop.

Events such as the Covid 19 pandemic and the war in Ukraine show an interesting potential of investigating supply chain risk management practice changes over time in a longitudinal research linked to relevant events during the period.

Investigating the long-term effect of the Covid 19 pandemic on supply chain risk management is also interesting, particularly in light of Jüttner, Peck, and Christopher (2010) statement that organizations often tend to return back to normal after a major disruptive event.

Finding an optimal combination of risk mitigation strategies with quantitative data based on a cost-benefit analysis of mitigation practices and risk impact- and probability could also be a suggestion for further research that could create great benefit for organizations.

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# Appendices

## Appendix 1: Interview guide

### Definitions

These are the definitions I use for the following terms in the questions for this interview.

**Key suppliers:** *Suppliers that are important for the business in the form of a high purchasing volume (e.g. raw materials for production) or that have a large impact on the profit of the business.*

**Disruption:** *The shipment from your supplier is being disrupted from being delivered at the agreed place of delivery.*

**Delays:** *The shipment from your supplier is being delivered later than agreed at the agreed place of delivery.*

### General questions

1. Can you briefly describe your organization and the type of work you perform?
2. What's the main categories of goods and services you purchase?
3. Which of these main categories are most relevant for the rest of the questions in this interview, which is about supply chain risk management in conjunction with disruptions and delays?
4. Can you describe the organization's supply chain?
5. Where are your key suppliers located? (Norway, Europe?, Other parts of the world?)

### Experienced risks

1. Have you experienced any delays the last three years?
  - If yes what were the main reasons? And how long approximately were the delays (in days)?
2. Have you experienced any disruptions the last three years?
  - If yes what were the main reasons?

### Risk consequences

1. What are the consequences of the delays you have been experiencing during the last three years?

*Examples: Stop in production/reduced production, increased lead times, reduced quality, use of alternative suppliers/material, difficulty meeting customer demand, greater financial losses, increased transportation costs (to reduce delays), increased holding costs (larger stock), change from global sourcing to local sourcing or insourcing, difficulty in predicting future demand, strained relationship with suppliers and customers*

2. What are the consequences of the disruptions you have been experiencing during the last three years?

3. Which of these consequences (that you have mentioned) would you say had the most impact

on your organization?

4. On a scale of high/medium/low, how much would you say that disruptions and delays have affected your organization the last three years?

## **Supply chain risk management**

### *Risk identification*

1. To what extent are you informed from your suppliers about possible disruptions and delays in the supply chain?
2. To what extent are you searching for potential disruptions and delays in the supply chain yourself?
3. What types of risk identification practices did you have before January 2020?
4. How have your risk identification practices changed the last three years? Have you done some adaptations?

### *Risk assessment*

5. When you have identified a supply risk, to what extent are you evaluating the probability that it can lead to a disruption or delay in your supply chain?
6. When you have identified a supply risk, to what extent are you evaluating the impact that can occur in the supply chain?
7. To what extent do you classify and prioritize the risks that you identify?
8. Do you use any specific techniques or tools to assess risks? If yes, please specify.
9. What types of risk assessment practices did you have before January 2020?
10. How have your risk assessment practices changed the last three years? Have you done some adaptations?

### *Risk mitigation*

11. To what extent are you coming up with strategies to avoid disruptions and delays occurring? (Proactively)
  - Please give examples
12. To what extent are you coming up with actions to minimize the consequences of disruptions and delays when they first occur? (Reactive)
  - Please give examples
13. What types of risk mitigation practices did you have before January 2020?
14. How have your risk mitigation practices changed the last three years? Have you done some adaptations?
15. Do you handle risks with low frequency and high impact differently than risks with high frequency and low impact?
  - Has this changed after the recent years' events?