BUILDING SUPPLY CHAIN RESILIENCE IN THE FINNISH CONSTRUCTION-RELATED MANUFACTURING INDUSTRY

Lappeenranta–Lahti University of Technology LUT

Master's Programme in Supply Management, Master's Thesis

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Kaisa Mankki

Examiners: Professor Katrina Lintukangas

Postdoctoral Researcher Elina Karttunen

ABSTRACT

Lappeenranta–Lahti University of Technology LUT

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Kaisa Mankki

Building Supply Chain Resilience in the Finnish Construction-Related Manufacturing Industry

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Keywords: supply chain, supply chain resilience, supply chain management, supply risk mitigation, risk management

Recent global crises and rising geopolitical and economic uncertainties have made the contemporary business environment increasingly unpredictable. This has highlighted the need for companies to strengthen the resilience of their supply chains to prepare for and minimise the negative impacts of possible supply disruptions.

The aim of this thesis is to analyse how Finnish manufacturing companies operating within the construction industry can enhance the resilience of their supply chains. This thesis was conducted in collaboration with a Finnish manufacturing company in the construction industry. To support this objective, this thesis additionally examines potential supply risk factors and attempts to identify practical risk mitigation methods. The study employs a qualitative case study approach, with data collected through semi-structured interviews with the case company's suppliers and internal stakeholders. The data was analysed using thematic analysis.

The findings of this study suggest that building supply chain resilience requires companies to identify potential risks, encourage collaboration, commitment and trust with suppliers, ensure open and transparent sharing of information, and proactively develop strategies to anticipate and manage risks. The analysis revealed eight supply risk factors, encompassing product-specific, supplier-related and market-related factors. In addition, eleven practical risk mitigation methods were identified, classified as either internal or supplier-related. While most of the findings align with existing literature, some introduce new perspectives on supply chain resilience.

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Toimitusketjun resilienssin vahvistaminen Suomen rakennusalaan liittyvässä valmistavassa teollisuudessa

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Viimeaikaiset globaalit kriisit sekä kasvava geopoliittinen ja taloudellinen epävarmuus ovat tehneet nykypäivän liiketoimintaympäristöstä entistä ennalta-arvaamattomamman. Tämä on lisännyt tarvetta vahvistaa yritysten toimitusketjujen resilienssiä, jotta ne voivat varautua mahdollisiin toimitushäiriöihin ja minimoida niiden kielteiset vaikutukset.

Tämä pro gradu -tutkielma tutkii sitä, miten suomalaiset rakennustuotevalmistajat voivat kehittää toimitusketjujensa resilienssiä. Tutkimus on toteutettu yhteistyössä suomalaisen rakennustuotteita valmistavan yrityksen kanssa. Työssä tarkastellaan myös toimitusriskeihin vaikuttavia tekijöitä sekä käytännön keinoja toimitusriskien hallintaan ja ehkäisyyn. Tutkimuksen empiirinen osa toteutettiin laadullisena tapaustutkimuksena. Aineisto kerättiin puolistrukturoiduilla haastatteluilla, joihin osallistui sekä kohdeyrityksen toimittajia että sisäisiä sidosryhmiä. Kerättyä aineistoa analysoitiin temaattisen analyysin avulla.

Tutkimuksen tulokset osoittavat, että toimitusketjujen resilienssin vahvistaminen edellyttää yrityksiltä riskien tunnistamista, yhteistyön, sitoutumisen ja luottamuksen edistämistä toimittajien kanssa, avointa ja läpinäkyvää tiedonvaihtoa, sekä proaktiivista strategioiden kehittämistä riskien hallitsemiseksi. Analyysissa tunnistettiin kahdeksan toimitusriskitekijää, joista kukin voidaan luokitella kuuluvaksi joko tuotekohtaisiin, toimittajiin liittyviin tai markkinoihin liittyviin tekijöihin. Tämän lisäksi analyysissa tunnistettiin yksitoista käytännön riskienhallintamenetelmää, jotka voidaan jaotella sisäisiin ja toisaalta toimittajiin liittyviin keinoihin. Vaikka suurin osa havainnoista on yhdenmukaisia aiemman tutkimuskirjallisuuden kanssa, osa tuloksista tuo esiin uusia näkökulmia toimitusketjujen resilienssin vahvistamiseen.

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“Kaikki on hyvin epävarmaa, ja juuri se tekee minut levolliseksi.”

— Tove Jansson

As I reach the end of five years of study, I’m struck by how much this time has shaped who I am today. My time at LUT University has given me friends who feel like family, unforgettable experiences, invaluable opportunities, and a deeper understanding of what truly inspires me. I would not be here without the support and encouragement of those who have accompanied me on this journey.

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I am forever grateful to my parents for their unwavering guidance, support, encouragement and for teaching me the true value of education. As they have always said, no matter what I may lose in life, the knowledge that I carry with me is something that can never be taken away. Words cannot truly capture how thankful I am to my sister, Aino. You have always been there for me, supporting and encouraging me to be the best version of myself. As a line from a song goes, ‘mä en luota kehenkään niinku luotan mun siskoon.’ I want to thank my friends for all the precious moments, laughs and even tears that we’ve shared. You mean the world to me. Last but not least, I want to thank my dog, Nero, for bringing joy to my life every single day. With this chapter of my life coming to an end, I look forward to all the opportunities that lie ahead.

Kaisa Mankki

Lappeenranta, 9.11.2025

ABBREVIATIONS

RMP	Risk Management Process
RMS	Risk Management Strategy
RRR	Readiness, Response and Recovery
SCC	Supply Chain Collaboration
SCF	Supply Chain Flexibility
SCR	Supply Chain Resilience
SCRM	Supply Chain Risk Management
TA	Thematic Analysis

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Use of AI

Grammarly was utilised to minimise grammatical errors and to enhance language fluency. ChatGPT and Microsoft Copilot were utilised to support idea generation, enhance language fluency, refine the structure of the thesis, and assist in the development of the research and interview questions.

1 Introduction

Recent shifts in the global business environment have highlighted the importance of supply chain resilience. United States President Donald Trump's trade policies, which include tariffs on almost all European exports to the United States (O'Carroll 2025), have prompted trade disputes and intensified market volatility, while Russia's war of aggression against Ukraine has impacted the stability of supply chain relations globally and caused supply disruptions (Toygar & Yildirim 2023, 191; Hamidu et al. 2023, 361). Furthermore, supply chains and logistics are affected by the increasing frequency of extreme weather events, such as hurricanes and floods, caused by climate change (Çevik 2024, 368). As the world we live in becomes more unpredictable, it is crucial that businesses take measures to strengthen their supply chains' ability to predict, adapt to, and recover from the negative impact of these changes.

The significance of supply chain resilience has become more acknowledged in the construction and manufacturing industries in recent years (Bello et al. 2024, [no pagination]; Hamidu et al. 2023, 361–362). Furthermore, the COVID-19 pandemic and the resulting disruptions to global supply chains have led manufacturing companies to acknowledge the importance of enhancing the resilience of their supply chains (Hamidu et al. 2023, 361–362). However, achieving this can be challenging, as supply chains are becoming broader, often spanning across the globe, and the potential risks are becoming more prevalent. (Christopher & Peck 2004, 1) This phenomenon is equally applicable to the supply chain activities of companies operating in the construction and manufacturing industries. Due to the construction industry's "complex and multifaceted" nature, its supply chains tend to be broad and fragmented and consist of multiple stakeholders (Bello et al. 2024, [no pagination]). As supply chain risks cannot be avoided, companies must implement effective risk management strategies to address them (Shishodia et al. 2023, 880).

The findings of past studies suggest that, within the context of the construction and manufacturing industries, the resilience of a supply chain can be ensured through risk management practices and by establishing resilience strategies (Baghalzadeh Shishehgarkhaneh et al. 2024, 12; Hamidu et al. 2023, 375). The development and expansion

of the construction industry could be considered crucial, as it aids in both the generation of job opportunities and in increasing economic growth (Quan et al. 2022, 265). Baghalzadeh Shishehgarkhaneh et al. (2024, 1) support this view, suggesting that the construction industry has a significant role in creating jobs for "both skilled and unskilled labors", resulting in economic growth.

The aim of this thesis is to examine how the supply chain resilience of manufacturing companies operating in the Finnish construction industry can be enhanced. Furthermore, this study analyses how supply risks and the implementation of practical risk mitigation strategies affect supply chain resilience. The research is conducted in collaboration with a Finnish manufacturing company operating in the construction industry. As a by-product of this thesis, a new risk management tool is developed for the focal company.

1.1 Research Objectives and Questions

This thesis aims to contribute to the academic field of supply chain risk management by providing insight into the factors that shape supply risks and thereby influence supply chain resilience. Additionally, this thesis attempts to identify practical methods for addressing supply risks and improving supply chain resilience in the context of manufacturing companies operating in the construction industry. To achieve these objectives, this study employs one primary and two secondary research questions.

The primary research question of this thesis is:

1. *How can supply chain resilience be improved in Finnish manufacturing companies operating within the construction industry?*

While the two secondary research questions are:

2. *Which factors should be considered when assessing the probability and potential impact of supply risks?*

3. *What practical methods can manufacturing companies utilise to mitigate supply risks?*

The primary research question outlines the overall direction and scope of this study by setting the focus on enhancing supply chain resilience. It defines the main objective of this study and serves as the basis for the two secondary research questions. In order to provide greater depth to the primary research question, two secondary research questions have been formulated. The aim of the former secondary research question is to provide further insight into which factors impact supply risks, as the identification of them can be beneficial for evaluating the probability and impact of supply risks. Through the latter secondary research question, practical approaches for mitigating supply risks will be suggested. The secondary research questions complement the primary research question by focusing on specific aspects of supply chain resilience, which allows for a more detailed and comprehensive exploration of the topic.

1.2 Conceptual Framework

The conceptual framework of this study is visualised in Figure 1. The conceptual framework presents the key concepts of this study and illustrates the connections between them. The focus of this study is on supply chain resilience. This thesis aims to provide further insight into how the identification of supply risk factors can enhance supply chain risk management, and how effective supply chain risk management can, in turn, support the identification of these factors, resulting in increased supply chain resilience. Furthermore, the connection between the utilisation of supply chain resilience strategies and supply chain resilience will be analysed.

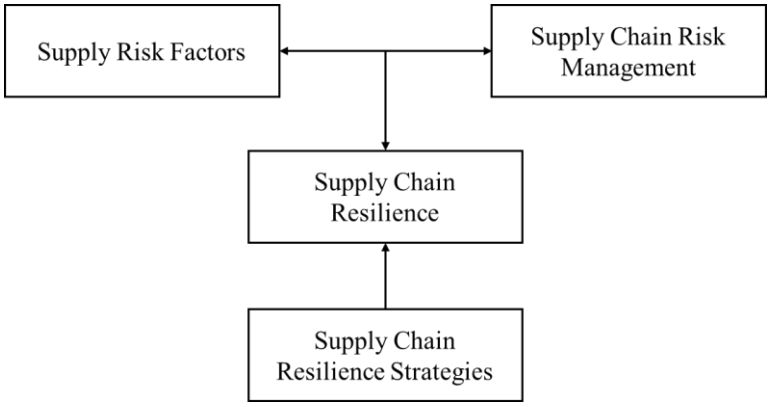

Figure 1. Conceptual framework of the study

1.3 Definitions of Key Concepts

In this section the most relevant key concepts are defined. These concepts will be explored in greater depth in the second chapter.

Supply chain: The "linkage of supply-related activities across multiple functions and organisations" (Nakano 2019, 3). A supply chain consists of all the steps, whether direct or indirect, that contribute to fulfilling a customer's request (Carmignani 2009, 399).

Supply chain risk management: The collaborative effort between organisations to manage risks through the utilisation of both quantitative and qualitative methods, with the aim of identifying, assessing, reducing, and tracking unforeseen events or conditions that could negatively affect "any part of a supply chain." (Ho et al. 2015, 5036)

Supply chain resilience: The ability of a supply chain to prepare for and respond to disruptions, recover quickly and cost-efficiently from said disruptions, and ultimately reach a more resilient and improved state following the disruption. (Tukamuhabwa et al. 2015, 5599)

Supply risk: The risk linked to upstream disruptions. Supply risks arise when a commercial transaction involving a supplier will have significant consequences for the organisation. (Shafiq et al. 2017, 1387)

1.4 Limitations

In order to not make the scope of this study too broad, certain constraints have been placed. This study focuses on European and North American supply chains of manufacturing companies operating in the manufacturing and construction industry and does not consider supply chains outside of these continents. Therefore, the findings of this study might not be applicable to companies operating in other industries or continents. Furthermore, as the data utilised for the purposes of this study is gathered from internal and external stakeholders of a case company, the generalisation of the findings might be limited. As the case company wishes to stay anonymous, the research does not focus on any particular raw material or product, as doing so could identify the case company.

1.5 Research Methodology

This thesis is divided into theoretical and empirical parts. In the theoretical part, findings of past studies and concepts relevant to this study are introduced and discussed. The theoretical part serves as a basis for the empirical part.

The empirical part of this study relies on qualitative research methods. The utilisation of qualitative research methods can be beneficial for gaining deeper insights into complex phenomena, and for answering “what”, “how” and “why” questions. (Lim 2025, 199–200). More specifically, this study utilises a case study approach. The utilisation of a case study approach can be beneficial, as it allows the development of “novel theoretical insight stemming from case-specific contextualised findings” (Hoon 2013, 522). The data collected for the purposes of this study was gathered through semi-structured interviews, which were conducted with both internal stakeholders and suppliers of the case company. The interview transcripts were analysed through hybrid thematic analysis. The research methodology is described in greater detail in chapter 3.

1.6 Structure of the Thesis

This thesis has been divided into six chapters (see Figure 2.). In the first chapter, a brief introduction is given to the topic, the objectives and research questions are presented, the conceptual framework of this study is discussed, the key concepts of the thesis are defined, and the research methodology is described.

The second chapter consists of a literature review, in which the most relevant topics within the context of this study are discussed in greater detail. The literature review provides a basis for the third chapter, where the methodology used to conduct the research of this thesis is introduced and justified. In addition, the research approach and data collection method are described.

In the fourth chapter, the findings of the study are presented. In the fifth chapter, the research questions are addressed, and the findings are discussed in relation to past literature. Lastly, in the final chapter, final conclusions are made, limitations of the study are addressed and suggestions for future research areas are given.

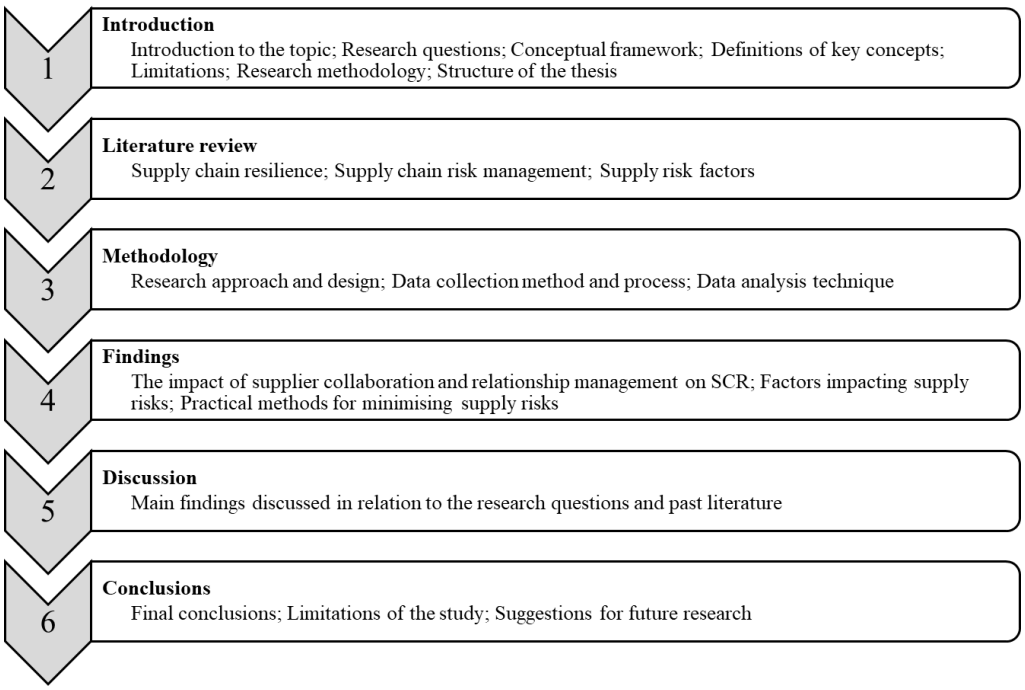

Figure 2. Structure of the study

2 Literature Review

The aim of this chapter is to provide the reader with a deeper understanding of supply chain resilience, supply chain risks and supply chain risk management. In order to achieve this, this chapter examines relevant literature and theoretical frameworks, which offer insights into current academic perspectives on the topics. Furthermore, this chapter will serve as the foundation for developing the interview questions.

2.1 Supply Chain Resilience: Key Concepts and Strategies

Each supply chain activity is prone to risks and disruptions (Kummer et al. 2022, 3). For example, significant events such as political instability, diseases and terrorism can negatively impact the ability of a company to produce and distribute their products (Tukamuhabwa et al. 2015, 5592). These kinds of unexpected disruptions within the supply chain of a company can lead to negative operational and financial outcomes. Therefore, companies need to focus on minimising their exposure to risks by ensuring the resilience of their supply chains. (Kummer et al. 2022, 3)

The concept of supply chain resilience (SCR) could be described as a "multidimensional criterion." (Qader et al. 2022, 2) Although the term "resilience" is somewhat broad, a number of definitions have been proposed (Kummer et al. 2022, 4). Within the context of supply chain management, resilience could be described as the ability of a supply chain system to return to its original state, or an improved state, after the occurrence of a disruption (Shishodia et al. 2003, 882). This definition is supported by Belhadi et al. (2022, 4489), who propose that SCR could be defined as "the supply chain's adaptive capacity to deal with disruptive events and to swiftly regain its previous performance level."

The resilience of a supply chain can be assessed by analysing the three following facets: Readiness, Response and Recovery (RRR). Readiness refers to a company's ability to plan and be prepared for any unexpected disruptions in its supply chain. Response describes a company's capability to encounter and address supply chain disruptions. Finally, recovery

entails the ability of a company to “reorganise and design” its supply chain operations to their original state. (Qader et al. 2022, 3)

Belhadi et al. (2022, 4489) suggest that SCR strategies usually focus on specific risks that need to be addressed, and can be either proactive, reactive, or both. Proactive strategies tend to focus on the supply chain itself, and within the context of SCR, practical examples of these kinds of strategies include supplier development and management, and supplier relationship management. Reactive strategies, on the other hand, focus more on the mitigation of possible, more complex, risks. Reactive strategies include, for example, contingency planning and disaster management. (Can Saglam et al. 2021, 1226)

Based on the existing literature, the most common SCR strategies appear to be collaboration, agility and flexibility (see Table 1.). These strategies will be discussed in greater detail in the following sections.

SCR Strategy	Definition	SCR Strategic Approaches	Author(s)
Collaboration	The development of strong and long-lasting partnerships in which supply chain members share information, resources, and risks to achieve common goals.	Information sharing and collaborative communication	Cao & Zhang (2011, 166); Scholten & Schilder (2015, 478); Can Saglam et al. (2022, 4)
		Goal congruence	
		Decision synchronisation	
		Incentive allignment	
		Resource-sharing	
		Joint knowledge creation	
Agility	A company's ability to rapidly adapt to unexpected changes in demand or supply.	Market sensitivity	Christopher (2000, 38); Tukamuhabwa et al. (2015, 5605)
		Virtualisation	
		Process integration	
		Network-based structure	
Flexibility	The ability of a company to adjust to the changing demands in its environment and stakeholders with as little time and effort as possible.	Product development flexibility	Jin et al. (2014, 27); Tukamuhabwa et al. (2015, 5604); Manders et al. (2017, 1009); Piprani et al. (2022, 310)
		Production flexibility	
		Logistics flexibility	
		Supplier's flexibility	
		Supply base flexibility	

Table 1. SCR strategies

2.1.1 Collaboration as a Supply Chain Resilience Strategy

During the COVID-19 pandemic, supply chains globally experienced numerous challenges, including disruptions to supply, demand and distribution (Kummer et al. 2022, 41). The importance of collaboration and communication between companies became especially apparent in the aftermath of the pandemic (Zhou et al. 2024, 779). Within the context of

SCR, collaboration could be defined as “the capacity of two or more autonomous firms to work effectively together, planning and executing supply chain operations toward common goals” (Scholten & Schilder 2015, 471).

Enhancing collaboration within the supply chain could offer companies numerous advantages, including increased visibility, improved flexibility and enhanced punctuality of deliveries. Moreover, Supply Chain Collaboration (SCC) can offer companies the opportunity to achieve economies of scale and learning effects, resulting in the creation of a unique resource, which can become a crucial contributor to a company’s competitive advantage. (Zhou et al. 2024, 779) Furthermore, SCC allows supply chain partners to create synergies, streamline joint planning and strengthen real-time information sharing. These activities are necessary for responding to and recovering from supply chain disruptions, while they also minimise the overall impact of such disruptions. (Scholten & Schilder 2015, 473)

SCC is characterised by multiple elements, including communication and collaboration, the sharing of information, the setting of strategic goals, the sharing of benefits and the sharing of risks between the partners of a supply chain. These elements demonstrate the capability of supply chain partners to collaborate, plan and carry out operations in order to achieve common goals. (Zhou et al. 2024, 779) Furthermore, Scholten and Schilder (2015, 473) argue that, within the context of SCR, collaboration as a factor can be characterised by: (1) Information-sharing; (2) Goal congruence; (3) Decision synchronisation; (4) Incentive alignment; (5) Resource-sharing; (6) Collaborative communication; and (7) Joint knowledge creation.

Information sharing describes the degree to which a company provides its supply chain partners with relevant, accurate, complete and confidential information in a timely manner (Cao & Zhang 2011, 166). The findings of past studies suggest that information sharing can have a significant impact on SCR. Information sharing together with collaborative communication can enhance the visibility, flexibility and velocity of a supply chain. Furthermore, information sharing and communication have a notable role in the early recognition and identification of possible supply chain disruptions. (Scholten & Schilder 2015, 478)

The quality of communication can also have an impact on the effectiveness of information sharing. In essence, the quality of communication focuses on the value of the information being exchanged between partners rather than on the amount of communication. When the quality of communication is high, it is more likely that the members of a supply chain have timely access to "extensive and accurate information on the supply chain." (Can Saglam et al. 2022, 4)

Goal congruence refers to the extent to which the members of a supply chain believe that their own objectives are achieved when the overall objectives of the supply chain are met (Scholten & Schilder 2015, 473). Goal congruence could also be described as "the degree of goal agreement, compatibility, or fit among supply chain partners." Goal congruence can be achieved, for example, by supply chain partners developing a common vision for supply chain management and agreeing on the processes needed to realise said vision. (Cao et al. 2010, 6618)

Decision synchronisation describes the process of supply chain partners coordinating decisions regarding the planning, solution seeking and operations of a supply chain with the goal of maximising its benefits (Cao et al. 2010, 6619; Scholten & Schilder 2015, 473). Decision synchronisation is often characterised by joint decision-making and problem solving through the creation of cross-functional and organisational teams. This approach allows the supply chain partners of a company to work together to develop different strategies for improvement when risks or unexpected issues occur. Furthermore, decision synchronisation can positively impact the commitment of supply chain partners to implement the developed strategies. (Fayezi & Ghaderi 2022, 164)

Incentive alignment describes the process of supply chain partners sharing costs, risks and benefits. It is essential that both benefits and losses are shared equally between the members of a partnership in order for it to be successful. In addition, incentive alignment motivates the members of a supply chain to act in accordance with mutual objectives, for example through the sharing of important information. Furthermore, it can increase cooperation and commitment and reduce opportunistic behaviour. (Cao et al. 2010, 6619; Fayezi & Ghaderi 2022, 164)

Resource-sharing involves supply chain partners investing in, utilising and collectively developing assets and capabilities with each other (Cao et al. 2010, 6620; Scholten & Schilder 2015, 473). Within this context, resources consist of "physical assets, such as manufacturing equipment, facilities, and technology." It is essential that both parties invest into resources mutually in order for the collaboration to be sustainable. (Cao et al. 2010, 6620) Collaborative resource-sharing also strengthens the mutual advantage that supply chain partners might gain during the disruption recovery process (Mustapha et al. 2022, 115604).

Joint knowledge creation refers to the degree to which supply chain partners collaborate to develop their understanding of, and ability to adapt to the market and its competitive environment (Cao et al. 2010, 6620; Scholten & Schilder 2015, 473) Knowledge creation activities can be divided into two categories: knowledge exploration and knowledge exploitation. Knowledge exploration refers to the process of seeking and capturing relevant knowledge, whilst knowledge exploitation describes the process of assimilating and implementing knowledge. Enhancing joint knowledge creation can be beneficial, as it allows the supply chain partners to innovate and stay competitive in the long-term. (Cao et al. 2010, 6620)

2.1.2 Agility as a Supply Chain Resilience Strategy

Supply chain agility could be defined as the supply chain's "ability to respond quickly to unpredictable changes in demand or supply" (Tukamuhabwa et al. 2015, 5605). Ensuring the agility of a supply chain can be beneficial, as it can help in delivering the correct product to the customer at the correct time. Furthermore, a company's ability to quickly adapt to environmental changes can offer a competitive advantage over competitors who react more slowly. (Calvo et al. 2020, 55). Christopher (2000, 38) suggests that an agile supply chain can be described as having four key characteristics: (1) Market sensitivity; (2) Virtualisation; (3) Process integration; and (4) a Network-based structure (see Figure 2.).

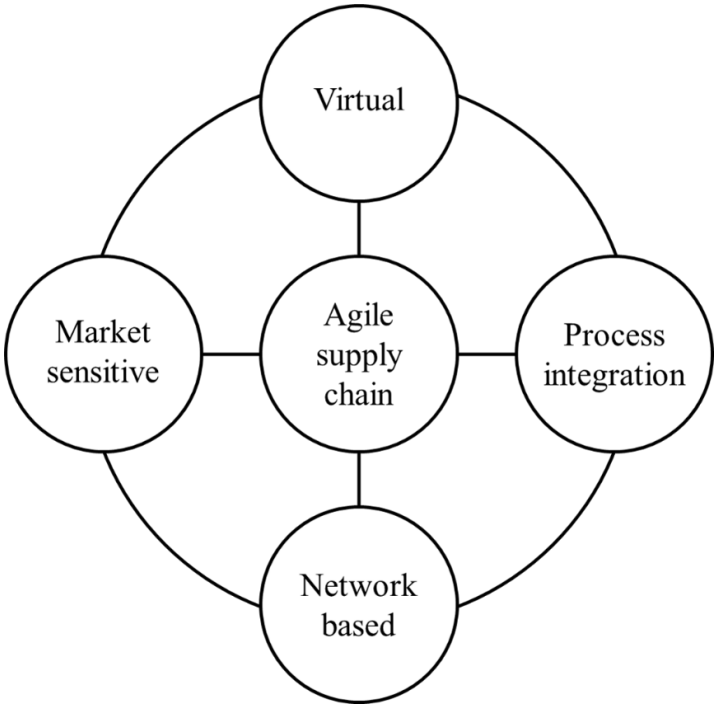

Figure 3. The agile supply chain (Christopher 2000, 40)

Market sensitivity refers to a supply chain's ability to interpret and adapt to actual demand. As many companies are forecast-driven rather than demand-driven, they tend to base their forecasts and inventory levels on past sales or shipments data rather than on actual customer needs. However, the utilisation of information technology to gather real-time data regarding points of sale can be beneficial for understanding market needs and swiftly responding to them. (Christopher 2000, 38) *Virtualisation* describes the process of companies utilising information technology to share information between their buyers and suppliers (Christoper 2000, 38–39). The role of information technology integration and flexibility is especially important within the context of supply chain agility (Fayezi et al. 2017, 394). However, the effective sharing of information between supply chain partners is only possible through the third characteristic: process integration. *Process integration* refers to companies collaborating with their buyers and suppliers to develop products, align systems and mutually exchange information. The last characteristic of an agile supply chain, *network-based structure*, is based on the idea of a supply chain being a collaborative network of interconnected partners. In other words, a supply chain with a network-based structure is characterised by a company's ability to "structure, coordinate and manage their relationships with their partners." (Christoper 2000, 38–39)

2.1.3 Flexibility as a Supply Chain Resilience Strategy

Flexibility as an SCR strategy could be defined as the capability of a company to adjust to the changing demands of its environment and stakeholders with as little time and effort as possible (Tukamuhabwa et al. 2015, 5604). In essence, the aim of supply chain flexibility (SCF) is to give companies a competitive advantage through allowing them to adapt to shifting supply and demand. This adaptability enables them to introduce and modify their products to meet customer demands in an efficient manner. (Piprani et al. 2022, 309) Furthermore, flexibility allows for the resources of a company to be redeployed with less effort when uncertainties arise. Flexibility can be applicable to both a company and its supply chain. (Tukamuhabwa et al. 2015, 5604)

According to Jin et al. (2014, 27) a manufacturing firm's SCF can be divided into five dimensions: (1) Product development flexibility; (2) Production flexibility; (3) Logistics flexibility; (4) Supplier's flexibility; and (5) Supply base flexibility. The first three dimensions focus on a company's manufacturing flexibility. The final two dimensions concentrate on flexibility factors related to a company's suppliers. (Piprani et al. 2022, 310) These flexibility dimensions will be explored in greater detail below.

Product development flexibility could be defined as "the ability of supply chain partners to collaborate and coordinate to produce completely new products economically and with no additional time to meet the market demand." Product development flexibility is a significant SCF dimension, as it allows companies to "modify and foresee" their innovation strategies in response to present or upcoming environmental changes. The role of product development flexibility becomes especially relevant in product competition, as it enables companies to quickly expand and diversify their strategic actions during decision-making. Product development flexibility can be enhanced through decisions regarding supplier selection, supplier management, and the overall structure of the supplier network. Additionally, it has been suggested that product development flexibility could be increased through the management of technology, development processes and competencies. (Fantazy & Salem 2016, 530–531)

Production flexibility refers to the company's ability to make more flexible production decisions. Typically, production flexibility involves the adjustment of production quantities (volume flexibility) or product mixes (mix flexibility). (Moreno & Terwiesch 2015, 428) However, production flexibility can also refer to a company's ability to switch between different products or adjust certain features of products with minimal effort. The higher the production flexibility of a company is, the more likely the company is to avoid operating losses, thus lowering the risk of financial distress and its associated costs. (Reinartz & Schmid 2016, 1505–1506)

Logistics flexibility describes the capability of a company's procurement system to manage different "receipt and delivery requests accurately, quickly, and efficiently" (Jin et al. 2014, 27). The concept of logistics flexibility could also be defined as the ability of a company to "align, adapt and adjust the process of the goods flows including the inbound and outbound activities and the storage of the goods to changing customer needs". Logistics flexibility consists of multiple activities related to the physical movement of goods both internally and throughout the supply chain, with the goal of sustaining customer satisfaction. (Sandberg 2021, 696)

The activities associated with logistics flexibility can be divided into two categories, namely activities related to purchasing management and activities related to physical distribution. Purchasing management activities consist of supply-related activities, including demand forecasting, requirements planning, inventory management, warehousing, material handling, packaging, and purchasing. Physical distribution activities, on the other hand, include activities such as warehousing, material handling, packaging, finished good inventory, distribution planning, order processing, transportation and customer service. (Jafari 2015, 949)

Supplier's flexibility refers to the ability of a supplier to adapt its operations to meet the purchasing company's component needs while ensuring that the final products meet the demands of the final customer. Supplier's flexibility plays a crucial role in the purchasing company's product development, production and logistics capabilities. When examining supplier's flexibility from the viewpoint of a manufacturing company, the most significant aspects of this dimension are order quantity and product variety, as they determine the

supplier's ability to deliver the correct amount and type of products on time. (Jin et al. 2014, 27)

Supply base flexibility describes the ability of a company to adjust its buyer-supplier relationships with minimal penalties in cost, time and effort. Supply base flexibility focuses only on the relationship between the manufacturer and its suppliers rather than on the individual firms themselves. This flexibility dimension can be examined from two perspectives, namely range and mobility. Range refers to the number of suppliers that the company has access to. When unforeseen issues arise, it is essential that a company has access to multiple competent suppliers to which the company can reallocate their orders. This allows the purchasing company to stay in their intended manufacturing schedule. Mobility, on the other hand, describes the purchasing company's ability to develop new supplier relationships, modify existing supplier relationships and switch purchasing orders to alternative suppliers. (Jin et al. 2014, 27)

2.1.4 The Role of Data within the Context of Supply Chain Resilience

Data analytics capability describes a company's ability to gather, store and analyse data to obtain useful information, which can be utilised to gain competitive advantage. Additionally, analytics capability refers to the integration of tools, techniques and processes that allow a company to process, organise, visualise and analyse data to acquire valuable insights. This enables companies to make more informed decisions regarding their business operations. (Dubey et al. 2021, 112)

When organisations have greater access to information, they can respond more quickly to changes in their environment (Kokkinou et al. 2023, 325). The ability of a company to process information and data is closely linked to the company's SCR. The findings of a study conducted by Lu et al. (2024, 738) suggest that supply chain information processing capability has a positive effect on SCR. The authors propose that companies should aim to develop different information systems and utilise advanced information technology in order to obtain and analyse "information along the whole supply chain." In addition, the authors

suggest that companies should try to acquire information from their supply chain partners and “compete together as a chain”, rather than compete as separate companies.

The nature of data that should be utilised to ensure SCR depends on the type of risk being assessed. For example, Schoenherr et al. (2023, 10) argue, that when analysing risks that are specific in nature, such as supplier and market risks, companies can utilise their own data sources as the data and metrics utilised are usually objective. However, when the risks in question are non-specific in nature, such as geopolitical events or natural disasters, the data being used is typically based on “composite indexes”, which are commonly obtained from third-party sources. (Schoenherr et al. 2023, 10)

2.2 Supply Chain Risk Management

The concept of supply risk has been given numerous definitions. For instance, Ho et al. (2015, 5035) define supply risk as “the likelihood and impact of unexpected macro and/or micro level events or conditions that adversely influence any part of a supply chain leading to operational, tactical or strategic level failures or irregularities.” This definition is further supported by Tang and Nurmaya Musa (2011, 26), who suggest that supply chain risks should be defined as low-probability events that occur unexpectedly and have the potential to cause notable negative effects on the system.

Similarly to the concept of SCR, various definitions have been proposed for Supply Chain Risk Management (SCRM). Gurtu and Johny (2011, 1) define SCRM as the “implementation of strategies and plans to manage supply chain networks through constant risk assessment and reduce vulnerabilities to ensure resilience in supply chains”. Furthermore, they describe SCRM as a structured and phased process of identifying, assessing, prioritising, mitigating and monitoring possible disruptions in supply chains. The definition proposed by Gurtu and Johny (2011, 1) is somewhat supported by Tang (2006, 453), who suggests that SCRM could be defined as “the management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity.”

2.2.1 Supply Chain Risk Management Process

A five phase Risk Management Process (RMP) can be employed in the identification and assessment of potential risks. The RMP framework (see Figure 3.) consists of five phases: (1) Risk identification; (2) Risk measurement; (3) Risk assessment (4) Risk evaluation; and (5) Risk control and monitoring. This framework allows the examination of the severity of the consequences of risks and the development of appropriate risk mitigation strategies. (Tummala & Schoenherr 2011, 475)

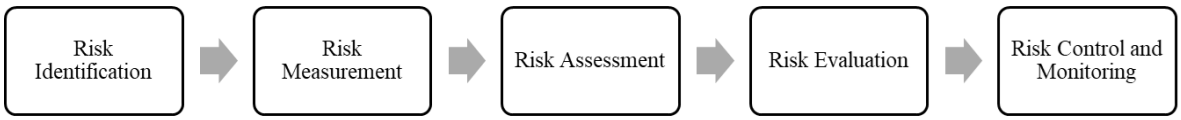

Figure 4. Supply chain risk management process (adapted from Tummala & Schoenherr 2011, 477)

The first phase of RMP consists of the identification of potential supply chain risks related to a specific issue. In order for the appropriate risk mitigation strategies to be applied, it is necessary to identify and understand the potential consequences of a risk. (Tummala & Schoenherr 2011, 476) The evaluation of possible risks is a crucial aspect of risk identification, as it can aid in the discovery of the potential elements that might generate disruptions (Deiva Ganesh & Kalpana 2022, 1335).

The second phase of RMP entails the identification of the possible consequences of the risks identified in the first phase. Additionally, at this stage, the extent of the identified risks should be evaluated. (Tummala & Schoenherr 2011, 476) Schoenherr et al. (2023, 1) argue that it is essential that companies foster a strong "culture of continuous measuring" across all areas of activity, as this allows them to make objective decisions and prioritise the risks which require immediate attention. The majority of RMP approaches utilise one or multiple parameters to characterise the risks. However, the most commonly utilised measure is a

risk's "disruptive impact on company operations", which describes the risk's severity or intensity. (Schoenherr et al. 2023, 3)

During the third phase of the RMP, the probability of the materialisation of each previously identified risk should be assessed (Tummala & Schoenherr 2011, 478). Within the context of RMP, risk assessment aims to estimate, based on both quantitative and qualitative information, the possibility of a risk occurring. When assessing the identified risks, it is important that both the potential consequences and opportunities caused by them are assessed. Furthermore, risk assessment includes the examination of the extent to which the identified risks affect, impede and promote one another. (Duong et al. 2023, 1373).

Choudhary et al. (2023, 583) argue that, as there are multiple dynamics and influences that impact the risk assessment process, it would be impossible to develop a universal approach to risk assessment. However, they have proposed a framework based on the most common approaches utilised in risk assessment. This framework is illustrated in Figure 5.

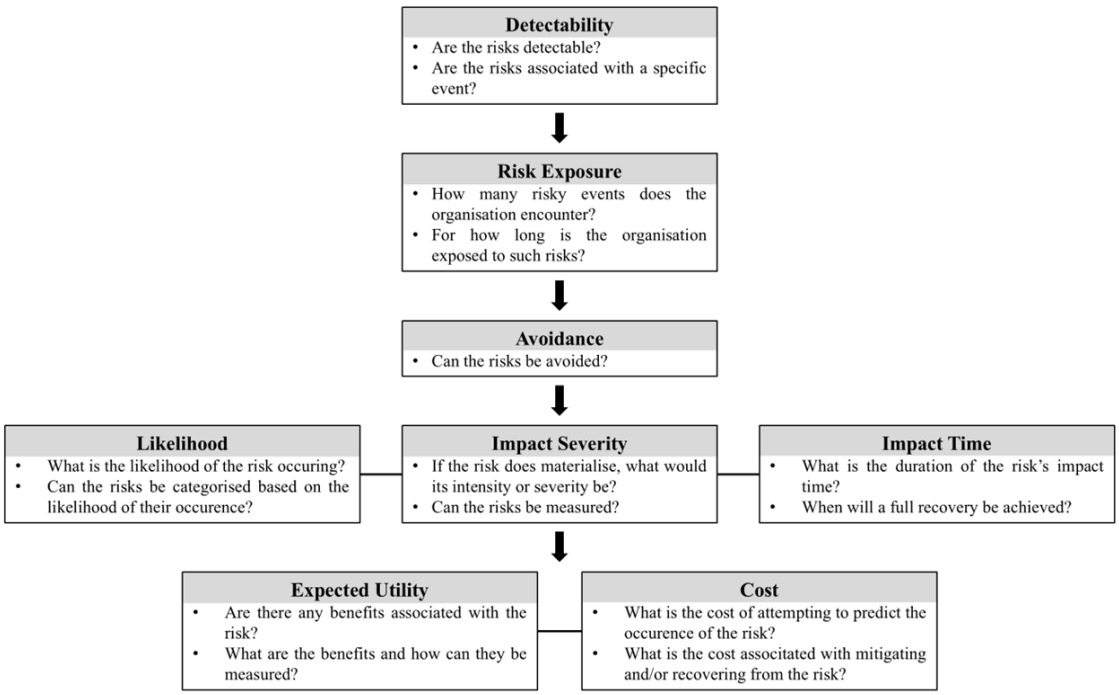

Figure 5. Supply chain risk assessment framework (adapted from Choudhary et al. 2023, 584)

Risk evaluation consists of two phases: risk ranking and risk acceptance. In risk ranking, the potential risks are ranked based on their consequences and probabilities. In risk acceptance, on the other hand, the "acceptable levels of risk" are established. After these steps, appropriate risk mitigation strategies are developed. (Tummala & Schoenherr 2011, 478–479)

During the final step of RMP, the applied risk mitigation strategies and their outcomes are examined. Furthermore, corrective actions can be taken if the outcomes of the applied strategies have not been favourable. Additionally, during this phase, reports regarding potential deviations from desired outcomes, abnormal situations and supply chain disruptions should be made. (Tummala & Schoenherr 2011, 480)

2.2.2 Supply Chain Risk Management Strategies

The focus of SCRM is on the identification and assessment of the probabilities and consequences of risks. SCRM also encompasses the selection of suitable risk management strategies to minimise both the likelihood of unfavourable outcomes and the potential negative effects of such outcomes. Risk mitigation, on the other hand, concentrates on minimising the negative consequences of materialised risks. (Manuj & Mentzer 2008a, 141)

Researchers have proposed different strategies and models to minimise supply chain disruptions associated with different types of risks (Tang, 2006, 452). The most common risk management strategies (RMSs) could be divided into eight categories: (1) Avoidance; (2) Acceptance; (3) Postponement; (4) Speculation; (5) Hedging; (6) Control; (7) Transferring/Sharing Risks; and (8) Security. (Hajmohammad & Vachon 2016, 50–51; Manuj and Mentzer 2008a, 142)

As an RMS, *avoidance* is utilised when the risks associated with operating in a particular product or geographic market, or engaging with a specific supplier, are considered too significant to justify (Manuj & Mentzer 2008a, 142). This strategy refers to the elimination of the risk source. A practical example of the implementation of this strategy could be avoiding supplier-related risks by switching from a high-risk supplier to a low-risk one. (Hajmohammad & Vachon 2016, 50)

Acceptance is an RMS, in which a potential risk is simply accepted. When this approach is employed, no additional measures are taken to prevent the risk, and resources are instead allocated to damage control. In other words, the potential risk is only addressed if it actually occurs in the future. (Hajmohammad & Vachon 2016, 51)

Postponement refers to the process of "delaying the actual commitment of resources to maintain flexibility and delay the incurring of costs" (Manuj & Mentzer 2008a, 142). Furthermore, postponement can transfer supply chain risks to the "most appropriate player in the supply chain", which can minimise the overall risk (Yang & Yang 2010, 1905). As an RMS, postponement can be divided into two categories: form postponement and time postponement. Form postponement entails delaying activities such as the labelling, packaging, assembling and manufacturing of an item. Time postponement, on the other hand, refers to delaying the shipment of goods from manufacturing facilities until a customer order is actually received. (Manuj & Mentzer 2008b, 206)

Speculation could be defined as the opposite of postponement. When speculation is implemented as an RMS, decisions are made based on expected customer demand (Manuj & Mentzer 2008a, 142). Approaches associated with speculation include maintaining an inventory of finished products rather than component parts and allocating resources in advance while decreasing unit costs through economies of scale (Manuj et al. 2014, 242).

Within the context of RMS, *hedging* refers to companies having a scattered portfolio of suppliers, customers and facilities. Through hedging, companies can ensure that if an unfavourable event occurs, it does not impact all entities at once or to the same extent. Practical examples of hedging strategies include dual sourcing and maintaining multiple supplier contracts. (Manuj & Mentzer 2008a, 142) However, it should be noted that as an RSM hedging can be expensive, as it requires the creation of "multiple options for decision variables" (Manuj & Mentzer 2008b, 208).

Control as an RMS refers to a tactic utilised by a company to reduce supply risks by increasing the company's ability to manage risks regarding supply and demand. An example of this tactic is conducting flexible supplier contracts with clauses that account for "possible changes in the environment and associated risks." (Manuj & Mentzer 2008a, 142–143)

Transferring/Sharing Risks describes a strategy that involves transferring risk to, or sharing risks with, other participants within a supply chain. Practical examples of this strategy include outsourcing, offshoring, and contracting. (Manuj & Mentzer 2008a, 142–143) The transferring or sharing of risks can be done within a supply chain either with a short-term or long-term focus (Manuj & Mentzer 2008b, 209).

Security as an RMS involves the identification of potential risks and the implementation of safety measures to minimise the impact of said risks should they occur (Calvo et al. 2020, 46). The aim of the security approach is to enhance a supply chain's ability to track movements and identify suspicious or unusual elements. Security involves collaboration with government and port officials to ensure regulatory compliance and to prevent unnecessary delays at border crossings. (Manuj & Mentzer 2008b, 210)

2.3 Supply Risk Factors

As a concept, supply risk could be defined as any factor that negatively impacts the inward flow of resources to the extent that the continuity of a company's operations is threatened (Cheng et al. 2012, 4). Supply risk could also be defined as "the transpiration of significant and/or disappointing failures with in-bound goods and services" (Zsidisin et al. 2000, 187).

Companies must be aware of existing supply risks, as they can significantly impact their overall performance. A supplier's inability to deliver inbound goods can negatively affect the purchasing company, resulting in the entire downstream of a supply chain being disrupted. When a critical supplier of a purchasing company is unavailable or when the delivered components fail to meet certain quality standards, the purchasing company will often experience immediate negative consequences, such as production delays. (Zsidisin et al. 2004, 398) Furthermore, if a manufacturing company cannot follow its production and delivery schedule to meet the requirements of its customers, the company's reputation can be negatively impacted. Over time, this can make it more challenging for the company to survive in a competitive business environment. (Sakhare et al. 2024, 325)

Supply risk is a "multi-dimensional construct" influenced by factors such as the source of supply, market conditions and the ability to meet customer demands (Cheng et al. 2012, 4).

The identification of the sources of supply risks is essential. For instance, the findings of a study conducted by Zsidisin and Ellram (2003, 22) suggest that there is a significant connection between the sources of a supply risk, and the strategies utilised to manage said risk. Furthermore, when the sources of supply risks are assessed and understood, purchasing companies can develop long-term approaches for the mitigation and management of said risks (Zsidisin et al. 2004, 410).

Within the context of supply risks, risk factors can be categorised into broader groups based on their shared characteristics. These groups are also known as risk dimensions. Risk dimensions represent the variables that "cannot be predicted with certainty" and which have the potential to negatively impact the inbound supply performance. Risk factors, on the other hand, refer to the particular events or situations that contribute to a risk dimension. In other words, risk factors refer to the possible sources of a risk. (Wiedenmann & Größler 2021, 653)

As part of risk identification, the potentially relevant supply risk factors should be identified and categorised in a way that aligns with a company's risk management objectives (Wiedenmann & Größler 2021, 658). The findings of past studies indicate that what companies perceive to be a supply risk varies across industries (Zsidisin 2003a, 222). Therefore, it can be concluded that there is no universally accepted approach for categorising these risks.

A possible approach for the categorisation of risk dimensions and their supply risk factors is presented in Table 2. This categorisation is based on the findings of past literature and consists of four risk dimensions: (1) Market-related risks, (2) Supplier-related risks, (3) Sourcing-related risks, and (4) Environment-related risks. These risk dimensions and the risk factors associated with them will be examined in more detail in the following sections.

Risk Dimension	Risk Factors	Authors
Market-related	Market price increase	Zsidisin (2003a, 220); Zsidisin (2003b, 18); Zsidisin et al. (2004, 405); Micheli et al. (2009, 167)
	Number of available suppliers	
	Geographical concentration of suppliers	
Supplier-related	Financial stability	Zsidisin & Ellram (2003, 17); Zsidisin (2003b, 16–20); Zsidisin et al. (2000, 188–189); Micheli et al. (2009, 167–168); Hudnurkar et al. (2017, 191); Sakhare et al. (2024, 324)
	Capacity restrictions	
	Ability to adjust to volume and mix changes	
	Unpredictable cycle times	
	Delivery risk	
	Quality problems	
	Cost reduction abilities	
Sourcing-related	Single sourcing	Hudnurkar et al. (2017, 197)
	Outsourcing	
	Sourcing flexibility	
Environment-related	Natural disasters	Hudnurkar et al. (2017, 197)
	Political instability	

Table 2. Supply risk factors

2.3.1 Market-Related Risks

Market-related risks are risks which are directly linked to the structure of the procurement market (Micheli et al. 2009, 168). From a risk perspective, market-related risks focus on the financial returns of an organisation (Zsidisin 2003a, 218). Market-related risks can also refer to the conditions of a supply or supplier market. This risk dimension consists of three risk factors: market price increase, number of available suppliers and geographical concentration of suppliers. (Zsidisin 2003a, 220; Zsidisin 2003b, 18; Zsidisin et al. 2004, 405).

Market price increase refers to the trends, events or developments that might lead to the increase of prices (Zsidisin 2003b, 16). The findings of a study conducted by Zsidisin (2003b, 20) suggest that when the prices of a product are viewed as being unstable, the perceived risks associated with this factor are higher. Conversely, when the prices are stable or declining, the perceived risk is lower. When assessing this risk factor, it is important to analyse past trends, information regarding the price predictions for the product, and any events or developments which have the potential to cause cost increases (Steele & Court 1996, 88).

As the name suggests, the *number of available suppliers* as a risk factor refers to the number of suppliers that are available to fulfil orders. However, the number of available suppliers can also refer to the presence of monopoly or oligopoly conditions within the supply market (Zsidisin 2003b, 16). The availability of a supplier changes randomly over time. A supplier

can be either available or unavailable. When the supplier is considered to be available, the supplier can fulfil a replenishment order as soon as it is placed. However, when a supplier is unavailable, it will not accept any orders and remains unavailable until it becomes available again. (Mohebbi & Hao 2006, 993) When the number of available suppliers is low, the perceived risk of this factor tends to be high. When there are many available suppliers, the perceived risk tends to be low. It is essential for an organisation to have capable, qualified and certified suppliers, as this can have a significant impact on whether the company's supply strategy is successful or not. (Zsidisin 2003b, 18–20)

Geographical concentration of suppliers describes suppliers being located within the same geographical location. When multiple suppliers are located in the same geographical area, a major disruption in that location can simultaneously impact all of them (Zsidisin 2003a, 223). The findings of past studies indicate that a concentrated supplier base can increase the risk of supply disruptions, as it could be more challenging to find alternative suppliers if a supply disruption occurs (Chen et al. 2023, 70).

2.3.2 Supplier-Related Risks

Supplier-related risks encompass the risk factors associated with suppliers in the supply network of a company. Supplier-related risks generally arise from two sources: relational risks and performance risks. Relational risks occur when the "partners in an inter-firm alliance do not commit themselves to joint efforts". Performance risks, on the other hand, occur when the actual goals of the partnership are not met. (Micheli et al. 2009, 167–168) Companies should aim to assess and select suppliers which are in "good financial health and manufacturing in politically stable or low-risk natural disaster areas". Supplier-related risks can also occur when the purchasing company exceeds a supplier's capacity or financial scale, making it difficult for the supplier to meet the company's requirements. (Zsidisin et al. 2000, 189) Among the various risk dimensions, supplier-related risks appear to include the highest number of contributing factors.

As the name suggests, *the financial stability* risk factor relates to the supplier's financial health. If the operations of a supplier are not profitable, the supplier's ability to remain in

business might be at risk. Therefore, the significance of this supply risk factor increases when the purchasing company establishes a relationship with such a supplier and becomes, at least partially, dependent on said supplier. The supply risks associated with this risk factor arise when the supplier becomes unavailable, resulting in the buying company having to find alternative, and at times unfamiliar, sources of supply. (Zsidisin et al. 2000, 188)

Capacity restrictions describe a supplier's inability to produce a certain amount of output within a given period of time. (Zsidisin 2003b, 16) The capacity restrictions of a supplier become especially apparent when there are significant fluctuations in demand. A supplier might not, for example, have the equipment, available employees, or access to the required materials to manage sudden increases in demand. (Zsidisin et al. 2000, 188) When the supplier's capacity is limited, the perceived risk of this factor tends to be high. When the supplier has a "capacity cushion", this risk factor is generally perceived as less significant. (Zsidisin 2003b, 20)

Ability to adjust to volume and mix changes as a risk factor refers to the supplier's capability to respond to the buying company's requirements when there are fluctuations in demand regarding quantity and the type of component needed (Zsidisin & Ellram 2003, 17). The findings of past studies suggest that product volume and mix requirements have the potential to "pose significant threats to purchasing organisations". When the supplier is inflexible regarding volume and mix changes, the perceived risk of this factor tends to be high. On the other hand, when the supplier is flexible, the perceived risk tends to be low. (Zsidisin 2003b, 20)

Unpredictable cycle times refer to the unpredictability of the duration of time between a buying company placing a purchase order with a supplier and receiving the goods. When the variability in cycle times is high, the likelihood of forecast errors occurring increases. When the cycle times of a supplier are unpredictable, the perceived risk of this factor tends to be higher. When the cycle times of a supplier are predictable, the perceived risk tends to be lower. (Zsidisin 2003b, 16–20)

Delivery risk refers to the supplier's delivery failure (Hudnurkar et al. 2017, 191). Manufacturing companies tend to be highly dependent on the delivery reliability of their upstream suppliers to ensure the continuity of their production (Sakhare et al. 2024, 324). At

times, sales may be lost as a result of the supplier's inability to deliver the required goods on time. Suppliers might be unable to deliver products as a result of issues internal to the supplier, such as equipment breakdowns or strikes, or as a result of transport disruptions, such as accidents. It is also possible that the delivery arrives on time, but the products do not comply with the order, resulting in the rejection of the entire delivery. (Dupont et al. 2018, 1057)

Quality as a risk factor refers to the supplier's ability to meet the buying company's specifications and requirements (Zsidisin 2003b, 16). Quality-related risks have the potential to significantly and negatively affect the purchasing organisation, as they can affect the whole supply chain, including the final customers. Issues regarding quality can arise from suppliers not properly maintaining their equipment, the supplier's insufficient training in quality practices, or damage occurring during transit. (Zsidisin et al. 2000, 188) When the supplier is unable to ensure quality in its products, the perceived risk of this factor tends to be higher. When the quality level of the supplier's products is high, the perceived risk tends to be lower. (Zsidisin 2003b, 20)

Cost reduction abilities describe the supplier's ability to "lower the cost of the same goods or services". When the supplier's cost reduction ability is low, the perceived risk of this factor tends to be high. On the other hand, when the supplier's cost reduction ability is high, the perceived risk tends to be lower. (Zsidisin 2003b, 16–20)

2.3.3 Sourcing-Related Risks

Sourcing-related risks encompass risks originating from the sourcing process itself (Hudnurkar et al. 2017, 197). This risk dimension can be divided into three risk factors: (1) Single sourcing, (2) Outsourcing, and (3) Sourcing flexibility.

Single sourcing refers to a scenario in which "a buyer chooses a single supplier even though other comparable suppliers exist in the supplier base". The aim in the utilisation of single sourcing strategy is to develop a strategic partnership between a buyer and a supplier to enhance close collaboration and to maximise shared benefits. However, the utilisation of this strategy can lead to companies being overly dependent on a single source of supply, which

in turn can result in the buying company being exposed to higher levels of supply risk. (Yu et al. 2009, 790–791)

Outsourcing is a common strategy utilised by companies to reduce costs and increase profits. This strategy is characterised by companies "relying on a third party to run certain business functions". Outsourcing allows companies to decrease the time to market as well as increase the quality of their products. However, certain risks are associated with this strategy. For instance, due to the asymmetry of information, companies utilising this strategy can experience uncertainty regarding decision making. (Zhu 2016, 121–122)

Sourcing flexibility refers to the buying firm's and its processes' ability to quickly react or respond to changes in supply requirements. The importance of sourcing flexibility becomes especially apparent when addressing issues caused by dependence and complexity. Sourcing flexibility can offer companies benefits such as shortened lead times and reduced stock-outs and inventory in their supply chains. (Wagner et al. 2018, 329)

2.3.4 Environment-Related Risks

Environment-related risks arise from the "interactions between a supply chain and the external environment in which it operates" (Hudnurkar et al. 2017, 197). This risk dimension can be divided into two risk factors: natural disasters and political instability

Natural disasters, such as floods, earthquakes, hurricanes and tornadoes, as well as accidents, fires or illnesses, can occur. Although these kinds of risks tend to be outside the control of the buying company or its suppliers, they can have significant effects. For instance, disasters or accidents occurring at supplier sites or during transits can negatively impact the purchasing organisation and its entire supply chain. (Zsidisin et al. 2000, 189)

Political instability refers to risks arising from political turmoil (Hudnurkar et al. 2017, 192). Trade wars and protests can cause significant disruptions to the supply chain of a company. Furthermore, civil unrest can result in time delays and loss of communication within a supply chain. (Sakthivel et al. 2021, 8–9)

3 Methodology

In this chapter the chosen research methodology is outlined. Furthermore, the research methods used for the purposes of this study are presented and justified, and the data collection process is described. Lastly, the reliability and validity of the research methods are discussed.

3.1 Research Approach

This study will adopt a qualitative research approach. Qualitative research could be described as "a broad term covering various methods of investigating phenomena in the real-world setting" (Adeoye-Olatunde & Olenik 2021, 1358). The aim of qualitative research is to produce data that is descriptive in nature (Taylor et al. 2016, 18). In other words, the data and information being collected and analysed is usually nonquantitative and typically consist of textual materials such as interview transcripts and documents (Saldana 2011, 3). In essence, qualitative research can offer valuable insights into real-world issues without the need to quantify data (Oranga & Matere 2023, 2). Qualitative research could also be described to be inductive in nature. This means that concepts and insights are developed by identifying patterns within the data instead of collecting data to evaluate pre-existing models, hypotheses, or theories. (Taylor et al. 2016, 18)

The utilisation of qualitative research methods can be beneficial when the research questions are open-ended and not necessarily measurable. Furthermore, the adoption of a qualitative research approach can be useful when gathering information about participants' experiences and perceptions regarding real-world issues or problems. (Oranga & Matere 2023, 3) Considering these characteristics, the utilisation of a qualitative research approach was considered appropriate for the purposes of this study.

3.2 Research Design

This study adopts a case study design. When conducting research through the case study approach, the aim is to gain insight into a specific, typically contemporary topic, issue or phenomenon. Within the context of business research, this approach involves collecting data from the actual setting of a phenomenon, such as a university or a company. (Farquhar 2012, 6)

According to Farquhar (2012, 6) a case study approach is appropriate for exploring "how", "who" and "why" questions. In addition, the utilisation of a case study approach can be beneficial when the aim is to explore the impact of "contextual conditions" on the phenomenon being studied (Baxter & Jack 2008, 545). This research approach usually concentrates on exploring one or multiple units of study through the utilisation of research methods such as surveys and interviews. Case studies are considered to be empirical in nature, as they rely on knowledge and experience, and commonly involve the collection and analysis of data. (Farquhar 2012, 6)

It should be noted that one cannot assume that the case chosen for a case study will accurately represent a broader phenomenon, as humans are often unpredictable and their behaviour and actions are greatly influenced by the context in which they operate. However, it is still possible to identify the areas of interest within certain contexts, such as places or groups, and utilise them as cases. (O'Reilly 2025, 30)

3.3 Data Collection Methods

Semi-structured interviews were conducted to gather data for the purposes of this study. Semi-structured interviews are one of the most commonly utilised qualitative data collection methods (Adeoye-Olatunde & Olenik 2021, 1358). This interview approach is often considered to be "versatile and flexible", as it can be adopted in both individual and group interviews. Furthermore, the structure of the interview can be adjusted based on the objectives and research questions of the study. (Kallio et al. 2016, 2955)

When conducting semi-structured interviews, some prior knowledge of the research topic area is required, as the interview questions are developed based on this knowledge. The structure of a semi-structured interview is defined in advance, as the questions are formulated prior to the interview. However, the questions should not be strictly followed. Instead, the questions should serve as a guide to help participants focus on relevant themes and topics. (Kallio et al. 2016, 2955) Therefore, the questions should be "designed to be sufficiently open" to allow the interviewer to ask follow-up questions based on the participant's responses (Wengraf 2001, 24).

One of the most notable advantages of semi-structured interviews is that while the interview questions are, to a certain degree, structured and comprehensive, the tone of the interview remains casual and conversational. It should be noted, however, that this advantage has its limitations. While the interview format offers some structure, the comparison of responses can be challenging, as the interpretation of the same question can vary between participants. (Eriksson & Kovalainen 2008, 82)

3.4 Data Collection Process

This study recruited 18 participants, out of which 17 agreed to participate. Both suppliers and internal stakeholders of the case company were interviewed to gain insights from internal as well as external perspectives. Four of the participants were representatives from different supplier companies, while the remaining 13 were internal stakeholders of the case company. All 13 internal stakeholders, who took part in the study, had some level of involvement in the focal company's strategic operations, either in the past or at the time of the interviews.

All 17 participants received an invitation to participate in the study via email. The participants were provided with the interview questions in advance to allow them to reflect on the topic and potentially prepare their responses. Four of the interviews were held in English, while 13 were conducted in Finnish.

Interviewee	Connection to Case Company	Interview Language
1	Supplier	English
2	Internal Stakeholder	Finnish
3	Internal Stakeholder	Finnish
4	Internal Stakeholder	Finnish
5	Internal Stakeholder	Finnish
6	Internal Stakeholder	Finnish
7	Supplier	Finnish
8	Internal Stakeholder	English
9	Internal Stakeholder	Finnish
10	Internal Stakeholder	Finnish
11	Internal Stakeholder	English
12	Supplier	English
13	Internal Stakeholder	Finnish
14	Supplier	Finnish
15	Internal Stakeholder	Finnish
16	Internal Stakeholder	Finnish
17	Internal Stakeholder	Finnish

Table 3. Overview of the participants

Two different question sets were prepared for the interviews; one intended for the suppliers (see Appendix 1) and one for internal stakeholders (see Appendix 2). The suppliers' question set consisted of eleven questions. The first two questions were background questions regarding the participant's role in the supplier company, while the rest of the questions addressed the participant's views on themes such as delivery disruptions, delivery reliability, and collaboration and communication between the supplier company and its clients. The question set of the internal stakeholders consisted of 20 primary questions, two of which included three follow-up questions. The question set of the internal stakeholders was divided into four sections. In the first section, the participants were asked to describe their role within the case company and reflect on how supply chain disruptions affect their work. In the second section, the participants were asked questions regarding their experiences and perceptions of supply chain resilience, while the questions in the third section addressed their

views on supply risks. Lastly, in the fourth section, the questions focused on the participants' views on aspects related to risk mitigation.

Of the 17 interviews, 12 were conducted remotely via Teams, while the remaining five were conducted in-person. The interviews were conducted during a span of three weeks. In order to enhance audio reliability and minimise the risk of data loss, the interviews were recorded both with a phone-based voice recording application and a tape recorder. In total, the interviews generated 9 hours and 11 minutes of audio data, which were transcribed to facilitate the analysis of the collected material.

3.5 Data Analysis

The data collected for the purposes of this study was analysed using thematic analysis (TA). TA refers to a method utilised to identify, analyse and interpret "patterns of meaning", or "themes" within qualitative data. This data analysis method offers a structured and accessible approach to developing codes and themes for qualitative data. As "smallest units of analysis", codes are utilised to highlight features of the data that might be meaningful within the context of the research question. When grouped together, these codes form themes, which represent broader patterns in the data. (Clarke & Braun 2017, 297)

The thematic analysis of this study followed a hybrid approach, containing both deductive and inductive reasoning (Hoang et al. 2023, 1406). This approach involves the utilisation of pre-defined themes, which are created based on a "theoretical framework developed through engagement with the literature". In addition, the hybrid approach involves the development of themes from the data itself. (Proudfoot 2023, 308) The adoption of a hybrid approach can be beneficial, as it enables the integration of themes drawn from existing literature with those that emerge from the utilised data (Anderton & Ronald 2018, 272).

TA typically consists of six phases. The analysis begins with familiarising, during which the researcher immerses themselves in the data to grasp its scope and complexity. In the second phase, known as coding, initial codes are created based on the data. During the third phase the identified codes are grouped into potential themes. In the fourth phase, the themes are reviewed, and their suitability is assessed in relation to the coded extracts and the data set.

During the fifth phase the details of each theme are refined, and the overall narrative of the analysis is clarified. Finally, in the sixth phase a report is produced. (Kushnir 2025, 6)

The thematic analysis conducted as part of this study followed, to a great extent, the phases proposed by Kushnir (2025, 6). After transcribing the interviews, the interviewer reviewed each transcript individually, identified quotes relevant to the study, and developed initial codes based on the research questions and the literature review. In addition to applying pre-determined codes, inductive coding was utilised to capture themes that were not anticipated in advance but appeared to be meaningful in the context of the study. Following the coding process, similar codes were combined into larger themes. These themes were then reviewed and refined to ensure that they aligned with both the theoretical framework and the data.

3.6 Reliability and Validity

Reliability could be defined as "the extent to which the findings can be replicated". Validity, on the other hand, describes how objective and free from bias the results of a study are. (Ali & Yusof 2011, 30) The reliability of a study can be examined through validity. If the data can be considered to be high in validity, then it can also be considered high in reliability. (MacQueen et al. 2011, 82)

The validity of a study conducted using qualitative research methods can be assessed by examining the study's descriptive validity and generalisability. Descriptive validity refers to the accuracy of the data, and in qualitative research the data should accurately reflect, for example, what a participant has stated during an interview. Furthermore, the data should be reported with the same accuracy, meaning that the transcription of an interview must accurately represent the content of the conversation. (Thomson 2011, 78) However, the translation of interview transcripts might affect the accuracy of the data (Esposito 2001, 576). Since most of the interviews were held in Finnish, and the transcribed data was later translated into English, it is possible that some information may have been lost in translation.

The generalisability of a study describes the extent to which the study's results can be applied universally. Since the focus of qualitative research tends to be on the concepts and characteristics of a specific group, the findings might only be applicable to groups with

similar characteristics. (Thomson 2011, 79) The reliability and validity of a study can be increased by collecting and comparing data from different sources. If the same themes or topics emerge “within data from different participant groups”, the validity of the findings increases. (MacQueen et al. 2011, 85–86) Collecting data from both internal and external stakeholders of the case company could potentially increase the validity of the findings of this study.

4 Findings

In this chapter, the results of the thematic analysis are discussed. In the first section, the impact of supplier collaboration and relationship management on supply chain resilience are examined. In the second section, the participants' perceptions of factors impacting the probability and severity of supply risks are identified and their implications are presented. Lastly, in the third section, the identified practical approaches to mitigate supply chain risks are inspected. Quotes from the transcribed interview data are included to illustrate and support the findings. At the end of each quote, the interviewee's number and whether they were an internal stakeholder or a supplier are shown in brackets to ensure clarity.

4.1 The Influence of Supplier Collaboration and Relationship Management on SCR

Many of the interviewees perceived supplier collaboration and relationship management to be essential for mitigating supply risks, preventing supply chain disruptions and building supply chain resilience. Multiple interviewees highlighted the importance of collaboration and relationship management between the supplier and the purchasing company:

> *"…supplier collaboration [is an effective approach for preventing supply risks]. [It] is kind of present at every level of the company: the buyers, the factory, production management… and at times even at the CEO level, depending on the suppliers. There's a wide range and a variety of measures and strategies [related to supplier collaboration]."* (Interviewee 6, internal stakeholder)

> *"Our suppliers have faith in working with us, so I'd say that the relationship that you have with your suppliers also influences [overcoming supply chain disruptions]."* (Interviewee 3, internal stakeholder)

Communication and information sharing, trust and supplier commitment were identified as significant contributors to effective collaboration and supplier relationship management. These factors will be discussed in greater detail in the following sections.

4.1.1 Communication and Information Sharing

Both internal stakeholders and suppliers emphasised the importance of communication and information sharing for preventing supply risks and minimising their impacts. Many of the interviewees noted that open communication and timely information sharing can be beneficial for the identification of potential risks. Furthermore, communication and information sharing were perceived to support the joint development of strategies to address the identified risks.

> *"I think that communication is key in the sense [that] at least… if the customer knows [that there are issues in delivery], then [the customer] can also change [their] production planning around."* (Interviewee 1, supplier)

> "*…in [a] supply chain… [it's about] being open to your vendors and then having that open communication and preparing ahead of time. If you're able to have that information earlier than later, then you're given that time to plan ahead and to kind of create some actions in order to go around those obstacles. […] You can have all the tools, all the AI, if you say, everything. But if you don't have that open communication with suppliers, none of those tools are going to work."* (Interviewee 11, internal stakeholder)

In addition, communication was seen as an effective method for minimising the negative effects of materialised risks. As stated by one of the interviewees:

> *"If there's an issue regarding the quality [of a product or material], then of course we try to inform our supplier about it as soon as possible, so they can react, check their own stock, and send new materials that meet the quality requirements."* (Interviewee 10, internal stakeholder)

However, an imbalance between the interests of the purchasing company and the supplier could potentially impact the extent of transparent information sharing. While the purchasing company may want to receive information about potential risks from the supplier as early as possible, the supplier might prefer to withhold such information until it is likely or certain that the risks will materialise.

> *"Usually, when a disruption occurs, we don't communicate about it immediately to our customers. Only if we can't find a solution to it, or if it becomes clear that [the disruption] will also affect our customers' deliveries, then at that point we contact the customer and try to find a solution that will minimise the impact for our customers."* (Interviewee 7, supplier)

> *"…especially with bigger disruptions, suppliers tend to do everything they can, until the last possible moment, to ensure that their deliveries look good and to maintain the image of having everything under control […], but they could be more open about [disruptions] without fearing that it's going to hurt their reputation or that we'll start shifting too much business away from them in advance or something like that. Sometimes, or even quite often, these [disruptions] come as more of a surprise than they should."* (Interviewee 16, internal stakeholder)

One of the interviewees suggested that this dilemma can, to some extent, be resolved by building trust and strengthening the relationship with the supplier. When there is trust between the buyer and the supplier, the supplier might be more willing to share information about potential risks without fear that doing so will reflect negatively on them. As stated by the interviewee:

> *"We have a [raw material] distributor, who's a close vendor, who we source our [raw material] from. [Because of] the US tariffs that have come in, he advised me months before, saying that there will be a price increase to customers on their end. He's giving me some notice in regard to what I can do on my end so that I can mitigate the risk. […] We've built that relationship. The supplier had already been circulating that information internally, even though the prices had not increased yet, and this was before the customers became aware of it. It's really about getting that early notice, which to me reflects honesty and trust on his part. He's giving me the heads up while knowing that the information is still a bit confidential."* (Interviewee 11, internal stakeholder)

4.1.2 Trust

Trust was perceived to be an important element in mitigating supply disruptions and enhancing supply chain resilience. There appeared to be a strong connection between trust and information sharing. Higher levels of trust were thought to promote open information sharing, while transparent and frequent sharing of information was seen to further enhance the building of trust:

> *"Once you've built a good rapport with a vendor, and that trust, they're actually open with you…"* (Interviewee 11, internal stakeholder)

On the contrary, low levels of information sharing were perceived to decrease trust. In addition, a lack of transparency in information sharing was considered to negatively impact trust, as it can indicate that the supplier perceives the relationship as less meaningful or strategic than the buyer does. One participant recounted a past experience that illustrates how a lack of transparency in communication can negatively impact trust:

> *"I was at a trade fair, and another supplier came up to me and said, 'did you hear what happened to your supplier?", and I had no idea [about what had happened]. It turned out to be something that had even been made public in a press release, and yet, that supplier had not informed us. So of course, that immediately damaged the trust that I had for that supplier. It made me think, 'do we not have that kind of a strategic partnership that I thought we had? Why would you not tell us about this?'"* (Interviewee 17, internal stakeholder)

4.1.3 Supplier Commitment

Supplier commitment was perceived to be an important aspect of collaboration. Some of the interviewees emphasised that the case company attempts to ensure the commitment of its suppliers through development projects:

> *"We've attempted to encourage our suppliers to commit to [case company's] operations through various development projects…"* (Interviewee 4, internal stakeholder)

Some internal stakeholders and suppliers also highlighted how, in some cases, building commitment with a supplier can be more beneficial than securing the lowest possible price. Agreeing to pay a higher price or allocating higher order volumes can make the supplier more committed to the purchasing company. This can be advantageous when supply disruptions occur, as the supplier might be more motivated to address and resolve the issue:

> *"In order to increase trust, it's… Well, [suppliers] are salesmen. They'd love to sell, right? It's all based on volume and having them commit to larger volumes. […] One vendor said to me, 'okay, it's either you're looking for the cheapest price, or you kind of go with a bit more', but you're building that relationship in that sense, and you have that better service, you have that commitment. When it comes down to problems, issues, disruptions, they're there to help, right? When you go to another vendor, where it's the cheapest you can get in the market, they're not particularly interested in helping or serving you if you're getting the lowest rate, because they're not really getting anything out of it. So, it's about building that trust and having that balance…"* (Interviewee 11, internal stakeholder)

4.2 Factors Impacting Supply Risks

This section will examine in greater detail the factors that the participants viewed as being important to consider when assessing supply risks. The identified factors have been divided into three main categories. The main categories are product-specific factors, supplier-specific factors and external factors. Some of these categories have been further divided into subcategories that collectively contribute to the overall impact of the main category. The main categories and their subcategories are listed together in Table 4.

Factors Impacting Supply Risks	
Main category	Subcategory
Product-specific factors	Product type
	Substitutability
	Impact on continuity
	Inventory/safety stock
Supplier-related factors	Location of supplier
	Flexibility of supplier
Market-related factors	Market conditions
	Availability of suppliers

Table 4. Factors impacting supply risks

4.2.1 Product-Specific Factors

Many of the interviewees noted that the nature of the product can influence how vulnerable the product is to supply risks. Both internal stakeholders and suppliers highlighted this in their interviews. Each identified product-specific factor will be discussed in greater detail below.

Product Type

Within the context of this study, the term "product type" describes whether a product or item has been customised to meet the needs of the focal company, or whether the product in question is a non-customised bulk product. Many of the interviewees noted that customised items tend to be more prone to supply risks than bulk items due to their specific design requirements, longer production lead times, and limited supplier availability. The level of product customisation was seen as one of the key indicators for determining which products should be treated as higher in priority when assessing supply risks. Additionally, the level of product customisation influences whether the utilisation of multiple suppliers for a certain item or raw material is deemed necessary:

> *"If an item is considered to be a bulk item, a standard item, then basically anyone can supply it. But there are certain items that are specifically tailored*

> *for us… Those are not bulk items anymore. So, it's important to identify which items are not bulk items, as they require special attention."* (Interviewee 3, internal stakeholder)

> *"If we know that a material is relatively standard, then supplier duplication isn't necessary, because suitable, alternative materials are readily available. In those cases, it naturally doesn't make sense to have alternative suppliers."* (Interviewee 6, internal stakeholder)

Product type also influenced the severity of risks associated with a given product. Supply risks were frequently perceived as being higher for customised, non-bulk products:

> *"I would say that for us, the most critical items are ones that are specifically customised for us."* (Interviewee 3, internal stakeholder)

One of the interviewed suppliers noted that the customisation of a product can also impact how flexibly suppliers can respond to the changing needs of the purchasing company. Lower levels of product customisation could potentially be linked to increased supplier flexibility:

> *"…because we don't have very customised products, we can very easily adapt to changes if needed."* (Interviewee 1, supplier)

Substitutability

Substitutability refers to the extent to which suitable alternative products can be accessed if the preferred product is unavailable. Product type appeared to affect the extent to which a product could be substituted. Products with less customisation were generally seen as easier to substitute. Additionally, products for which the company only has one supplier were seen as being more difficult to substitute:

> *"I'm not really sure if [raw material] can even be replaced in any way. It's a bit of an issue [if we cannot access it], there's just no substitute for it."* (Interviewee 16, internal stakeholder)

> *"I'd say that it is generally more difficult to find substitutes for items for which [the case company] only has one supplier."* (Interviewee 3, internal stakeholder)

Impact on Continuity

Impact on continuity refers to the extent to which the unavailability of a product affects the operations of the company. The interviewees highlighted that the availability of certain products is essential for the company's operations and is therefore required to maintain continuity of production:

> *"The sudden unavailability of [a specific raw material] can halt all the following stages of the production chain…"* (Interviewee 13, internal stakeholder)

> *"[A specific material] is critical for us, and [its unavailability] could even halt production…"* (Interviewee 16, internal stakeholder)

Inventory and Safety Stock

Whether a certain product or material has an inventory or a safety stock was seen as an important factor to consider when assessing the supply risks associated with specific products. Items with no inventory or safety stock were generally perceived as being more prone to supply risks than those with such buffers:

> *"Supply chain disruptions are definitely more common in products that do not have an inventory. […] When there are disruptions in the supply of products that we have inventories for, the effects tend to be less severe, as we can rely on our inventory."* (Interviewee 10, internal stakeholder)

Furthermore, whether a product was made-to-order or not appeared to impact whether it had an inventory or a safety stock. Some of the interviewees highlighted that products that were made-to-order do not usually have an inventory or a safety stock in place:

> *"Some of the items that we buy are made-to-order. For such items we do not have any kind of safety stock in place, so when there are issues with getting these kinds of products, we of course have to react more quickly."* (Interviewee 10, internal stakeholder)

4.2.2 Supplier-Related Factors

Some of the factors influencing the interviewees' perception of supply risks were related to the suppliers. The supplier's location and flexibility especially appeared to have an impact on the perceived probability of a risk materialising. Each identified supplier-related factor will be discussed in greater detail below.

Location of the Supplier

The location of a supplier was viewed as a contributing factor to supply risks and supply chain resilience. The majority of the interviewees noted that the geographical location of a supplier can be a root cause for various supply risks. Furthermore, the participants highlighted that factors related to the supplier's location can create conditions that increase the vulnerability of a supply chain. The geographical location of a supplier was considered crucial, as the participants noted that the probability of geopolitical risks can be higher in certain locations or countries than in others,

> *"Of course [the geographical location of the supplier] does have an impact on the frequency of supply disruptions. Given the changes in the political landscape globally, it inevitably influences our operations, particularly from the perspective of [supply chain] resilience."* (Interviewee 6, internal stakeholder)

> *"…some of our components come from higher-risk countries. These risks are something we are definitely aware of."* (Interviewee 10, internal stakeholder)

Several interviewees expressed concern over the potential impact that geopolitical risks, such as wars and trade wars, might have on supply chains both globally and in Finland. They

noted that such political instabilities could result in supply shortages, higher prices and delivery delays. Within the current global context, the participants were particularly worried about the effects of potential changes in the trade relations and policies of the United States after the election of Donald Trump as president.

> *"I think geopolitics is a pretty big topic right now. I guess I thought, maybe a bit naively at first, that something like a political shift in the U.S. doesn't really have to impact business. I mean sure, it could cause higher taxes or something […] but in the recent weeks I've kind of had to change my view and admit like 'okay, I guess it does have a direct impact' on how the different actors, companies, banks, everyone in the business ecosystem operate. It could be possible that certain national tensions start to cause barriers to business. […] I suppose I always thought there'd be some effect, but I didn't really grasp at first just how much [geopolitics] could actually impact, say, even Finland, or Finnish companies' supply chains, or companies' operations in general… It's actually pretty crazy when you think about it."* (Interviewee 15, internal stakeholder)

> *"I think [with the] tariff situation from Trump, what we have is an indirect impact. Our [specific raw material] is not provided through the U.S., so we're not tariffed at all in regard to [raw material]. […] However, it's an indirect [impact] because it's based off the market value. Our market value does increase then, right, because other countries are being, you know, penalised. And that's where the market value of say, [raw material], rises and we get impacted. So how do we make adjustments for that?"* (Interviewee 11, internal stakeholder)

The participants also reflected on the impact that Russia's war of aggression against Ukraine has had, and continues to have, on global supply chains. Some of the interviewees highlighted that the war has led to the unavailability of certain materials:

> *"…these days you have to look at things globally, and with Russia's impact… well, when the war first started […] it had a really radical effect on multiple levels. It even led to certain raw materials almost being completely unavailable [in the upstream of supply chains]."* (Interviewee 17, internal stakeholder)

> *"Business operations in Russia were completely shut down in 2022. [A raw material] was actually on the sanctions list, meaning you couldn't get [raw material] from Russia."* (Interviewee 9, internal stakeholder)

> *"When Russia attacked Ukraine and the war started, it significantly impacted supply chains at the time, as the borders were closed."* (Interviewee 3, internal stakeholder)

The geographical location of a supplier was also viewed as potentially increasing the risk of logistics-related disruptions. Some of the interviewees noted that certain countries and locations might be more prone to adverse weather conditions, which could cause challenges for transportation. Furthermore, it was noted that the supplier's location can limit the number of available transportation methods:

> *"There can be different kinds of weather phenomena […], those could cause potential risks. Like when the weather causes a ship to get stuck sideways in a canal and so on. Those kinds of things have influenced how we've started preparing for such risks, […] after all, we are exposed to all of those."* (Interviewee 16, internal stakeholder)

> *"…well, for example, there have been unexpected floods in Central Europe, and we should take these kinds of things into account. For example, a truck might be unable to deliver goods because a bridge might be closed because a river has flooded. So of course we have to prepare for such events, especially if they become more common."* (Interviewee 9, internal stakeholder)

> *"…in logistics, it'd be good to be prepared and have enough resources, so that if there's a major disruption, that we could map out alternative [transportation methods] ourselves. Like, if ships aren't running, can we quickly bring something in via road using a different route*?" (Interviewee 17, internal stakeholder)

Supplier Flexibility

The flexibility of a supplier was frequently perceived as an important aspect to consider within the context of supply risks and supply chain resilience. The participants highlighted

that a flexible supplier can help the purchasing company both prepare for potential risks and recover from risks that have materialised.

> *"Of course, it's important that the supplier has the ability to react fast. It's always good if the supplier has some flexibility in their capacity, so that they can respond quickly to sudden increases in demand. Naturally, that's a good thing for us."* (Interviewee 10, internal stakeholder)

4.2.3 External Factors

External factors could be described as factors which are outside of the purchasing company's control. Market conditions and the availability of suppliers specifically were highlighted as significant aspects to consider when evaluating supply risks. These factors are further examined below.

Market Conditions

Market conditions were perceived to be significantly impacted by the general demand and availability of a product or raw material. Some of the interviewees noted that the general demand and availability of a product are interconnected; when the availability of a product or raw material is limited, the competition between companies to obtain said product or raw material intensifies. Some of the interviewees perceived material shortages to be one of the most significant sources of supply chain disruptions:

> *"Supply chain disruptions… well, they usually come down to material availability. The most common case is that there is a shortage of a certain material, which directly impacts our ability to manufacture our products."* (Interviewee 6, internal stakeholder)

> *"When there is a significant decline in the availability of a key raw material, it could be considered to be a major supply chain disruption. At the moment, there is a shortage of [raw material] across the entire European market. This means that the balance between supply and demand has shifted to the point where suppliers even have to limit deliveries to their customers. This is clearly*

> *a supply chain disruption, or more specifically, a market disruption."* (Interviewee 16, internal stakeholder)

Availability of Suppliers

Some interviewees noted that the availability of suppliers in the market can impact the probability and severity of risks. As one of the interviewees highlighted, certain raw materials are easier to access, as there are more available suppliers of said material in the market:

> *"[A specific raw material] is universal. Someone will always be producing it."* (Interviewee 3, internal stakeholder)

Another interviewee explained that it is common practice in one of the supplier companies to regularly assess the number of available suppliers in the market for a specific product. As stated by the interviewee:

> *"For some of our products we don't regularly use two suppliers, but for those items we've conducted preliminary reports on the available suppliers that we could potentially use as alternatives."* (Interviewee 7, supplier)

4.3 Practical Methods for Minimising Supply Risks

In this section, the practical methods, which were identified from the transcribed interview data, for minimising supply risks and enhancing supply chain resilience will be discussed and analysed. In addition, the practical implications and advantages of these methods will be explored. These approaches and their implications are addressed from the viewpoints of both the case company and its suppliers. The identified approaches have been divided into two categories for the sake of clarity: internal and supplier-related approaches. The identified approaches are summarised in Table 5.

Risk Mitigation Methods	
Approach type	Practice
Internal	Regular risk assessment
	Dual sourcing
	Inventory and safety stock management
	Moving a process in-house
	Daily internal meetings
	Staying informed on current world events
Supplier-related	Supplier auditing
	Face-to-face meetings
	Sharing of forecasts
	Sharing of resources
	Joint-product development

Table 5. Methods for minimising supply risks

4.3.1 Internal Approaches

Internal approaches refer to practical methods within a company that can improve both the detection of supply risks as well as facilitate the process of recovering from them. In total six internal risk mitigation methods were identified. These approaches will be discussed individually below.

Regular Risk Assessment

Regular risk assessment was perceived to be an effective risk mitigation approach. Many of the internal stakeholders noted that risk assessment can be beneficial for the early identification of potential risks and the evaluation of the impact they may have. Furthermore, during the risk assessment, preventative measures can be developed, and the effectiveness of previously implemented methods can be assessed.

> *"We usually identify potential risks through risk assessment. So, we do these risk assessments, during which we think about what the most significant risks for us are, and then we identify the sources of these risks, and then we decide on what measures we take to [prevent or mitigate] the risks. If these measures*

> *are unsuccessful, then we'll assess the risk again."* (Interviewee 5, internal stakeholder)

> *"We have regular meetings for risk assessment. During these meetings we've identified risks, and this has allowed us to develop mitigation strategies for these risks. By doing this we've been able to minimise the probability of the risk materialising. […] We've also been able to reduce the effects of materialised risks."* (Interviewee 6, internal stakeholder)

Dual Sourcing

The interviewees consistently noted dual sourcing to be one of the most effective methods for minimising supply risks and enhancing supply chain resilience. Dual sourcing was perceived by both the case company's internal stakeholders and suppliers as a useful approach for mitigating supply risks and increasing supply chain agility. The main advantage of dual sourcing was perceived to be its impact on the continuity of supply. In other words, if one supplier is unable to deliver a product or a raw material, the companies can source the product or material from another supplier. Having multiple suppliers for critical raw materials and components was also seen as being essential:

> *"If we think about, for example, raw material suppliers, our aim has always been to not rely on just one supplier. The goal is that if there's some kind of a disruption with one supplier, we can quickly source the material from another [supplier]. So, having multiple suppliers really helps prevent major disruptions."* (Interviewee 5, internal stakeholder)

> *"[…] for certain materials we utilise this kind of dual sourcing practice […] that in itself already reduces the likelihood of disruptions, because we have the option to allocate volume if needed, since we can buy the same item from two different suppliers."* (Interviewee 6, internal stakeholder)

> *"One thing which could maybe be considered to be a [risk minimisation] method is that for our most critical [materials], we always use two suppliers…"* (Interviewee 7, supplier)

However, one of the interviewees noted that dual sourcing does not always guarantee total protection against supply disruptions. Even when companies have two suppliers for a certain product, large and sudden changes in order volume can be difficult to manage, as the other supplier might lack the stock or capacity to respond to such increase. Therefore, it could be suggested that dual sourcing can be an effective method for managing smaller disruptions, but less effective for addressing bigger ones. One interviewee highlighted that timely communication between the supplier and the purchasing company is crucial for preventing such issues:

> *"…even though we have two alternative suppliers for [product], if one of them runs into a problem… Well, they each have certain allocated volumes, like, we order X percent from you and Y percent from you, and we've given them forecasts so they can prepare for our demand. But if one supplier has an issue and we suddenly need to shift a lot of volume to the other, they won't instantly have the stock levels to serve us, and they might not have the capacity either if they've already sold their capacity elsewhere. That's really one of the practical problems with dual sourcing. It works in some situations for smaller order quantities, but if there's a bigger problem and we have to reallocate a lot of volume at once, it just doesn't work right away. […] we need to get earlier notice from our suppliers about any potential disruptions, because if they only tell us at the last minute, it doesn't help us. We can't react in time."* (Interviewee 10, internal stakeholder)

Inventory and Safety Stock Management

Inventory and safety stock management were consistently perceived by both internal stakeholders and suppliers as useful methods for minimising supply risks. Maintaining a safety stock was considered particularly important for products which are not sourced from multiple suppliers. Furthermore, inventory management was viewed as essential for ensuring the continuity of operations and production:

> *"Some of our items don't have multiple suppliers, and we take that into account in our safety stock levels […]. Safety stocks are, in a way, a risk minimisation method."* (Interviewee 3, internal stakeholder)

A few of the suppliers highlighted the connection between safety stocks and delivery reliability. While purchasing companies can utilise inventories and safety stocks to minimise the impacts of supply disruptions, suppliers can also utilise them to prevent supply disruptions from happening:

> *"We rarely have delivery delays, mainly because most of the products… actually I think that all the products that we deliver to [case company] have a buffer stock. So even if our supplier has supply disruptions or delivery delays, our buffer stock prevents the problem from escalating…"* (Interviewee 14, supplier)

> *"We always have buffer stocks in place, and this really helps minimise delivery disruptions. […] when you always deliver from stock, it's quite impossible to have delays, at least in our company."* (Interviewee 12, supplier)

Furthermore, one of the internal stakeholders explained that for products without alternative suppliers, agreements can be made with the existing supplier to maintain higher safety stock levels for said products:

> *"For certain products for which we haven't found a second supplier yet, we've agreed with the existing supplier that they will keep higher stock levels for us. That way, if there are supply disruptions, they don't immediately affect us and our business, and we can keep our operations going."* (Interviewee 3, internal stakeholder)

Moving a Process In-House

Two of the interviewees, one supplier and one internal stakeholder, discussed the positive impact that moving a process in-house can have on supply chain resilience. The supplier described how having their own tool shop and moving this process in-house has helped the company to be less dependent on their own suppliers. This has allowed the supplier to be more flexible, as they can address possible production disruptions immediately themselves:

> *"We are really flexible, [because of] our own tool shop. [We're not] dependent on some other outsourced companies that maybe produce the tool for us […] there are always some delays. Our tool shop is only utilised for our needs, [and] we don't offer any tools to be sold outside of the company. We only use our tool shop for our own needs, and this is really, really important. When something in production breaks, we can immediately take the tool down, go to the tool shop, repair it, and in two hours we can continue producing [product]. This [would] never be possible if you [didn't] have your own tool shop, because you would have to remove the tool, and then you [would] have to call some outsourced shop, and then [wait] to be served. [It could take] one week, two weeks, to repair the tool. [Having a process in-house] I would say, is really important for flexibility and delivery performance."* (Interviewee 12, supplier)

The internal stakeholder noted that moving an outsourced process in-house could be beneficial, as it would allow the case company to have more control over their supply chain. However, the interviewee also emphasised that this would require the development of necessary expertise, which could be resource intensive:

> *"Moving certain outsourced processes in-house could be beneficial […], as we've kind of aimed for our supply chain to be, you know, as much under our control as possible […], but then again, we might not really have the required experience in some areas, so it would be quite a big task to build up the expertise for it."* (Interviewee 4, internal stakeholder)

Daily Internal Meetings

Frequent and timely internal communication was perceived to be an effective approach for minimising supply risks and for enhancing supply chain resilience. Several internal interviewees emphasised the benefits of having daily meetings between the company's production- and operations-related departments to facilitate the timely sharing of information. It was noted that such daily meetings can enhance information sharing and help to identify the potential impacts of supply disruptions on each department:

> *"In our daily meetings, we immediately analyse how seriously a potential risk might have materialised, and what kind of actions are required, and then communicate accordingly."* (Interviewee 15, internal stakeholder)

> *"...when a risk is identified, and especially when it begins to materialise, we discuss it in our daily meetings [...], where all the [relevant] department heads are present, which allows us to react immediately."* (Interviewee 6, internal stakeholder)

Staying Informed on Current World Events

Many of the interviewees highlighted the importance of staying informed on current global events, as it can help identify potential risks. Furthermore, being aware of potential changes in the global economic landscape was perceived as being beneficial for the proactive development and implementation of risk management strategies.

> *"As the world is currently changing a lot, it would be really important for us to be prepared for everything, so that if something does happen, we don't have to think about it too much. So that we've already figured out in advance the actions that we need to take."* (Interviewee 5, internal stakeholder)

> *"Right now [we prepare for supply chain disruptions] by being aware of the environment, being aware of the economy, seeing what's coming our way and forecasting, and preparing for the worst, because if you prepare for the worst, you can't get any worse, right?"* (Interviewee 11, internal stakeholder)

> *"By keeping an eye on the market situation, you get that early idea of a potential disruption. Before it becomes a visible supply chain disruption, you've already been able to anticipate it and [make adjustments, such as] changing the supply chain [accordingly] well in advance."* (Interviewee 3, internal stakeholder)

4.3.2 Supplier-Related Approaches

Some of the identified risk mitigation approaches could be described as being supplier focused. In other words, these approaches involve the supplier. The most frequently mentioned approaches will be discussed individually in greater detail below.

Supplier Auditing

The auditing of suppliers was deemed to be an effective way of mitigating supply risks. Through supplier auditing, the purchasing company can identify potential risks, as well as agree on corrective actions with the supplier. Furthermore, auditing can help purchasing companies to gain insight into the supplier's operations. Supplier auditing was additionally perceived to be a useful approach for enhancing supplier collaboration:

> *"Supplier auditing could be described as an essential tool for [supplier collaboration]. […] We perform audits on our suppliers every year, and during these audits we can identify which areas need to be developed, but most importantly, we get a better picture of the supplier's situation."* (Interviewee 3, internal stakeholder)

> *"If there are supply chain disruptions, we'll usually perform audits in the supply chain, during which we figure out why something has happened, and what the corrective actions are. We develop solutions with our suppliers, so that we can prevent similar disruptions from happening in the future. It could be described as process development."* (Interviewee 5, internal stakeholder)

Face-to-Face Meetings

Some of the participants highlighted the importance of having regular face-to-face meetings with suppliers. Face-to-face meetings were perceived to be more effective for information sharing than online meetings. Many of the participants believed that face-to-face meetings allowed the sharing of information to be both more flexible and extensive. Furthermore, face-to-face meetings were perceived to be crucial for the improvement of supplier relationships:

> *"…in face-to-face meetings you get to address a broader range of topics [than in online meetings]. […] you also usually have more time to discuss different kinds of things in face-to-face meetings."* (Interviewee 3, internal stakeholder)

> *"Frequent face-to-face meetings with the most critical suppliers are very important. You can address certain issues, for example, in online meetings, but meeting people in real life and going through certain things in greater detail*

> *is very important for the development of the supplier-buyer relationship. [Face-to-face meetings] are essential for collaboration and trust-building."* (Interviewee 16, internal)

Sharing of Forecasts

Many of the interviewees noted that the sharing of forecasts is essential. The sharing of forecasts with suppliers was described to be common practice in the case company, as it gives suppliers some level of insight into the predicted order volumes. This approach was also deemed particularly important by suppliers, as it allows them to plan their production and operations accordingly:

> *"We have forecasts of anticipated order quantities, which we share with our suppliers."* (Interviewee 4, internal stakeholder)

> *"[The] transparent sharing of long-term plans [is beneficial for improving collaboration between the supplier and the focal company]. This is, I would say, the best way for us to help, [for] us [to] be a good supplier. To inform us really early, if you have any plans to, for example, reduce or increase [order quantities]. […] So [that] we can follow up with your forecast. And this is what I would say is really, really helpful for us, to be informed early so [that] we can prepare for any changes."* (Interviewee 12, supplier)

> *"The more reliable the forecast of our customer's needs is, the better we can ensure that we have the capacity to meet these needs."* (Interviewee 7, supplier)

Sharing of Resources

Some of the internal stakeholders described how the sharing of resources, such as tools and equipment, can help prevent certain supply risks from materialising. The sharing of resources was deemed especially important within the context of critical products with only one regular supplier. As described by one of the interviewees:

> *"For most of the critical products we have multiple suppliers, but for some we don't. However, for [a specific critical product] we only have one regular supplier, but we've given [a tool necessary for the production of said product] to a few other suppliers. So, if our regular supplier has some issues, we can turn to the other suppliers as they already have the necessary tool. That's how we've tried to mitigate the risks associated with [specific critical product]."* (Interviewee 6, internal stakeholder)

Joint Product Development

Some of the interviewed suppliers highlighted the benefits that joint product development can have on minimising supply disruptions. Involving the supplier in the development of products can prevent potential disruptions, such as problems with product quality, from emerging. Furthermore, joint product development was perceived to positively impact the development of a long-term supplier-buyer relationship:

> *"We have some customers with whom we've worked for over 30 years. We have a customer in [country], and they always involve us in the development of new products. They send us some initial models of the products, and ask like, 'okay, can you check this? Would you do anything differently?', and we always give them advice, free of charge of course. I think that because of this, they always order the parts from us. I think that this has also had a positive impact on our performance in delivery and product quality. I think that [joint product development] can be advantageous in building long-term relationships between the companies."* (Interviewee 12, supplier)

5 Discussion

The purpose of this study was to examine how Finnish manufacturing companies in the construction industry can enhance the resilience of their supply chains. This study also attempted to identify factors impacting supply risk and practical approaches to mitigate supply risks. In this chapter, the findings of this study will be analysed in relation to the research questions and existing literature. The study had one primary and two secondary research questions, which will be addressed individually below.

1. *How can supply chain resilience be improved in Finnish manufacturing companies operating within the construction industry?*

Supplier collaboration and relationship management were identified as important drivers of SCR. These were deemed especially useful for preventing and mitigating supply risks. The findings of past studies suggest that supplier collaboration relationships play a significant role in the mitigation of potential supply chain risks (Dijmarescu 2024, 689). Collaboration can increase SCR by reducing uncertainty, improving preparedness for disruptions, and enhancing the alignment of goals and decision-making (Adobor 2019, 545–546).

Information sharing, trust and supplier commitment were recognised to be the most critical factors for enhancing supplier collaboration and relationship management, which in turn promote SCR. Each of these elements and their implications will be further discussed below.

Trust between the supplier and the purchasing company was perceived to have a notable impact on SCR, primarily because it increases transparent sharing of information. In other words, when the two parties trust each other, they are more willing to share important information. Furthermore, there appears to be a strong correlation between trust and information sharing. Lower levels of information sharing tend to lead to reduced trust, while higher levels of trust seem to increase the sharing of information. This perception is supported by the findings of past studies. Mandal and Sarathy (2018, 212S) suggest that an inter-relationship exists between communication, trust, commitment and cooperation within the context of SCR. Communication and mutual trust are essential for supplier collaboration,

as they enable the open exchange of important information (Dijmarescu 2024, 694–695). In addition, Adobor (2019, 546) suggests that higher levels of trust and collaboration among supply chain partners strengthen the resilience of a supply chain, while lower levels weaken it.

Both internal and external sharing of information were perceived to increase SCR. In addition, there appeared to be a clear connection between the transparent and timely sharing of information and SCR. When information regarding possible disruptions, potential risks and future plans is shared openly and in a timely manner, both the buying company and its suppliers can adjust their operations accordingly. The sharing of information was perceived to provide multiple benefits. For instance, it can help with the early identification of risks, the formation of risk management strategies and the minimisation of the negative effects of a materialised risk. The findings of a study conducted by Mandal and Sarathy (2018, 212S) suggest that communication directly impacts SCR. This view is further supported by the findings of past studies, which suggest that information sharing and collaborative communication can enhance SCR, as they can increase the visibility and flexibility of a supply chain. Furthermore, low levels of information sharing can reduce SCR. (Scholten & Schilder 2015, 478)

Supplier commitment was found to positively contribute to SCR, as committed suppliers tend to be more motivated to quickly address potential disruptions. In addition, supplier commitment can be increased by agreeing to higher prices, increasing order volumes, and including the supplier in development projects. These findings are supported by Acar et al. (2022, 495), who suggest that a supplier's commitment to service and relationship maintenance strengthens the buying company's supply chain performance in challenging conditions.

In addition to collaboration, trust, communication and information-sharing, and supplier commitment, the recognition of possible sources of supply risks were perceived to enhance SCR. By identifying the potential sources of supply risks, companies can implement appropriate strategies to manage possible risks and minimise their potential impact. This finding aligns with existing research, which highlights that a company's ability to detect early signs of potential supply chain disruptions is critical for building a resilient supply chain (Shishodia et al. 2023, 885). Furthermore, the identification of potential risks is

generally considered to be a central aspect of enterprise risk management (Pettit et al. 2013, 46).

The utilisation of practical risk mitigation methods was also perceived to increase SCR. Various risk mitigation strategies were considered valuable for the early identification of supply risks, preparing for potential risks, and minimising the negative impacts of materialised risks. The findings of Scholten et al. (2014, 223) suggest that the implementation of risk mitigation practices is crucial, as they allow effective preparation, response, and recovery during disruptions, thereby enhancing SCR.

2. *Which factors should be considered when assessing the probability and potential impact of supply risks?*

One of the objectives of this study was to identify supply risk factors that should be considered when assessing the likelihood and impact of potential supply risks. The findings of this study suggest that three main dimensions should be considered when identifying and assessing supply risks: product-specific, supplier-related and market-related factors. This categorisation of the main dimensions closely aligns with the supply risk framework proposed by Micheli et al. (2008, 854), and, to some extent, with existing frameworks, including the model of supply chain risk sources and risks by Hudnurkar et al. (2017, 189–192) and the supply risk framework by Zsidisin et al. (2000, 189). However, the existing frameworks are considerably broader than the one presented in this study. While these frameworks address aspects such as legal risks (Hudnurkar et al. 2017, 191; Zsidisin et al. 2000, 189), information system risks (Hudnurkar et al. 2017, 190; Micheli et al. 2009, 167), and financial risks (Hudnurkar et al. 2017, 190), this study focuses specifically on the factors most frequently highlighted by the participants.

Product-specific factors describe elements within a product that can make it more or less prone to supply risks. The participants highlighted that products with high levels of customisation tend to be more prone to supply risks than non-customised products. This finding is consistent with existing literature, which suggests that customised product supply chains are particularly vulnerable to disruptions (Ren & Zhao 2025, 1). In addition, the participants frequently highlighted the importance of considering a product's substitutability and its impact on operation continuity when assessing supply risks. This aligns with Kraljic's

portfolio analysis, which suggests that products which are crucial to the firm or have limited sources of supply carry a greater supply risk (Cordell & Thompson 2018, 96). Furthermore, products without inventory or safety stock were considered to be more vulnerable to supply risks, whereas having inventory or safety stock was perceived as a practical method for mitigating supply risks. Although past literature appears to consider inventory either as a risk due to the costs associated with it (Hudnurkar et al. 2017, 190–191) or as a practical risk mitigation method (Zsidisin et al. 2000, 190), the lack of an inventory as a source of supply risk is not necessarily addressed.

Supplier-related factors consistently appeared as important determinants of supply risk probability. These factors consist of aspects directly related to the supplier. The findings of past research suggest that a company's first-tier suppliers can be considered to be the primary sources of supply risks (Verghese et al. 2022, 1; Chopra et al. 2007, 551 as cited in Brusset & Teller 2017, 62). In alignment with past literature, which suggests that a supplier's location can significantly affect its exposure to political, economic, and natural risks (Deane et al. 2009, 864–865), the participants frequently highlighted how the location of a supplier can influence both the likelihood and impact of potential supply risks. However, existing research appears to address environmental influences more broadly as supply chain risks, rather than examining them specifically in the context of individual suppliers' locations. The participants also perceived supplier flexibility to be an essential aspect to consider when evaluating supply risks. Based on the interviews, it could be suggested that a supplier's inflexibility may be a source of supply risk, particularly for products that rely on a single, inflexible supplier. Past studies have highlighted that supplier flexibility allows companies to respond efficiently to changes through the supplier's resources and capabilities (Forslund et al. 2021, 5). Thus, it could be suggested that supplier flexibility enhances SCR. However, existing literature offers limited insight into how the inflexibility of a supplier might create or promote supply risks.

Lastly, market-related factors reflect external conditions beyond the control of the purchasing company. The participants noted that changes in market conditions, especially fluctuations in overall demand and supply, as well as the availability of suppliers for a given product can influence the supply risks associated with said product. These findings are consistent with past studies. For instance, Hudnurkar et al. (2017, 191) suggest that market shortages and the limited availability of qualified sources of supply could be considered both

a source of supply risks and a risk in itself. This view is further supported by Micheli et al. (2008, 852), who argue that a low number of qualified suppliers could be considered to be a market-related source of supply risks.

3. *What practical methods can manufacturing companies utilise to mitigate supply risks?*

The findings of this study indicate that manufacturing companies can utilise a range of practical methods to mitigate supply risks. The identified methods primarily aim to strengthen the purchasing company's ability to identify, anticipate, prepare for, and mitigate the negative effects of potential supply risks. For the sake of clarity, the identified methods have been divided into two categories: internal and supplier-related approaches.

Internal approaches refer to practical measures that a company can take internally to manage supply risks. Some of the identified approaches, such as regular risk assessment, aim to increase the company's ability to both anticipate and respond to supply risks. As stated by the participants, regular risk assessment can support the identification and evaluation of risks, as well as promote the development of preventative measures. Risk assessment appears to be one of the most commonly utilised methods for mitigating supply risks, and it is generally regarded as an essential stage in the risk analysis process (Duong et al. 2023, 1373). When supply risks are assessed as part of a company's regular supply management practices, the company can gain early insights into their likelihood and potential impact. However, while risk assessment is valuable, it should be regarded as only one phase of a company's broader risk management strategy. (Zsidisin et al. 2004, 408)

Dual sourcing, along with inventory and safety stock management, was frequently considered as one of the most effective methods for minimising supply risks. Both of these methods were regarded as factors for ensuring operational continuity. Dual sourcing was considered particularly important for critical products, whereas inventory and safety stock management was regarded as essential for products with only one supplier. In past literature, dual sourcing is often considered to be an effective method for managing unexpected supply disruptions (Rajabzadeh et al. 2024, 11; Yu et al. 2009, 789). The utilisation of multiple suppliers can also reduce the extent to which a company is exposed to risks. (Namdar et al. 2018, 2344). Additionally, past research emphasises the value of effective inventory

management for enhancing SCR. Inventory supports a company's operational continuity by providing both immediate availability of materials during demand spikes and a buffer against supply disruptions. (Guo et al. 2025, 451)

Some of the identified internal methods, such as having regular internal, cross-departmental meetings and staying informed about current world events, intend to strengthen the company's ability to identify and stay aware of potential risks. Gaining and sharing information appear to be at the centre of these two approaches. As uncertainty increases, so do the requirements for information processing. In existing supply chain literature, internal integration, which involves cross-functional collaboration and information sharing, is considered to be essential for managing large volumes of complex information. (Ivanovic et al. 2025, 56–57) Therefore, it could be suggested that regular cross-departmental meetings are an effective means of facilitating collaborative, risk-related information sharing. Participants further highlighted the importance of remaining aware of current world events, as the contemporary business environment is both highly uncertain and rapidly changing. However, while employees might independently monitor global developments in their own time, developing risk management practices that rely on gaining such awareness can be challenging.

Some participants noted that, in theory, moving a process in-house could enhance SCR by increasing transparency and control, although the case company has no intentions of pursuing this approach. In order to balance control and flexibility, some companies utilise dual-track supply chain models, which combine in-house production with strategic outsourcing (Park et al. 2025, 118). However, changing the sourcing strategy from outsourcing to in-house production does not appear to be a common approach for increasing SCR (Baur & Flach 2022, 228).

In addition to internal approaches, the findings of this study highlight several supplier-related practices that can be utilised to enhance SCR, including supplier auditing, face-to-face meetings, sharing of forecasts, sharing of resources and joint product development. The identified supplier-related practices emphasise the importance of transparent information sharing and collaboration between the buying company and its suppliers. Past studies suggest that information sharing is essential for increasing the visibility, collaboration, agility and performance of a supply chain (Baah et al. 2022, 452). In practice, for example, the mutual

sharing of forecasts allows both the supplier and the purchasing company to adjust their operations and production schedules accordingly, and to anticipate potential supply disruptions, which could increase the supply chain's visibility.

In addition to information sharing, some of the identified practices emphasise buyer-supplier collaboration. The sharing of resources, such as tools and equipment, with suppliers was perceived by the participants as an effective way to mitigate supply risks. The findings of past studies suggest that collaborative resource sharing can be effective for minimising the negative effects of disruptions within a supply chain (Mustapha et al. 2022, 115604). In addition, the interviewed suppliers noted how joint product development can help mitigate potential supply risks. When suppliers are involved in product development, they can contribute their expertise and provide input on design aspects that influence manufacturability, which helps align the product with their production capabilities and mitigate potential supply risks. This perception aligns with past literature, which suggests that including suppliers in product development can be "considered as a way to avoid or minimise various risks related to the supply chain." However, collaborative product development increases SCR only when the buyer and the supplier communicate effectively with one another. (Kędzia & Staniec 2022, 973, 978).

Some of the identified supplier-related practices combine information sharing with collaboration. While supplier audits are typically performed to ensure that suppliers meet certain standards (Castka et al. 2022, 1297), the participants noted that they can also be utilised to promote both collaboration and the detection of potential risks. Furthermore, the participants highlighted that face-to-face meetings allow information to be exchanged more flexibly and extensively, which could promote the detection of possible supply risks while fostering collaboration. The findings of past studies suggest that face-to-face communication can promote collaboration, increase cooperation rate, and enable participants to "distinguish cooperative people from noncooperative people" (He et al. 2017, 2832–2833).

6 Conclusions

Recent events, such as COVID-19, as well as current political and economic uncertainties, have highlighted the importance of building and maintaining resilient supply chains. The primary aim of this study was to provide insight into how Finnish manufacturing companies operating in the construction industry could enhance their SCR. To support this objective, this study also attempted to identify factors impacting supply risks and practical methods for mitigating supply disruptions. The results indicate that trust, collaboration, commitment and information sharing between buyers and suppliers are essential for effectively managing supply risks and enhancing SCR. These four factors appear to be highly interconnected: when one increases, the others tend to increase as well, whereas decreases in one can lead to decreases in the others.

Multiple potential supply risk factors were identified in the study, including product-specific, supplier-related and market-related factors. The identification of supply risk factors enables companies to detect and address more specific risks that could lead to supply disruptions. Recognising these factors, their sources and their associated risks allows companies to develop strategies and implement practices that improve SCR.

The study identified several practical methods for mitigating supply risks. Many of the identified methods centre on sharing and collecting information both externally and internally. When buyers are informed of potential supply risks and their underlying causes, they can adjust their operations accordingly and develop more effective risk mitigation strategies to address them. However, obtaining transparent information from suppliers can be challenging, especially when the information might reflect negatively on them. Therefore, the building of trust between the buyer and supplier is crucial for encouraging open and honest sharing of information.

Both internal and external collaboration can foster SCR. Internal collaboration, such as having regular cross-departmental meetings, enhances information sharing and increases awareness of potential risks. By collaborating with suppliers, companies can improve information sharing and develop trust, which in turn can enhance SCR.

Based on the findings of this study, it can be concluded that SCR is a complex concept influenced by numerous interrelated factors. The building of SCR requires that companies recognise potential supply risks and factors that impact them, promote collaboration, commitment and trust across the supply chain, exchange information effectively, and proactively implement strategies to both anticipate and manage potential risks. Furthermore, by understanding how these elements influence one another, companies can build supply chains that not only survive disruptions but emerge stronger from them.

6.1 Limitations and Suggestions for Future Research

The study has several limitations that should be addressed. The data utilised in this study was collected from internal and external stakeholders of one company, which may limit the generalisability of the findings. While the inclusion of suppliers might have provided some additional perspective, their awareness of their client's connection to the study may have affected the objectivity of their responses. Furthermore, as the focus of the study was on a manufacturing company operating specifically in the construction industry, the results may not be applicable to other manufacturing companies operating in different industries. As the data of this study was analysed using thematic analysis, it should be acknowledged that, within this approach, the same dataset can have multiple different interpretations (Crowe et al. 2015, 618). Therefore, another researcher working with the same dataset could potentially reach different conclusions.

Future research could further explore how supplier flexibility, or inflexibility, affects the perceived extent of supply risk, as prior studies appear to primarily address supplier flexibility in relation to the disruption recovery process. Additionally, future studies could examine which other approaches, aside from trust building, might increase suppliers' willingness to share information regarding potential supply risks openly and without fear of being perceived negatively. Lastly, it could be valuable to explore how companies can effectively track global developments that indicate potential supply risks and integrate these practices into their risk management processes.

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Appendices

Appendix 1. Suppliers' interview questions

1. What is your role in the company?

2. How long have you been working in your current position?

3. How often do you encounter disruptions in deliveries, and what are they usually caused by?

4. How does your company prepare for delivery disruptions?

5. How does your company respond when delivery disruptions occur?

6. How does your company aim to prevent or minimise delivery disruptions?

7. How do your customers support you in ensuring delivery reliability?

8. How flexibly can you respond to changing customer needs (e.g. quantities, schedules, products etc.)?

9. How quickly are delivery risks typically responded to, and how soon are other supply chain members

informed?

10. What communication channels or systems do you use when communicating with your customers?

11. How could the collaboration between your company and its customers be improved?

Appendix 2. Internal stakeholders' interview questions

Background Questions:

1. What is your role in the company?

2. How long have you been working in your current position?

3. In what ways do supply chain disruptions impact your work?

Supply Chain Resilience:

4. What are the most common disruptions affecting your company's supply chain?

5. How does the company respond when disruptions occur in its supply chain (e.g. delivery delays,

quality issues etc.)?

6. How does the company prepare for supply chain disruptions?

7. What strategies of practical measures does your company use to recover from supply chain disruptions?

8. What kinds of measures or strategies does your company use to prevent supply chain disruptions?

9. Could you describe a situation where your company faced a supply chain disruption?

- How was the disruption handled?
- What factors helped resolve the disruption?
- What could be done differently if a similar disruption occurred again?

Supply Risks:

10. What are the most common supply risks for your company?

11. How do these risks impact your work?

12. How does your company identify and monitor supply risks in practice?

13. Could you give an example of a situation where a supply risk materialised?

- How was the risk handled?
- What factors influenced the way the situation was resolved?
- What could be done differently if a similar risk were to occur again?

14. Do you have alternative suppliers you can rely on in case of a crisis?

Risk Mitigation:

15. What strategies of practical measures does your company use to prevent supply-related risks?

16. Does your company have multiple suppliers for critical materials or components?

17. How do you collaborate with suppliers to manage and reduce risks?

18. How quickly are risks typically addressed, and how soon is this information shared with other supply chain members?

19. What communication channels or systems do you use when working with suppliers?

20. In your opinion, how could collaboration between your company and its suppliers be improved?