



**UNIVERSITY  
OF TURKU**

Turku School of  
Economics

# **Managing geopolitical risks in global supply chains**

Case study in the maritime and energy industry

International Business, Department of Marketing and International Business  
Master's thesis

Author:  
Sanni Leskinen

Supervisor:  
PhD Eriikka Paavilainen-Mäntymäki

02.04.2026  
Tampere

Student's statement regarding the use of Artificial Intelligence (AI) for preparing and/or writing this thesis:

**I have not used any AI-based tools.**

**I have used AI-based tools.** Their use is documented in the Appendix. The AI tools were used in a way that complies with academic integrity guidelines.

The originality of this thesis has been checked in accordance with the University of Turku quality assurance system using the Turnitin Originality Check service.

## **Master's thesis**

**Subject:** International Business

**Author:** Sanni Leskinen

**Title:** Managing geopolitical risks in global supply chains: case study in the maritime and energy industry

**Supervisor:** PhD Eriikka Paavilainen-Mäntymäki

**Number of pages:** 92 pages + appendices 5 pages

**Date:** 02.04.2026

### **Abstract**

The frequency and significance of geopolitical risks and disruptions have increased drastically in the last decades, with the pandemic and ongoing conflicts in international relations. These risks have extensive disruptive impacts for global supply chains. The globalization, complexity and interconnectedness of global supply chains make them increasingly vulnerable to these disruptions. Therefore, it is crucial to research the ways in which geopolitical risks can be managed in global supply chains.

This study investigates how geopolitical risks impact supply chains in the maritime and energy industry, and how they could be managed to avoid disruptions. It explores the factors that create vulnerability to these risks, and how the impacts vary between different kinds of supply chains. Furthermore, it analyses the differences in how local and global geopolitical risks cause impacts in these supply chains. The theoretical framework consists of literature on geopolitical risks, their impacts on supply chains and on supply chain risk management. Traditional supply chain risk management processes and strategies are presented, after which their applicability to geopolitical risks is discussed.

This study is conducted as a single case study in a multinational corporation operating in the maritime and energy industry. It utilizes a mixed methods approach involving qualitative semi-structured interviews in the case company supply management organization, as well as quantitative secondary data from the case organization and the GPR index used to assess the level of geopolitical risk on a global and country-specific level.

The results of the study suggest that the impacts of geopolitical risks are ultimately realized as price increases and delays and disruptions in deliveries. It finds that the impacts of geopolitical risks vary based on the type of supply category. Furthermore, it finds that some supply categories are more vulnerable to local geopolitical risks, while some to global geopolitical risks. It argues that traditional supply chain risk management strategies, such as diversification, are applicable to geopolitical risks, but the main challenge of managing them is the identification of the risks. In addition, it considers the challenges and contradictions related to implementing said risk management strategies.

**Keywords:** geopolitics, geopolitical risks, global supply chain, supply chain disruptions, risk management, supply management, maritime and energy industry, mixed methods

## **Pro gradu -tutkielma**

**Oppiaine:** Kansainvälinen liiketoiminta

**Tekijä:** Sanni Leskinen

**Otsikko:** Geopoliittisten riskien hallinta globaaleissa toimitusketjuissa: tapaustutkimus merenkulku- ja energia-alalta.

**Ohjaaja:** PhD Eriikka Paavilainen-Mäntymäki

**Sivumäärä:** 92 sivua + liitteet 5 sivua

**Päivämäärä:** 02.04.2026

### **Tiivistelmä**

Geopoliittisten riskien toistuvuus ja määrä ovat nousseet merkittävästi viime vuosikymmenien aikana, esimerkiksi pandemian ja jatkuvien kansainvälisten suhteiden konfliktien johdosta. Näillä riskeillä on merkittäviä haitallisia vaikutuksia globaaleihin toimitusketjuihin. Globaalien toimitusketjujen globalisaatio, kompleksisuus ja verkottuneisuus nostaa niiden haavoittuvuutta näille häiriöille. Siksi on tärkeää tutkia tapoja, joilla geopoliittisia riskejä voidaan hallita globaaleissa toimitusketjuissa.

Tässä tutkimuksessa tarkastellaan sitä, miten geopoliittiset riskit vaikuttavat toimitusketjuihin merenkulun- ja energiateollisuuden toimialoilla sekä sitä, miten niitä voidaan hallita häiriöiden välttämiseksi. Tutkielma tarkastelee tekijöitä, jotka aiheuttavat alttiutta geopoliittisille riskeille ja sitä, kuinka vaikutukset vaihtelevat eri toimitusketjujen välillä. Lisäksi se tutkii sitä, miten lokaalit ja globaalit geopoliittiset riskit vaikuttavat toimitusketjuihin eri tavoin. Teoreettinen viitekehys muodostuu geopoliittisia riskejä, niiden vaikutuksia toimitusketjuihin, sekä toimitusketjun riskinhallintaa käsittelevästä kirjallisuudesta. Toimitusketjun riskinhallintaa lähestytään perinteisten riskinhallinta prosessien ja strategioiden kautta, minkä jälkeen niiden soveltuvuutta geopoliittisille riskeille analysoidaan.

Tämä tutkimus on toteutettu tapaustutkimuksena, joka keskittyy yhteen globaalisti toimivaan yritykseen merenkulku- ja energiateollisuuden toimialalla. Se hyödyntää monimenetelmällistä lähestymistapaa sisältäen laadullisia puolistrukturoituja haastatteluita tapausyrityksen hankintaorganisaatiossa, sekä kvantitatiivista sekundääristä aineistoa tapausyrityksestä sekä GPR indeksistä, joka arvioi geopoliittisen riskin tasoa globaalisti sekä maakohtaisella tasolla.

Tutkimuksen tulokset osoittavat, että geopoliittiset riskit johtavat hinnan nousuihin, sekä viiveisiin ja häiriöihin toimituksissa. Se osoittaa, että geopoliittisten riskien vaikutukset vaihtelevat riippuen hankintakategoriasta. Lisäksi se osoittaa, että jotkin hankintakategoriat ovat alttiimpia paikallisille geopoliittisille häiriöille, kun taas toiset globaaleille. Se väittää, että perinteiset toimitusketjun riskinhallintakeinot, kuten hajauttaminen, soveltuvat geopoliittisten riskien hallintaan, mutta suurin haaste niiden hallinnassa on riskien tunnistaminen. Tutkimus käsittelee myös haasteita ja ristiriitoja mainittujen riskinhallintakeinojen implementoinnissa.

**Avainsanat:** geopolitiikka, geopoliittiset riskit, globaalit toimitusketjut, toimitusketjuhäiriöt, riskinhallinta, hankinnan johtaminen, merenkulku- ja energiateollisuus, monimenetelmätutkimus

# TABLE OF CONTENTS

<b>1</b>	<b>Introduction</b>	<b>8</b>
1.1	Background and context	8
1.2	Research context and case company	10
1.3	Purpose and structure of the study	10
<b>2</b>	<b>Theoretical background</b>	<b>12</b>
2.1	Geopolitical risks	12
2.2	The GPR Index	14
2.3	Impacts of geopolitical disruptions to supply chains	15
2.3.1	Internal political instability	16
2.3.2	Tensions between countries without conflict	16
2.3.3	Piracy or terrorism	17
2.3.4	Trade war	18
2.3.5	Nationalist movements	19
2.3.6	Armed conflicts	19
2.3.7	Cyber risks	21
2.4	Managing supply chain risk	22
2.4.1	Processes and strategies	22
2.4.2	Supply chain resilience	26
2.4.3	Mitigating geopolitical risk	27
2.4.4	Decision making during geopolitical disruption	30
2.5	Synthesis of the theoretical framework	34
<b>3</b>	<b>Methods</b>	<b>36</b>
3.1	Research approach	36
3.1.1	Single case study	36
3.1.2	Mixed methods research	37
3.2	Data collection	39
3.2.1	Qualitative data	39
3.2.2	Quantitative data	42
3.3	Data analysis	43
3.3.1	Qualitative data	43
3.3.2	Quantitative data	45
3.3.3	Mixed methods: Integrating the data	46

<b>3.4 Evaluation of the study</b>	<b>46</b>
3.4.1 Qualitative data	46
3.4.2 Quantitative data	48
3.4.3 Research ethics	49
<b>4 Findings</b>	<b>50</b>
<b>4.1 Observations from the qualitative data</b>	<b>50</b>
4.1.1 Defining geopolitical risks	50
4.1.2 Impacts of geopolitical risks	50
4.1.3 Management of geopolitical risks	53
4.1.4 Summary of current state at case company	58
<b>4.2 Observations from the quantitative data</b>	<b>59</b>
4.2.1 T-tests	59
4.2.2 Crosstabulation	62
4.2.3 Regression	67
<b>4.3 Integrating the data</b>	<b>68</b>
<b>5 Discussion and conclusions</b>	<b>69</b>
<b>5.1 Managing geopolitical risks in maritime and energy supply chains</b>	<b>69</b>
<b>5.2 Theoretical contributions</b>	<b>73</b>
<b>5.3 Managerial implications</b>	<b>75</b>
<b>5.4 Limitations and future research</b>	<b>77</b>
<b>6 Summary</b>	<b>79</b>
<b>References</b>	<b>80</b>
<b>Appendices</b>	<b>93</b>
<b>Appendix 1 List of interview questions</b>	<b>93</b>
<b>Appendix 2 Declaration of the use of AI</b>	<b>95</b>
<b>Appendix 3 Sample sizes</b>	<b>97</b>

## **FIGURES**

Figure 1 The basic constructs in SCRM	23
Figure 2 Conceptual framework of SCRM process	23
Figure 3 Supply chain logics during geopolitical risk	31
Figure 4 General scenario planning process	33
Figure 5 Supply chain scenario planning	33
Figure 6 Theoretical framework	35
Figure 7 Research process	38

## **TABLES**

Table 1 Types of geopolitical risk	15
Table 2 Supply chain risk management strategies	25
Table 3 Initial list of characteristics for category selection	40
Table 4 Revised list of characteristics of selected categories	41
Table 5 Interview details	41
Table 6 Data sources	42
Table 7 Operationalization table	44
Table 8 T-Test country-specific GPR	60
Table 9 T-Test global GPR	61
Table 10 Crosstabulation country-specific GPR	63
Table 11 Crosstabulation global GPR	65
Table 12 Buffer groups	66
Table 13 Crosstabulation buffer groups	66
Table 14 Regression results	67
Table 15 Contributions to themes identified in theory	74

# 1 Introduction

## 1.1 Background and context

The search for the lowest cost of supply has driven the globalization of manufacturing supply chains (Handfield et al. 2020, 1651). Factors such as globalization, outsourcing and the focus on efficiency instead of effectiveness, have increased the level of risk in supply chains (Jüttner et al. 2003, 205). These highly globalized, interconnected and multi-tiered supply chains are capable of efficient flow of goods and services but create vulnerability to a variety of propagating risks (Habibi et al. 2025, 6229). Supply disruptions are significant risks to business operations, and they can result in increased cost, loss of profit or reduction in reputation (Bier et al. 2020, 1835). Additionally, global supply chains serve an important role in international development, as the capability of a country to prosper, is significantly dependent of their participation in the global economy (Gereffi & Lee 2012, 24). However, in the last decades, nationalism has also been on the rise (Bieber 2018, 519), and discussions about deglobalization have emerged (Gao et al. 2023, 1).

The past decade has seen many significant geopolitical events, which have had extensive effects on international relations, commodity prices and global supply chains, among others. Significant events include UK's exit from the EU, the trade war between the United States and China, the COVID-19 pandemic and Russian's invasion in Ukraine. (Bednarski et al. 2025, 536.) The events mentioned have had repercussions on global supply chains but extend beyond the supply chain in the form of sanctions, blockades as well as different economic and labor related issues, in turn disturbing global trade (Alexander et al. 2022, 1061). Europe's economy depends significantly on international trade, and the recent geopolitical disruptions including the pandemic have shed light on the vulnerability of Europe's supply chains (Sielker & Dannenberg 2025, 41). In addition, individual, often shorter-term events with low probability, such as the blockage of the Suez Canal by the containership Ever Given (Tran et al. 2025), the eruption of volcano Eyjafjallajökull in Iceland (Lee & Preston 2012), the earthquake and tsunami of Japan in 2011, and the nuclear accident in Fukushima Daiichi (Park et al. 2013) disturb supply chains and show the vulnerability of global dependencies. The management of supply chain disruptions has become vital to firms, as they have been exposed to disruptions in the turmoil and uncertainty present in the global environment (Ambulkar et al. 2015, 111). Global supply chains' resilience has been damaged by the increased geopolitical uncertainty and risk. The flow of material, services and capital across the globe have been disturbed, making the stability of them a vital factor for firm performance with extended effects on financial markets and general well-being. (Chang et al. 2025, 1.) The combination of increased complexity and globalization of supply chains,

and the occurrence of unexpected adverse events have drawn growing attention to supply chain risk management and its importance (Shekarabi et al. 2025, 1). Traditional supply risk management methods and tools that rely on historical data are no longer sufficient, and newer, more proactive systems that can anticipate future risks are needed for risk mitigation to be successful (Gao 2015, 136).

While there is notable research on geopolitical disruptions, Bednarski et al. (2025, 543) found that frequency, complexity and impact of geopolitical risks to supply chains have thus far remained as a peripheral topic and research has been focused on other aspects of geopolitical disruptions. Their research shows that the impacts of geopolitical disruptions establish a new subfield of research, which is yet to be treated as a cohesive body of knowledge. Furthermore, the research on geopolitical disruptions tends to focus on specific geopolitical events, instead of investigating geopolitical risks as a concept on a broader scale (Charpin & Cousineau 2025, 1010). This forms the theoretical motivation for this thesis. The existing research in geopolitical risks in within supply chains has emphasized resilience and adaptability to respond to disruptions in the short term but lack the understanding of how they can be turned into strategies that are effective in the long run, considering the consistently unpredictable environment (Zheng et al. 2025, 1182). This is supported by Roscoe et al. (2020, 1500), who state that more attention should be given to address how firms create and implement strategies to “achieve fit with an external business environment disrupted by geopolitical events”. Sielker and Dannenberg (2025, 42) have also highlighted the need for research on the long-term implications of violent conflicts and geopolitical tensions to global production and value chains. Similarly, Bai et al. (2025) note that the impacts of geopolitical risks to global supply chain decisions remain unclear, despite extensive research on the economic impacts of political risk. Altogether, research on supply chain disruptions related to geopolitical risks in specific is lacking, considering the considerable amount of literature on supply chain disruptions in general (López et al. 2025, 4). The need for research on different kinds of supply chains, with differing products or requirements, in the context of geopolitical disruptions is highlighted by Duong et al. (2025, 1107), who provided evidence from the perspective of temporary health care supply chains.

The changes in the geopolitical environment have significant impacts on Finnish companies and their supply chains. Preparing for these risks is crucial, to avoid the most harmful risks, but also to capture the opportunities this situation gives. (Confederation of Finnish Industries 2025) Furthermore, the case company has reported geopolitical risks, tensions and unpredictability as a significant risk in both its main operating markets. There are concerns related to potential disruptions of supply chains, price impacts, and demand related impacts, amongst others. On the organizational level, it categorizes

geopolitical risks as a strategic risk. On the other hand, supplier and subcontractor risk is categorized as an operational risk. (Case Company 2025.)

## **1.2 Research context and case company**

The case company is a multinational corporation headquartered in Finland, operating in the maritime and energy sectors. The case company has a global supply management organization, which is the focus of this study. The supply management organization is divided into local and global categories, out of which the global categories are in focus in this study. Five of the global categories were selected for data collection in this study. The interviewed categories differ from each other for instance in the types of products purchased, the location of suppliers, types of value chains, lead times and extent of focus on product development.

Both of the case organization's main markets, maritime and energy, are significantly impacted by for example the development of sustainability initiatives, and other significant decisions and changes globally. The maritime industry is experiencing quick changes in the market due to technological, environmental and geoeconomic shifts (UNCTAD 2025). A significant part of global trade relies on maritime market (Verschuur et al. 2025), making the maritime industry an important sector globally. In addition to containerships, cruise, ferry, offshore and LNG segments are important markets to the case company (Case company, website). The energy sector is subject to changes in climate initiatives as well as today's geopolitical tensions. It is a vital sector, supplying electricity to modern economies. (IEA 2025.) Key developments in the market include changes in trade policies, but also growing demand (Case company, website).

## **1.3 Purpose and structure of the study**

This thesis has a theoretical and a practical motivation. Its objective is to take part in the discussion about impacts of geopolitical risks to supply chains with empirical findings. The practical aim of this thesis is to find ways that geopolitical risks can be identified and mitigated within global supply chains in the maritime and energy sector. This study is commissioned by a multinational corporation, which is a leading provider of sustainable solutions in the maritime and energy industry. For the purpose of the case company, this thesis will take the perspective of a multinational corporation headquartered in Finland, particularly in identifying the most relevant geopolitical risks to assess. This thesis will answer the following research question:

*RQ1: How geopolitical risks could be managed in maritime and energy sector global supply chains?*

The main research question captures the whole topic being researched and aims to provide a holistic picture of the important topics to consider in the management of geopolitical risks. To answer the main research question, this thesis will address the following sub-questions:

*SQ1: What types of geopolitical risks typically affect global supply chains in the maritime and energy sector and how?*

*SQ2: What risk management strategies can be used for managing geopolitical risks in the maritime and energy sector?*

The purpose of the first sub question is to investigate what types of geopolitical risks are most significant for supply management in a maritime and energy industry company. This sub problem is crucial to understand, to be able to assess the kinds of risk management strategies that could be effective in managing geopolitical risks. The second sub problem focuses on the strategies that have or would be effective in managing geopolitical risks. The understanding of potential risk management strategies is a prerequisite for being able to analyze the applicability of different strategies. It also captures the aspects considered most difficult in managing geopolitical risks, as well as potential barriers related to implementing the identified risk management strategies. It also supports in identifying the key challenges in terms of geopolitical risks from the perspective of the case company.

The thesis will begin with an overview of the existing literature and theoretical background. This part is divided into two main chapters, first of which will cover geopolitical risks and their impacts to supply chains whereas the second part will focus on risk management practices. These will be followed by the methodology chapter, which will reiterate the research approach and explain the research methods used. The fifth chapter will discuss the findings of this study and link them to theoretical framework. The last chapter will conclude the thesis and its findings, after which will follow the references and appendices.

## 2 Theoretical background

### 2.1 Geopolitical risks

Caldara and Iacoviello (2022, 1195) defined geopolitical risk as “the threat, realization, and escalation of adverse events associated with wars, terrorism, and any tensions among states and political actors that affect the peaceful course of international relations”. Geopolitical risks vary from minor disruptions to major conflicts that can cause disruptions in supply chains, resource depletion and demographic shifts among other potential economic, political, social and environmental impacts (Feng et al. 2024, 1). The geopolitical environment in which global supply chains operate, is increasingly uncertain (Chang et al. 2025, 2).

Global supply chains have developed as a means of globalization, as governments and businesses aim to gain competitive advantage and optimize production costs by sourcing it from specialized and developing countries. They are influenced by governments, businesses and other organizations amongst others. (Herold & Marzantowicz 2023, 2215.) Offshoring, defined as the relocation of a firm’s value chains to foreign location, is often motivated by lower production costs and materials, increased revenues, flexibility as well as access to new ideas, human capital and developing markets (Hansen et al. 2017, 2051; Pedroletti & Ciabuschi 2023, 1). Although these increasingly globalized, interconnected and therefore complex supply chains work highly efficiently when the environment is stable, they are highly vulnerable to risks and disruptions (Kamalahmadi & Parast 2016, 116), which can hinder their supply chains and financial performance (Hansen et al. 2017, 2051). Furthermore, the increased complexity makes the management of risks and disruptions more challenging (Bier et al. 2020, 1835). Today, supply chains typically consist of multiple tiers of actors (Sarkar & Kumar 2015, 169). While this enhances efficiency, the interconnectedness of the different tiers (intra-tier and inter-tier) increases the supply chain’s vulnerability due to the cascade of disruptions across tiers (Habibi et al. 2025, 6230). As supply chains are connected and intertwined, the ripple effect is a significant challenge in supply risk management. The ripple effect consists of forward and backward propagation of disruption, that originate at either the supplier or customer side. (Li et al. 2021, 1117.)

Bode and Wagner (2015) studied the impact of supply chain complexity on frequency of supply chain disruptions. Complexity was divided into three categories: horizontal, vertical and spatial. Horizontal complexity is defined as the number of direct suppliers to the focal firm, whereas vertical complexity is understood as the number of tiers in the supply chains, causing risk for chain reactions. Spatial complexity refers to the geographical distance between the firm and its suppliers. The study found

that while horizontal complexity has the strongest positive effect on the frequency of supply chain disruptions, the frequency of disruptions grows at an accelerating rate when combined with spatial complexity. As supply chains are increasingly global, i.e. spatial complexity increases, they become more vulnerable to geopolitical risks and disruptions (Tse et al. 2024, 1). Charpin & Cousineau (2025) found that geopolitical tension and political divergence influence firms' supply bases by reducing the proportion of foreign partners. However, they also showed that firms increase the complexity, both horizontal and spatial, of their supply base to mitigate geopolitical disruptions. The implications are paradoxical, as supply base complexity has been shown to expose supply chains to disruptions.

Supply chain risks can be categorized into operational risks, which consist of the ordinary disruptions in the supply chain operations related to supply and demand fluctuations, and disruption risks, which consist of low frequency and high impact incidents (El Baz & Ruel 2021, 1). Based on this categorization, geopolitical risks could be relevant in both categories, but perhaps more significantly in disruption risks. Another example of supply chain risk categorization is by Ho et al. (2015, 5035), who divided supply chain risks into macro-risks and micro-risks, out of which geopolitical risks would be considered macro-risks. Macro-risks are further divided into natural risks caused for instance "by weather-related disasters, and man-made risks, such as war and political instability" (Ho et al. 2015, 5035). Ultimately, supply chain risks are realized as long lead-times, stock outs, inability to meet customer demands and increases of production costs and therefore losses to the firm (Mital et al. 2018, 159).

Extreme conditions caused by wars, pandemics and climate change among others, can disturb global supply chains in multiple ways (Sodhi & Tang 2021, 7), and their vulnerability was shown by the challenges caused by Covid-19 pandemic and the war in Ukraine (Herold & Marzantowicz 2023, 2220). Geopolitical risk compromises the resilience, reliability and flexibility of global supply chains. Firms are pushed to adopt excess inventory and reshore operations, which undermine the efficiency of supply chains. (Chang et al. 2025, 2.)

Furthermore, geopolitical tensions can disturb cross-border coordination and collaboration, which are crucial for global supply chains and information sharing amongst supply chain partners. Therefore, trust and business relationships within the firms can be damaged in the long run. (Chang et al. 2025, 2.) Trust is essential for supplier-buyer collaboration, but it should be noted that it can reduce alertness and proactive risk management in politically unstable environments (Choksy et al. 2025, 13). Collaboration and exchange of information within the supply chain, especially of potential sources of risk, is a vital part of reducing risk and uncertainty (Christopher & Peck 2004, 9; El Baz & Ruel

2021, 9). Information sharing during disruptions is crucial for the supply chain partners to be prepared, but it can also help build trust and reliability in the buyer-supplier relationship (Sarkar & Kumar 2015, 176). The quality of the relationship between the buyer and the supplier can have implications on for instance the adoption of requirements by the focal firm, and visibility beyond the first tier of suppliers (Melnyk et al. 2022, 175). “Frequent interactions and knowledge sharing based on mutual trust and social ties are critical in coordinating value chains that rely on complex information that is not easily transmitted”, also known as relational value chains (Gereffi & Lee 2012, 25).

According to The Global Risks Report 2026 (World Economic Forum 2026a) the two risks clearly seen as most severe, are geoeconomic confrontation and state-based armed conflict, both categorized as geopolitical risks. From the perspective of Finnish businesses, the geopolitical environment is changing rapidly, and the impacts are significant. Some of the major geopolitical risks for Finnish businesses include the prolonged war in Ukraine, the weakness and fragmentation of the EU, the turbulence of the US in the era of Trump, the intensifying competition between the great powers such as the US-China relations, EU relations with China, the expansion of the Middle East crisis as well as climate change. (Confederation of Finnish Industries 2025.) According to the case company’s annual report (2025) the most significant geopolitical risks include the continuing war in Ukraine, escalation of conflict in the Middle East, risk of confrontations in Asia, rapid changes in the trade policy of US. They can impact trade routes and result on longer shipping routes, disturb supply chains, increase transportation costs, increase commodity prices and impact the demand market, amongst other impact.

## **2.2 The GPR Index**

The GPR index was developed by Caldara and Iacoviello (2022) with the purpose of measuring the threat, realization and escalation of adverse geopolitical events in real-time. The index counts all published news articles discussing geopolitical risks, by using an algorithm that spots words associated with geopolitical risks, such as “war”, “threat” and “invasion”. The GPR index is shown as the proportion of news articles covering geopolitical events, compared to the number of news articles altogether. Looking back in time, the GPR index spikes during adverse geopolitical events, supporting the indexes plausibility. Furthermore, the index has a country-specific measure of geopolitical risk, which counts news articles where the name of a country is used together with words associated with geopolitical risk. There has been some use of the GPR index in researching the impacts of geopolitical risks, for instance Demir et al. (2025) study on the effects of global uncertainty

and risks on metal prices, and Mei et al. (2020) who studied the effect of geopolitical risk on oil futures price volatility. Examples of past GPR index spikes include such as September 2001 (9/11 attacks), January 2020 (outbreak of Covid-19), March 2022 (Russia's attack in Ukraine), and March 2026 (USA's attack in Iran), but it also varies daily (GPR Index).

There is however some criticism regarding the extent to which GPR index can universally capture geopolitical risk. Bondarenko et al. (2024) argued that there are differences in the ways different nations perceive geopolitical risk, which affects the index of geopolitical risk given to a country at a specific time. Using Russia as a case country, they built on Caldara and Iacoviello's (2022) work and developed a geopolitical risk indicator using textual analysis of local newspapers, instead of US newspapers, with findings indicating that geopolitical risk cannot be measured in a universal way. This critique is acknowledged, however the GPR index is considered sufficient for use in the context of the case company.

### 2.3 Impacts of geopolitical disruptions to supply chains

López et al. (2025) identified six different types of geopolitical disruption that impact supply chains, which are listed in Table 1. This identification of types is vital for understanding the impacts and developing the needed actions for risk management. To explore the different types of risk, this categorization will be utilized in the remaining of this chapter, and the risk categories will be covered in more detail in the next six sub chapters.

**Table 1 Types of geopolitical risk (López et al. 2025)**

Type of geopolitical disruption	Definition
Internal tension due to internal political instability (Internal political instability)	Domestic geopolitical disruptions and tension due to lack of democracy, corruption, institutional and governmental instability, labor-related conflicts as well as conflicts between ethnic or religious groups (p. 11)
Tensions between countries without direct economic or armed conflict (Tensions between countries without conflict)	Situations where an external factor cause one or both countries to respond. It can also include tensions related to national sovereignty that initially do not lead to economic or armed conflict (p. 11)
Internal or external tension due to piracy or terrorism (Piracy or terrorism)	Geopolitical disruptions related to armed attacks or assaults by terrorist or pirate groups, due to religious or economic motives amongst others (p. 11)
Tensions between countries with economic conflict but not armed conflict (Trade war)	Trade wars where there is economic tension between countries, characterized by protectionist mechanisms and commercial restrictions or trade barriers, such as quotas and tariffs (p. 11)
Internal tension due to independence and dependence (Nationalist movements)	Nationalist movements where a specific country or region tightens its laws and policies or strives for independence from supranational entities, such as the EU, with the goal of strengthening its identity, culture, or interests (p. 12)

Tensions between countries with both economic and armed conflict	Events where two or more armies are in conflict, whether war is declared or not (p. 12)
--	---

López et al. (2025, 2) have not ranked these risk categories in terms of severity but is rather focusing on the severity of the impacts and the type of management methods that could be used to decrease them. However, considering the number of different impacts linked to each type, internal political instability and tensions between countries with economic conflict but not armed conflict are linked to the highest numbers of different impacts. However, this does not consider the severity of the impacts. (López et al. 2025, 23-24.)

### 2.3.1 Internal political instability

Impacts for supply chains related to internal political instability include delay or disruption of material flow, caused by lack of material or disruption in production, for example due to labor related issues. Additional disruptions may relate to transactions, occurring from volatile demand and difficult planning, lacking documentation and the bullwhip effect. “Effects in the delay or disruption can be caused by the lack of material itself, or by a disturbance in production machine tools or workers.” (López et al. 2025, 11.) An example of an event in this category would include the extensive strikes of the industrial sector in Finland 2025 involving multiple different unions, as a result of which cargo handling at ports was blocked, and manufacturing was blocked in many organizations (Technology Industry Employers of Finland 2025). Another example would be the political and economic crisis of Sri Lanka in 2022, which was mainly caused by internal political decisions and governance failures (World Economic Forum 2022).

Hansen et al. (2017, 2064) found that firms in the offshoring industry typically aim to avoid political risk, such as political instability. Some of the most frequent and impactful subcategories of political risk relevant for this category in business process offshoring were perceived to be predictability of labor regulations, organized labor strikes, corruption and social unrest (Hansen et al. 2017, 2061).

### 2.3.2 Tensions between countries without conflict

An example of a geopolitical event related to tensions between countries without conflict would be the Covid-19 pandemic, which resulted in differing responses between countries, and challenged or disturbed supply chains between them (López et al. 2025, 11) and has quickly become one of the most significant disruptive events of the modern world (Gereffi 2020, 288). Disruptions such as the Covid-19 pandemic disturb supply and demand on a large scale, while impacting the resilience and robustness of supply chains (El Baz & Ruel 2021, 1). The Covid-19 pandemic weakened supply chain

performance through delays, supply disruptions, labor shortages and demand fluctuation (Duong et al. 2023, 1980), while shutting down every economy in under two weeks (Handfield et al. 2020, 1657). It challenged supply chains' viability and adaptation under severe uncertainty (Ivanov 2021, 3535). Handfield et al. (2020, 1656) found that these massive economic disruptions are so forceful, that they have undermined the effectiveness of typical acts of supply chain optimization related to negotiating better contracts, prices and such. Ivanov (2020, 11) found that in the context of epidemic outbreaks as a supply chain risk, the most important determinants of the extent of impacts are the timing and scale of the ripple effect, and the sequence of the closing and opening of facilities at different levels. They argued that the consideration of the scale of the ripple effect is more important than the consideration of where the epidemic has started, and the percentage of supply base located in the origin region. Kovács and Sigala (2021, 46) highlighted that the likelihood of disasters and pandemics has been disregarded as improbable, even though their impacts are extensive, and while rare, disruptions such as Covid-19 are not in fact once in a lifetime events. Furthermore, they reminded that similar disruptions could stem from other, perhaps more likely events as well.

### 2.3.3 Piracy or terrorism

Examples of piracy or terrorism would include the Houthi rebels, Somali pirates and the 9/11 incident. These attacks may disrupt the flow of material, money and information within the supply chain. (López et al. 2025, 11; 13.) The Red Sea, which is the shortest and quickest shipping route between Asia and Europe, has been under geopolitical tension due to the attacks of Yemen's Houthi rebels on commercial vessels (Rai 2025, 1). In addition to direct disruptions of supply chains, these events have ripple effects on the shipping industry and hence global value chains. These impacts are realized as lower overall trade volumes, increasing shipping costs, congestion of cargo hubs and ports as well as equipment and capacity shortages. (Rai 2025, 10.) Cargo ships sailing through the Horn of Africa and the Suez Canal, which is one of the key passages for global maritime supply chains, are also under the threat of pirate attacks (Sullivan 2010, 242). A major part of global supply chains relies on maritime transport, and more specifically on certain 'maritime chokepoints', which are narrow passageways that are critical for global maritime trade. These chokepoints are vulnerable to disruptions, and they can have major impacts on global supply chains. (Verschuur et al. 2025, 1.)

Tan et al. (2024) found that supplier-customer relationships suffer and are more likely to be terminated because of a terrorist attack near the supplier's location. On the other hand, Bueno-Solano and Cedillo-Campos (2014, 10) found that there is a disruptive bullwhip effect related to terrorist attacks, which propagates from the customer to the supplier. However, when the duration of

disruption exceeds the highest level of safety stock inside the supply chain, the bullwhip effect is reversed.

#### 2.3.4 Trade war

Tensions between countries with economic conflict but not armed conflict relate to trade wars where there is economic tension between countries, characterized by protectionist mechanisms and commercial restrictions or trade barriers, such as quotas and tariffs. These events arise from willingness of countries to preserve economic sovereignty, and recent examples could include tariffs between the US, Canada and Mexico, (López et al. 2025, 11) and the trade war between the US and China (Fang & Xu 2026). Governments' trade actions, such as tariffs, quotas and sanctions in response to geopolitical risks impact the targeted firm(s) as well as their suppliers headquartered in the targeting country. Suppliers located in other countries than the targeting country may experience negative impacts, but also positive impacts from demand moving to these other suppliers. (Jacobs et al. 2022, 904-906.) Additionally, Yang et al. (2025, 948) posited that under geopolitical tension, when faced with the decision whether to reconfigure supply chains in rival countries, there is a trade-off between meeting domestic political demands and the cost of adjusting the supply chain.

Disruptions caused by trade war, and other adverse international political events may cause firms to reduce the complexity of their supply base and the involvement of foreign suppliers as a risk mitigation act (Fan et al. 2022, 818). Being two of the world's largest economies, the tensions between China and the US have had significant implications on global trade flows and increased uncertainty. The trade war started in 2018, when the Trump administration imposed extensive tariffs and sanctions for multiple products. (Fang & Xu 2026, 1.) In 2018, the US imposed extensive section 232 tariffs on multiple products, especially steel and aluminum (The European Commission 2025), the purpose of which are to protect national security (The White House 2025). Additional section 301 tariffs were imposed on Chinese goods. Both tariffs led to retaliatory tariffs by multiple affected countries and economic areas, including the European Union. (Dong & Kouvelis 2020, 25.) According to Dong and Kouvelis (2020, 34) tariffs can affect supply chains on multiple stages. Tariffs are hard to predict in terms of timing and duration, and their effects are manifold, considering product interdependence and shared product structures. Additionally, when tariffs impact a firm's suppliers, they will respond and adjust in ways that secure their own operations, for instance by increasing prices. These tariffs were removed from EU imports in 2021 but reactivated in March of 2025 and increased further in June of 2025 (The European Commission 2025).

### 2.3.5 Nationalist movements

Internal tension due to independence and dependence relate to nationalist movements where a specific country or region tightens its laws and policies or strives for independence from supranational entities, such as the EU, with the goal of strengthening its identity, culture, or interests. The change of subjection to different laws causes disruptions in international trade. Brexit serves as a good example of this category of risks. (López et al. 2025, 12.) Nationalist beliefs and institutions manifest as willingness of a nation to set itself apart from others and avoid foreign influences, triggering geopolitical events that disturb supply chains. These nationalist actions are taken by governments, but also by citizens and private sector firms, and they are motivated by a desire to protect their nation from supposed harmful foreign activities. (Charpin 2022, 4-5.) Meyer (2017, 78) stated that nationalist agendas are on the rise and being increasingly supported by people that feel somehow unsatisfied with the outcomes of globalization. The rise of nationalism is shown all around the world in presidential elections, successes of far-right parties and the nationalist policies of politicians (Bieber 2018, 519). Conversations about globalization have even shifted towards deglobalization, which is related to the decoupling of global value chains, especially focusing on the decoupling of China from US-led global value chains. The implications of this decoupling are significant, especially in high-tech industries such as semiconductors. (Gao et al. 2023, 1.)

The United Kingdom's exit from the EU, known as Brexit, had consequences on businesses, amongst other through increased barriers to cross-border trade (European Commission 2021). Moradlou et al. (2021) found that as a result of Brexit, a significant number of companies have relocated, or at least relocated production facilities from the UK to the EU, while moving distribution centers from the EU to the UK. Roscoe et al. (2020, 1523) found that MNCs perceived heightened supply chain uncertainty surrounding Brexit but were able to reduce the uncertainty using worst-case scenarios. What differentiates these kinds of disruptions from the others, is that there is a long-time horizon involved in the disruption, and it affects a wide variety of firms. As the buildup time for the disruptions is so long, it is not considered a low probability incident. (Hendry et al. 2019, 448.)

### 2.3.6 Armed conflicts

Armed conflicts have significant impacts on global supply chains, such as embargoes, damage to infrastructure, and loss of human capital. Disruptions to supply chains are caused by destruction and interruption of transport routes and infrastructure such as airports, resource extraction sites and power stations. (Sielker & Dannenberg 2025, 42) Maritime supply chains are vulnerable to disruptions to port operations and trade flow during armed conflict (Chen et al. 2025, 1). Sielker and Dannenberg

(2025, 44-48) highlighted the risks related to infrastructure corridors between Europe and Asia. They recognized six major corridors on land-based routes (the Cross-Russia Corridor, the Baltic Crossing, the Ukraine Land Crossing, the Caucasus-Black Sea – Ukraine Crossing, the Caucasus-Black Sea – Danube Crossing, and the Turkey Crossing) and three on maritime routes (the Arctic – North Sea Corridor, the Suez Canal, and the Cape Route via South Africa). While maritime routes remain as the most significant transport route between Asia and Europe, land-based trade routes have been developed as an option for a faster and more flexible transport, however coming with higher cost and increased dependency on some countries. The risks related to these corridors can be summarized as termination of trade along a route due to sanctions or armed conflicts, risks of additional conflicts, reduced capacity and cost and time implications of using a more secure trade route. Georgoulas et al. (2025, 181) revealed that the impacts of geopolitical risk to maritime shipping are long-term and increasing over a 10-year time interval. The impacts relate not only to freight rates, but also to the volume of transported goods and the sustainable transition of the maritime shipping industry.

A recent example of events in this category would be the Ukraine war (López et al. 2025, 12), and it has shown how armed conflicts disrupt global supply chains (Sielker & Dannenberg 2025, 49). The Ukraine war has had extensive effects on global maritime supply chains, by disrupting energy trade and increasing shipping costs among other impacts. It has had especially significant effects on European countries due to the dependency on Russian energy. (Chen et al. 2025.) As a result of Russia's attack in Ukraine, energy prices rose record high and started an energy crisis within Europe, after which the EU swiftly decided to reduce its dependence on Russian fossil fuels, while speeding up the process of moving towards clean energy altogether. (European Council 2025). Impacts related to energy availability are critical for the subject of this study, as the manufacturing of iron and steel products requires a substantial amount of energy in many steps of the process (Li & Zhu 2014, 603).

Russia's invasion of Ukraine has led to massive sanctions against Russia imposed by the EU (Council of the European Union), the UK (UK Government), and the US (U.S. Department of State), amongst others. Sanctions are defined as the restriction or prohibition of specific economic activities with another country, often imposed as a response to geopolitical threats or acts (Bondarenko et al. 2024, 12). As a result, firms have reconsidered and cut their linkages with Russia, for instance by terminating sales and production in Russia, as well as sourcing products or raw materials from Russia. Many major firms have suspended their supply chains from Russia and the conflict region, creating need for rapid reconfiguration of their supply chains. (Srai et al. 2023, 290) This activity is called unhooking the supply chain, which Srai et al. (2023, 290) define as “the process by which firms suspend or permanently deactivate their supply chain assets from a geographical territory”. However,

this reconfiguration of supply chains has been mostly done by firms in Europe, the United Kingdom and the United States, while on the other hand firms in China, India, Turkey, Brazil and South Africa have continued trade in Russia, some even expanding operations (Srai et al. 2023, 290).

Furthermore, the situation in the Middle East is escalating, with the USA and Israel attacking Iran. The conflict is expected to have extensive effects on the global economy, oil prices, as well as supply chains, as flights are being cancelled, and cargo ships are being rerouted. (Yle 2026a; Yle 2026b; Maersk 2026.)

### 2.3.7 Cyber risks

In addition to the previously mentioned risk categories, cyber risks are important to analyze in this context. Geopolitical risks pose threats that can disrupt digital infrastructures and supply chains (Zheng & Gong 2024, 7), which is why cyber risks should also be considered when managing geopolitical risk. Cybersecurity is crucial for businesses, as digital assets are highly vulnerable to malicious intervention (Shukla et al. 2023, 5267). Geopolitical tensions have caused cyber operations and attacks that are aimed at weakening their competitors by stealing sensitive data or disrupting supply lines (Khan et al. 2025, 2). According to an insight report by the World Economic Forum (2026b), geopolitically motivated cyberattacks are the most significant factors influencing cyber risk mitigation strategies, with 91% of the largest organizations having changed their cybersecurity strategies as a response to geopolitical volatility. For example, in December 2025, there were massive cyberattacks in Poland's cyberspace, targeting numerous wind and solar farms, a heat and power plant, as well as a private company in the manufacturing sector. These attacks affected information systems but also physical industrial equipment. (Ministry of Digital Affairs, Republic of Poland.)

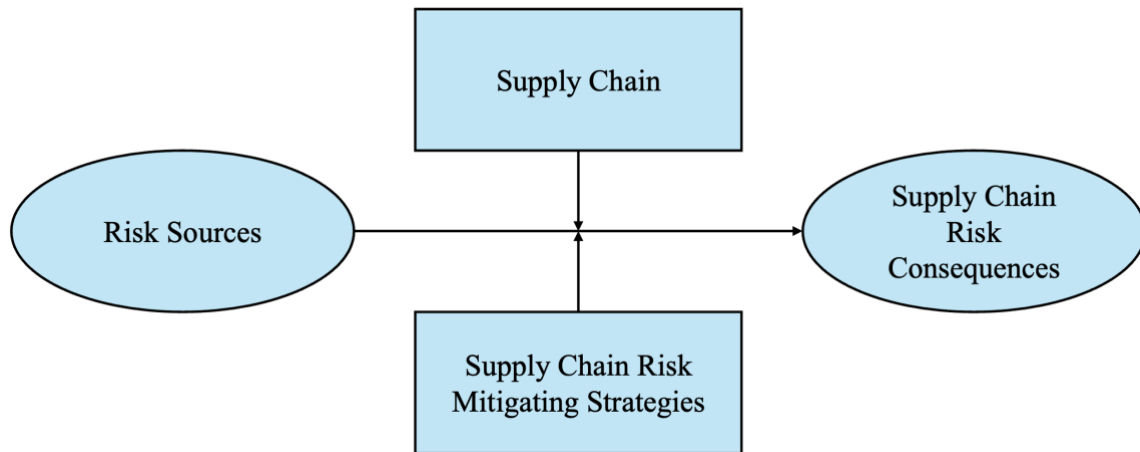
Supply chain cybersecurity is a relatively new concept, and a major challenge of it is the management of the different tiers of suppliers, as the failure of a lower tier supplier to protect itself from cyber threats may have significant indirect implications for the focal firm in the supply chain (Melnyk et al. 2022, 168; 178). Cyberattacks can cause disruptions on operations, which may lead to propagated negative effects on the entire supply chain. This risk is increased by high interdependence on supply chain nodes. (Sawik 2022; Shukla et al. 2023) The number of cyberattacks is increasing, while several companies that have been victims of an attack, have been unprepared (Handfield et al. 2025, 11). Furthermore, cyberattacks have become a significant source of risk for port operations (Tran et al. 2025, 2).

## 2.4 Managing supply chain risk

### 2.4.1 Processes and strategies

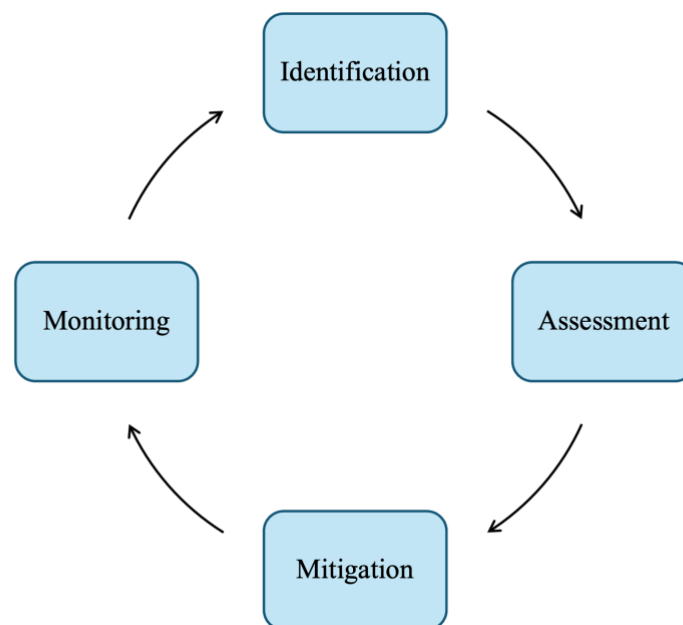
Supply chain risk has been defined in different ways by researchers (Ho et al. 2015, 5035). For example, Jüttner et al. (2003, 200) defined supply chain risks as “any risks for the information, material and product flows from original supplier to the delivery of the final product for the end user”, while Wagner and Bode (2006, 303) defined it as “the negative deviation from the expected value of a certain performance measure, resulting in negative consequences for the focal firm”. While the terms ‘risk’ and ‘disruption’ have been used interchangeably in this study, disruptions risks often refer more specifically to risks that are characterized as low-probability and high-impact (Dolgui et al. 2020, 1285).

While traditional risk management consists of the identification, analysis and control of risks, supply chain risk management extends the management of risks to the entire supply chain, adopting a cross-company perspective (Thun & Hoenig 2011, 243). In defining the concept of supply chain risk management, Jüttner et al. (2003, 199) identified four core constructs, which are visualized in Figure 1. Risk sources refer to uncertain variables that increase unpredictability, which arise from the interaction of the supply chain with its environment (e.g. terrorist attacks or earthquakes), the boundaries of the supply chain actors (e.g. strikes, machine failures), or the interactions between organizations within the supply chains, which are caused by inefficient coordination throughout the supply chain. Examples of the latter include implications related to the complexity of supply chains, lack of ownership, chaos, and the lack of responsiveness to changing environmental conditions. Supply chain on the other hand refers to the factors in the supply chain strategy that drive risk, while supply chain risk mitigating strategies aim to mitigate risk. Supply chain risk consequences summarize the consequences of a risk source, taking into account driving and mitigating forces.



**Figure 1** The basic constructs in SCRM (adapted from Jüttner et al. 2003)

The goal of supply chain risk management is to identify potential risks and take needed actions to manage them (Mital et al. 2018, 161). It is often categorized into four key processes: risk identification, risk assessment, risk mitigation and risk monitoring (Ho et al. 2015, 5061). The conceptual framework of the supply chain risk management process is shown in Figure 2.



**Figure 2** Conceptual framework of SCRM process (adapted from Ho et al. 2015)

*Risk identification* is the step of recognizing the events and phenomena that cause uncertainty in the environment, and it is crucial for being able to determine the needed actions for risk management (Hallikas et al. 2004, 52). El Baz and Ruel (2021, 8) highlighted the importance for risk identification

measures in improving the robustness and resilience of their supply chains, as it determines how the risk is assessed, mitigated and controlled and therefore defines the outcome of risk management practices. While traditional supply chain risk management searches for operational issues that could potentially turn into disruptions, firms are now also scanning their operational environments for risks that could originate from the context of the supply chain as well as sustainability issues that can cause reputational damage and adverse stakeholder reactions. Systemic addressing of the potential risks related to one's supply chains is the first step for being able to take proactive, improving actions. (Busse et al. 2026, 83.) Traditional methods however rely on supplier scorecards, and they are ineffective for risk mitigation purposes, as their estimations of the future are based on historical data. Instead, newer supplier monitoring systems anticipate risks in advance, by screening market signals and predictive risk metrics. These systems can continuously follow a supplier's risk probability index, which have been proven extremely effective in for instance predicting bankruptcy. (Gao 2015, 136.) This is important, as companies often realize the vulnerability of their supply chain only after a disruption occurs (Bier et al. 2020, 1835). AI (artificial intelligence) adoptions, such as Large Language Models (LMMs) have recently been researched as new methods for supply chain risk identification (Fang et al. 2026).

Risk identification is followed by *risk assessment*, where the identified risks are assessed and prioritized in terms of likelihood and impact, to be able to determine the correct risk management actions (Hallikas et al. 2004, 53). While it is difficult to measure or quantify the likelihood of a risk precisely, it is crucial to assess the identified at least in a qualitative way (Thun & Hoenig 2011, 244). One possibility for quantifying the impact of a risk, is focusing on the financial impact, through estimating the longevity of the effect on deliveries, and the financial impacts cumulated in that time. (Norrman & Jansson 2004, 446.) AI adoptions have been researched for risk assessment as well. For instance, Quan et al. (2026) have developed a LLM model for risk assessment that understands the unstructured sources of data such as news narratives or social media feeds, whereas traditional risk assessment frameworks rely on structured data, such as crime rates, bankruptcy and strikes. Its strengths are in capturing the context, interdependence and fast-evolving nature of disruptions. As the company, its environment, and the risk factors change, the identified risks need to be monitored (step 4) to notice any changes in their likelihood or consequences and therefore reassess them (Hallikas et al. 2004, 54).

For the third step of the process, both terms *risk mitigation* and *risk management* have been used in the literature (Ho et al. 2015; Manuj & Mentzer 2008; Jüttner et al. 2003). Supply chain risk management strategies are often divided into six categories: "postponement, speculation, hedging,

control/share/transfer, security, and avoidance” (Manuj & Mentzer 2008, 206). Definitions of these strategies are summarized in Table 2.

**Table 2 Supply chain risk management strategies**

Strategy	Definition
Postponement	Delaying some of the activities in the supply chain until receiving customer orders, to avoid building up inventory of final products, and enable product finalization or customization according to customer preference (Van Hoek 2001, 161)
Speculation	“Maintaining inventory of finished products, making manufacturing and logistics decisions based on anticipation of customer demand, with the goal of reducing unit costs through economies of scale.” Opposite approach to postponement. (Manuj et al. 2014; Pagh & Cooper 1998)
Hedging	“Having a globally dispersed portfolio of suppliers and facilities such that a single event will not affect all the entities at the same time and/or in the same magnitude” (Manuj & Mentzer 2008, 208)
Control/share/transfer	“Controlling, sharing or transferring risks through vertical integration, contracts and agreements” (Manuj & Mentzer 2008, 209)
Security	Encompasses information systems security, freight breachers, terrorism, vandalism, crime and sabotage. Aimed at increasing the ability of a supply chain to identify unusual elements, and working with governments to proactively comply with regulations and avoid delays at border-crossing points (Manuj & Mentzer 2008, 210)
Avoidance	Driving probabilities associated with risk events of a decision to zero by ensuring it does not exist (i.e. exiting through divestment) or preempting adverse events (i.e. auditing). Used when risks associated with a specific market or supplier are considered unacceptable. (Manuj & Mentzer 2008, 210)

The effectiveness of a selected risk management strategy is affected by supply chain conditions. Managers should also consider both the advantages and disadvantages of the different strategies when making the selection. (Manuj & Mentzer 2008, 216.) Some challenges in implementing sufficient supply chain risk management relate to the underestimation of the likelihood or impact of risks, lack of familiarity with appropriate risk management instruments and the difficulty of quantifying the benefits of risk management (Thun & Hoenig 2011, 244). The different supply chain risk management strategies often co-exist and gradually change over time as supply chain uncertainty reduces. For example, a firm may start with a wait-and-see strategy, while simultaneously employing reactive and proactive strategies, with the focus gradually moving to the latter. (Roscoe et al. 2020, 1522.)

The last step of the process is *risk monitoring*, which has received the least attention in literature. It is however a crucial step, as an early warning monitoring system aids the execution of a robust risk prevention system that is more cost-effective than risk mitigation in practice. (Ho et al. 2015, 5061.) Norrman and Jansson (2004, 449) suggested that risk monitoring is needed, if the assessed risk level

is very high, or high and not mitigated. Additionally, if the residual risk level after mitigation actions is not acceptable, it should remain monitored. A dilemma of supply chain risk management is having formalized processes and integrated resources, that are still capable of being adaptive (Norrman & Wieland 2020, 663).

Supply chain integration is defined as strategic interconnectedness and alignment with its suppliers and customers, which supports the smooth and efficient flow of goods through the supply chain, while providing access to resources and capabilities of the supply chain partners, without having to possess those internally (Schoenherr & Swink 2012, 99). Kauppi et al. (2016, 493) found that supply chain integration actions and traditional supply chain risk management practices combined are effective in managing exogenous disruption risks. It is crucial to be aware of the external environment of where one's supply chains are located, and to take actions to manage the exogenous risks along the supply chain.

#### 2.4.2 Supply chain resilience

Traditionally, supply chain risk management is thought of as keeping safety stocks and lead time buffers, but today's highly globalized and digitalized world the focus has shifted to having a resilient supply chain to mitigate risks (Mital et al. 2018, 159). The increase of geopolitical risk has had significant adverse impacts on supply chain resilience (Chang et al. 2025, 7). Resilience was defined by Christopher and Peck (2004, 2) as "the ability of a system to return to its original state or move to a new, more desirable state after being disturbed". The characteristics of a resilient global supply chain include agility, adaptability and effective coordination, and with these capabilities, it can withstand unexpected external impacts and recover quickly to its normal way of operating (Chang et al. 2025, 2). The need for efficient, but simultaneously resilient supply chains has grown as supply chains have been impacted by different kinds of disruptions (Kamalahmadi & Parast 2016, 116).

Lee (2004) argued that top-performing supply chains possess three distinct qualities: agility, adaptability and aligned interests. A supply chain with these qualities react quickly to sudden changes in demand or supply, they adapt over time with respect to changing market structures and strategies, and they have aligned interests with all the firms in the supply network, resulting in all partners optimizing the supply chain. In the instable business environment caused by geopolitical tensions and shifting economic powers and such, supply chain adaptability is essential (Phadnis 2023, 24). While a resilient supply chain is more likely to be able to withstand unexpected shocks, high geopolitical uncertainty can undermine these characteristics (Chang et al. 2025, 2). A combination of different

strategies is needed to build supply chain resilience during geopolitical disruptions (Duong et al. 2025, 1107).

Digitalization of the supply chain can have benefits on supply chain resilience (Zouari et al. 2020, 172). A digital supply chain utilizes digital hardware and software in a way that makes operations more valuable, agile and effective while supporting interaction between organizations. Digitalization can for example make delivery of goods quicker and the real-time inventory and management of stock more efficient. It can improve the proactivity of supply chains, by identifying issues quickly or prior to their occurrence, also increasing the flexibility of the supply chain. (Büyüközkan & Göçer 2018, 165-166.) While digital supply chain tools improve supply chain resilience, Zouari et al. (2020, 172-173) emphasized the importance of digital maturity, both for successful adoption of digital supply chain tools, but especially for supply chain resilience capabilities themselves. Furthermore, AI technologies have shown to be effective in improving supply chain resilience, especially in the manufacturing industry. An example of this is the adoption of AI-based scenario modelling used in anticipation of disruptions and the dynamic adjustment of supply chain operations, or the use of machine learning models to optimize inventory levels when exposed to different types of uncertainties. (Zaoui et al. 2025, 2438.) Similarly, Wu et al. (2025) found that AI investments can provide substantial benefits for supply chain optimization and diversification, especially by reducing coordination costs and improving information transparency.

### 2.4.3 Mitigating geopolitical risk

Handfield et al. (2020) argued that the massive forces of economic disruption in the past years overshadow the small and subtle changes, often aimed at negotiating better contracts with suppliers or optimizing cost, making their effects marginal. Furthermore, the focus on cost efficiency and just-in-time approaches might not fit supply chains operating in an unstable environment, as these types of supply chains are prone to break during disruption (Kovács & Sigala 2021, 46).

Geopolitical risks should be integrated into supply chain risk management frameworks and firms should proactively prepare for potential disruptions, aiming to mitigate their impacts. At the same time, it was revealed that higher operational capabilities and resources, such as firm resilience, operational slack and cash holding can improve adaptability and therefore help stabilize the supply chain under geopolitical risk. In practice, these factors can reduce the need for substantial and costly changes in supply chain's during times of disruption. (Zhu et al. 2024, 1056-1058) Furthermore, the ripple effects of supply chain disruption at the supplier can be mitigated by higher resilience capacity, including higher safety stock, enhanced supply chain visibility and quicker response plans (Li et al.

2022, 1119). Based on the found impacts of the Ukraine war on maritime supply chains, Chen et al (2025, 8) recommend designing “alternative shipping routes, enhancing port redundancy, and advancing logistics digitalization to increase supply chain resilience against future disruptions.” In addition to increasing inventory at own facilities, it is beneficial for a supplier to have inventory during disruption. Moreover, first-tier suppliers can bridge the benefits of inventory slack from the second-tier supplier to the focal firm. (Durach et al. 2024, 1277.)

As a result of geopolitical tension and increased vulnerability, firms have recently begun friendshoring their supply chains (Deng et al. 2025, 1). While reshoring, also referred to as ‘reverse offshoring’, covers the relocation of value chains back to its original location (Martínez-Mora & Merino 2014, 225), friendshoring is related to moving value chains to politically affiliated countries (Deng et al. 2025, 1). Contrary to prior assumption, Bai et al. (2025) found that when geopolitical risk in a country is high, politically affiliated countries increase their number of suppliers in that country, with the goal of seizing a perceived opportunity rising from the uncertainty. On the opposite, countries with low political affiliation decrease their number of suppliers due to perceived threat. However, Charpin and Cousineau (2025, 1023) pointed out the challenges of friendshoring, related to the uncertainty of the longevity of perceived “friendship”, and that while they decrease dependence on one country, they might end up merely moving it to a different one, instead of eliminating the dependence. Another finding of their study is that as firms reduce their foreign tier-1 supply bases, the pool of potential tier-2 suppliers decreases and hence leads to supplier sharing on tier-2. This leads to increased dependence on a smaller number of suppliers, which spreads the effect of a potential disruption. (Charpin & Cousineau 2025)

On the other hand, some have recommended redundancy, instead of reshoring, as a strategy to improve the resilience of supply chains that have become increasingly fragile as a result of globalization and the reduction of inventories (Gereffi 2020, 296). Redundancy in supply chains can be achieved through having multiple suppliers, safety stock, overcapacity and backup suppliers, for instance (Kamalahmadi et al. 2022, 1993). The weakness of redundancy as a strategy for supply chain resilience is that it increases total fixed costs due to investments into additional assets but provides no benefit to the system unless a disruption occurs (Mackay et al. 2019, 1550). Flexibility is another popular strategy for improving supply chain resilience (Yang et al. 2024, 1), which focused on the ability of a supply chain to adapt and adjust to a disruption rapidly (Han et al. 2020, 4547). Kamalahmadi et al. (2022) proposed a hybrid model combining capabilities from both redundancy and flexibility practices to improve resilience towards disruption risks.

Diversification has long been a significant topic in management on many different fields of research, such as financial economics and marketing. While the idea remains the same, the practical conceptualization and definition varies in different fields. (Ramanujam & Varadarajan 1989, 523-524.) In this study and context, the definition by Wang et al. (2024) is applied. Wang et al. (2024, 103) defined supply chain diversification as “the extent to which a firm strategically diversifies its product types and supplier and customer base to hedge potential or existing supply chain risks”.

Zhu et al. (2024, 1056-1058) found that firms can reduce the impacts of geopolitical risks on their supply chains by strategically diversifying their supply chain, as it reduces dependence on an individual supplier. The supply base should be regularly analyzed and the need for diversification should be assessed. Higher dependence on a single supplier also puts the buyer at risk for forward propagation of disruption, meaning that a disruption at the supplier may lead to negative impacts at the focal firm (Li et al. 2022, 1119). Supply chains can be diversified in terms of suppliers, product lines, or geographical locations, which is crucial in mitigating risks arising from geopolitical tensions and disruptions (Lee & Baek 2025, 3-4). Charpin (2022, 18) recommended firms to identify key supplies and consider dual sourcing, or moving supply in-house or to a different country, as well as piling up inventory, as they foresee increasing economic nationalism in their or a supplier’s home country. Charpin and Cousineau (2025, 1023) urge firms to acknowledge the political environment beyond the countries of theirs and their suppliers, as potential effects extend further.

Kahiluoto et al. (2020, 285-286) argued that contrary to prior beliefs, diversity of supply base in itself does not enhance resilience, but it is specifically diversity in response to uncertainty and disruption that achieves the benefit. Furthermore, this diversity in response must exist within a purchase category, amongst suppliers delivering components with similar functions. This type of diversity may however show for instance as diverse locations or firm sizes of suppliers, where they are expected to respond to or be influenced by uncertainties and disruptions in different ways. Furthermore, it should be noted that due to factors such as quality requirements, technological specifications or geographical restrictions, diversification and dual sourcing is not always a feasible option. In these situations, increasing supply chain visibility through information sharing is an example of an alternative strategy for risk mitigation. (Yoon et al. 2020, 1364.)

While firm-level capabilities and strategies are addressed in supply chain resilience, institutional theory adds the perspective that these actions are considerably affected by government policies (Lee & Baek 2025, 6). Lee & Baek (2025, 18) highlighted the effectiveness of a cooperative approach between firms and the government using South Korea as an example. Actions taken by the South

Korean government to support firms include for instance, identification of critical items within the supply chain, establishing monitoring systems, offering financial assistance for overseas manufacturing and improving communication with relevant countries to prevent supply chain disruption. Based on findings from the disruption impacts of Covid-19, El Baz and Ruel (2021, 9) argue that more network collaboration and inter-organizational sharing of resources and capabilities are needed, to prepare for different disruptions impacts scenarios that cannot be mitigated by a single firm. On the other hand, Choksy et al. (2025, 11) found that supplier capabilities do not significantly improve resilience when the political environment is volatile.

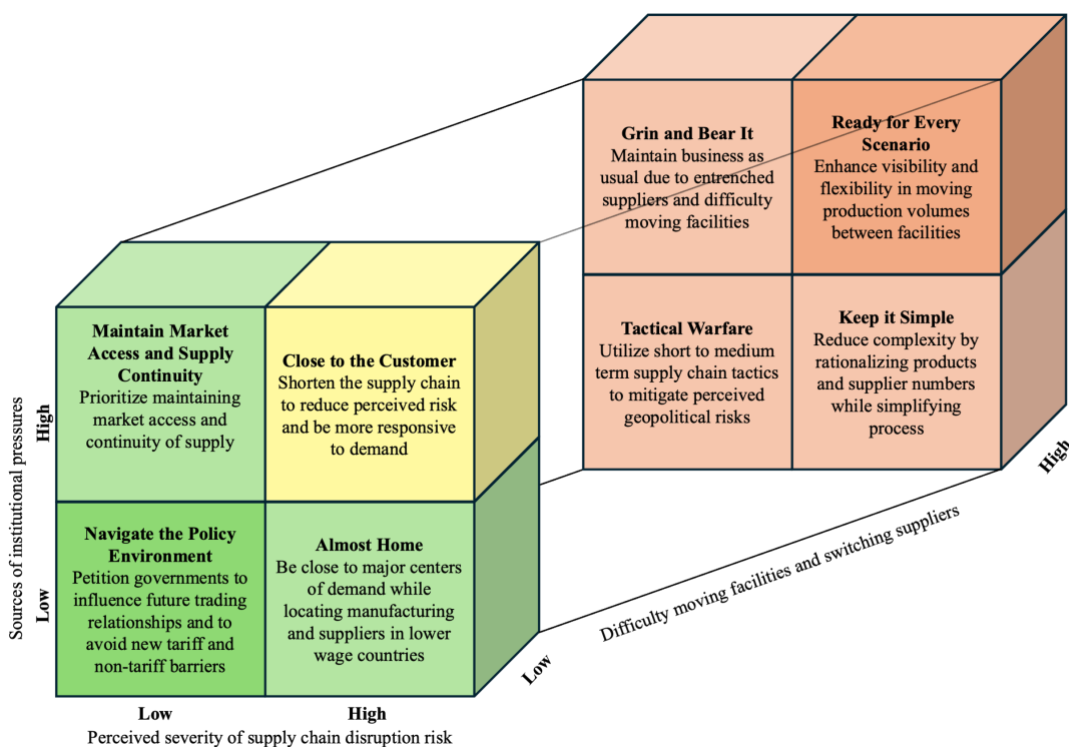
Another factor to consider are regulations posed by the European Union, and such. For example, as part of its conflict management policies, the EU aims to restrict trade in conflict resources (Vlaskamp 2019, 407). In 2017, the European Parliament and the Council of the European Union established a system for supply chain due diligence concerning trade of tin, tantalum and tungsten, their ores, and gold from conflict-affected and high-risk areas. The revenue of these minerals in conflict-affected and high-risk areas can finance and therefore support the continuation of violent conflict, as well as abuse of human rights by armed groups and security forces in these areas. Union importers must adopt the due diligence in their supply chain policy, communicating it to suppliers and incorporating it into contracts and agreements with suppliers. Union importers are required to conduct documentation of import of these minerals, while also organizing third-party audits to inspect activities, processes and systems used to implement this due diligence and make recommendations to improve it. The regulation also obliges Union importers to enforce risk management processes to identify and assess risks of adverse impacts in their mineral supply chains, including a strategy to prevent and mitigate them. (Council of the European Union 2017)

#### 2.4.4 Decision making during geopolitical disruption

Moradlou et al. (2025) found that during geopolitical disruptions when choosing the location of manufacturing supply chains, managers prioritize undisturbed supply and flow of material across national borders and access to different markets, over low costs and improved infrastructure. Furthermore, they highlighted the view that when making these decisions, managers are often under uncertainty with incomplete information and tight timelines, which are conditions intensified by geopolitical disruptions. Roscoe et al. (2020, 1523) propose that managers could begin with a wait-and-see strategy only committing intangible resources as uncertainty in the supply chain is high and gradually add reactive or proactive strategies employing also tangible resources as supply chain uncertainty decreases. In the long-term, wait-and-see strategies are used to acquire knowledge, while

reactive and proactive strategies in the medium and short term are aimed at reducing the probability and severity of the supply chain disruption.

Additionally, Davarzani et al. (2015, 1580) studied the impacts of sanctions on supply chains and categorized the found risk mitigations actions based on decision making levels, which are strategic, tactical and operational. The strategic level includes actions such as localization of procurement, changing suppliers and shifting the share of suppliers. Tactical actions include changing the route of transport, utilizing intermediary companies to purchase parts and debit-based payment. Operational actions comprise of ways to complete a blocked transaction, including hiring alternative transport companies, changing the mode of transport and switching the bank in charge of financial transactions.



**Figure 3 Supply chain logics during geopolitical risk (Roscoe et al. 2022)**

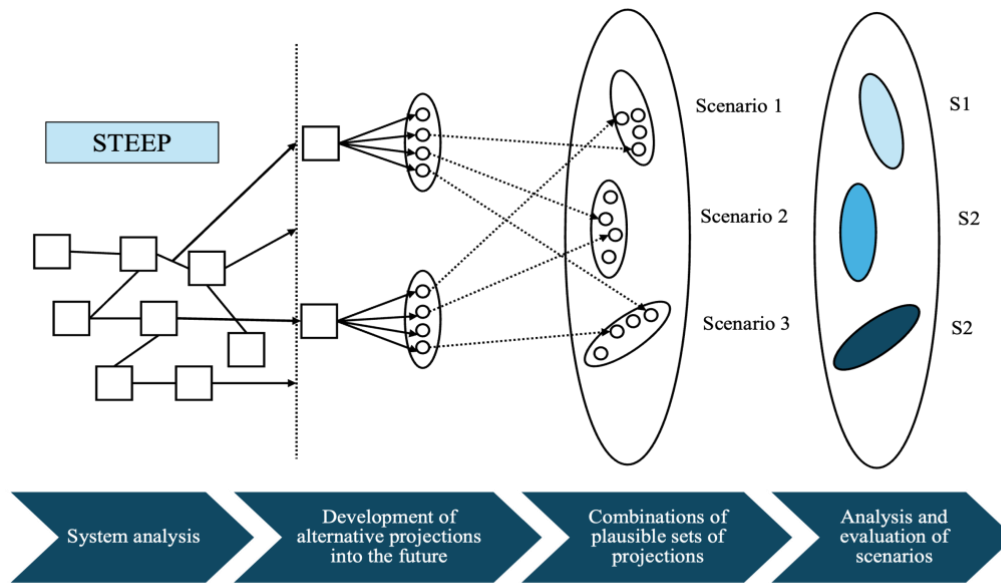
Supply chain logics is a construct developed by Roscoe et al. (2022, 1423) that is built on their finding that during geopolitical disruption, the forces influencing supply chain decisions are 1) the perceived intensity of institutional pressures, 2) the ease of moving suppliers and supply chain assets, and 3) the perceived severity of supply chain disruption risk. Figure 3 visualizes the different logics employed by supply chain managers, based on different combinations of the three identified forces. It is a system of reasoning employed by supply chain executives to navigate uncertain global operating environments. In this thesis, the dimension of “difficulty moving facilities and switching suppliers”

is especially important, as it arises as an important theme in the results from the case company and is also a relevant factor in the discussion of diversification as a strategy.

Perceived institutional pressures are related to expectations of customers, competitors, suppliers, trade associations and regulators to alter supply chain design during major geopolitical events. Perceived severity of supply chain disruption risk related to how managers rank different risks in severity, and how this perception differs between managers. Thirdly, the difficulty of moving suppliers and supply chain assets affects the willingness of managers to do such actions. Together, the different combinations of these factors (low vs. high) lead to one of the eight defined supply chain logics for decision making of supply chain managers during geopolitical disruption. (Roscoe et al. 2022.)

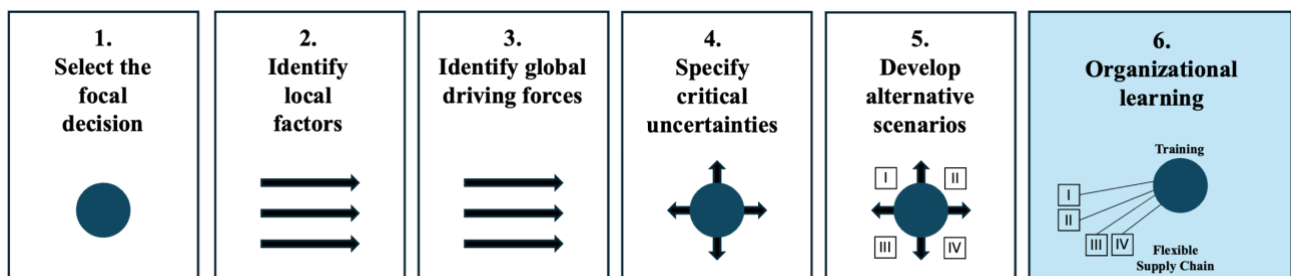
Scenario planning is a process used to explore several possible futures to support strategic decision-making under uncertainty (Linneman & Klein 1983, 94). Its use has been increasing for half a century, as a response to increasing uncertainty, interdependence and complexity that is a result of significant changes, such as globalization and changes in regulation (Schoemaker 1993, 193). The exploration of multiple views of the future aid in preparing for and being able to adapt to the different environments they could bring (Phadnis et al. 2015, 1401).

After defining the topic of study, the first step of scenario planning is the identification of current trends as well as internal and external factors that can affect the future environment. The STEEP (Social, Technological, Environmental, Economic and Political) approach can be used to find relevant trends that have varying plausible outcomes in the long term. The next step is to outline the different possible developments of the key trends and factors in the future. The different developments should vary from one extreme to another, for example in terms of likelihood, or the extent to which the development is positive or negative. After that, the outlined outcomes are combined in different ways to construct scenarios. As the last step of scenario planning, the scenarios are given descriptive names and supplemented with narratives of what its key characteristics are, how they differ from one another, and who are the winners and losers of each scenario. (Schoemaker 1993; Lorenz & Veenhoff 2013; Melkonyan et al. 2019.) The general scenario planning process is visualized in Figure 4.



**Figure 4 General scenario planning process (Lorenz & Veenhoff 2013)**

Scenario planning could be a useful tool for supply chain decision making as well (Joglekar & Phadnis 2020). Figure 5 summarizes the supply chain scenario planning process as explained by Joglekar and Phadnis (2020, 74). Step 1 contains selecting a focal decision that the organization can control and wants to find a solution to using scenario planning. In step 2, the scenario planning team focus on local factors that the organization can influence but not control. Step 3 focuses on global driving forces, which cannot be influenced by the organization, while in Step 4 they identify critical uncertainties from the perspective of the topic of study. In step 5, the specified uncertainties are used to construct potential scenarios. Finally in step 6, having developed these scenarios, the team can focus on organizational learning through actions that increase supply chain flexibility in light of the identified scenarios.



**Figure 5 Supply chain scenario planning (Joglekar & Phadnis 2020)**

Furthermore, Phadnis and Joglekar (2021) recommend collaborative scenario planning in dyadic teams between the buyer and the supplier to increase preparedness for future disruptions and

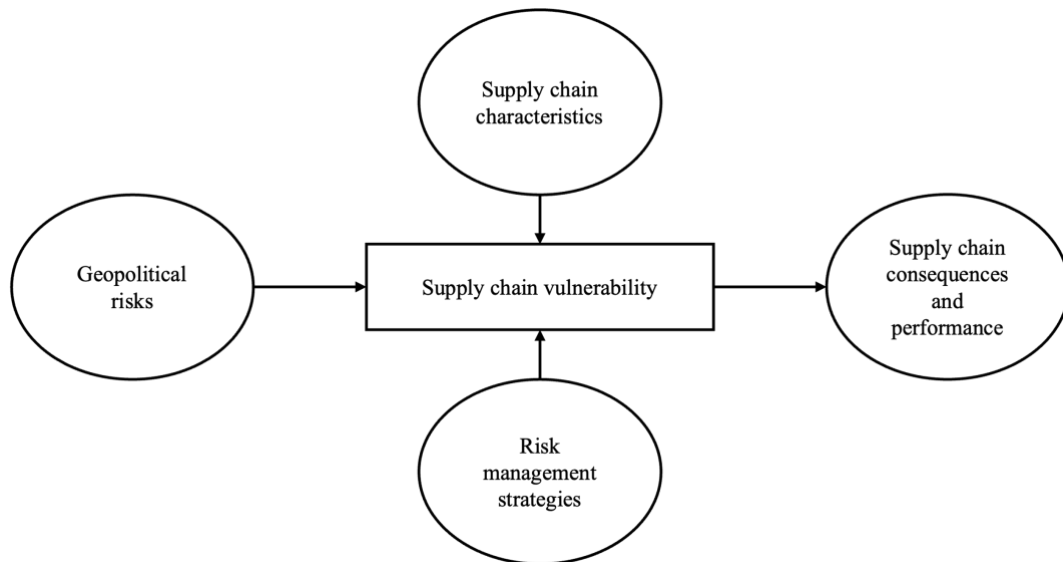
uncertainty related to abrupt regulatory changes. The benefit of collaborative work is that more driving forces for disruptions are recognized. Similarly, El Baz and Ruel (2021, 9) recommend inter-organizational cooperation to prepare for different disruption risks such as the Covid-19 pandemic, as the impacts cannot be mitigated by a single firm.

## **2.5 Synthesis of the theoretical framework**

This chapter summarizes the theoretical background of this thesis and builds a theoretical framework that leads to the empirical section of the study and its position in building theory. The literature highlights the increasing uncertainty in the global environment characterized by a variety of different kinds of geopolitical risks (Bednarski et al. 2025) that increase supply chains' vulnerability to a variety of propagating risks (Habibi et al. 2025). Today's supply chains are characterized by complexity, globalization and interconnectedness (Kamalahmadi & Parast 2016) which have exposed supply chains to a variety of disturbances, and in turn grown the importance of supply chain risk management (Shekarabi et al. 2025).

Six categories of geopolitical risks are identified (López et al. 2025) and additionally cyber risks are considered to be included in the geopolitical risks to be considered and the different kinds of impacts connected to each category of geopolitical risks are introduced. Based on the literature, globalization, complexity, interconnectedness (Kamalahmadi & Parast 2016) and the existence of multiple tiers of suppliers are recognized as the main supply chain characteristics increasing vulnerability. The GPR index (Caldara & Iacoviello 2022) is recognized as the most applicable tool for measuring geopolitical risk.

Adaptability (Zhu et al. 2024), redundancy (Gereffi 2020), friendshoring (Deng et al. 2025), alternative shipping routes (Chen et al. 2025), diversification (Lee & Baek 2025) and visibility (Yoon et al. 2020) were introduced as some of the most important methods for increasing supply chain resilience and mitigating geopolitical risk. Supply chain decision making was explored from the perspective of geopolitical risks, through understanding the different dimensions that affect decision making under geopolitical disruption (Roscoe et al. 2022). Scenario planning was discussed as a tool to explore the future to support decision making (Joglekar & Phadnis 2020).



**Figure 6 Theoretical framework (modified from Jüttner et al. 2003)**

The theoretical background of this study combines literature on geopolitical risks and supply chain risk management, which builds the theoretical framework of understanding how vulnerability of global supply chains is formed by the characteristics of supply chains combined with the risk management strategies implied, and how that vulnerability turns geopolitical risks into consequences on supply chains and their performance. The theoretical framework is summarized in Figure 6, which adapts the constructs in supply chain risk management developed by Jüttner et al. (2003), and geopolitical risk is explored as the risk source. The purpose of the empirical part of this study is to understand the relationship between the factors recognized in Figure 6, and to understand the most relevant geopolitical risks and how supply chain characteristics and risk management strategies can be formed to improve supply chain performance in the end.

## 3 Methods

### 3.1 Research approach

This chapter outlines the chosen research approach. After the presentation of the approach, the collection and analysis of the different types of data will be discussed. Finally, the evaluation of the research is discussed, followed by ethical considerations, including explanation of the use of AI in this thesis.

#### 3.1.1 Single case study

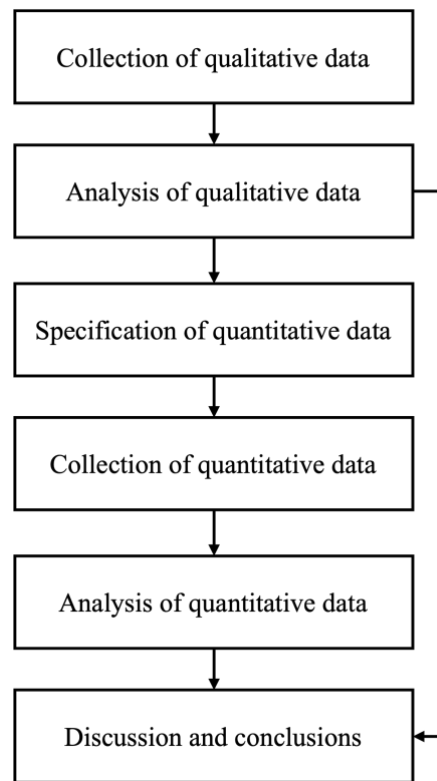
A case study is an intensive, highly focused approach that analyzes a case or cases that are considered meaningful evidence for the argument. A case is a spatially and temporally defined phenomenon that comprises the phenomena being studied. (Gerring 2016, 27-28.) Case studies can be further categorized into single case and multiple case studies (Yin 2003, 14) or alternatively, into intensive and extensive case studies (Eriksson & Kovalainen 2016, 133). Since this study focuses on one organization, it is classified as a single case study. The case study is an excellent approach, when the goal is to study a phenomenon within its real-life context, through asking “how” or “why” questions (Yin 2003, 1). It allows for holistic, in-depth knowledge gathering about the phenomenon in a specific context, using multiple sources of data, both qualitative and quantitative (Eriksson & Kovalainen 2016, 131-132). Furthermore, case studies allow for rich understanding of the phenomenon being studied, allowing the researcher to acknowledge the complexities and contradictions of real life (Flyvbjerg 2006, 237). It also adopts the approach of an intensive case study, as the goal is to understand the case from the inside, providing thick, contextualized interpretation instead of aiming to generalize and generate theory through the comparison of multiple cases (Eriksson & Kovalainen 2016, 133). This approach is natural for this study, as the goal is to investigate the problem holistically from the perspective of the case company, aiming to understand what kinds of risks are relevant for the case company, and how it could improve its resilience towards them. Furthermore, possible applications of the results are only aimed at other MNCs operating in the same industry, and theoretical generalization is not aimed for. However, this case could be considered a typical representation of a global manufacturing firm being impacted by geopolitical risks, which is one of the possible rationales for choosing the single case approach (Yin 2003, 41). A typical case must represent features that are common within a larger population, in this case other MNCs operating in similar industries (Gerring 2016, 56). While the findings of a case study cannot be formally generalized into theory, it has great potential to build knowledge in the field (Flyvbjerg 2006, 227).

The selection of the single case approach is also limited by the resources such as time required for multiple case studies (Yin 2003, 47). A good strategy for a case study allows the researcher to unfold the story with its many-sided, complex and conflicting findings from the actors involved in the study, which is this study is supported by the selection of differing supply categories, to understand the different views of people working with different kinds of supply chains (Flyvbjerg 2006, 238).

### 3.1.2 Mixed methods research

Mixed methods research combines two or more methodologies, most commonly qualitative and quantitative. Mixed methods provide a comprehensive, in-depth understanding of complex phenomena, by achieving complementary advantages of different research methods. (Roslyn & Xanthe 2023, 41-42.) The goal of mixed methods is to build a holistic picture of the subject, while widening the researcher's perspective to different types of interpretations. The results of mixed methods research may be unexpected and not aligning with prior understanding and theories, which encourages them to develop innovative solutions. (Hurmerinta-Peltomäki & Nummela 2004, 163.)

Mixed methods research can be categorized to three different types of research designs: convergent, embedded, and sequential designs. In convergent designs, multiple sets of data are collected and analyzed separately, until integration of the findings. In embedded research design, there is a primary research method, and another is included as a significantly smaller component of the study. Sequential designs on the other hand start with one method, the results of which directly impact the methodological approach of the second. (Roslyn & Xanthe 2023, 42.) The approach adopted in this thesis can be considered a sequential design, as the qualitative data is collected first, and utilized in formulating the hypotheses for a quantitative study, that tests these findings. Both sets of data will be analyzed separately, followed by an integration of findings to develop a rich description of the phenomenon studied. The sequential research process is shown in Figure 6.



**Figure 7 Research process**

Mixed methods may be used to build a theoretical understanding and findings using qualitative methods, followed by a quantitative study that test the validity of findings generated using qualitative methods. In a qualitative driven mixed methods study, the quantitative component serves as a supporting component to the qualitative study, taking an assisting role. (Hasse-Biber et al. 2015, 9-10.) In this thesis, qualitative methods are used to develop a deep understanding of the impacts and management of geopolitical risks in global supply chains. The qualitative findings combined with an extensive literature review are used to develop hypotheses, that are tested using quantitative methods. The role of the quantitative data is to quantify the extent to which geopolitical risks impact the supply chains of the participants. Additionally, the control variables of the quantitative data were chosen based on both the results of the interviews and the data accessible for this project. The inclusion of quantitative data was seen as necessary, as it was expected that without a full disruption of a supply chain, the case organization or the participants might not be aware of potential impacts of geopolitical risks.

Quantitative studies on the impacts of geopolitical forces on supply chains remain scarce in the literature (Charpin & Cousineau 2025, 1009), which motivates the use of mixed methods for this thesis. However, Chang et al. (2025) did a quantitative study using a global supply chain dataset to investigate the effect of geopolitical risk of supply chain resilience. They found that greater geopolitical risk is correlated with lower supply chain resilience. Instead, this thesis will investigate the correlation between geopolitical risk and the delay of a delivery, focusing on one case company. The quantitative data is supplementary to the qualitative data, in that its purpose is to quantify the impacts of geopolitical risk on the purchasing categories of the case company being studied. It also serves another purpose, which is to explore whether the GPR index could be an effective indicator for the case company to anticipate disruptions related to geopolitical risk.

The opportunity to use multiple sources of evidence is a major strength of a case study approach (Yin 2003, 97). The mixed methods approach enables both methodological and data triangulation. Data triangulation refers to the use of multiple different types of data, with the goal of gaining a comprehensive understanding of the phenomenon being studied. Method triangulation on the other hand refers to the use of multiple different methods of data collection and analysis. (Eskola & Suoranta 1998, 69-70.) In this study, triangulation is used by utilizing both qualitative and quantitative data, with different respective collection and analysis methods. Qualitative data is used to gain a deeper understanding of the phenomenon, and to understand the specific implications for the case being studied. Quantitative data is used to get a quantified measure for the impacts of geopolitical risk on the case company's supply chains, and the characteristics of supply that strengthen or weaken the potential correlation. Data triangulation can also address potential issues of construct validity in case studies, as the multiple sources of evidence provide multiple measures of the phenomena being studied (Yin 2003, 99).

## **3.2 Data collection**

### **3.2.1 Qualitative data**

Interviews are one of the best sources of information for a case study (Yin 2003, 89). Semi-structured interviews use a predefined list of open-ended interview questions, where the interviewee can answer based on their own words, whereas in a structured interview, the answer options are often the same for each interviewee (Eskola & Suoranta 1998, 87). In this study, the same list of interview questions is used for seven interviewees due to the similarity of their roles, but the form of questions is slightly modified for the eighth interviewee due to the slight difference in their role. Interviewees 1-7 all work for an assigned purchasing category, either as a category manager or a strategic purchaser, while

interviewee number eight manages the supply management for a specified region and is therefore not working with suppliers as directly as the others but provides a picture of the risks related to supply chains in their assigned region. Due to the qualitative nature of the interviews, the participants were selected purposefully based on expected knowledge about the research topic and richness of the data to be collected, instead of using sophisticated sampling methods (Eriksson & Kovalainen 2016, 53). To gain rich data, it was important to have participants from different kinds of purchasing categories with different supply bases. This study has focused on five global supply categories. In the case company, supply management is divided into global and local categories. Global categories are divided according to component type and respective suppliers, and they are responsible for the supply of the assigned components globally. When suppliers are shared between two or more categories, the responsibility of said supplier is assigned to the category with highest spend.

A matrix of different types of characteristics were defined, in order to select the categories to be studied in a structured and systematic way. These characteristics are listed in Table 3.

**Table 3 Initial list of characteristics for category selection**

Characteristics	Category 1	Category 2	Category 3	Category 4
Location / distance	Global	Nearby (Europe)	Global / Asia	Nearby (Europe)
Lead times	Long	Medium / Long	Varied / Short	Short
Forecasting	Good	Good	More difficult	Difficult
Spend	High	High	Medium / Low	Medium / Low
Steps in SC	High	Medium	Medium	Low
Volume	Low	Medium	Medium	High
Number of suppliers	Low	Medium	Medium	High

The selection of differing categories supports the richness of the findings. The inclusion of different kinds of categories provides insights from different geographical areas and product markets, as well as different supply chains that are influenced by differing lead times, volumes and such. The initial characteristics for selecting categories were created to guide the selection of the categories. Four initial categories were chosen based on the predefined characteristics. The fifth category was chosen with the snowball method, based on recommendation of one of the interviewees who expected that they would have relevant input for the topic of this study. The final matrix for selecting categories was decided based on available quantifiable data, which are shown in Table 4. The main indicators used for selecting the categories were spend and lead time. First, the categories were divided based on lead times. Two categories with high lead times (A and B), that differed in spend were selected.

**Table 4 Revised list of characteristics of selected categories**

Characteristics	Category A	Category B	Category C	Category D	Category E
Number of countries	Low	Low	Medium	High	High
Lead times	Long	Long	Medium	Medium	Short
Spend	Low	High	High	Medium	Medium
Volume	Low	Low	Low	Medium	High
Number of suppliers	Low	Low	Medium	High	High

Next, two categories with medium or short lead times that differed in spend were selected (C and E). Category D was selected later using the snowball method, based on suggestion of an interviewee in category C. Other characteristics (as shown in Table 4) were gathered after the selection of the categories. Forecasting and steps in supply chain were left out, as there was not a clear way to quantify these characteristics. Location was substituted by the number of countries in the supply base due to clear quantifiable measure. At the end, the study included five categories which all possess different combinations of the measured characteristics. The eighth interviewee was contacted for the purpose of reaching saturation, as they provided valuable insights into a specific geographical area. This interviewee's category is named X in this study.

As recommended by Hirsjärvi and Hurme (1991, 87), the interviews began with broader and simpler questions, moving on to more specific questions as the interview proceeded. With broad and open-ended questions, the participants were encouraged to approach the topic from their preferred perspective, motivating genuine and interesting answers. The list of interview questions is found in Appendix 1, and details of the interview participants are shown in Table 5.

**Table 5 Interview details**

Interviewee	Category	Duration	Timing
Interviewee 1	B	34min	November 2025
Interviewee 2	B	41min	November 2025
Interviewee 3	E	53min	November 2025
Interviewee 4	E	56min	November 2025
Interviewee 5	A	35min	November 2025
Interviewee 6	C	42min	November 2025
Interviewee 7	D	49min	December 2025
Interviewee 8	X	1h 12min	December 2025

The interviews were held via Teams, in English or Finnish. The interviews were recorded, and Teams Copilot was used to transcribe the interviews. The accuracy of the transcriptions was verified with the help of the recordings.

### 3.2.2 Quantitative data

The quantitative data used in this thesis is secondary, as it was initially collected for other purposes (Saunders et al. 2023, 342). The purpose of the quantitative data in this study is to give more insight into the impacts of geopolitical risks on supply chains, through analyzing the correlation between the GPR index and delay of a purchase order. Additionally, it can be used to investigate whether the GPR index could be used to identify and assess geopolitical risk at the case company. The quantitative data is collected from two different sources. The country specific GPR Index data is collected from Caldara and Iacoviello's website, where the data is openly available to download (GPR Index). The data types and their sources can be seen in Table 6.

**Table 6 Data sources**

Name	Description	Source
Delivery data	Purchase order data, including PO creation date, actual delivery date, lead time (agreed, requested, confirmed and delivered), category number, supplier number, and Incoterm®	Case company reporting tool
Supplier countries	Supplier numbers and countries	Case company reporting tool
GPR Index	Global and country-specific GPR indexes	Caldara and Iacoviello

The main body of the data is the delivery data file, which has approximately 350 000 lines of data. After defining the data needed, a data expert at the case company was contacted to support with finding the best source to extract the data from. After deciding on a specific report, all default filters were first cleared, and then the application of filters was reconsidered. Most of the filters remained cleared, but six filters were applied to the data: category (only the 5 selected categories used), direct materials (indirect materials filtered out), date error (lines with error excluded), cost center (special PO's without direct purchase of a material), test orders (new unvalidated materials) and material group (irrelevant material groups, such as travel and documentation excluded).

### 3.3 Data analysis

#### 3.3.1 Qualitative data

The qualitative and quantitative data were first analyzed separately and integrated later in the findings and discussion step. The qualitative data analysis was approached with content analysis, which aims to analyze the content and meanings in the qualitative data (Eriksson & Kovalainen 2016, 119).

The first step of analyzing qualitative data is typically thematization. The goal of thematization is to find the themes in the data relevant for the research problem, and to analyze the occurrence of them throughout the data. Thematization is often done by distinguishing different themes in the data and organizing quotes relevant for each theme. (Eskola & Suoranta 1998, 175-176.) With thematization, it is possible to find a collection of different answers and findings for the presented questions (Eskola & Suoranta 1998, 180). The thematic analysis of the interview data followed the phases of thematic analysis defined by Braun and Clarke (2006).

As the first step of thematization, the researcher read all the transcriptions and stated coding main themes that occurred in the text. The themes in thematic analysis can be derived inductively from the data, or deductively from the theoretical framework (Braun & Clarke 2006, 83). A combination of these strategies was employed, as major themes were derived from the theoretical framework, but some themes or subcategories of themes were also identified while reading the data. Most of the identified themes aligned with the research and interview questions, but there were also some themes that emerged from the text, such as barriers and challenges related to implementing certain risk management actions that were identified as impactful. After reading and roughly coding each interview, following themes were identified from the data. Table 7 presents the operationalization table, which shows the identified themes and sub-themes, and how they connect to the research questions. Furthermore, it notes the interview questions related to each theme, as well as the chapter numbers containing the analysis of each theme. The list of interview questions is found in Appendix 1.

**Table 7 Operationalization table**

Research question	Sub questions	Themes	Sub themes	Interview questions	Analysis chapter
RQ: How geopolitical risks could be managed in maritime and energy sector global supply chains?	SQ1: What types of geopolitical risks typically affect global supply chains in the maritime and energy sector and how?	Characteristics of the category	Supply base Products Forecasting Visibility to the 2 <sup>nd</sup> tier Lead times Supplier selection Transportation	1 7 14 15	4.1.2
		Geopolitical risks	Defining concepts Geopolitical risks now Operating in the turbulent environment	2 5 16	4.1.1
		Impacts of geopolitical risks	Potential impacts of geopolitical risks Impacts of geopolitical risks in the past Measuring impacts	3 4 6	4.1.2
	SQ2: What risk management strategies can be used for managing geopolitical risks in the maritime and energy sector?	Risk management processes	Risk identification process Risk assessment process Risk management tools	10 11	4.1.3
		Managing geopolitical risks	Management of past geopolitical events Consideration of geopolitics in long term plans Strategies for managing geopolitical risks	8 9 12 13	4.1.3
		Barriers to implementing identified risk management strategies	Limitations in the supplier market Purchasing power Justification of choices Speculation	15	4.1.3
		Support from the organization	Information sharing Identification of future risks	17	4.1.3

After the themes were identified and refined, the researcher started analyzing each theme based on data gathered from all interviews (Braun & Clarke 2006, 92). A separate document was created for this step, which listed all of the themes. After that, each theme was analyzed from the original coded documents, and main ideas from all the interviews were listed under the theme. The last step of the thematization process is producing the report (Braun & Clarke 2006, 93). Using the gathered data

analysis document, the analysis was written up in the findings chapter. If additional details were required, the researcher referred to the coded transcription documents.

### 3.3.2 Quantitative data

The quantitative data analysis was conducted as a quasi-experimental impact analysis, including a group analysis using t-tests and crosstabulation, and a simple regression model to estimate the magnitude of the effect. The quasi-experimental approach aims to identify the causal effects from specific events or situations and estimate the features of the causal relationship (Angrist & Krueger 1999, 1280). In the quasi-experimental framework, causal relationships are explored by comparing groups that are not randomly selected but act as suitable comparison groups. They explore an exogenous source of variation, in this case the GPR index. Analyses may include for instance analysis of the mean difference between the groups. A weakness of the design is that the results may not be generalizable to other firms or groups. (Meyer 1995.)

The purpose of the quantitative analysis is to support the qualitative data by examining whether there is a correlation between the GPR index and the delay of a delivery. The unavailability of components was noted as the worst outcome of a risk, which is why the indicator being measured is delay of a delivery. It is analyzed as delay in days, and also with a binary OTD (on-time delivery) variable, which defines the delivery as on-time or late, based on the requested delivery date of an order.

After combining the different sources of data into one master file, the data were grouped to low and high months of geopolitical risk, according to both the country-specific and global index. The grouping was done into two groups of equal size, based on the median value of each index. All the remaining analyses were ran for all groups, to examine the differences in the mean value of the group with low GPR and high GPR, separately based on the country-specific and global GPR index. The separation of the country-specific and global GPR allowed the exploration of whether there is a difference in the impact of local and global factors. Furthermore, the investigation was done for the whole sample, as well as split by category and Incoterm®, to explore where the impacts are most significant. The split between categories was done to understand if either local or global geopolitical risks are especially significant for some categories. The split between Incoterm was done to explore the significance of transportation, as when Incoterms® with extended seller responsibility such as DAP (Delivered at Place), DDU (Delivered Duty Unpaid) and DDP (Delivered Duty Paid) are used, the lead times used in this study include the transportation time as well, whereas when Incoterms® such as FCA (Free Carrier) and EXW (Ex Works) are used, where responsibility is moved to the buyer at an earlier time (supplier premises or port for instance), lead time includes only the

manufacturing or assembly time of the product. The analyses were done using SPSS, and a table containing the sample sizes of each group (category and Incoterm®) for each GPR group can be found in Appendix 3.

### 3.3.3 Mixed methods: Integrating the data

Integrating qualitative and quantitative data is a core challenge in mixed methods research (Åkerblad et al. 2021, 152). In this study, the qualitative and quantitative data were analysed separately with methods suitable for each type. The integration of these results took place in the discussion section of this study, where connections were made between the results to gain a comprehensive understanding of the topic. While the qualitative data was used to answer both sub questions, the quantitative data was mainly used to answer the first sub question related to the impacts of geopolitical risks. Still, it did provide some insights for the risk management perspective as well, especially in the analysis of the effect of lead time buffers.

The discussion of results was approached through the research questions, and findings from each type of data were brought in whenever they provided insights. This was a reiterative process where findings of each data type were viewed repetitively, in order to draw conclusions from the different insights. Still, the process was quite straight-forward, as both data were originally approached from the perspective of the research questions. When reporting the findings to the impacts of geopolitical risks, the findings from each type of data were compared. The potential contradictions in the findings provided valuable ideas in analysing the overall results to the research question. While qualitative data was especially valuable in understanding the ways in which geopolitical risks have or could impact supply, the quantitative data revealed the characteristics of the groups most or least impacted in each scenario.

## 3.4 Evaluation of the study

### 3.4.1 Qualitative data

Since this study employs a mixed methods approach, it is crucial to separately evaluate the trustworthiness of the study for both qualitative and quantitative data, as the criteria developed for evaluating quantitative do not fit qualitative research projects, and vice versa (Eriksson & Kovalainen 2016, 304). In qualitative research, the researcher needs to continuously consider the trustworthiness of their research throughout the collection and analysis of data, as the challenge of separating the evaluation of trustworthiness from the analysis of the data is not as clear as in quantitative research. (Eskola & Suoranta 1998, 209.) The acknowledgement of the researcher's subjectivity and role as a

research tool is in the core of evaluation in qualitative research, and the evaluation needs to consider the whole research process (Eskola & Suoranta 1998, 211). The significance of trustworthiness is the convincing of the audience of the fact that the findings of a study deserve attention. (Lincoln & Guba 1985, 290). The trustworthiness of this study is evaluated using Lincoln and Guba's (1985) criteria, which calls for analysis of the credibility, transferability, dependability and confirmability.

The *credibility* of a study refers to internal validity, which is concerned with the extent to which the findings are accurate and represent reality. It is focused on techniques that support the likelihood of producing credible findings and interpretations. The techniques include prolonged engagement and triangulation, amongst others. Prolonged engagement refers to the length of the researcher's involvement in the topic being studied. In addition, it involves building trust, by demonstrating to the research participant that the results will not be used against them. (Lincoln & Guba 1985, 290; 301-303.) In this study, prolonged engagement is supported by the researcher's involvement in the case organization, enhancing better understanding of the research context and topics being studied. Furthermore, sufficient information about the purpose of the study was provided to the interview participants beforehand, to build trust between the researcher and the participants. Furthermore, methodological triangulation was used to increase the likelihood of making credible interpretations. Triangulation by different methods refers to using multiple different methods for data collection and analysis (Lincoln & Guba 1985, 305-306.) In this study, both qualitative and quantitative data was collected, to find meaningful interpretations by combining people's experiences on the topic being studied, and exploring correlations found in quantitative data. Additionally, other qualitative data, such as annual reports from the case organization were utilized to give organizational perspectives and purpose to the study.

*Transferability* refers to the extent to which the results can be generalized to other settings or contexts. To make it possible for other researchers to consider the transferability of the results in other context, it is crucial to provide sufficient information about the context of the study and data collected. (Lincoln & Guba 1985, 297-298.) To support transferability, information about the case organization and the interview participants was provided with as much detail as possible while still maintaining anonymity. Furthermore, interview participants were selected based on defined criteria, to ensure perspectives of different types of supply chains and product categories, to not limit the findings to any specific characteristics, but yet maintaining comparability. For the subject of study, it was crucial for the interviewees' purchasing categories to vary especially in the supply bases' geographical locations but also the type of product market, with varying levels of purchasing power and different

challenges that affect the selection of risk management strategies. By doing this, the results could hopefully be applied to other organizations in the industry.

*Dependability* is concerned with the reliability of the results and methods used. An example of dependability would be the auditing the methodologies used, which is rooted in the idea of fiscal audit. Dependability therefore deals with the extent to which the methods and results are objective and independent of the research situation. (Lincoln & Guba 1985, 316-317.) This study aims to achieve dependability through transparent description of the research process, by documenting each step of data collection and analysis carefully. The goal is for another person to be able to follow the steps of the process and come to similar conclusions, which is derived from the idea of inquiry audit.

Finally, the objectivity of the research is analyzed through *confirmability*. This criterion is interested in the consistency between the data and the interpretations made from it. The conclusions made need to be clearly supported by the data used. It is recommended to keep clear records of the data in different categories, such as raw data, analysis products (Lincoln & Guba 1985, 318.) In this study, records of the research process and data were stored systematically, for example naming each document clearly to represent whether it is raw data, reduced data or analysis made from the data. Additionally, multiple methods were used to add to the objectivity of the results, and thorough review of theory was completed to ensure promote sound interpretation of the findings.

### 3.4.2 Quantitative data

Quantitative research has many statistical methods and tool that are used to assess the reliability and validity of the research. *Validity* refers to the ability of the research to measure what it was designed to measure. (Hirsjärvi et al. 2009, 231.) *Internal validity* is concerned with whether the differences in the dependent variable (delivery delay and OTD) are caused by differences in the explanatory variables (GPR) in the context of the study (Meyer 1995). This has been addressed by running separate analyses by different groups, and through using an external variable (the GPR index) as the source of variation. *Reliability* refers to the reproducibility of the results, as in the extent to which the results are not random (Hirsjärvi et al. 2009, 231). For instance, the p-value and Pearson's Chi Squared value has been used to assess the significance of the results. In addition, confidence intervals were considered.

By doing each test separately for the whole data, and then split in different groups, the researcher was able to identify the conditions in which the relationships would likely exist in reality, instead of relying on the average results of a diverse population. Especially in the split by category allowed, the

results varied significantly between each group, which allowed the conclusion that geopolitical risks are significant in some specific category. In addition, the results of the quantitative analysis were combined with a richer qualitative analysis and a thorough review of literature, and it was hence possible to back the results of the quantitative data by theory and experiences.

### 3.4.3 Research ethics

One of the ethical principles of conducting research is informed consent (Eriksson & Kovalainen 2016, 63). For this thesis, the interview participants were provided with a description of the study, along with a consent form. The documents provided detailed information about the purpose of the study and the reasoning for selecting the participants. Additionally, it was clearly stated that participation is voluntary, and the participant can withdraw at any point during the process without any negative consequences. The participants were also provided a privacy notice, which explained where and for how long the data will be stored. The collected data was anonymized, and the interviewees' identities are kept anonymous throughout the thesis. The commissioning company has paid a compensation to the writer of the thesis, which is important to disclose explicitly in the thesis (Eriksson & Kovalainen 2016, 67). However, statements in the thesis are views of the interview participants or the researcher, and do not represent the view of the case company.

Ethics have been considered in multiple phases of the research process. For example, one of the dilemmas of research ethics related to qualitative research is related to the use of interview transcripts and quotations. The dilemma is raised as the researcher may wish to present statements as originally stated in the interview but must consider the potential implications for the interviewee. (Mero-Jaffe 2011, 243.) This is one of the ethical considerations applied in this study, as the researcher was mindful about the use of direct quotation. To transparently describe the issue as experienced by the participants, quotations were used word for word. However, the quotations selected for the thesis were such where they could not be linked to the specific participant, nor that the content of the quotation would cause any negative perceptions of the participant.

Most of the literature used for the theoretical framework of the thesis were retrieved from databases provided by the University of Turku. In addition to suitability, the reliability of the journal was assessed, and the publication year was considered. The use of the quantitative data provided by the case company was discussed carefully, and only the data necessary for doing the analysis was exported. All sensitive or irrelevant data was deleted from the data sheets. The data was sent through a software of the case company that ensures secure transfer of the documents.

## 4 Findings

### 4.1 Observations from the qualitative data

#### 4.1.1 Defining geopolitical risks

As there are many different definitions for geopolitical risks, it was important to understand the interviewees' understanding of what geopolitical risks are, to be able to analyze the results in greater depth. This provides valuable background for analyzing what types of geopolitical risks are most important from the perspective of the case company. While the interviewees' definitions were not identical, most answers included themes such as uncertainty and changes related to world politics and international relations. Some of the interviewees focused on what geopolitical risks are on a more general level, while some highlighted the practical implications they have on supply chains. Many interviews provided tariffs and other trade regulations as well as wars and conflicts between countries as examples. Additionally, some considered the inclusion of pandemics and cyber risks.

#### 4.1.2 Impacts of geopolitical risks

To understand what type of geopolitical issues most significantly impact the case company's supply chains, and what kinds of impacts they have, the interviewees were asked to describe a situation from the past, where a geopolitical risk has realized in their category. All interviewees had experienced impacts of geopolitical risks on their supply chains. The clearly most mentioned event were the tariffs, and other trade regulations imposed by and between the USA, China and the EU. The direct impact of the tariffs was increase in price for materials from US suppliers delivering to China. However, some of the increases could be avoided or reduced through negotiation. The biggest risk related to trade war however is the possibility of an export ban which would mean a discontinuation of deliveries. While that has not happened so far, it is noted that when a new trade policy has been set in place, some time is needed to understand the implications of it, which can and has caused a temporary suspension of deliveries. Furthermore, it is noted that the tariffs themselves are not the main issue, but it is the constant volatility of the situation, that increases uncertainty and makes it difficult to manage, as Interviewee 4 summarizes:

“And also, the question is not really the tariff itself, but it is about how instable, volatile is the scenario between these two countries... every day it can happen that there is a news and then after two days it's not valid anymore. So, for this reason it's really difficult to be to prepare any long-term plan and then in this in this respect you should be just faster in reaction.” (Interviewee 4)

For impacts related to price, some contract clauses have been negotiated about sharing the risk for future situations. It is evident that the core risk related to the ongoing trade war is the uncertainty and unpredictability. Furthermore, a market risk is seen in the United States related to the changing trade and climate politics, combined with the increasing data center boom, may affect the market in which the case company operates, indirectly affecting the supply side as well. These factors may cause macro level uncertainties, which could in turn affect the suppliers. The tensions between China and Taiwan should also be followed, as they have a direct impact on the availability of chips. Some electronics suppliers have also moved their manufacturing to other Southeast Asian countries due to the trade conflicts between China and the Western countries (see for example Yang & Chan 2023). Many electronics manufacturers want to build production nearby, which requires massive investments, resulting in price increases. The majority of the risks the interviewees are currently following relate to global trade politics, especially to China and the U.S. Furthermore, some EU instruments, such as the CBAM (Carbon Border Adjustment Mechanism) impact the purchase of components from outside the EU and gives additional work for supply management to ensure needed documentation and compliance to the mechanism.

Covid-19 is an event that had a variety of different kinds of impacts for supply chains. The impacts could be considered indirect, as Covid-19 resulted in political decisions, that in turn affected the availability of components. Additionally, a few suppliers went out of business during the pandemic. A major factor for this is the reduce of purchase volumes from the case company, due to lost sales during the pandemic. This strengthens the view that the demand market also has the potential to impact the supply side. Furthermore, individual unexpected events such as the blockage of the Suez Canal by the container ship Ever Given in March of 2021 have had monetary and delivery time related impacts. In addition, the Houthi attacks on container ships in the Red Sea is an example of a recognized transport related risk, where for example a delivery could be delayed due to rerouting of a container ship. These kinds of events highlight the vulnerability of the supply chain during transportation. In addition to long transportation times, some interviewees associate some other risks to suppliers located far away. These include not being able to go and see what is happening when an issue arises and having to rely on remote control and having to plan purchases and maintaining a buffer due to long lead times. Additionally, if an issue occurs, such as a quality issue, it takes a longer time to get replacement, if the lead time is long.

It is important to note that risks are not only related to the direct suppliers, but the large webs of sub suppliers are at risk of being disturbed as well. Most interviewees have limited visibility to sub suppliers, which is noted as a risk. However, it would be impossible to manage all sub suppliers,

which gives more importance to choosing the right suppliers, that can be trusted to manage their supply base well. Many interviewees agreed that when problems related to sub suppliers arise, suppliers will often share who the sub supplier is, or at least where they are located. When a new agreement is made, it is made sure that they have a secure supply of critical key components and while the name of the sub supplier might not be known, the country of origin often is, and it is recommended to have more than one source.

Due to the war in Ukraine, sub supplier(s) located in Ukraine had to be replaced quickly. This had a negative impact on availability of components of at least one category. In situations where there are no direct impacts of the war in Ukraine due to having no suppliers in the conflict area, there is a risk related to the availability of energy, raw material and such. Moreover, since suppliers are no longer allowed to source material from Russia and they have now had to source them elsewhere, there is a risk that the supply of raw materials is now dependent on a small number of shared sub-suppliers, potentially causing impacts related to price and availability. While most people are aware of the Russia-Ukraine war, it is noted that there are many other wars ongoing in the world that we might not even know of that could impact global supply chains as well. In general, the global political situation is risky, with tensions between countries, different kinds of conflicts, military threats and diplomatic crises. Even without war, or other clear risk factors, the characteristics of a country, such as the level of instability of a country should be taken into consideration. An example could be a country, where the government changes constantly.

Cyber risks were also considered by some interviewees, with one having seen a cyber-attack at one of their suppliers. There was a cyber-attack to a supplier, which caused a malfunction of the ERP system and suspended operations for a couple of weeks, resulting in delays to the case company. The attacker is unknown, which is common in cyber security related attacks. There is also a risk of speculation and fake news, and it would be important to have a place where you can find factual information. Interviewee 4 brings this up explicitly:

“Flow of information. We have to be always up to date, because sometimes also fake news or just speculation can create more damage than benefit. So means that it is important that we have one entity in (*Case company X*) that can give us information...clear and unique information, not gossip ideas” (Interviewee 4)

The impacts of geopolitical risks can be measured for example using different key performance indicators, such as price, lead time, delivery reliability and number of notifications. However, these are only applicable for analyzing the risk after realization, but generally for geopolitical risks it is

crucial to use proactive tools and measures. Using only these indicators, the risk will be noticed too late to act on it.

#### 4.1.3 Management of geopolitical risks

The price impacts related to trade war risks, such as tariffs, have been mitigated through negotiation and application of contract clauses for sharing the risk in potential future situations. To protect availability, some interviewees have built buffers for risky materials and consider finding alternative sources in a different geographical location. Diversification was the most mentioned strategy for mitigating geopolitical risks. Single sourcing is seen as a big risk, and when possible, alternative sources should be found, preferably in a different country. Having multiple sources is considered to cover a significant number of risks. In addition to supplier diversification, some interviewees considered diversification on a broader scale, as in having alternative transport routes, and for the supplier to have more than one production site. Moreover, diversification should go beyond the first tier, and it would be important for the direct supplier to ensure alternative sources for subcomponents. There are however many challenges related to multiple sourcing. For many categories, there is a very limited number of suppliers worldwide, making it difficult to have more than one supplier, or find a new supplier if something were to happen in the established supply chain. For some very specific materials, there can even be only one supplier globally. Additionally, some components require a very long and intensive product development and validation process due to the type of technology needed, making it very difficult to act fast, and find a supplier that is capable of the needed development. For large components that need huge investments for the needed equipment, the finances become a barrier for establishing a new supplier. For example, the foundry business is quite harmful for the environment as they require a lot of energy and land, and come with high emissions, investors are hesitant to fund a new factory. It is therefore much easier for established manufacturers to make a smaller investment. In some components, there are much bigger buyers in other industries, who have more power to affect the market. Ownership of design or technology is also a limiting factor, since if a supplier owns it, it is not possible to have an alternative source, and developing a new design would require a lot of time and possibly changes to other related components, to find a compatible design. Furthermore, when design is owned by the supplier, the buying side has very limited capability to affect the supply chain beyond the direct supplier. Another challenge is the justification of choosing a more expensive supplier, as non-monetary benefits of a supplier can be more difficult to measure. Moreover, these actions should be done proactively, but often priority to finding a second source is only given when the issue is already at hand. There should be a good readiness for taking a new supplier, so that in case a risk realizes, actions can be done quickly. For

these reasons, diversification can be difficult to implement, especially in the first tier, even though the importance of it is recognized. Localization is also a tool for managing risk. Having suppliers in a country where the case company itself operates may protect it from some risks.

Especially when there are barriers to implementing diversification or purchasing power is low, it is vital to maintain good relationships with existing suppliers and ensure the continuity of it. A good cooperation between the buyer and supplier may aid in gaining visibility of the supply chain as a whole and enable collaboration in ensuring efficient systems for managing it. Good communication and flow of information is crucial, so that the buyer is notified by the supplier immediately in case of any issues or potential risks. It is beneficial to discuss with the supplier about what is happening in their supply chain, and also encourage the supplier contact person to have the same conversations internally with their sourcing and purchasing organization, who have a better picture of what is happening in their supply base. Furthermore, it is important to have a good flow of information internally across departmental boundaries, such as sales and R&D, to ensure smooth and efficient actions. Another strategy for building resilience towards geopolitical risks are buffers, including safety stock as well as inventory at different stages of the supply chain, so that in case of risk realization, the system is able to absorb the impact. Having too high buffers however carries the risk that if sales volumes unexpectedly decrease, such as in the case of the pandemic, there might not be enough purchase volumes to suppliers to keep them afloat when the safety stock covers a long period of time.

In making long term plans and strategies for their respective categories, all interviewees would consider geopolitical factors where possible, although there is no official systematic analysis of geopolitics. Mainly, it would show in where they hope to find new suppliers. Particularly this is noted for countries participating in trade conflicts, such as the USA and China. Localization is part of the strategy of some categories. Some consider localization as preferring to have suppliers in Europe, while some would like to have suppliers where they are needed, respective to which location of the case company the components are delivered to. Strategies related to finding new suppliers differ between the categories, for example in whether more focus is on diversification or localization. All in all, most interviewees consider geopolitical risks, such as risks of trade war, important factors to keep in mind when planning for the future. On a more general level, the importance of other factors than price, especially availability, and the stability of the supplier's country are highlighted by multiple interviewees. The pandemic and the recent impositions of trade regulations has increased the level of focus on geopolitical issues.

As mentioned, when selecting a new supplier for a new or existing component, all interviewees would consider geopolitical factors to some extent, when possible. However, the ability to do that is limited, especially due to the low number of potential suppliers worldwide. For that reason, many would work with established suppliers. In addition to the country of a potential supplier, some would investigate the location of the supplier's factory and headquarters, as well as the ownership of the company. Connection to tariffs and sanctions are checked. When sourcing a new component, the supply of critical subcomponents is often reviewed with the supplier. The priorities are to review whether the availability of critical key components is secured, preferably through multiple sourcing. Furthermore, the supplier's capabilities and systems for supply chain management on a more general level may be assessed, as they are responsible for the supply chain and ensuring sufficient availability for needed resources. The suppliers should have an efficient system to measure the performance of their suppliers. Selecting a supplier that has these important capabilities is crucial. If any risks are noticed, or issues arise at some point, a deeper look into the supply of subcomponents can be taken. Furthermore, these systems can be audited also later throughout the supplier relationship.

Many interviewees also mentioned business continuance or contingency plans as tools for managing risks. The suppliers need to provide plans for how they will mitigate risks, and what they will do in case specific risks are realized. While the supplier is responsible for this plan, it can also be made together. It is also noted that other qualities not directly related to risk management, such as sustainability, flexibility and transparency may aid in being resilient towards geopolitical risks. For example, when working with a supplier from a country with higher instability or corruption, having a certification for sustainability can be an indication of a more resilient supplier. Flexibility in production, for example through alternative production sites or through subcontractors may increase resilience.

The benefit of having alternative transport routes was mentioned by a few interviewees. Amongst other benefits such as costs, having an alternative transport route could help in shielding from geopolitical risks during transportation, for example in cases such as the blockage of the Suez Canal, or attacks of the Houthi rebels on the Red Sea. One interviewee had investigated the alternative of a rail route from Asia, which is however not feasible now due to the attack of Russia in Ukraine. One interviewee also brought up the perspective that transport costs are often overlooked, and that a supplier closer to the case company with higher prices could potentially be more affordable in the long run, considering the total costs including transportation costs.

While there are strong tools for increasing resilience towards geopolitical risks, such as diversification, localization and auditing suppliers' systems for supply chain management, the difficulty of identifying and predicting geopolitical risks is emphasized in the data. As mentioned, for example by Interviewee 1, the biggest challenge with geopolitical risks is the volatility and unpredictability of them.

“I have to say, you never know which risks are happening and you never know what will happen in the future, so for us some issues are not even known. So how can you mitigate them if you do not even know them?” (Interviewee 1)

Based on the interviews, there is no common systematic way of identifying risks at the case company, but information about potential risks or issues are received from multiple different sources, such as different people in the organization, suppliers, statistics (KPI), audits, and people within the purchasing team. Risks are systematically identified at different points such as during supplier selection or in the category strategy, but the way of doing it seems somewhat different between the categories. For geopolitical risks in specific, there is no specific process in place. What is common amongst the interviewees, is that risks are assessed and evaluated together with the purchasing team, and actions are defined based on this evaluation. Risks are assessed and evaluated in terms of impact and likelihood or frequency. Impacts are analyzed in terms of availability, price and quality. Again, the importance of communication and flow of information is emphasized, especially from the supplier. Having global purchasing teams, there is also the benefit of the information of a situation happening in a different country is shared more quickly. Many of the interviewees also discuss geopolitical risks with suppliers, in order to better understand what the impacts may be. The case company also uses a risk management software that notifies the respective people in case there is risk at one of their suppliers or in the area the supplier is located. These could be situations such as fires, floods or road blockages. It also gives a risk score for countries and individual companies, that considers all types of risks, including for example financial issues.

It is important to be informed about that is happening around the world, and what could possibly become a risk for one's supply chains. Taking a deeper look into one's own responsibility area, is an opportunity to recognize issues that could potentially turn into a risk. One idea mentioned for risk identification was scenario planning. While not known to be in use currently, it could potentially be an effective tool in exploring the future. Scenario planning could be used by building varying pictures of the future and utilizing these scenarios in decision making. Additionally, the possibilities for using data to predict risks should be explored. Support from the risk management organization could be useful in risk assessment.

The view on whether the case organization could do something to support the management of geopolitical risks varied between the interviewees. Some interviewees felt that no support is needed from the organization, and all information that may be needed is already made available. On the other hand, multiple interviewees had some ideas on how the case organization could support the management of geopolitical risks. These ideas were mainly related to information sharing and risk identification. It would be helpful to have a known place, where you can find an information package about the development of i.e. tariffs, so that you can easily navigate to a place with correct and up-to-date information. On the other hand, it would be beneficial to have better information available about who you could contact to discuss with when a related question arises. One brought up an idea about a category specific report about what is happening in countries with significance to that specific category, such as the development of energy prices or union actions in a specific country where that category has important suppliers. Support could be used in identifying and assessing potentially emerging geopolitical risks. It was also highlighted that a more common stand and guidance on geopolitical risks would be needed on an organizational level, because they are not only a matter of supply management, but there are many functions and individual persons in the organization whose actions play a key role. Therefore, it would be important for the organization to have a common view, for example in how a political change should be interpreted from the case company's point of view. Moreover, this view should be effectively communicated throughout the organization. Another interviewee highlighted that while each category is the expert of their product and the respective market and have the best view on what the significant risks are, the case company should align on the number of resources that should be spent on risk management. That way, the organization is aligned on what resources should be spent on managing a specific risk, and the costs or other consequences of the risk realizing are understood. For example, Interviewee 7 brought up this perspective:

“It should be decided on the organizational level, how much money we want to invest in risk management, because it is like bringing an umbrella in case it rains and if it doesn't, it is useless” (Interviewee 7, translated)

Referring to the analogy from Interviewee 7, if it is decided not to bring an umbrella, the chance of it raining must be accepted. Setting up a new supplier or taking some other risk management actions often come with costs, which results in hesitance with risk mitigation actions, even if risks are identified. There is often greater focus on risks after disruptions have already occurred. More priority and resources should be given to proactive risk management. Beyond firm-level considerations, stakeholder involvement could be considered as part of managing geopolitical risks, since they are not exclusive to the case company, but affect the society and environment around it as well.

#### 4.1.4 Summary of current state at case company

Based on the interview data, geopolitical risks are relevant for the case company's supply chains. So far, implications have been mainly financial, but also related to availability through lead time impacts, for example. Some of the financial impacts have been tackled through negotiations and contract clauses. It is agreed that the most severe risks relate to the unavailability of goods at the right time and with good quality. All interviewed categories are making strategies and aiming to take risk management actions that would ensure the availability of components, whether related to geopolitical risks or not. These strategies include diversification, multiple sourcing, localization, buffers and maintaining good supplier relationships. More specific risk management actions include for example business continuity plans, as well as reviews and audits of suppliers' supply chain management and risk management systems. The importance of the flow of information was enhanced in multiple contexts.

Based on the interview data, it could be interpreted that the most common and perhaps effective risk management strategies for geopolitical risks are those that increase supply chain resilience as a whole. For example, multiple sourcing protects the supply of components quite from a large variety of risks. The same applies to selecting good suppliers and efficient sharing of information, amongst others. Still, geopolitical risks challenge the supply chains with their unpredictability and with the potentially very severe impacts when considering for example the risk of a sanction, which could result in the suspension of deliveries for a prolonged period of time. For this reason, it is still critical to screen the environment for potentially emerging geopolitical risks. There is no universal process for risk identification and assessment across the categories in terms of geopolitical risks, however, discussions involving the whole purchasing team was evidently the most important form of risk assessment and evaluation. In all categories, risk identification and assessment is conducted for example during supplier selection, and creation of the category strategy. Some of the suggested ideas for risk identification included scenario planning, information packages of significant changes per country, and using data to predict risks. These ideas, combined with findings from the literature and quantitative data will be analyzed further in the discussion chapter.

It was found that some of the needed support tools mentioned by the interviewees, such as a known place where up-to-date information is collected about the proceeding of tariffs for instance, already exist at the case company, which suggests that communication about risk management tools and reports could be improved. Many find information about risk management tools from their colleagues, while some had done searches in the company Intranet to find information. There is not a risk

management toolbox specific to geopolitical risks, but the challenge lies in identifying these risks, where actions should be taken.

## 4.2 Observations from the quantitative data

As the first step of the quantitative analysis, all data sheets were combined according to the delivery line data. Each line was given a country indicator, and a country specific GPR index (based on requested delivery date month and year, and supplier country). Each line was also given the global GPR index based on the month and year of the requested delivery date. After all data were combined into one master file, the analysis was begun. Additionally, performance measures (lateness and OTD) were calculated. Lateness was measured as days = document date (actual delivery date) – requested delivery date. OTD was given a value of 0 or 1, where 0 is a late delivery and 1 is an on-time delivery (document date is less than or equal to requested delivery date). The tables provided in this chapter include all results where all needed values were produced (such as the t-value and p-value). For some analyses, the sample size was too small for these values to exist. All analyses were done for both the country-specific GPR index and the global GPR index, to examine whether there is a difference in the significance of local factors or global factors.

### 4.2.1 T-tests

The first step of the analysis was a t-test for the equality of means across the low country-specific GPR and high country-specific GPR. The independent t-test is used to compare the means of two samples and to examine whether the potential difference in sample means is indicative of a genuine difference between the samples or merely a result of high fluctuation in the population (Field 2024, 485). The purpose of this test was to examine whether there is a statistically significant difference in the mean lateness or orders in months with low and high country-specific GPR index. After running the test for the whole data, it was split according to purchasing category, with the goal of seeing if the difference is more or less significant in some category. Lastly, the data was split according to Incoterm®. The split based on Incoterm® provides insight for instance into the role of transportation, in some Incoterms® (such as FCA) the buyer is responsible for the transportation and therefore the transportation time is not included in the lead time used in this study, while in some Incoterms® (such as DAP) the seller is responsible for the transportation, and the transportation time is therefore included in the lead time used in this analysis.

Table 8 summarizes the findings of the t-test comparing the mean value within low and high country-specific GPR index groups. Levene's test was not used because it can produce significant results even

with small variances when the sample is large (Field 2024, 301), and therefore results of test statistics were gathered from the “equal variances not assumed” row. The two-sided p-value was used to assess significance. The t-value is calculated by dividing the difference in means by the standard error and is therefore indicative of the strength of the difference. The p-value assess the significance of the results, and the usual criterion is that a  $p < 0.05$  indicates statistically significant results. (Field 2024, 495.) In table 8, rows where  $p < 0.05$  are highlighted in green.

**Table 8 T-Test country-specific GPR**

Comparison	Mean Low GPR (country)	Mean High GPR (country)	Mean diff	t	p
All	-5,22	-6,50	-1,28	6	<0.001
Cat A	32,92	25,56	-7,36	0,61	0,545
Cat B	8,7	15,63	6,93	-8,04	<0.001
Cat C	17,63	7,44	-10,19	0,92	0,36
Cat D	-5,21	-6,2	-0,99	0,14	0,89
Cat E	-6,67	-11,91	-5,24	27,79	<0.001
No Inco	3,4	-	-	-	-
Inco CIP	-4	-29,67	-25,67	-	-
Inco CPT	2,76	19	16,24	-2,73	0.007
Inco DAP	-3,82	-5,55	-1,73	2,3	0.003
Inco DDP	6,48	-19,13	-25,61	11,98	<0.001
Inco DDU	20,5	3	-17,5	15,65	<0.001
Inco EXW	-1,36	2,7	4,06	-1,79	0.075
Inco FCA	-5,42	3,61	9,03	-30,1	<0.001
Inco FOB	-	-159	-	-	-

A negative mean indicated that orders were on average delivered in advance compared to the requested delivery date, while a positive value indicates a delay. The difference is measured in days. The first analysis comparing the means in the whole sample, there was a small but statistically significant difference, and unexpectedly, order in months with high country-specific GPR index were on average delivered 1,28 more in advance. In the category split, significant results were found only for categories B and E. In category B, orders were on average delivered 6,93 days more late in months with high country-specific GPR. In category E instead, orders were on average delivered 5,24 days more in advance. Categories B and E differ significantly from each other in all characteristics defined in this study (see table 4), which could potentially explain the difference in how country-specific geopolitical risk affects deliveries.

In the comparison between different Incoterms®, most significant differences were found with orders using CPT (Carriage Paid To), DDP (Delivered Duty Paid), and DDU (Delivered Duty Unpaid). With CPT, orders were on average delivered 16,24 days more late in months with high GPR, while with DDP and DDU orders were on average delivered more in advance (25,61 and 17,5 days respectively). A commonality between these three Incoterms® is that seller responsibility extends quite far in the supply chain, only leaving the final distribution to the buyer facilities to the buyer. As the lead time in these Incoterms® includes the transportation time, a potential explanation for an order to arrive early could be the use of a faster shipping mode, such as air freight, which are common tools for expediting shipments in urgent situations (Chiang 2010, 526).

The same t-tests were run based on the global GPR index as well. Similarly, the data were divided into low and high global GPR groups, and means were compared for the same splits as with the country-specific GPR index. The findings are summarized in Table 9.

**Table 9 T-Test global GPR**

Comparison	Mean Low GPR (global)	Mean High GPR (global)	Mean diff	t	p
All	-4,86	-6,70	-1,84	8,6	<0.001
Cat A	12,09	50,83	38,74	-3,51	<0.001
Cat B	13,26	13,57	0,31	-0,33	0,74
Cat C	-14,92	105,65	120,57	-5,32	<0.001
Cat D	-32,05	18,4	50,45	-6,98	<0.001
Cat E	-7,78	-10,12	-2,34	12,82	<0.001
No Inco	7,66	2	-5,66	0,344	0.34
Inco CIP	-32,67	5	37,67	-	-
Inco CPT	1,34	16,64	15,3	-3,09	0.002
Inco DAP	-4,31	-5,91	-1,6	2,68	0.007
Inco DDP	-15,66	-22,05	-6,39	12,17	<0.001
Inco DDU	8,83	-	-	-	-
Inco EXW	0,03	-0,55	-0,58	0.34	0.735
Inco FCA	-2,01	-2,2	-0,19	0,78	0.437
Inco FOB	-82,2	-543	460,8	-	-

Similarly to the country-specific GPR, orders were on average delivered slightly more in advance during months with high global GPR. In the comparison between purchasing categories, statistically significant results were found for all categories, except for category B. The results for category E align with the results of the full sample, in that orders were delivered slightly more in advance during

months with high global GPR. Instead, for categories A, C and D, the results suggest that orders were delivered significantly later (39, 121 and 50 days respectively) during months with high global GPR. Key differences between categories A, C and D and category E, are that lead times are shorter, are number of deliveries are higher in category E compared to the other three (see table 4). In other measured characteristics, there is no clear factor that would distinguish category E from the other three. Category B with no significant difference is characterized by high lead times and spend, but low number of deliveries, suppliers and countries.

In the comparison of Incoterms®, significant differences were found in orders using CPT, DAP and DDP. This is similar to the findings of the country-specific index. Orders with CPT were delivered on average 15,3 days later during months with high global GPR, which is strongly aligned with the findings of the country-specific GPR. Orders utilizing DAP or DDP were on average delivered slightly more in advance during high global GPR. In both the country-specific GPR and global GPR analysis, there was no significant difference in between low and high GPR with Incoterm® EXW and FCA. These are both Incoterms® where transportation is under the responsibility of the buyer, and transportation time is therefore not included in the lead time metric used in this study. This would suggest that the impact of geopolitical risk is significant during transportation. It should still be noted that while disruptions during transportation will not show in the data for Incoterms® EXW and FCA, a possible explanation for a delayed delivery by a supplier is the late arrival of subcomponents, which on the other could be related to disruptions in transportation. It is common that multiple components are purchased from sub suppliers, and assembly is done by a first tier supplier (Niu et al. 2026). The unavailability of critical components is a significant reason for postponements and disruptions (Katsaliaki et al. 2022; Xiong et al. 2025).

In general, there are more differences in mean lateness seen in the tests using the global GPR index, indicating that global factors would have a stronger impact on the case company's supply chains than local factors. This result is logical, as these supply chains consist of a network of global supplier and sub suppliers, increasing vulnerability to global factors (Habibi et al. 2025).

#### 4.2.2 Crosstabulation

Secondly, a crosstabulation analysis was used to examine the association between GPR and delivery performance (OTD). Table 10 summarizes the results of the crosstabulation for country-specific GPR. The column labelled "OTD% Low" shows the percentage of on-time deliveries in the low country-specific GPR group, while the next column shows the percentage of on-time deliveries for the high country-specific GPR group, and the fourth column shows the difference between these two values.

**Table 10 Crosstabulation country-specific GPR**

Scope	OTD% Low	OTD% High	$\Delta$ OTD%	RR Late (Low)	95% CI	RR Late (High)	95% CI inverted	$\chi^2$ p-value
All	76,8 %	70,5 %	-6,3 %	0,786	0,775-0,797	1,272	1,255-1,290	<0.001
Cat A	45,8 %	37,4 %	-8,4 %	0,865	0,584-1,281	1,156	0,781-1,712	0.438
Cat B	56,7 %	54,0 %	-2,7 %	0,941	0,917-0,966	1,063	1,035-1,091	<0.001
Cat C	34,3 %	64,5 %	30,2 %	1,852	1,432-2,395	0,540	0,418-0,698	<0.001
Cat D	76,7 %	66,7 %	-10,0 %	0,699	0,501-0,978	1,431	1-022-1,996	0.035
Cat E	78,9 %	74,6 %	-4,3 %	0,829	0,815-0,842	1,206	1,188-1,227	<0.001
Inco=0	70,0 %	-	-	-	-	-	-	-
CIP	100,0 %	66,7 %	-33,3 %	-	-	-	-	0.505
CPT	53,8 %	67,1 %	13,3 %	1,403	1,137-1,731	0,713	0,578-0,880	<0.001
DAP	77,8 %	71,7 %	-6,1 %	0,785	0,746-0,826	1,274	1,211-1,340	<0.001
DDP	53,1 %	74,5 %	21,4 %	1,838	1,614-2,094	0,544	0,478-0,620	<0.001
DDU	0,0 %	25,0 %	25,0 %	1,333	0,757-2,348	0,750	0,426-1,321	0.439
EXW	69,7 %	68,5 %	-1,2 %	0,962	0,754-1,227	1,040	0,815-1,326	0.755
FCA	76,9 %	67,1 %	-9,8 %	0,701	0,69-0,713	1,427	1,403-1,449	<0.001
FOB	-	100,0 %	-	-	-	-	-	-

The RR value shows the relative risk of a late delivery in each of the groups (low GPR and high GPR). A positive value can be interpreted as a higher risk of a late delivery in the high GPR group, while a negative value can be interpreted as a lower risk of a late delivery in the high GPR group. In this study, the typical confidence interval (CI) of 95% is used. The confidence interval shows the limits within which the true value of the population parameter would fall for a certain percentage of samples, here 95%. (Field 2024, 74) SPSS was used to calculate the RR and CI values for the low country-specific GPR, and the values for the high-risk group are the inverted values of those. To see if there is a statistical relationship between these variables, the Pearson's Chi-square ( $\chi^2$  p) was used.

For the whole data, OTD was 6,3 percent lower in the high GPR group compared to the low GPR group, and there is a 27,2 percent higher risk of a late delivery in the high GPR group. This aligns with the expectation, that geopolitical risk weakens delivery reliability (Chang et al. 2025, 2). It is however contrary to the finding assessing delay in days. This means that a larger number of orders were delivered late in comparison to the request, but the ones delivered in advance were delivered enough days in advance for the average lateness to still be negative. The category split produced significant results for all categories except category A, where datapoints were split unevenly amongst the two groups, with the low GPR group only having 24 data points. In categories B, D and E, the

risk of a late delivery is higher (6,3%, 43,1% and 20,6% respectively) when GPR is high. Contrarily, in category C, the risk of a late delivery is 85,2% higher to appear in the low GPR group than the high GPR group.

In the Incoterm® comparison, the likelihood for a late delivery is higher in the high GPR group for DAP and FCA (27,4% and 42,7% respectively), and in the low GPR group for CPT and DDP (40,3% and 83,8% respectively). DAP and DDP have the same sharing of costs, risks and insurance between the buyer and the seller, and the lead time includes transportation in both cases, which does not support the hypothesis that there would be significance to whether transportation time is included or not. A clear difference between the two however is that for DAP, the sample size is divided quite evenly to low and high-risk groups, while for DDP, the majority of data points fall into the high GPR group, indicating that DDP is used more with supplier from countries with a relatively high number of high country-specific GPR index months. The finding on FCA deliveries indicates that local geopolitical factors weaken the delivery reliability of the supplier, without considering transportation. An example of a type of risk that could potentially impact the supplier locally, without impacts on transportation, would be internal political instability resulting from for example labor-related conflicts (López et al. 2025).

Table 11 summarizes the results of the crosstabulation for global GPR. For the whole data, the result was opposite, and the risk of a late delivery was 7% higher in the low-risk group than in the high-risk group, which would indicate that local factors have a negative as well as stronger effect on delivery reliability than global factors. However, in the category specific results, the risk of a late delivery in the high-risk group is significantly higher than in the low group in categories A, C and D (37,7%, 161,1% and 191,5% respectively). The probability is extremely high in categories C and D, which do work with similar products based on the interviews. In the measured characteristics, they share similar lead times but differ from each other quite significantly in for example the number of suppliers and countries. Category A shares almost none of the measured characteristics with categories C and D. In category C, the difference between the results of the country-specific GPR and global GPR is very significant. With category D, a late delivery was more likely in the high-risk group for both indexes, while category A did not have statistically significant results for the country-specific GPR. In categories B and E, the likelihood of a late delivery was slightly higher in the low global GPR group (4,2% and 8% respectively), while in the country-specific GPR the likelihood was slightly higher for the high-risk group, suggesting that local geopolitical factors would perhaps have more of a negative impact on delivery reliability in these categories.

**Table 11 Crosstabulation global GPR**

Scope	OTD% Low	OTD% High	$\Delta$ OTD%	RR Late (Low)	95% CI	RR Late (High)	95% CI inverted	$\chi^2$ p- value
All	72,5 %	74,3 %	1,80 %	1,07	1,055-1,085	0,935	0,922-0,948	<0.001
Cat A	46,6 %	26,4 %	-20,20 %	0,726	0,57-0,924	1,377	1,082-1,754	0.015
Cat B	53,9 %	55,7 %	1,80 %	1,042	1,017-1,067	0,960	0,937-0,983	<0.001
Cat C	68,1 %	16,7 %	-51,40 %	0,383	0,305-0,482	2,611	2,075-3,279	<0.001
Cat D	85,7 %	58,4 %	-27,30 %	0,343	0,256-0,461	2,915	2,169-3,906	<0.001
Cat E	75,6 %	77,4 %	1,80 %	1,08	1,062-1,097	0,926	0,912-0,942	<0.001
Inco=0	62,5 %	50,0 %	-12,50 %	0,75	0,199-2,827	1,333	0,354-5,025	0.679
CIP	100,0 %	-	-	-	-	-	-	0.046
CPT	60,7 %	56,6 %	-4,10 %	0,905	0,752-1,088	1,105	0,919-1,330	0,288
DAP	74,2 %	75,5 %	1,30 %	1,056	1,004-1,111	0,947	1,004-1,111	0,034
DDP	71,4 %	77,1 %	5,70 %	1,244	1,206-1,283	0,804	0,779-0,829	<0.001
DDU	16,7 %	-	-	-	-	-	-	-
EXW	66,9 %	72,2 %	5,30 %	1,19	0,953-1,486	0,840	0,673-1,049	0,123
FCA	72,7 %	73,4 %	0,70 %	1,027	1,011-1,044	0,974	0,958-0,989	0.001
FOB	100,0 %	100,0 %	0,00 %	-	-	-	-	-

In the Incoterm® split, all Incoterms® with statistically significant results (DAP, DDP and FCA) had a higher probability of a late delivery in the low global GPR group. For DDP, this aligned with the results of the country-specific GPR, while for DDP and FCA the results were opposite. The increase in probability of a late delivery in the low-risk group for DDP and FCA is still quite minimal (5,6% and 2,7% respectively), indicating that the effect of global geopolitical risk is not especially strong in those groups.

A further crosstabulation analysis was done to explore the impact of a buffer in the lead time. Buffer lead-time was defined as:

$$\text{Buffer} = \text{Requested LT} - \text{Agreed LT}$$

The data were divided into four buffer groups (Table 12). Group 1 includes orders that were placed with a lead time shorter than the agreed lead-time. Group 2 includes orders that were placed using the agreed lead-time  $\pm 2$  days, to include minor deviations, and those cases where there is a specific weekday agreed for a delivery date. The orders that were placed with a lead-time buffer were divided into two groups (low and high buffer) based on the median buffer within the positive buffer group.

The median buffer of the orders with a lead-time buffer was 31,31 days which defines the split of groups 3 and 4.

**Table 12 Buffer groups**

Buffer group	Definition
1	< -2.0000001
2	-2 – 2
3	3 – 31,31
4	> 31,31

Table 13 summarizes the results of the crosstabulations per each buffer group and GPR index. In all GPR groups, the ratio of on-time delivery was clearly lowest in buffer group 1, which is expected. Additionally, in most groups the ratio on on-time delivery increases as the buffer increases. While the difference is quite minimal between groups 2-4, the rate of on-time delivery was best in group 3, where lead-time buffer is 2-31,31 days. The OTD% was the lowest for the high country GPR group in buffer groups 1-3. To thoroughly understand the significance of a lead-time buffer, a regression model should be created.

**Table 13 Crosstabulation buffer groups**

Buffer group	OTD %				Mean	χ <sup>2</sup> p-value
	Low country GPR	High country GPR	Low global GPR	High global GPR		
1	65,2 %	58,1 %	60,1 %	60,7 %	61,0 %	<0.001
2	77,4 %	72,2 %	74,1 %	75,4 %	74,8 %	<0.001
3	79,3 %	73,9 %	75,7 %	77,6 %	76,6 %	<0.001
4	77,0 %	74,9 %	74,5 %	76,7 %	75,8 %	<0.001

The OTD% was the lowest for the high country GPR group in buffer groups 1-3. The differences between any of the GPR groups are quite minimal, although the difference is the largest between the low and high country-specific GPR group. When comparing the difference between the best performing buffer group with the worst performing one within each GPR group, the difference is larger in the high-risk groups in both the country-specific and global GPR index. This could potentially indicate that a lead-time buffer is more beneficial when geopolitical risk is high. To thoroughly understand the significance of a lead-time buffer, a regression model was created.

### 4.2.3 Regression

A binary logistic regression was estimated, with on-time delivery (OTD) as the outcome. The use of a binary logistic regression is applied, as the dependent variable (OTD) is a binary measure of on-time, or not on-time. This approach allows the exploration of whether GPR has an impact on the likelihood of an on-time delivery. The goal was to examine the effect of local and global GPR on OTD, so country-specific GPR (high vs low) and global GPR (high vs low) were used as main predictors. Buffer days were scaled per 10 days and centered at zero days, so that the effects of GPR are analyzed when there is no buffer, and after that the effect of the buffer is added into the relationship. Interaction terms Local GPR \* Buffer (10 days, centered) and Global GPR \* Buffer (10 days, centered) were created to test whether buffer makes the effect of GPR stronger or weaker. Category and Incoterms® were used as control variables. Table 14 summarizes the results of the regression.

**Table 14 Regression results**

Term	Exp(B)	95% CI	p-value	Interpretation
Local GPR group (high vs low)	0,761	0,743-0,780	<0.001	Local GPR effect on OTD at zero buffer
Global GPR group (high vs low)	1,09	1,068-1,112	<0.001	Global GPR effect on OTD at zero buffer
Buffer 10 days	1,006	1,003-1,010	<0.001	Baseline buffer effect under low GPR
Buffer 10 x Local GPR group	1,041	1,037-1,045	<0.001	Does buffer strengthen/weaken the local GPR effect?
Buffer 10 x Global GPR group	1,005	1,001-1,009	0.007	Does buffer strengthen/weaken the global GPR effect?

Based on the regression results, at zero buffer days, orders during high local GPR had a 24% lower chance of being on time than during low local GPR. For global GPR the results were opposite, and at zero buffer, orders during high global GPR had a 9% higher chance of being on time than during low local GPR. Based on the buffer x local GPR interaction term, each added 10 days of buffer increases the effect of local GPR by 4,1%. The baseline buffer and the buffer x global GPR interaction term effects are quite insignificant, as effect is under 1%.

To explore the effect of adding lead-time buffer during high GPR, the Exp(B) value of the baseline buffer can be multiplied by the interaction term. The result would be 1,047 for high local GPR and 1,011 for high global GPR. Therefore, the effect of a lead time buffer is positive during high local GPR (at supplier's country), and each added 10 days of buffer would increase the odds of an on-time delivery by 4,7%.

### 4.3 Integrating the data

In integrating the findings of the qualitative and quantitative data, both provide insights into the kinds of geopolitical risks that impact the supply chains of the case company, and how these impacts are realized. Based on the quantitative data, a distinction was made between local and global geopolitical risks, based on the comparison of the country-specific and global GPR Index. From the perspective of the whole sample, local factors were more impactful. However, some categories were noticeably more affected by global factors. Based on the qualitative data, trade war and regulations such as tariffs or export bans were most frequently mentioned as risks having had impacts in the past, as well as seen as risks with most potential impacts in the near future. These risks could be considered as local or country-specific, as the impacts are directly related to the country being subject to trade regulations, and they would directly increase said country's country-specific GPR index. In category B, country-specific geopolitical risk had adverse effects on the delay of deliveries in days, and in the OTD. Category E on the other hand had positive effects on delay in days, but a negative effect on OTD alongside category D.

On the other hand, geopolitical risks that could be considered global, were also identified in the qualitative data. These included the Covid-19 pandemic, market risks related to climate politics and the blockage of the Suez Canal. The latter could be considered global, as it has the potential to disrupt global transport routes, regardless of the origin of the shipment. The quantitative data suggests that categories A, C and D are significantly impacted by the level of geopolitical risk globally, both on delay in days and on OTD. All in all, the uncertainty and unpredictability related to geopolitical risks is enhanced.

While the qualitative findings provided more insights into the risk management practices, the quantitative data had a supporting role in assessing the importance of a lead time buffer. The results of the crosstabulation highlight the importance of good planning, as ordering with a lead time shorter than the one agreed, correlated with a significantly lower rate of OTD. Still, a lead time buffer could be beneficial when country-specific GPR is high. In the qualitative data, buffers were also brought up, while mostly related to buffer stocks.

## 5 Discussion and conclusions

### 5.1 Managing geopolitical risks in maritime and energy supply chains

This study examined the impacts of geopolitical risks to global supply chains in the maritime and energy industry, focusing on a single case company. The main research question was “*RQ1: How geopolitical risks could be managed in maritime and energy sector global supply chains?*” The main research question was divided into two sub questions, which helped formulate the answer to the main research problem. This chapter aims to answer the research questions using the results of this study and drawing connections to prior literature. The first sub question of this thesis was: *SQL: What types of geopolitical risks typically affect global supply chains in the maritime and energy sector and how?* This sub question will be answered first by defining geopolitical risks and the most significant risks from the case company’s perspective, after which the potential and already realized impacts of geopolitical risks will be discussed.

Based on the data collected in this study, *geopolitical risks* were defined as uncertainty and changes related to world politics, that impact supply chains and the society. The most used definition in the literature for geopolitical risks is that of Caldara and Iacoviello (2022, 1195): “threat, realization, and escalation of adverse events associated with wars, terrorism, and any tensions among states and political actors that affect the peaceful course of international relations”. Another related term is *geopolitical disruptions*, which has recently been defined by Bednarski et al. (2025, 538) as “conflicts or disputes between nation states that interfere in the smooth flow of goods and services in global supply chains”. The latter is strongly aligned with the definition built from the data of this study. Furthermore, this study suggests the inclusion of cyber risks in the theme of geopolitical risks. One paper recognizing cyberattacks as a disruptive effect of a geopolitical disruption was found (López et al. 2025). In addition, cyber risks have been discussed together with geopolitical risks in research on supply chain disruptions (Habibi et al. 2025; Ramirez & Le 2025). Furthermore, geopolitical risk has been discussed as a factor that indirectly exposes countries to cybersecurity risks (Zheng & Gong 2024). Based on the interviews, the geopolitical risks impacting the case company can be summarized as wars, trade regulations, tariffs, pandemics, instability (of e.g. governments), cyberattacks and market risks.

The impacts of geopolitical risks were identified in both the interviews and in the quantitative analyses. The impacts of geopolitical risks are realized as increases in price and delays or terminations of deliveries. This aligns with the literature on geopolitical risks (Roscoe et al. 2020; Moradlou et al.

2021; Bai et al. 2025). Disruptions in availability were highlighted more frequently and considered the most critical consequence. Uncertainty was a recurring theme, and for example in the case of tariffs, the volatility of the trade policies was noted as the most challenging part of the tariffs. Similarly, one of the impacts of trade war risks identified by López et al. (2025) was uncertainty surrounding transactions. Indirect risks related to changes in the market and demand that result from geopolitics were also identified as having potential impacts on supply management. This is supported by López et al. (2025), who identified market volatility and shifting consumer demands as disruptive effects of geopolitical disruptions. Indirect impacts from e.g. wars related to the availability of raw materials and energy are also recognized. The literature has also recognized these, and for example Chen et al. (2025) highlighted the disruption related to energy from the perspective of global supply chains.

Based on the quantitative analyses utilizing the whole data, orders were delivered more in advance during months with high GPR. A potential explanation for this could be that under geopolitical risk, buyers aim expedite orders more. This aligns with Chang et al. (2025), who found that companies tend to build precautionary inventory under geopolitical risk. In the case of the lead time including also transportation, the advanced delivery of an order could potentially be explained by the utilization of a faster transportation mode (Chiang 2010, 526). While orders were on average delivered in advance when measured in days, the OTD rate was lower in the case of high country-specific GPR. The findings of this thesis suggested that delivery reliability is impacted negatively by local geopolitical risk, but not global. This is contrary to what is mostly suggested in the literature, as geopolitical risks have been shown to impact supply chains globally, due to disruptions in transport routes (Sielker & Dannenberg 2025) and the ripple effect (Herold & Marzantowicz 2023) amongst others. However, when examining the impacts of global GPR on the category level, significant differences were identified between the categories. From that, it can be concluded that the effects of both local and global geopolitical risk vary significantly based on industry, market and type of supply chain. There is some support from prior literature with similar findings, such as Choudhury (2025) who found that some sectors are more associated with expected geopolitical risk than others. From the case company's perspective, categories B and E are more vulnerable to local geopolitical risk, while categories A, C and D are more vulnerable to global geopolitical risk. To conclude, the vulnerability to local or global factors depends on the supply chain. It could be analysed, if the difference in whether local or global geopolitical risks are more harmful, would be an indication to aim for a diversification or localization strategy.

The Incoterm® used caused significant variance in the delay and OTD of an order, however, there was no clear repetition of a pattern recognized. The Incoterms® can be roughly divided into two groups based on seller responsibility of transportation (CIP, CPT, DAP, DDP and DDU) and buyer responsibility of transportation (EXW and FCA) which defines how lead-time is treated in the used data. Delay was increased with high GPR in 3 out of 4 tests for CPT, however, no evident conclusion can be made from this finding. There is very little research on Incoterms®, and especially studies on implications for supply chains from both buyer and supplier perspective are very scarce (Vogt & Davis 2020, 304). Prior literature on geopolitical risks highlights the vulnerability of logistics during geopolitical tension (Alqaralleh et al. 2024). As Incoterms® are a widely used system for sharing the risks during transportation (Vogt & Davis 2020, 304), it could be a topic to investigate future within geopolitical risks' research. As delivery time was used as a measure, the consideration of different ship modes would have been crucial, as it impacts the delivery time tremendously.

The second sub question of this thesis was “*SQ2: What risk management strategies can be used for managing geopolitical risks in the maritime and energy sector?*”. This question will be addressed next, including risk management strategies used by the interviewees and strategies that could potentially be useful. In addition, challenges related to implementing these strategies will be covered.

Based on the findings of this thesis, diversification is noted as the most important strategy for managing geopolitical risks, which aligns with prior literature (Zhu et al. 2024; Lee & Baek 2025). It was considered important to diversify the supply base in terms of suppliers, countries, transport modes and production sites. In the literature, supply chain diversification has similarly been considered mainly in terms of suppliers, geographical locations, product lines (Lee & Baek 2025) and transport routes (Sielker & Dannenberg 2025). There are also other perspectives, such as Kahiluoto et al. (2020), who highlighted response diversity, i.e. the way supplier respond to disruptions. However, challenges and barriers related to implementing diversification were also identified. These challenges are especially related to a limited supply market, but also to other factors such as low purchasing power or hesitance for large investments. Yoon et al. (2020) also identified that diversification is not always feasible and suggested increasing visibility and information sharing as an alternative strategy. Similarly, the importance of communication, information sharing and maintaining good relationships were highlighted in the interviews. They are considered crucial in all cases, but especially in cases where diversification is not possible and there is need to rely on a single supplier. Furthermore, sharing information across functions within the organization is considered important. According to Roscoe et al. (2022) (Figure 3), difficulty moving facilities and switching suppliers is one of the key dimensions defining the supply chain logics implied by managers during

geopolitical disruption. For situations characterized by high difficulty moving suppliers, and high perceived supply chain disruption risk, Roscoe et al. (2022) identified two logics for supply chain decision making based on the level of institutional pressures. When institutional pressure is low, the supply chain logic is defined as “reduce complexity by rationalizing products and supplier numbers while simplifying process”, while with high institutional pressure, it is “enhance visibility and flexibility in moving production volumes between facilities”.

On the other hand, localization was considered as a strategy by multiple categories. Localization was considered in terms of having suppliers where they are needed, as in close to the case company’s production or other facilities. According to Bednarski et al. (2025), localization has been researched as a strategy to minimize the impacts of geopolitical disruptions, along with regionalization and backshoring. However, research lacks in analysis of the costs and viability of these strategies. Similar challenges were highlighted in the interviews, as the idea of a tool to calculate total costs of working with a lower cost supplier further away versus a more expensive supplier nearby was brought up, with the goal of having a systematic way of justifying a more expensive supplier. Additionally, Bednarski (2025) highlighted the perspective of considering the amount of investment needed for moving a chain of highly specialized suppliers into a different geographical area. The consideration is a balance between the advantages and costs of doing the investment.

A significant theme in this study and in related literature are the risks related to sub suppliers. Supply chains at the case company consist of multiple tiers, and visibility beyond the first tier is generally limited. The network of sub suppliers increases the vulnerability of the supply chains to more risks. Habibi et al. (2025) highlighted the increased risks related to multi-tier supply chain structures, and the different risks associated with specific tiers. Charpin and Cousineau (2025) found that when firms reduce their supply base as a result of geopolitical risks, the pool of sub-suppliers shrinks, resulting in sub supplier sharing and therefore exposure to more disruptions. While the risks related to limited visibility of sub suppliers is acknowledged, the interviewees mostly agree that there would be no resources for managing the massive number of sub suppliers, nor would it be a smart use of resources. However, some feel that it would be better to have more information about the sub tiers. Ang et al. (2017) found that firms have very differing levels of information about their sub tiers of suppliers. Furthermore, they suggested that when the degree of supplier sharing increases in the second tier, manufacturers prefer to induce first tier suppliers to mitigate risk via contract terms, instead of relying on direct mitigation efforts. Similarly, this study finds that it is crucial to select suppliers that are capable of managing the supply chains beyond them and audit their systems for supply chain management when needed. In most categories, it is required of the supplier to disclose the supplier

or supplier's country of the critical key components, to scan for potential risks related to single sourcing or geopolitical risks for instance.

For tariff risks, which were identified by multiple interviewees, the main risk mitigation actions included building buffers or safety stocks and negotiating contract clauses to agree on the sharing of potential price impacts related to tariffs. Similar findings were made by López et al. (2025), who identified strategic stock as a supply chain decision for mitigating trade war related risks, and Fang et al. (2026) who found that firms tend to buffer against external uncertainty. Buffers could also be considered in terms of lead time, as placing orders with a lead time longer than the agreed lead time with the goal of reserving capacity and allowing thorough planning of production and purchasing of subcomponents. The quantitative analyses in this study indicate that buyers could benefit from a lead time buffer when local geopolitical risk is high at the supplier's country. Buffers, both related to stock and to lead time, could help build redundancy in the supply chain, which is recommended by some literature for improving literature (Gereffi 2020; Kamalahmadi et al. 2022).

While it was generally agreed that key performance indicators, such as price levels, delivery times and delivery reliability can be used as measures to analyze the impacts of a risk after the fact, geopolitical risks cannot be proactively identified from these indicators. This supports the argument of Gao (2015), who claimed that traditional risk management methods that rely on historical data are no longer sufficient. It can be concluded that risk identification is likely the most challenging phase of managing geopolitical risks, due to their unpredictable nature. Roscoe et al. (2022) argued that the perceived level of geopolitical risk differs amongst managers. In general, most interviewees consider open conversations amongst the category team a valuable process for risk identification. In line with Thun and Hoenig (2011), risks are assessed in terms of likelihood and impact. As the category teams are local, they have a benefit of local presence in important countries, which can allow earlier identification of risks in some instances. Some proposed tools for risk identification include scenario planning, use of data and assistance of AI. Scenario planning has been researched by Joglekar and Phadnis (2020) for supply chain decision making and for anticipating regulatory disruptions in dyadic teams between the buyer and supplier (Phadnis & Joglekar 2021). Technologies, such as AI, have been researched from the perspective of supply chain management (Zaoui et al. 2025), supply chain diversification (Wu et al. 2025) and risk identification (Fang et al. 2026).

## **5.2 Theoretical contributions**

This study aimed to fill several gaps identified in the literature. By studying the management of geopolitical risks as a broader concept instead of focusing on a specific event, this study fills the gap

identified by Charpin and Cousineau (2025). Earlier research suggests that the perspectives on how to create supply chain strategies that protect the supply chains from geopolitical risks in the long run remains unclear (Zheng et al. 2025), which this study fills by exploring the strategies implied by different kinds of supply categories to improve resilience in the future, while considering the challenges that limit the capability to take these actions. In addition, it provides insights into the impacts of geopolitical disruptions on different kinds of supply chains, which is a lacking perspective in the literature (Duong et al. 2025). This study suggests that different kinds of supply chains are to some extent affected by different kinds of risks, some being more vulnerable to local risks while others are more affected by global events. It shows that the level of impacts to delivery reliability differs between categories characterized by different volumes, technologies, lead times and spend. Table 15 lists the key themes identified in the literature, and summarizes the key findings of this study for each theme.

**Table 15 Contributions to themes identified in theory**

Literature theme	Findings
Geopolitical risks	Main challenge of geopolitical risks is related to their unpredictability, and the uncertainty of global politics
Impacts or consequences of geopolitical risks	Impacts of geopolitical risks relate to price and availability, out of which availability is more severe Geopolitical risks impact supply chains locally (in direct supplier's country) and globally, but their priority depends on the supply chain
Supply chain vulnerability	Weak visibility to sub suppliers causes risk, and concentration of sub suppliers spreads the potential impact. Still, it is not efficient to aim to control the whole chain, but key is in selecting suppliers that can manage the chain onwards.
Supply chain risk management	Diversification and multi-sourcing protect the supply chain from a variety of risks, including geopolitical and more traditional risks Structural issues such as size of supply market, purchasing power, technology ownership and development, and investment related questions significantly affect the viability of diversification of suppliers Different types of diversification, such as by suppliers, by countries, by production sites or by transport routes can be applied Localization is seen to protect the supply chain from some disruptions, for instance related to trade regulation Flow of information, between the buyer and the supplier, and within the organization is crucial Geopolitical risks are a type of risk source, but many traditional supply chain risk management processes and strategies apply Lead time buffers may be beneficial when local GPR is high at supplier's country
Measuring geopolitical risk	GPR Index had statistically significant differences between groups. Traditional measures, such as KPIs can be used for measuring the impacts of an already realized geopolitical risk, but more proactive measures are needed for identification.

This study advances theoretical understanding by identifying the central challenges related to managing geopolitical risks in global supply chains. One of the key findings of this study that can be applied to theory is the understanding that the management of geopolitical risks in global supply chains utilizes similar risk management strategies and techniques as supply chain risk management in general, but the main issue lies in identifying the risks. It extends the argument that forward-looking and proactive systems are needed for successful risk management (Gao 2015) to the context of geopolitical risks. The identification of geopolitical risks requires understanding of the future, whereas in identifying the typical risks within supply chains, such as capacity issues, can more often be identified by analysing the current state. This study enhances the understanding that the impacts of geopolitical risks on supply chains can arise from indirect factors, such as conflicts happening in a geographical area where no direct suppliers are located, or from changes in the demand market.

Overall, this study provides empirical evidence from a globally operating company to further the development of the new subfield of research focusing on the effects of geopolitical disruptions on supply chains identified by Bednarski et al. (2025). Furthermore, it provides quantitative findings on the impacts of geopolitical risks on supply chains, as called for by Charpin and Cousineau (2025).

### **5.3 Managerial implications**

This study provides insights into the main challenges related to geopolitical risks from the perspective of supply chains, and how they could potentially be managed. The findings can be used by managers at the case company and in other organizations in a similar industry. For the case company, it is evident that categories have a good understanding of how they can manage risks identified in their category. Therefore, the main development area in terms of geopolitical risks at the case company lies in identifying the risks specific to each category. This study implies that local and global geopolitical risks have different ways of impacting supply chains, and some supply chains are more vulnerable to local factors, while some to global factors. To manage geopolitical risks effectively, organizations should analyze the local and global geopolitical factors that increase the level of risk the most. It is perhaps best to assess on a category level, as they operate in different geographical and product markets, exposing them to different risks and vulnerabilities. Scenario planning could be considered on the category level, to enhance understanding of the variety of potential futures and in turn help identify the risks that could directly or indirectly affect the supply.

A systematic way of reviewing and assessing risks would be beneficial, as it enables the proactive initiation of risk mitigation actions (Busse et al. 2026). However, the ways and processes of conducting the management and mitigation phase of the process is category specific. Geopolitical

risks are recommended to consider when selecting a new supplier, and regularly as part of a systematic process, such as strategy creation. It could be beneficial to analyze, whether the supply chain under analysis is more vulnerable to local or global geopolitical risk, and determine actions based on that. Risk management actions for a supply chain more dependent on local factors could include actions related to the supplier or suppliers such as having alternative suppliers or building buffers, while a supply chain more affected by global factors could benefit from actions such as alternative transport routes, or analysis of the next tiers of the supply chain. In defining a systematic process for geopolitical risk identification, an effective organization-wide framework for methodologies related to geopolitical risk identification would be one that helps the managers think of factors beyond the direct supply chain that could cause disruptions down the line but not limit their ability to apply their experience and understanding of the environment in selecting the actions implemented. For example, a scenario planning process (such as in Figures 4 and 5) could be defined by the organization and executed by category teams.

Based on the results, diversification of supply should be aimed for whenever possible, as it is seen to mitigate a variety of risks. This study highlights the importance of exploring different kinds of diversification, for instance diversification of suppliers, geographical areas, transport routes and production sites. The suggestion of Kahiluoto et al. (2020) to increase resilience by diversifying supply in terms of how they respond to disruptions, is also an interesting idea for this context. When diversification of suppliers is not possible due to limitations in the market, other forms, such as diversification of production sites or transport routes could be considered.

While localization is also seen as an effective strategy to mitigate geopolitical risks, managers should be cautious about not causing the pool of sub suppliers to not become too concentrated. If many supply chains are moved to the same geographical area, it is likely to lead to dependence on a smaller number of suppliers of tier 2 shared by the direct suppliers, which causes the effects of a disruption to spread (Charpin & Cousineau 2025). Still, having suppliers near the focal firm's operations is seen to reduce the level of risk in the supply. Suppliers located further away leads to reliance on remote control and grows the importance of monitoring risks related to transportation and global geopolitical risks.

Managers should consider increasing visibility to suppliers beyond the first tier, if possible. While it is not possible, or efficient use of resources to monitor every sub supplier, it is agreed that suppliers of critical sub supplier would be important to recognize. On the other hand, it is helpful to audit or perhaps co-develop the direct suppliers' processes for supply management, as they carry the

responsibility of the supply chain onwards. Single sourcing and high levels of supplier sharing should be avoided in the second tier and onwards.

Lead time buffers could be effective in improving delivery reliability when local geopolitical risk at the supplier's country is high. In practice, it requires placing orders earlier than required based on agreed lead time for a component. In other scenarios, while orders were on average delivered with a slightly better rate of on-time delivery when lead time buffer was high, the difference is quite minimal assuming order is not placed under the agreed lead time. However, the difference is significant, if order is placed under the agreed lead time. Therefore, it is crucial to ensure that agreed lead times are accurate and aligned with the time needed at the supplier. Furthermore, purchases should be planned in a way that orders under lead time are avoided. This highlights the importance of intra-organizational communication, to avoid urgent unplanned requirements.

#### **5.4 Limitations and future research**

As this study focuses on a single case organization, a key limitation of it is in its generalizability to theory or other organizations. While the conclusions made can aid the decision-making in other organizations, the findings are limited to the case organization. A limitation in the used quantitative data, is that it extends only to the past four years. There are also some limitations related to measurements in the quantitative data, as for example the OTD indicator is used as a binary indicator, and it does not consider the extent or reasons behind the of delay. While the lateness indicator considers the number of days in delay, it does not consider the reasons behind the delay, which could relate for example the request of the buyer to postpone a delivery. The GPR index is also applied only at the time of original requested delivery date and does not therefore take into account the level of GPR during the manufacturing of the components or at the time of the actual delivery, if its advanced or postponed.

Furthermore, the quantitative results could be analysed further, for example by identifying significant geopolitical events in that time frame and analysing whether there is a difference in the impact relationship based on if and how these events have been acknowledged and managed. An interesting direction for future research would be to conduct research on different industries, for example through conducting a similar study using a multiple case approach. This would allow the comparison of results and better generalization of findings. For the case organization, conducting scenario planning for example as action research could be an interesting way to continue this research.

Future research should aim to find tools for identifying future geopolitical risks in a resource effective way. For example, applications of data analysis and AI could be researched further. An interesting direction could also be research on the mechanisms in which geopolitical risk is realized as supply chain impacts.

## 6 Summary

The purpose of this study was to investigate the management of geopolitical risks and disruptions on global supply chains in the maritime and energy sectors. As the frequency of geopolitical risks is growing and the global business environment is characterized by constant changes, it was vital to explore the ways in which these risks can be managed from the supply chain perspective. The study was executed as a single case study for a company operating in the maritime and energy sectors.

The literature review was divided into three sections. First, the concept of geopolitical risks and how they arise were discussed. Next, they were divided into six different categories and the impacts related to each type of risk were summarised. Furthermore, cyber risks, their impacts and role as a geopolitical risk were discussed. Lastly, the processes and strategies of supply chain risk management were presented, after which their applicability to geopolitical risks was analysed.

The empirical part of this study was conducted with a qualitative-driven mixed methods approach. Semi structured interviews were conducted in the case company supply management, to understand the ways in which geopolitical risks impact supply chains and how they could be managed. Quantitative secondary data was retrieved from the case organization and the GPR index, to analyze the extent to which local and global geopolitical risk impacts global supply chains. This study focused on five supply categories with different types of products and supply chains.

The findings of this study suggested that geopolitical risks impact global supply chains directly and indirectly. It was found that different supply categories are exposed to different levels of impact from geopolitical risks. Furthermore, some are more strongly impacted by local factors, while some by global. Differences between utilized Incoterms® were also explored, but while there were significant differences between the results of each type, there was no clear logic behind these differences and the reasons behind them.

The results highlighted the significance of identification of geopolitical risk as a prerequisite for managing them. It was concluded that while more proactive, forward-looking tools are needed for the identification of geopolitical risks, the ways in which they can be managed align with traditional practices of supply chain risk management. Diversification is discussed as the key strategy for managing geopolitical risks, while there are several limitations related to its implementation.

## References

- Alexander, A. – Blome, C. – Schleper, M. – Roscoe, S. (2022) Managing the “new normal”: the future of operations and supply chain management in unprecedented times. *International Journal of Operations & Production Management*, Vol. 42 (8), 1061-1076.
- Alqaralleh, H. – Khoury, R. – Alshater, M. (2024) Tail-risk spillovers and interconnectedness in international logistics markets: a QVAR approach. *Cogent Economics & Finance*, Vol. 12 (1), 2411558.
- Ambulkar, S. – Blackhurst, J. – Grawe, S. (2015) Firm’s resilience to supply chain disruptions: Scale development and empirical examination. *Journal of Operations Management*, Vol. 33-34 (1), 111-122.
- Ang, E. – Iancu, D. – Swinney, R. (2017) Disruption Risk and Optimal Sourcing in Multitier Supply Networks. *Management Science*, Vol. 63 (8), 2397-2419.
- Angrist, J. – Krueger, A. (1999) Empirical strategies in labor economics. In: *Handbook of Labor Economics Vol. 3*, eds. Orley Ashenfelter – David Card, 1277-1366. Elsevier.
- Bai, X. – Zhou, K. – Zhang, B. – Xie, E. (2025) The dual effects of geopolitical risk on MNCs’ first-tier supply base: a political economy perspective. *Journal of International Business Studies*, Vol. 56 (9), 1125-1149.
- Bednarski, L. – Roscoe, S. – Blome, C. – Schleper, M. (2025) Geopolitical disruptions in global supply chains: a state-of-the-art literature review. *Production Planning & Control*, Vol. 36 (4), 536-562.
- Bieber, F. (2018) Is Nationalism on the Rise? Assessing Global Trends. *Ethnopolitics*, Vol. 17 (5), 519-540.
- Bier, T. – Lange, A. – Glock, C. (2020) Methods for mitigating disruptions in complex supply chain structures: a systematic literature review. *International Journal of Production Research*, Vol. 58 (6), 1835-1856.
- Bode, C. – Wagner, S. (2015) Structural drivers of upstream supply chain complexity and the frequency of supply chain disruptions. *Journal of Operations Management*, Vol. 36, 215-228.
- Bondarenko, Y. – Lewis, V. – Rottner, M. – Schüler, Y. (2024) Geopolitical risk perceptions. *Journal of International Economics*, Vol. 152., 104005.
- Bueno-Solano A. – Cedillo-Campos, M. (2014) Dynamic impact on global supply chains performance of disruptions propagation produced by terrorist acts. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 61, 1-12.

- Busse, C. – Duensing, S. – Schleper, M. (2026) Supply chain (as) risk: a unifying typology. *International Journal of Operations & Production Management*, Vol. 46 (13), 63-94.
- Büyüközkan, G. & Göçer, F. (2018) Digital Supply Chain: Literature review and a proposed framework for future research. *Computers in Industry*, Vol. 97, 157-177.
- Braun, V. – Clarke, V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology*, Vol. 3 (2), 77-101.
- Caldara, D. – Iacoviello, M. (2022) Measuring Geopolitical Risk. *American Economic Review*, Vol. 122 (4), 1194-1225.
- Case Company (2025) Annual Report.
- Case Company, website. retrieved 29.3.2026.
- Chang, X. – Song, Z. – Zhou, T. (2025) Geopolitical risk and global supply chain resilience. *Finance Research Letters*, Vol. 86, 1-8.
- Charpin, R. (2022) The resurgence of nationalism and its implications for supply chain risk management. *International Journal of Physical Distribution & Logistics Management*, Vol. 52 (1), 4-28.
- Charpin, R. – Cousineau, M. (2025) Friendshoring: how geopolitical tensions affect foreign sourcing, supply base complexity, and sub-tier supplier sharing. *International Journal of Operations & Production Management*, Vol. 45 (5), 1006-1031.
- Chen, J. – Fang, Q. – Li, C. – Xu, X. – Mao, Y. – Yu, F. (2025) Impact of the Russia-Ukraine conflict on the resilience of global shipping supply chains. *Regional Studies in Marine Science*, Vol. 91, 1-12.
- Chiang, C. (2010) An order expediting policy for continuous review systems with manufacturing lead-time. *European Journal of Operational Research*, Vol. 203, 526-531.
- Choksy, U. – Kurt, Y. – Gölgeci, I. – Khna, Z. – Shamim, S. – Jawad, M. (2025) Resilience of GVC suppliers in politically unstable regions: The roles of governance and trust. *International Business Review*, Vol. 34 (6), 102465.
- Choudhury (2025) US sectors and geopolitical risk: The investor's perspective. *Finance Research Letters*, Vol. 73, 106690.
- Christopher, M. – Peck, H. (2004) Building the Resilient Supply Chain. *The International Journal of Logistics Management*, Vol. 15 (2), 1-14.
- Confederation of Finnish Industries: Geotalouden murroksessa. Riskit ja mahdollisuudet yrityksille. (2025)
- Council of the European Union (2017) Regulation (EU) 2017/821 of the European Parliament and of the Council laying down supply chain due diligence obligations for Union importers of

tin, tantalum and tungsten, their ores, and gold originating from conflict-affected and high-risk areas. [https://eur-](https://eur-lex.europa.eu/legalcontent/EN/TXT/HTML/?uri=CELEX:32017R0821&from=EN)

[lex.europa.eu/legalcontent/EN/TXT/HTML/?uri=CELEX:32017R0821&from=EN](https://eur-lex.europa.eu/legalcontent/EN/TXT/HTML/?uri=CELEX:32017R0821&from=EN)

- Davarzani, H. – Farahani, R. – Rahmandad, H. (2015) Understanding econo-political risks: impact of sanctions on an automotive supply chain. *International Journal of Operations & Production Management*, Vol. 35 (11), 1567-1591.
- Demir, I. – Aydın, H. – Erkal, G. – Yalçınkaya, Ö. (2025) The effects of global uncertainty and risks on metal prices: Evidence from frequency and time domain causality tests. *Resources Policy*, Vol. 103, 105555.
- Deng, Z. – Wang, Y. – Xu, H. (2025) Supplier response to Apple's friendshoring. *Journal of Business Research*, Vol. 200, 115614.
- Dolgui, A. – Ivanov, D. – Rozhkov, M. (2020) Does the ripple effect influence the bullwhip effect? An integrated analysis of structural and operational dynamics in the supply chain. *International Journal of Production Research*, Vol. 58 (5), 1285-1301.
- Dong, L. – Kouvelis, P. (2020) Impact of Tariffs on Global Supply Chain Network Configuration: Models, Predictions, and Future Research. *Manufacturing & Service Operations Management*, Vol. 22 (1), 25-35.
- Duong, L. – Sanderson, H. – Phillips, W. – Roehrich, J. – Uwalaka, V. (2025) Achieving resilient supply chains: managing temporary healthcare supply chains during a geopolitical disruption. *International Journal of Operations & Production Management*, Vol. 45 (5), 1090-1118.
- Durach, C. – Peers, Y. – Wang, Y. – Repasky, T. (2024) Mitigating upstream disruptions: Effects of extended inventories in first- and second-tier suppliers. *Journal of Operations Management*, Vol. 70 (8), 1261-1285.
- El Baz, J. – Ruel, S. (2021) Can supply chain risk management practices mitigate the disruption impacts on supply chains' resilience and robustness? Evidence from an empirical survey in a COVID-19 outbreak era. *International Journal of Production Economics*, Vol. 233, 1-12.
- Eriksson, Päivi – Kovalainen, Anne (2016) *Qualitative methods in business research*. Sage Publications, London.
- Eskola, J. – Suoranta, J. (1998) *Johdatus laadulliseen tutkimukseen*. Vastapaino, Tampere.
- European Council (2025) Energy prices and security of supply. <https://www.consilium.europa.eu/en/policies/energy-prices-and-security-of-supply/>. accessed 30.01.2026.

- European Council: Russia's war against Ukraine: EU sanctions. <  
<https://www.consilium.europa.eu/en/policies/sanctions-against-russia/>> accessed 23.02.2026
- Fan, D. – Yeung, A. – Tang, C. – Lo, C. – Zhou, Y. (2022) Global operations and supply-chain management under the political economy. *Journal of Operations Management*, Vol. 68 (8), 816-823.
- Fang, J. – Su, B. – Wang, S. – Wang, B. (2026) Uncovering the risks of digital supply chains: A large language model framework for semantic identification and validation. *International Journal of Production Economics*, Vol. 291, 109858.
- Fang, C. – Xu, R. (2026) Exploring the impact of US-China tensions on innovation outputs: The moderating role of the financial sectors in both countries. *Technology in Society*, Vol. 84, 1-15.
- Feng, Y. – Sabir, S. – Quddus, A. – Wang, J. – Abbas, S. (2024) Do the grey clouds of geopolitical risk and political globalization exacerbate environmental degradation? Evidence from resource-rich countries. *Resources Policy*, Vol. 89, 1-11.
- Flyvbjerg, B. (2006) Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, Vol. 12 (2), 219-245.
- Field, A. (2024) *Discovering Statistics Using IBM SPSS Statistics*. London, Sage Publications.
- Gao, H. – Ren, M. – Shih, T. (2023) Co-evolutions in global decoupling: Learning from the global semiconductor industry. *International Business Review*, Vol. 32 (6), 102118.
- Gao, L. (2015) Collaborative forecasting, inventory hedging and contract coordination in dynamic supply risk management. *European Journal of Operational Research*, Vol. 245 (1), 133-145.
- Geopolitical Risk (GPR) Index by Caldara and Iacoviello.  
 <<https://www.matteoiacoviello.com/gpr.htm>>
- Georgoulas, D. – Tsioumas, V. – Stavroulakis, P. – Papadimitriou, S. (2025) Geopolitical risk and sustainable shipping: a quantitative approach. *Australian Journal of Maritime & Ocean Affairs*, Vol. 17 (2), 173-185.
- Gereffi, G. (2020) What does the COVID-19 pandemic teach us about global value chains? The case of medical supplies. *Journal of International Business Policy*, Vol. 3, 287-301.
- Gereffi, G. – Lee, J. (2012) Why the World Suddenly Cares About Global Supply Chains. *Journal of Supply Chain Management*, Vol. 48 (3), 24-32.
- Gerring, J. (2016) *Case study research: principles and practices*. Cambridge: Cambridge University Press, 2016.

- Habibi, F. – Chakraborty, R. – Abbasi, A. – Ho, W. (2025) Investigating disruption propagation and resilience of supply chain networks: interplay of tiers and connections. *International Journal of Production Research*, Vol. 63 (17), 6229-6251.
- Han, Y. – Chong, W. – Li, D. (2020) A systematic literature review of the capabilities and performance metrics of supply chain resilience. *International Journal of Production Research*, Vol. 58 (15), 4541-4566.
- Handfield, R. – Graham, G. – Burns, L. (2020) Corona virus, tariffs, trade wars and supply chain evolutionary design. *International Journal of Operations & Production Management*, Vol. 40 (10), 1649-1660.
- Handfield, R. – Earp, J. – Sadeghi, A. (2025) Reducing cybersecurity vulnerabilities in the supply base: Insights from cyber experts. *Technology in Society*, Vol. 82, 102947.
- Hansen, C. – Mena, C. – Skipworth, H. (2017) Exploring political risk in offshoring engagements. *International Journal of Production Research*, Vol. 55 (7), 2051-2067.
- Hallikas, J. – Karvonen, I. – Pulkkinen, U. – Virolainen, V. – Tuominen, M. (2004) Risk management processes in supplier networks. *International Journal of Production Economics*, Vol. 90 (1), 47-58.
- Hasse-Biber, S. – Nagy – Burke, J. (2015) *The Oxford handbook of multimethod and mixed methods research inquiry*. Oxford University Press, New York.
- Hendry, L. – Stevenson, M. – MacBryde, J. – Ball, P. – Sayed, M. – Lie, L. (2019) Local food supply chain resilience to constitutional change: the Brexit effect. *International Journal of Operations & Production Management*, Vol. 39 (3), 429-453.
- Herold, D. – Marzantowicz, L. (2023) Supply chain responses to global disruptions and its ripple effects: an institutional complexity perspective. *Operations Management Research*, Vol. 16, 2213-2224.
- Hirsjärvi, S. – Hurme, H. (1991) *Teema-haastattelu*. Helsinki: Yliopistopaino.
- Hirsjärvi, S. – Remes, P. – Sajavaara, P. – Sinivuori, E. (2009) *Tutki ja kirjoita*. Helsinki: Kustannusosakeyhtiö Tammi.
- Ho, W. – Zheng, T. – Yildiz, H. – Talluri, S. (2015) Supply chain risk management: a literature review. *International Journal of Production Research*, Vol. 53 (16), 5031-5069.
- Hurmerinta-Peltomäki, L. – Nummela, N. (2004) First the Sugar, Then the Eggs... Or the Other Way Round? Mixing Methods in International Business Research. In: *Handbook of Qualitative Research Methods for International Business*, eds. Rebecca Piekkari – Catherine Welch, 162-180. Edward Elgar Publishing.

- IEA (2025) World Energy Outlook 2025. <<https://www.iea.org/reports/world-energy-outlook-2025>> retrieved 29.3.2026.
- Ivanov, D. (2020) Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 136, 101922.
- Ivanov, D. (2021) Supply Chain Viability and the COVID-19 pandemic: a conceptual and formal generalisation of four major adaptation strategies. *International Journal of Production Research*, Vol. 59 (12), 3535-3552.
- Jacobs, B. – Singhal, V. – Zhan, X. (2022) Stock market reaction to global supply chain disruptions from the 2018 US government ban on ZTE. *Journal of Operations Management*, Vol. 68 (8), 903-927.
- Joglekar, I. – Phadnis, S. (2021) Accelerating supply chain scenario planning. *MIT Sloan Management Review*, Vol. 62 (2), 73-76.
- Jüttner, U. – Peck, H. – Christopher, M. (2003) Supply chain risk management: outlining an agenda for future research. *International Journal of Logistics: Research and Applications*, Vol. 6 (4), 197-210.
- Kahiluoto, H. – Mäkinen, H. – Kaseva, J. (2020) Supplying resilience through assessing diversity of responses to disruption. *International Journal of Operations & Production Management*, Vol. 40 (3), 271-292.
- Khan, K. – Khurshid, A. – Cifuentes-Faura, J. (2025) Do geopolitical risks induce a butterfly effect on cybersecurity? *Information Development*, 1-14.
- Kamalahmadi, M. – Parast, M. (2016) A review of the literature on the principles of enterprise and supply chain resilience: Major findings and directions for future research. *International Journal of Production Economics*, Vol 171, 116-133.
- Kamalahmadi, M. – Shekarian, M. – Parast, M. (2022) The impact of flexibility and redundancy on improving supply chain resilience to disruptions. *International Journal of Production Research*, Vol. 60 (6), 1992-2020.
- Katsaliaki, K. – Galetsi, P. – Kumar, S. (2022) Supply chain disruptions and resilience: a major review and future research agenda. *Annals of Operations Research*, Vol. 319, 965-1002.
- Kauppi, K. – Longoni, A. – Caniato, F. – Kuula, M. (2016) Managing country disruption risks and improving operational performance: risk management along integrated supply chains. *International Journal of Production Economics*, Vol. 182, 484-495.
- Kovács, G. – Sigala, F. (2021) Lessons learned from humanitarian logistics to manage supply chain disruptions. *Journal of Supply Chain Management*, Vol. 57 (1), 41-49.

- Lee, B. – Preston, F. (2012) Preparing for High-impact, Low-probability Events: Lessons from Eyjafjallajökull. Chatham House, London.
- Lee, H. (2004) The Triple-A Supply Chain. *Harvard Business Review*, Vol. 82 (10), 102-112.
- Lee, H. – Baek, S. (2025) South Korea's supply chain diversification in response to geopolitical risk: evidence from change point detection approach to battery industry. *Asia Pacific Business Review*, 1-25.
- Li, Y. – Zhu, L. (2014) Cost of energy saving and CO2 emissions reduction in China's iron and steel sector. *Applied Energy*, Vol. 130, 603-616.
- Li, Y. – Chen, K. – Collignon, S. – Ivanov, D. (2021) Ripple effect in the supply chain network: Forward and backward disruption propagation, network health and firm vulnerability. *European Journal of Operational Research*, Vol. 291 (3), 1117-1131.
- Lincoln, Y. – Guba, E. (1985) *Naturalistic Inquiry*. Sage Publications, Newbury Park.
- Linneman, R. – Klein, H. (1983) The Use of Multiple Scenarios by U.S. Industrial Companies: A Comparison Study, 1977-1981. *Long Range Planning*, Vol. 16 (6), 94-101.
- López, C. – Morales-Contreras, M.F. – Langella, I.M. – Alonso-Monge, J. (2025) Modeling supply chain disruptions due to geopolitical Reasons: A systematic literature review. *Transportation Research Part E*. Vol. 202, 104290.
- Lorenz, U. – Veenhoff, S. (2013) Integrated scenarios of sustainable food production and consumption in Germany. *Sustainability: science, practice & policy*, Vol. 9 (2), 92-104.
- Mackay, J. – Munoz, A. – Pepper, M. (2020) Conceptualising redundancy and flexibility towards supply chain robustness and resilience. *Journal of Risk Research*, Vol. 23 (12), 1541-1561.
- Maersk: Rerouting of ME11 and MECL Service around The Cape of Good Hope, 01.03.2026. <<https://www.maersk.com/news/articles/2026/03/01/me11-mecl-rerouting-cape-of-good-hope-march>> accessed 02.03.2026.
- Manuj, I. – Esper, T. – Stank, T. (2014) Supply Chain Risk Management Approaches Under Different Conditions of Risk. *Journal of Business Logistics*, Vol. 35 (3), 241-258.
- Manuj, I. – Mentzer, J. (2008) Global supply chain risk management strategies. *International Journal of Physical Distribution & Logistics Management*, Vol. 38 (3), 192-223.
- Martínez-Mora, C. – Merino, F. (2014) Offshoring in the Spanish footwear industry: A return journey? *Journal of Purchasing & Supply Management*, Vol. 20, 225-237.
- Mei, D. – Ma, F. – Liao, Y. – Wang, L. (2020) Geopolitical risk uncertainty and oil future volatility: Evidence from MIDAS models. *Energy Economics*, Vol. 86, 104624.

- Melkonyan, A. – Krumme, K. – Gruchmann, T. – Spinler, S. – Schumacher, T. – Bleischwitz, R. (2019) Scenario and strategy planning for transformative supply chains within a sustainable economy. *Journal of Cleaner Production*, Vol. 231, 144-160.
- Melnyk, S. – Schoenherr, T. – Speier-Pero, C. – Peters, C. – Chang, J. – Friday, D. (2022) New challenges in supply chain management: cybersecurity across the supply chain. *International Journal of Production Research*, Vol. 60 (1), 162-183.
- Mero-Jaffe, I. (2011) 'Is that what I said?' Interview Transcript Approval by Participants: An Aspect of Ethics in Qualitative Research. *International Journal of Qualitative Methods*, Vol. 10 (3), 231-247.
- Meyer, B. (1995) Natural and Quasi-Experiments in Economics. *Journal of Business & Economic Statistics*, Vol. 13 (2).
- Meyer, K. (2017) International business in an era of anti-globalization. *Multinational Business Review*, Vol. 25 (2), 78-90.
- Ministry of Digital Affairs, Republic of Poland: Energy Sector Incident Report – 29 December. <  
[https://cert.pl/uploads/docs/CERT\\_Polska\\_Energy\\_Sector\\_Incident\\_Report\\_2025.pdf](https://cert.pl/uploads/docs/CERT_Polska_Energy_Sector_Incident_Report_2025.pdf)>
- Mital, M. – Giudice, M. – Papa, A. (2018) Comparing supply chain risks for multiple product categories with cognitive mapping and Analytic Hierarchy Process. *Technological Forecasting & Social Change*, Vol. 131, 159-170.
- Moradlou, H. – Reefke, H. – Skipworth, H. (2021) Geopolitical disruptions and the manufacturing location decision in multinational company supply chains: a Delphi study on Brexit. *International Journal of Operations & Production Management*, Vol. 41 (2), 102-130.
- Niu, B. – Lai, C. – Wang, H. (2026) Shipment consolidation in assembly supply chains: Delivery delay, competition dynamics and resilience analysis. *Ocean & Coastal Management*, Vol. 271.
- Norrman, A. – Jansson, U. (2004) Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident. *International Journal of Physical Distribution & Logistics Management*, Vol. 34 (5), 434-456.
- Norrman, A. – Wieland, A. (2020) The development of supply chain risk management over time: revisiting Ericsson. *International Journal of Physical Distribution & Logistics Management*, Vol. 50 (6), 641-666.
- Pagh, J. – Cooper, M. (1998) Supply Chain Postponement and Speculation Strategies: How to Choose the Right Strategy. *Journal of Business Logistics*, Vol. 19 (2), 13-33.
- Park, Y. – Hong, P. – Roh, J. (2013) Supply chain lessons from the catastrophic natural disaster in Japan. *Business Horizons*, Vol. 56, 75-85.

- Pedroletti, D. – Ciabuschi, F. (2023) Reshoring: A review and research agenda. *Journal of Business Research*, Vol. 164, 114005.
- Phadnis, S. – Caplice, C. – Sheffi, Y. – Singh, M. (2015) Effect of scenario planning on field experts' judgement of long-range investment decisions. *Strategic Management Journal*, Vol. 36 (9), 1401-1411.
- Phadnis, S. – Joglekar, N. (2021) Configuring Supply Chain Dyads for Regulatory Disruptions: A Behavioral Study of Scenarios. *Production and Operations Management*, Vol. 30 (4), 1014-1033.
- Phadnis, S. (2023) A review of research on supply chain adaptability: Opening the black box. *Journal of Business Logistics*, Vol. 45 (1), 1-30.
- Quan, Y. – Liu, Z. – Benaben, F. – Montreuil, B. (2026) Leveraging large language models to enhance multi-agent risk assessment in supply chain networks. *International Journal of Production Research*, 1-29.
- Rai, A. (2025) Turbulent waters in the red sea: understanding maritime shipping business impacts and implications. *Journal of Transportation Security*, Vol. 18 (1), 17.
- Ramanujam, V. – Varadarajan, P. (1989) RESEARCH ON CORPORATE DIVERSIFICATION: A SYNTHESIS. *Strategic Management Journal*, Vol. 10 (6), 523-551.
- Ramirez, Z. – Le, T. (2025) Semiconductor supply chain resilience: Systematic review, conceptual framework, implementation challenges, and future research directions. *Computers & Industrial Engineering*, Vol. 210, 111518.
- Roscoe, S. – Skipworth, H. – Aktas, E. – Habib, F. (2020) Managing supply chain uncertainty arising from geopolitical disruptions: evidence from the pharmaceutical industry and Brexit. *International Journal of Operations & Production Management*, Vol. 40 (9), 1499-1529.
- Roscoe, S. – Aktas, E. – Petersen, K. – Skipworth, H. – Handfield, R. – Habib, F. (2022) Redesigning global supply chains during compounding geopolitical disruptions: the role of supply chain logics. *International Journal of Operations & Production Management*, Vol. 42 (9), 1407-1434.
- Roslyn, C. – Xanthe, G. (2023) *Handbook of Mixed Methods Research in Business and Management*. Edward Elgar Publishing, Cheltenham.
- Saunders, M. – Lewis, P. – Thornhill, A. (2023) *Research Methods for Business Students*. Harlow, Pearson International Content.
- Sarkar, S. – Kumar, S. (2015) A behavioral experiment on inventory management with supply chain disruption. *International Journal of Production Economics*, Vol. 169, 169-178.

- Sawik, T. (2022) Balancing cybersecurity in a supply chain under direct and indirect cyber risks. *International Journal of Production Research*, Vol. 60 (2), 766-782.
- Schoemaker, P. (1993) Multiple scenario development: Its conceptual and behavioral foundation. *Strategic Management Journal*, Vol. 14 (3), 193-213.
- Schoenherr, T. – Swink, M. (2012) Revisiting the arcs of integration: Cross-validations and extensions. *Journal of Operations Management*, Vol. 30 (1-2), 99-115.
- Shekarabi, S. – Mavi, R. – Mavi, N. – Macau, F. – Arisian, S. (2025) A novel robust optimization approach for supply chain resilience: The role of flexibility and collaboration. *International Journal of Production Economics*, Vol. 287, 1-23.
- Shukla, M. – Sarmah, S. – Tiwari, M. (2023) A multi-objective framework for the identification and optimisation of factors affecting cybersecurity in the Industry 4.0 supply chain. *International Journal of Production Research*, Vol. 61 (15), 6266-5281.
- Sielker, F. – Dannenberg, P. (2025) New economic geographies of war: risks and disruptions in Eurasian transport routes and supply chains through the military conflict in Ukraine. *ZFW – Advanced in Economic Geography*, Vol. 69 (1), 41-54.
- Sodhi, M. – Tang, C. (2021) Supply Chain Management for Extreme Conditions: Research Opportunities. *Journal of Supply Chain Management*, Vol. 57 (1), 7-16.
- Srai, J. – Graham, G. – Van Hoek, R. – Joglekar, N. – Lorentz, H. (2023) Impact pathways: unhooking supply chains from conflict zones—reconfiguration and fragmentation lessons from the Ukraine–Russia war. *International Journal of Operations & Production Management*, Vol. 43 (13), 289-301.
- Sullivan, A. (2010) Piracy in the Horn of Africa and its effects on the global supply chain. *Journal of Transportation Security*, Vol. 3, 231-243.
- Tan, W. – Wang, W. – Zhang, W. (2024) The Effects of Terrorist Attacks on Supplier-Customer Relationships. *Production & Operations Management*, Vol. 33 (1), 146-165.
- Technology Industry Employers of Finland (2025) The Fourth Strike Week of the Year Begins – No Solution in Mediation Yet. < <https://teknologiateollisuus.fi/teknologiatyonantajat/en/the-fourth-strike-week-of-the-year-begins-no-solution-in-mediation-yet/>> accessed 27.02.2026
- The European Commission (2025) Access2Markets: Section 232 tariffs on steel and aluminum imports. [https://trade.ec.europa.eu/access-to-markets/fti/barriers/details?barrier\\_id=14162](https://trade.ec.europa.eu/access-to-markets/fti/barriers/details?barrier_id=14162).
- The European Commission (2021) Consequences of Brexit. <[https://commission.europa.eu/strategy-and-policy/relations-united-kingdom/new-normal/consequences-brexit\\_en](https://commission.europa.eu/strategy-and-policy/relations-united-kingdom/new-normal/consequences-brexit_en)> accessed 02.03.2026.

- The White House (2025) Fact Sheet: President Donald J. Trump Restores Section 232 Tariffs. <https://www.whitehouse.gov/fact-sheets/2025/02/fact-sheet-president-donald-j-trump-restores-section-232-tariffs/>
- Thun, J. – Hoenig, D. (2011) An empirical analysis of supply chain risk management in the German automotive industry. *International Journal of Production Economics*, Vol. 131 (1), 242-249.
- Tse, Y. – Dong, K. – Sun, R. – Mason, R. (2024) Recovering from geopolitical risk: An event study of Huawei’s semiconductor supply chain. *International Journal of Production Economics*, Vol. 275, 109347.
- Tran, N. – Haralambides, H. – Notteboom, T. – Cullinane, K. (2025) The costs of maritime supply chain disruptions: The case of the Suez Canal blockage by the ‘Ever Given’ megaship. *International Journal of Production Economics*, Vol. 279, 109464.
- UK Government (2025) Russia sanctions: guidance. < <https://www.gov.uk/government/publications/russia-sanctions-guidance/russia-sanctions-guidance>> accessed 23.02.2026
- UNCTAD (2025) Review of maritime transport 2025. < <https://unctad.org/publication/review-maritime-transport-2025>> retrieved 29.3.2026.
- U.S. Department of State: Ukraine and Russia Sanctions. < <https://www.state.gov/division-for-counter-threat-finance-and-sanctions/ukraine-and-russia-sanctions>> accessed 23.02.2026
- Van Hoek, R. (2001) The rediscovery of postponement a literature review and directions for research. *Journal of Operations Management*, Vol. 19 (2), 161-184.
- Verschuur, J. – Lumma, J. – Hall, J. (2025) Systemic impacts of disruptions at maritime chokepoints. *Nature Communications*, Vol. 16 (1), 10421-13.
- Vlaskamp, M. (2019) The European Union and natural resources that fund armed conflicts: Explaining the EU’s policy choice for supply chain due-diligence requirements. *Cooperation and Conflict*, Vol. 54 (3), 407-425.
- Vogt, J. – Davis, J. (2020) The State of Incoterm® Research. *Transportation Journal*, Vol. 59 (3), 304-324.
- Wagner, S. – Bode, C. (2006) An empirical investigation into supply chain vulnerability. *Journal of Purchasing & Supply Management*, Vol. 12, 301-312.
- Wang, Q. – Zhou, H. – Zhao, X. (2024) The role of supply chain diversification in mitigating the negative effects of supply chain disruptions in COVID-19. *International Journal of Operations & Production Management*, Vol. 44 (1), 99-132.
- World Economic Forum (2026a) The Global Risks Report 2025, Insight Report.
- World Economic Forum (2026b) Global Cybersecurity Outlook 2026, Insight Report.

- World Economic Forum (2022) This visual breaks down the economic crisis in Sri Lanka.  
<<https://www.weforum.org/stories/2022/07/economic-politics-debt-protest-crisis-sri-lanka/>>
- Wu, B. – Chen, H. – Shi, Y. (2025) Influence of artificial intelligence development on supply chain diversification. *Finance Research Letters*, Vol. 78, 107210.
- Xiong, W. – Wu, D. – Yeung, J. (2025) Semiconductor supply chain resilience and disruption: insights, mitigation, and future directions. *International Journal of Production Research*, Vol. 63 (9), 3442-3465.
- Yang, B. – Song, J. – Wei, Y. – Li, J. (2025) Navigating geopolitical risks: How U.S. firms adjust supply chains amid U.S.–China rivalry. *Journal of International Business Studies*, Vol. 56, 937-949.
- Yang, C. – Chan, D. (2023) Geopolitical risks of strategic decoupling and recoupling in the mobile phone production shift from China to Vietnam: Evidence from the Sino-US trade war and COVID-19 pandemic. *Applied Geography*, Vol. 158, 103028.
- Yang, Z. – Wua, M. – Sun, J. – Zhang, Y. (2024) Aligning redundancy and flexibility for supply chain resilience: a literature synthesis. *Journal of Risk Research*, Vol. 27 (2), 313-335.
- Yin, R. (2003) *Case study research: design and methods*. Thousand Oaks CA: Sage Publications.
- Yle (2026a) Lähi-idän iskut uhkaavat koko maailmantaloutta – ekspertit kertovat, mitkä ovat isoimmat vaikutukset. 01.03.2026. <<https://yle.fi/a/74-20212902>> accessed 02.03.2026.
- Yle (2026b) Ilmaiskut sulkivat Lähi-idän vilkkaat lentokentät – Finnairin Paajanen: ”Portti itään on enemmän tai vähemmän suljettu”. 02.03.2026. <<https://yle.fi/a/74-20213051>> accessed 02.03.2026.
- Yoon, J. – Talluri, S. – Rosales, C. (2020) Procurement decisions and information sharing under multi-tier disruption risk in a supply chain. *International Journal of Production Research*, Vol. 58 (5), 1362-1383.
- Zaoui, S. – Foguem, C. – Tchunte, D. – Kamsu-Foguem, B. (2025) The application of artificial intelligence technologies in the resilience and the viability of supply chains: a systematic literature review. *Production Planning & Control*, Vol. 36 (16), 2429-2446.
- Zheng, Y. – Gong, B. (2024) Nexus between natural resources and digital economy: The role of geopolitical risk. *Resources Policy*, Vol. 89, 104600.
- Zheng, L. – Islam, N. – Zhang, J. – Behl, A. – Wang, X. – Papadopoulos, T. (2025) Aligning risk and value creation: a process model of supply chain risk management in geopolitical disruptions. *International Journal of Operations & Production Management*, Vol. 45 (5), 1178-1210.

- Zhu, M. – Miao, S. – Lam, H. – Yeung, C. (2024) Navigating through geopolitical risk: the role of supply chain concentration. *International Journal of Operations & Production Management*, Vol. 45 (5), 1032-1065.
- Zouari, D. – Ruel, S. – Viale, L. (2020) Does digitalising the supply chain contribute to its resilience? *International Journal of Physical Distribution & Logistics Management*, Vol. 51 (2), 149-180.
- Åkerblad, L. – Seppänen-Järvelä, R. – Haapakoski, K. (2021) Integrative Strategies in Mixed Methods Research. *Journal of Mixed Methods Research*, Vol. 15 (2), 152-170.

## Appendices

### Appendix 1 List of interview questions

#### Background

1. Could you please tell me about your category and your role in it?
  - a. What kinds of components are there in your category?
  - b. What kinds of steps are there in a typical supply chain in your category?
  - c. What is the annual volume in your category?
  - d. How well / far can you forecast demand in your category?
  - e. Where are your suppliers located?
  - f. What is your role in the category?
    - i. what is the time frame of the decisions you are responsible for?

#### Geopolitical risks and impacts

2. How would you define geopolitical risks?
3. Have some geopolitical events had an impact on your category / supply chains before? If so, how?
  - a. Is it specific to your category / to a country/supplier/component, or would you say it had impacts on a broader scale?
4. What tools / reports do you use to assess impacts?
  - a. What do you think are the most important indicators to follow?
5. What do you see as geopolitical risks (for your category) at this moment?
6. What kind of impacts do you expect these risks could have if they happened?
7. Are you able to affect transport routes or other transport related factors?
  - a. What transport modes do you utilize?

#### Risk Management

8. Have you taken any measures in your category to manage geopolitical risks? If so, have they appeared useful?
  - a. Do you use any risk management tools provided by the organization?
  - b. Do you think about geopolitical factors when making long term plans?
9. In what ways could geopolitical risks be managed from your perspective?
10. How do you identify risks in your category?

11. How do you determine which risk needs concrete mitigation actions? Generally, or with respect to geopolitics
  - a. If you choose to wait and see how a certain situation plays out, do you follow it or decide when to reassess
12. If you were to select a new supplier now, would you consider geopolitics as a factor? How?
13. What do you see as factors or characteristics that increase vulnerability to geopolitical risks? On the other hand, what do you think makes a supply chain more resilient towards them?
14. Do you have visibility beyond your direct suppliers?
  - a. Do you see risks there?
15. What (resources) does it take to switch suppliers for a component? Are there many alternative suppliers in the market?
16. As the geopolitical environment is relatively turbulent now, does that change how you work with your suppliers in some way?
  - a. do you discuss geopolitical risks or factors with suppliers?
17. Would you like to have guidance, or some kind of support from (case company) on geopolitical risks? If so, what kind?

## **Appendix 2 Declaration of the use of AI**

Text generative AI tools were used as a support tool in this study, but not to produce text or replace critical thinking. The main uses of AI were brainstorming of ideas, language editing and searching for information. It was not used to produce text, nor was it used as a source for information, but rather as support for the research process to guide the researcher in searching for information and considering different perspectives. For example, the ideas given by AI were used as to formulate search terms in different databases. AI was used to brainstorm ideas for structuring the chapters of the thesis. For language editing, AI was used to find synonyms, or better descriptive wording for expressing complex ideas. The AI tool mainly used for brainstorming purposes was ChatGPT. Additionally, ScopusAI was used to find more relevant articles in the Scopus database, as it allowed for a more complex search term. ChatGPT and CoPilot were used for finding credible articles to use as sources, however, any articles or books recommended by an AI tool were retrieved from official databases and their credibility was assessed before use. Furthermore, ChatGPT and CoPilot was used to guide the analysis of the quantitative data and the use of the SPSS software.

Example prompts:

### **ChatGPT, 6.11.2025**

“Hello, could I improve this research question in some way? How can the impacts of geopolitical risks be managed in the optimal way in global value chains?”

### **ChatGPT, 19.1.2026**

“Are there any quantitative studies using the GPR index as the independent variable?”

### **Chat GPT, 17.2.2026**

“How could you say in a different way x and x (2025) have also said”

### **ChatGPT, 4.3.2026**

“are there any other piracy or terrorism related geopolitical events that have disturbed supply chains than the Houthi rebels”

### **CoPilot, 17.3.2026**

“Hello, I am researching the impacts of geopolitical risks on supply chains...what could be some interesting options for a quantitative analysis”

**CoPilot, 17.3.2026**

“Would it be better to use the country-specific or global GPR index?”

**CoPilot, 28.3.2026**

“Could you suggest a good source (preferably an article) for integrating qualitative and quantitative data analysis in mixed methods research?”

### Appendix 3 Sample sizes

Group	Low GPR (country)	High GPR (country)	Low GPR (global)	High GPR (global)
All	112819	112437	115581	112795
Cat A	24	123	103	53
Cat B	10480	21757	16533	15782
Cat C	70	186	213	54
Cat D	193	165	434	161
Cat E	102052	90206	98298	96745
No Inco	10	0	8	4
Inco CIP	1	3	3	1
Inco CPT	405	237	331	311
Inco DAP	8773	8955	9209	8792
Inco DDP	260	46458	22682	24134
Inco DDU	2	4	6	0
Inco EXW	522	197	363	360
Inco FCA	102846	56577	82974	79192
Inco FOB	0	6	5	1