



SUPPLIER RISK MANAGEMENT IN THE TECHNOLOGY INDUSTRY

Lappeenranta–Lahti University of Technology LUT

Bachelor's thesis

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Nelli Korhonen

Examiner: Junior researcher Axel Zehendner

ABSTRACT

Lappeenranta–Lahti University of Technology LUT

LUT School of Business and Management

Business Administration

Nelli Korhonen

Supplier risk management in the technology industry

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The purpose of this thesis is to determine the current most critical supplier risks and the foremost supplier risk management practices in the technology industry. The research strives to support existing literature on supplier risks and supplier risk management practices by providing a real-life context. This thesis is executed as a case study for a Finnish technology company. The research is based on the data gathered from interviews with the case company's employees and secondary data. The collected data was then analyzed through qualitative content analysis.

As a result of the research, it can be concluded that supplier risks and their impact on the company's operations can be altogether mitigated through close supplier cooperation. Furthermore, it was found that lack of availability is the leading supplier risk at present. It is evident that the practice and development of supplier risk management practices are important for companies to properly identify, analyse and mitigate supplier risks. This is particularly important given the increasing complexity of global supply chains.

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Tämän kandidaatintyön tarkoituksena on määrittää nykyiset kriittisimmät toimittajariskit ja tärkeimmät toimittajariskien hallintakäytännöt teknologiateollisuudessa. Tutkimus pyrkii tukemaan olemassa olevaa kirjallisuutta toimittajariskeistä ja toimittajariskien hallintakäytännöistä tarjoamalla tosielämän kontekstin. Tämä kandidaatintyö toteutetaan tapaustutkimuksena suomalaiselle teknologiayritykselle. Tutkimus perustuu aineistoon, joka on kerätty haastatteleamalla tapausyrityksen työntekijöitä sekä sekundääriaineistosta. Kerätty aineisto analysoitiin laadullisen sisällönanalyysin avulla.

Tutkimuksen tuloksena voidaan todeta, että toimittajariskejä ja niiden vaikutuksia yrityksen toimintaan voidaan kaiken kaikkiaan lieventää läheisen toimittajayhteistyön avulla. Lisäksi tulokseksi saatiin, että saatavuuden puute on suurin toimittajariski tällä hetkellä. On selvää, että toimittajiin liittyvien riskienhallintakäytäntöjen harjoittaminen ja kehittäminen on tärkeää, jotta yritykset voivat tunnistaa, analysoida ja lieventää toimittajiin liittyviä riskejä asianmukaisesti. Tämä on erityisen tärkeää, kun otetaan huomioon, miten monimutkaisiksi globaalit toimitusketjut ovat kehitymässä.

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1. Introduction

Supply chain risks are the outcome of both internal and external sources of unpredictability. The potential disruptions induced by different elements within a supply chain network as well as the external environmental influences are a concern for both scholars as well as practitioners. (Lockamy and McCormack, 2012) Global supply networks have become excessively compounded and vulnerable to a variety of threats (Hallikas, Puumalainen, Vesterinen, Virolainen, 2005). The exceedingly complex supply network is the repercussion of contemporary business trends, the increase of the complexity of products and services as well as the generalization of outsourcing (Harland, Brenchley, Walker, 2003). The management of a global supply chain is demanding as the mitigation of one supply risk can potentially aggravate another issue. For instance, striving to decrease the effects of over-forecasting demand by obtaining a modest inventory can lead to the increased impact of any supply chain disruptions. (Chopra and Sodhi, 2004)

Companies implement actions of high consideration regarding the subject due to the rising frequency of worldwide calamities. These unforeseeable catastrophes are a constant reminder to businesses that their supply chain networks conduct in a progressively unreliable climate. However, not only major and large-scale circumstances in the supply chain network cause excessive costs and disturbances for a company. (Stephan, Wagner, Christoph, 2007)

Conducting global operations is a sensitive process due to several issues, including economic, political, logistical, competitive, cultural, and infrastructure. There are a myriad of possible challenges and risks that have the potential to disturb and interrupt an international supply chain. Due to this, a company's risk management strategies need to be developed to be applicable to all the countries involved in the supply chain. (Manuj and Mentzer, 2008)

Due to the aforementioned exceedingly complex supply networks and the rise of worldwide calamities, the importance of understanding the topic of supplier risk management is high. There have always been risks in supply chains and business in general. However, the interest in studying supply chain risks became more prominent as supply chain management became a recognized academic field. Currently, there has been increased interest to detect and mitigate the effects of actualized supplier risks on a company's operations. As the technology used to proactively manage supply chain risks continues to develop, new practices of supplier risk management emerge. (Zsidisin and Henke, 2019)

This study is executed as a case study for a Finnish technology company with an international supply chain network. The purpose of this thesis is to pinpoint the most critical supplier risks and look into the effectiveness of supplier risk management practices with a focus on a single company's experience. This study will provide insights into the challenges and opportunities of managing supplier risks. Additionally, this thesis will aim to identify the foremost practices for companies looking to improve their supplier risk management capabilities, through an in-depth analysis of the company's practices and experiences. The findings of this thesis can be utilized by researchers and industry professionals in understanding the vital factors of supply chain risk management in the industry of technology.

1.2 Objectives and research questions

The overall goal of this study is to identify the most critical supplier risks concerning the technology sector and to conclude how supplier risk management can aid in preventing and mitigating these risks. The objective of this thesis is to identify the foremost practices in supplier risk management in successfully mitigating and preventing supplier risks. Additionally, this thesis strives to determine the impacts of supplier risks on a company's operations.

In order to obtain an efficient understanding of the chosen subject, clear research questions need to be determined to limit the broadness of the study. Based on the objectives set, this thesis strives to determine the key supplier risks that jeopardize a technology company's international supply chain. Additionally, the objective is to determine the effects of supplier risk management in preventing and mitigating probable supplier risks. Based on the objectives set, two equivalent main research questions were formed:

1. What are the critical supplier risks in the technology industry?
2. Which are the foremost supplier risk management practices used to respond to supplier risks?

The first research question, “What are the critical supplier risks in the industry of technology?” attempts to identify and interpret the variety of supplier risks encountered by companies in the technology sector. This research question aims to investigate the different supplier risks as well as their impacts on the company’s supply chain. The second research question, “Which are the foremost supplier risk management practices used to respond to supplier risks?” investigates the practices and strategies the company utilizes to mitigate supplier risks. This research question aims to identify the foremost practices for supplier risk management.

1.3 Conceptualization

The conceptualization is designed to offer an overview of the research in this thesis. The illustration will outline the key concepts and ideas relevant to the thesis. Moreover, the framework provides a foundation for the reader to understand the research problem and helps guide the research process. Furthermore, the conceptualization will perform as a way to further introduce the reader to the topic of the thesis. The theory in this thesis is founded on prior literature mostly found in online sources. The main subjects of this thesis can be divided into three sections. The conceptualization is presented in Figure 1 below.

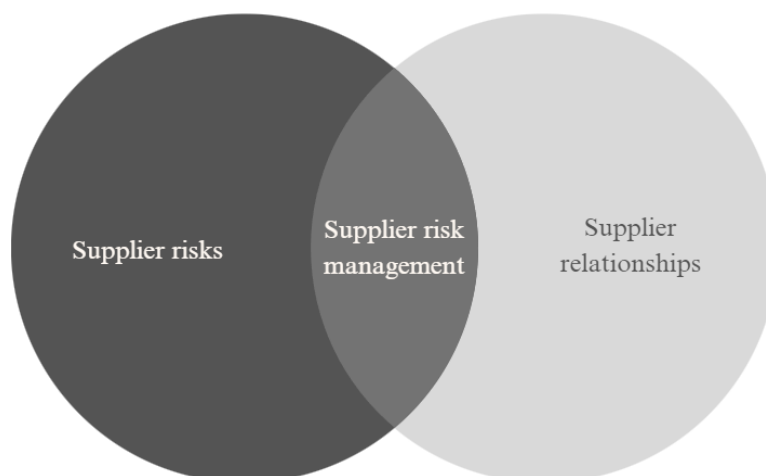


Figure 1. Conceptualization

The topics of this thesis consist of the investigation of supplier relationships, supplier risks and the foremost supplier risk management practices. The analysis of this thesis will focus on the three identified sections of the conceptualization. Supplier risks, supplier risk management and supplier relationships are all interconnected aspects of supply chain management. Supplier risk management is a part of a company's risk management strategy and is crucial for ensuring a company's operations function as planned. Supplier risks on the other hand are the potential risks related to suppliers that may cause disruptions to a company's operations or financial losses. By utilizing an efficient supplier risk management strategy, a company can minimize the impact the actualization of a supplier risk has on its operations (Kushner, 2022). A supplier relationship is the affiliation with the business that provides goods or services for the buying company (Entrepreneur, 2023). Managing supplier relationships entails assessing each affiliation and determining a plan to increase the benefit for the buying company (Landau, 2021).

1.4 Structure of the study

This thesis follows the 'standard' structure for a thesis. This structure consists of four parts. The thesis begins with an introduction to the subject and an explanation of the aims and scope. Furthermore, this section will include an explanation of the conceptualization. This section will be processed in chapter one and its subheadings. Following the introduction, the second chapter will address the theoretical background of the subject to provide the reader with enough information to comprehend the thesis. This section furthermore comprehends the literature review to highlight the related history and research of the topic. In this section, relevant theories and current prospects are alluded to. (Gruba and Zobel, 2017) The three core factors of this thesis are presented along with a theoretical background. The three main sections of the theoretical part are supplier risks, supplier relationships and supplier risk management practices. The third and fourth chapter contains the core section of this study. During chapter three, the research methodology, case company and analysis methods are presented. In chapter four, the research findings and results from the case company are presented. Chapter four further includes the results of the analysis of the empirical findings. At last, the synthesis of the thesis is addressed in chapter five. This chapter contains a critical

examination of the found results as well as a conclusion accomplished in light of the literature review and empirical findings. (Gruba and Zobel, 2017)

2. Theoretical background

This section discourses the prior literature and theories and aims to build a literature review regarding the subject. The aim of this chapter is to give a thorough assessment of the literature on supply chain risk management and highlight the major concepts, theories and techniques. Specifically, this chapter will address the types of supply chain risks and supplier risks and aim to categorize them, investigate the different strategies for identifying them and additionally identify the foremost practices in mitigating them. Furthermore, this chapter will discuss the potential future challenges and development of supplier risks and supplier risk management. This thesis strives to support the presented existing literature regarding supply chain risks and supplier risks as well as supplier risk management techniques by providing a real-life context.

2.1. Supplier and supply chain risks

Several researchers have made major contributions to the discovery, mitigation and evaluation of supply risks throughout the years. Even though there has been such broad research on the topic, the difference between supplier and supply chain risks has not been clarified. (Sarker, 2019) Certain risks are referred to as supply risks, others as supply chain risks and the remaining ones as supplier risks. Supplier risk as defined by Govindan and Jepsen (2016, 344) signifies a risk that originates from a sole first-tier supplier, which impacts the overall risk within a supply chain. Furthermore, supplier risk does not only convey the interruptions in a single supplier's operations. The risks can further affect other external and internal supply chain risks. (Govindan and Jepsen, 2016, 344) According to Jung, Lim and Oh (2011), supplier risks are a source of the total supply chain risk and can be described as the "purchasing firm's perceived probability". They described supplier risk as the effect an unexpected disruption in regard to an upstream supplier has on the processes of a supply chain. (Jung et al., 2011)

In contrast, supply chain risks as defined by Kull and Talluri (2008), are the risks associated with the factors influencing failures in flexibility, delivery, cost, quality and the overall confidence of a company. According to Zsidisin's (2003) proposed definition: "supply risk is defined as the probability of an incident associated with inbound supply from individual

supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety". Zsidisin (2003) perceives supply risk as a multifaceted conception. This is due to the influencing factors of supply risk including both sources and outcomes of risk. (Zsidisin, 2003)

Various global crises and their effects on companies' supply chains have received a lot of attention in the literature in the past decades. Through this, there has been considerable development regarding the amount of knowledge about resilience and assessing disruptions. Nevertheless, there is a lack of research regarding the daily disruptions and what frequently produces distress in sourcing professionals. (Donadoni, Roden, Scholten, Stevenson, Canito, Pieter van Donk and Wieland, 2019) The following chapters will present supply chain risks and supplier risks excerpted from existing literature, including risks that occur frequently as well as risks caused by worldwide calamities.

2.1.1 Types of supply chain risks

There are a myriad of potential risks threatening a company's supply chain, but the risks can be categorized into different classifications. According to Johnson (2001), all risks in the supply chain are either associated with product demand or product supply. The risks associated with product demand encompass seasonality and the volatility of trends. The public's perception is also a factor in demand risk. The risks in the product supply classifications include the capacity of manufacturing and logistics. (Johnson, 2001) Supply chain risks can also be classified into disruptions, delays, forecasts, receivables, intellectual property, procurement, capacities, and inventories as broadly categorized by Chopra and Sodhi (2004, 53). The categories and definitions are presented in table 1. Each risk category possesses its own influencing key factors and operational mitigation strategies. The impact of such risks on an establishment is determined by the sort of disruption and the organization's level of readiness. (Chopra and Sodhi, 2004, 53)

Risk Category	Definitions
Disruptions	Interference in material flow
Delays	Delays in material flow
Systems	Failure in company networks
Forecast	Disperancy between the company's expectations and actual demand
Intellectual Property	Risk of diminishing the value of intellectual property
Procurement	Unanticipated increases in acquisition costs
Unability to collect receivables	Unability to collect receivables
Excess inventory	Excess inventory
Excess capacity	Excess capacity

Table 1. Supply chain risks and the influencing key factors (Modified from Chopra and Sodhi, 2004, 54)

The first risk category is disruptions, which conveys an interference in material flow that has developed anywhere in a company's supply chain. These disturbances can be exceptionally damaging, as they can conduct an unexpected production shutdown. Material flow disturbances can be the outcome of labor strikes among other influences. According to Chopra and Sodhi (2004, 55), one way for companies to retaliate in such situations is to build inventory. However, this way of preparing can get costly. The reason behind this is that while the holding expenses would be consistently sustained, the inventory would be utilized only in the unlikely case of an interruption. However, the actions of building inventory seem appropriate in a situation where a disruption in material flow can be predicted with certainty. Furthermore, building inventory functions well when dealing with products that retain low-holding costs and with no risk of becoming obsolete. (Chopra and Sodhi, 55-56)

The second risk classification according to the risk categories by Chopra and Sodhi (2004, 55) is delays. Material flow delays commonly occur in situations where a supplier is unable to adapt to changes in demand. This is often due to the supplier's excessive utilization or another origin of added inflexibility. Delays in material flow can also be the outcome of poor-quality parts or products shipped by the supplier. Furthermore, in long-distance shipments delays can be a consequence of high degrees of inspection at borders or frequent changes in the form of transport. In the case that material flow delays maintain to recur, the company can prepare for these situations by developing a mitigation technique based on the prior knowledge gathered.

A solution a company could implement in hopes of preventing this disruption is balancing the inventory and capacity depending on product costs for instance. (Chopra and Sodhi, 2004, 55)

The third category, systems, conveys the risks regarding failures in a company's networks. As the essentiality of information infrastructure has grown increasingly more critical, disturbances can cause great harm to a company's operations. Chopra and Sodhi (2004, 56) see that the most suitable course of action in preparing is to maintain strong backup systems. Additionally, having a well-designed recovery process can aid in recovery from disturbances. (Chopra and Sodhi, 2004, 56)

The forecast risk category contains the risks caused by a discrepancy between the business's expectations and the actual demand. For instance, in the case that the company's expectations for demand were too low, products may not be accessible. This category concurs with the previous one, systems risk, as a forecast error of demand might be the outcome of an issue in the information infrastructure. Furthermore, these errors in expectations can be the outcome of seasonal demand and long lead times among other factors. This risk is especially relevant in situations where a few customers complete purchases of larger quantities than the company expected. (Chopra and Sodhi, 2004, 56)

The fifth risk classification is intellectual property risk. The risks in this category have grown increasingly more critical, as companies continue to further rely on external suppliers. Additionally, more companies rely on the same manufacturers which are also utilized by their competitors. Companies should prepare for these risks, as a company's probability is dependent on keeping a competitive edge. The risks can be mitigated by maintaining some of the company's production in-house, as to protect the company's intellectual property. (Chopra and Sodhi, 2004, 57) Examples of intellectual properties are patents and designs (Shemtov, 2021).

Unanticipated increases in acquisition costs due to shifting exchange rates or supplier pricing increases are referred to as procurement risk. For instance, the weakening of a currency can increase expenses for companies that have outsourced to another region. The risk of the exchange rate may be mitigated by balancing cost and revenue flows according to location, increasing flexibility of global capacity and establishing financial hedges. This category also involves the risk of price increases by suppliers, which becomes more probable in situations

where the company utilizes only a single supply source. In the case of price increases, the company can mitigate them in numerous ways. For instance, establishing long-term contracts and retaining redundant suppliers. In some rare circumstances, holding inventory can also function in mitigating the risk. (Chopra and Sodhi, 2004, 57-58)

The next category is receivables, which conveys the risk of not being able to collect the receivables. For example, a company offering credit cards suffered a stock plummet of more than 30% as a result of delinquent cardholders. The receivables risk could have been reduced by filtering the customers by their creditworthiness. Another viable option to reduce receivables risk along with filtering customers is to distribute the risk among a significant number of customers instead of selling to a single and substantial customer. In the case of distributing the risk among a large number of customers, the risk still exists in cases of a large-scale economic shock. (Chopra and Sodhi, 2004, 58)

Inventory risks convey the negative impact an excess inventory has on a company's financial performance. As there is a risk of falling prices, an excess inventory puts the company at risk. This risk classification is determined by three factors, which are the product's value, the rate of its obsolescence as well as the unpredictability of supply and demand. The holding of excess inventory is especially risky in situations with short life cycles or high-value products. Another factor which increases the amount of inventory risk is a high variety of products. A way to reduce inventory risk is to operate with a supplier that is highly responsive. This is especially important with products with a high value or short life cycles. Additionally, the risk can be lowered by maintaining excess capacity. (Chopra and Sodhi, 2004, 58-59)

The final classification of risk is capacity risk. The capacity of a company can only be expanded or lowered over time. As a result, a frequently used strategic option is to build more capacity. A way for management to reduce the risk of excess capacity is by making the current capacity more flexible. Additionally, by providing to consumers in different locations from the same plant, the company may be able to reduce surplus capacity. Increased flexibility as a mitigation strategy will greatly decrease capacity risk. (Chopra and Sodhi, 2004, 55, 59)

2.1.2 Types of supplier risks

Multiple supplier risks have also been excerpted from previous literature by Sarker (2019, 318). These risks and their definitions can be viewed in table 2. The first supplier risk classified is supply quality risk, which is defined as the supplier's inability to detect, manage and analyze the supply risk linked with quality. (Zsidisin, Petkova, Saunders and Bisseling, 2016, as cited in Sarker, 2019). This area of risk is managed by supplier quality management practices, which can be categorized into supplier integration, - development and - selection. These practices are utilized in order to reduce the potential negative influences of supplier quality risks on a company's performance. (Lo and Yeung, 2006, as cited in Zsidisin et al., 2016)

Supplier risks	Definitions	Reference
Supply quality risk	Supplier's lack of knowledge on identifying, assessing, and managing supply risk associated with quality	Zsidisin et al. (2016)
Yield uncertainty	The yield of supplier is not reliable	Chen et al. (2015)
Unreliable supplier	Supplier's are unreliable	Tiwari et al. (2015)
High dependence on suppliers	Buyer is highly dependent on supplier	Nguyen et al. (2017)
Innovation capability	Suppliers are not innovative enough	Sarker et al. (2016)
Technology risk	Suppliers are not technologically capable	Gualandris and Kalchschmidt (2015)
Bankruptcy risk	Supplier's financial volatility	Valverde (2015)
Trust	Buyers do not trust suppliers	Sinha et al. (2004)
Sustainability	Suppliers have sustainability issues in their premises	Foerstl et al. (2010)
Delivery performance ability	Suppliers are not able to deliver on time and at right quantity	Hallikas et al. (2002)
Supplier capacity constraints	Suppliers do not have the capacity to meet the buyers' demand	Zsidisin et al. (2000)
Nature of source	Suppliers who are the sole source or single source for the buying firm	Christopher et al. (2011)

Table 2. Supplier risks excerpted from previous literature (Sarker, 2019, 318)

The subsequent supplier risk, defined by Chen, Zhao and Shen (2015), is the unreliability of the yield of a supplier. (Chen et al., 2015, as cited in Sarker, 2019) This risk classification conveys the risk experienced by the potential concern for fairness suppliers may harbour (Chen et al., 2015).

The following risk classification as defined by Tiwari, Patil and Shahah (2015) is the risk caused by supplier unreliability (Tiwari et al., 2015, as cited in Sarker, 2019). According to the studies of Tiwani et al., (2015) supplier uncertainty can be reduced and mitigated by

utilizing low-cost suppliers and sequential orders rather than simultaneous orders (Tiwari et al., 2015).

The ensuing risk classification as compiled by Sarker (2019) is the risk of being highly dependent on suppliers (Nguyen, Nguyen, Deligonul and Cavusgil, 2017, as cited in Sarker, 2019). For a buying firm to be highly dependent on its supplier is risky due to the various negative influences they may have on a company in the case of a disturbance. The depletion of this threat is critical since the perception of risk can drastically alter the buyer's supplier relationship management tactics with the supplier. (Nguyen et al., 2017)

Following this risk is the risk of a lack of innovation capability in a supplier (Sarker, Engwall, Trucco, Feldmann, 2016, as cited in Sarker, 2019). By choosing a supplier that lacks innovation the buying company can potentially endanger its position as a leader of innovation in its industry (Sarker et al., 2016).

The sixth supplier risk is defined by Gualandris and Kalchschmidt (2015), and it conveys the technology risk the buying firm encounters in the case of a supplier not being capable technologically (Gualandris and Kalchschmidt, 2015, as cited in Sarker, 2019). For instance, in a situation in which a new innovation becomes the norm; if the supplier lacks the required technology, customers may be unwilling to purchase products/services that lack the new mandated standard. This potential situation highlights the correlation between technology and market changes. (Gualandris and Kalchschmidt, 2015)

Following this risk, there exists the threat of a supplier's financial volatility as defined by Valverde (2015) (Valverde, 2015, as cited in Sarker, 2019). Valverde's studies on the phenomenon show that there is a possibility to predict the losses the buying company will endure in the case of a supplier's bankruptcy. In the case of a supplier's bankruptcy, the buying company can experience increased costs and losses due to disruptions in the supply chain and loss of market share among other explanations. (Valverde, 2015)

The following supplier risk is defined by Sinha, Whitman and Malzahn (2004). This risk entails the lack of trust between the buying company and the suppliers. (Sinha et al., as cited in Sarker, 2019) According to Sinha et al. (2004), trust among trade partners is one of the most essential aspects influencing the entire supply chain management process. The

individuals involved in the business are an important element influencing trust. (Sinha et al., 2004) In the occurrence of a breach of trust, rebuilding is not feasible as long as the same individuals are associated (Mariotti, 1999, as cited in Sinha et al., 2004).

The subsequent supplier risk is the risk of suppliers maintaining sustainability issues in their premises, as defined by Foerstl, Reuter, Hartmann and Blome (2010). Irresponsible behavior in sustainability by the supplier may reflect poorly on the buying company (Carter and Jennings, 2004, as cited in Foerstl et al., 2010), as customers and stakeholders increasingly expect social and ecological sustainability. By mitigating the supplier sustainability risk, the buying company can reduce its risk of damage to reputation and unfavorable publicity. (Foerstl et al., 2004)

Delivery performance ability conveys the risk of suppliers not being able to deliver as indicated as well as the risk of inaccurate quantities delivered (Hallikas, Virolainen, Tuominen, 2002, as cited in Sarker, 2019). Customers frequently negotiate separate contracts with lower-level suppliers, making it difficult for first-tier suppliers to exert control over their own suppliers' performance. This can be especially difficult since some lower-level suppliers may be much more extensive and more influential than the first-tier suppliers. Unreliable supplier delivery performance lowers the buying firm's delivery reliability, due to its effects on production. The forecasting of demand is viewed as a high-risk action. There maintains the risk of demand forecasts losing their credibility, as customers often order according to worst-case scenarios in order to maintain reliability in deliveries. (Hallikas et al., 2002)

The following supplier risk is the risk of suppliers' not being able to meet the demand due to a lack of capacity (Zsidisin, Panelli, Upton, 2000, as cited in Sarker, 2019). Supplier capacity restrictions are one of the main reasons behind the buying firm's inability to produce the demanded products or services. Supplier capacity constraint is often caused by a lack of equipment or employees among other factors. (Zsidisin et al., 2000)

The last supplier risk as compiled by Sarker (2019) is the risk of a supplier being the single or exclusive source for the buying firm (Christopher, Khan, Yurt, 2011, as cited in Sarker, 2019). By utilizing a single-sourcing strategy the company maintains a high dependence on the supplier (Christopher et al., 2011). This risk can be mitigated by practicing dual sourcing

rather than single sourcing (Warburton and Stratton, 2002, as cited in Christopher et al., 2011).

2.2 Supplier risk management practices

Supplier risk management conveys the practices utilized to mitigate supplier risks. It is the process of detecting, assessing and managing potential risks that occur while working with suppliers. Supplier risk management is a part of a company's overall risk management strategy. Effective supplier risk management practices can aid in preventing disruptions in the company's operations. (Kushner, 2022) According to Sarker (2019), many supplier risk management practices require straightforward interference, unlike supply risk management techniques.

The assembled supplier risk mitigation techniques suggested for different supplier risks can be viewed in table 3. Tse and Tan (2011) propose that better visibility in a multi-tier global supply network would minimize the threat of a supply quality risk (Tse and Tan, 2011, as cited in Sarker, 2019). This conveys monitoring of lower-tier suppliers and calibrating the supplier assessment process (Tse and Tan, 2011). Chen et al. (2015), suggest the utilization of backup suppliers to solve the issue of yield uncertainty (Chen et al., 2015, as cited in Sarker, 2019). However, their suggestion has only been studied as a short-term solution (Chen et al., 2015).

Supplier risks	Risk mitigation techniques	Reference
Supply quality risk	Ensuring visibility in the multi-tier global supply network	Tse and Tan (2011)
Yield uncertainty	Using backup suppliers	Chet et al. (2015)
Unreliable supplier	Ordering sequentially and placing new order only when the	Tiwari et al. (2015)
High dependence on suppliers	Ensuring visibility by information technology integration between buying firms and their suppliers	Nguyen et al. (2017)
Innovation capability	Practicing single sourcing	Blome and Henke (2009)
Technology risk	Monitoring suppliers' ability to innovate	Gualandris and Kalchschmidt (2015)
Bankruptcy risk	Risk pooling through insurance	Valverde (2015)
Trust	Forming alliances	Alvarez et al. (2010)
Sustainability	Carefully selecting suppliers, phasing out suppliers that provide high non-remediable risk, and developing suppliers that provide remediable risk	Foerstl et al. (2010)
Delivery performance ability	Dual sourcing	Wang et al. (2010)
Supplier capacity constraints	Holding reverse capacity	Ellegaard (2008)
Nature of source	Re-evaluating supply base network design	Christopher et al. (2004)

Table 3. Supplier risk mitigation techniques excerpted from previous literature (Sarker, 2019)

The solution to unreliable suppliers as proposed by Tiwari et al., (2015) is to place sequential orders in advance (Tiwari et al., 2015, as cited in Sarker, 2019). Through this action, the uncertainty of supply can be mitigated, however, low-cost suppliers have to be available. Their studies show that sequential orders are a more effective option than simultaneous orders as the supply risk and expected service levels increase. (Tiwari et al., 2015)

The subsequent supplier risk is high dependence on suppliers (Nguyen et al., 2017, as cited in Sarker, 2019) In the case of a buying firm being highly dependent on its suppliers, Nguyen et al. (2017) suggest that the more dependent the buyer is on a supplier, the more visibility is required in order to mitigate the risk. When the buying company has a high level of supplier visibility, it will be aware of the operational and strategic difficulties confronting the supplier. This conveys the ability of the buying firm to reduce the potential of disruptions caused by unexpected changes from the supplier. (Nguyen et al., 2017)

In the case of the risk involving innovation capability, single sourcing can be used as a method to mitigate the risk (Blome and Henke, 2009, as cited in Sarker, 2019). By utilizing single sourcing, a company can foster an engagement with a supplier that offers knowledge creation and technology adaptation (Anderson, Davis-Blake, Erzurumlu, Joglekar and Parker, 2007; Dryer and Singh, 1998, as cited in Handley, Skowronski and Thakar, 2022).

The supplier risk of technology risk can be mitigated by monitoring the supplier's ability to innovate (Gualandris and Kalchschmidt, 2015, as cited in Sarker, 2019). Due to the uncertainty around the development of technology and customer demands the buying firm should monitor the ability of the supplier to adapt while staying financially stable (Gualandris and Kalchschmidt, 2015).

Valverde (2015) proposes the use of risk pooling through insurance to mitigate the risk of bankruptcy (Valverde, 2015, as cited in Sarker, 2019). By assessing the likelihood of supplier bankruptcy based on financial data, the buying firm can create an insurance contract that can mitigate the risk of supplier bankruptcy (Valverde, 2015).

The risk of breaches in trust can be mitigated by forming alliances (Alvarez, Pilbeam, Wilding, 2010, as cited in Sarker, 2019). By creating mutually beneficial relationships and steady relationships, the trust between the buying firm and the supplier can be improved (Alvarez et al., 2010).

The subsequent risk is sustainability (Foerstl et al., 2010, as cited in Sarker, 2019). Based on the studies of Foerstl et al. (2015), the sooner a company begins to examine the sustainability of a supplier, the higher the collection of their skills regarding sustainability risk management practices will be relative to their rivals.

The lack of reliable delivery performance ability can be mitigated through dual sourcing as suggested by both Wang, Gilland and Tomlin (2010) and Warburton and Stratton (2002) to lessen the high dependency on a single supplier. However, this risk can also be mitigated by thoroughly examining the underlying reasons behind the supplier's delivery risk and by seeking to solve them (Wang et al., 2010).

The risk of supplier capacity constraint can be mitigated by maintaining a reserve of inventory and capacity. By reserving resources, a production shutdown can be prevented. The mitigation of this risk requires preparedness and has its costs. By practicing only single sourcing and not holding reserve capacity, a company can expose itself to various risks. (Ellegaard, 2008)

The mitigation of the nature of source risk calls for a re-evaluation of a company's supplier network (Christopher et al., 2004). As suggested by Warburton and Stratton (2002), this risk can be mitigated by practicing dual sourcing instead of single sourcing in order to maintain less dependency on sole suppliers.

Suppliers can be evaluated through various tools and methods. One particular method is utilizing the ABC analysis tool, which is a method used to tier suppliers or inventory. The division of the subjects is based on cost per unit as well as the stock turnover rate or the quantity of stock. The purpose of this method is to aid supply chain professionals to divide the subjects into three main groups in order to apply necessary supplier management techniques. By doing this, the revenue can be increased and costs can be decreased. (Procurement Center, 2021)

Supplier categorization		
A	80 %	High risk
B	15 %	Medium risk
C	5 %	Low risk

Table 4. Supplier categorization using ABC analysis tool (Procurement Center, 2021)

The categorization is conventionally executed by the 80/20 rule. The first and most critical category, A, conventionally makes up 80% of the total value of the stock. By closely monitoring this category, a company can achieve different positive impacts while retaining low costs in inventory management. The subjects in category B make up around 15% of the total value of the stock. The subjects retaining the least value of a total stock are divided into category C, in which the category subjects maintain 5 % of the inventory value. (Procurement Center, 2021)

3. Data and methodology

This research is carried out as a qualitative case study. The data was collected from interviews with the case company employees and will be further analyzed with content analysis. Further information utilized in the analysis was gathered from secondary data, for instance, annual reports and a document regarding the supplier code of conduct. This chapter defines the methods and methods of analysis in more detail. Additionally, this chapter will provide a more detailed introduction to the case company and the industry.

This research is executed as a case study, which conveys that the research will aid to form an understanding of an issue through real-life context (Crowe, Cresswell, Robertson, Huby, Avery and Sheikh, 2011). Similarly, according to Puusa et al. (2020), the implementation of a case study enables the analysis of a phenomenon in a realistic environment. The goal of a case study is to utilize theory and experience. Through these types of studies, new theories can be introduced or existing ones can be elaborated on. In the context of investigating international businesses, case studies are more conventionally executed as multiple case studies due to their ability to be generalized. However, the utilization of a single case study method enables a more comprehensive understanding of a phenomenon. (Puusa et al., 2020)

3.1 Case Company

The case company of this study will remain nameless and will be referred to as “Company X”. Furthermore, the interviewees will remain anonymous, and will be referred to as “Person A” and so forth when needed. The case company is in the field of technology and offers B2B services divided into separate main lines of action.

The case company is a large-scale establishment and works with a wide range of suppliers. In indirect sourcing, the number of suppliers is up to a thousand. These indirect sourcing suppliers consist of both service-providing and material-providing suppliers. In direct sourcing, there are around thirty material suppliers across all projects.

The company has made it a goal to operate ecologically, socially and economically sustainable. The company has set goals and guidelines for its employees to make sure these goals are met. The sustainable processes focus on reaching the expected future norms of the industry, and the company hopes to achieve a role as a key factor in the development of the

industry. The overall objective of the case company is to achieve a low-carbon value chain in collaboration with its suppliers. To further aid in reaching this goal, emission reduction targets have been set for the key suppliers of the company. (Annual report, 2021)

3.2. Research data and methods

The analysis of the gathered data aims to truthfully describe and interpret the research subject. The findings are based on interviewees that were executed through email as well as secondary material. The interviewees are supply professionals and have experience working with the company's suppliers. It should be noted that the questions and answers have been translated from Finnish. The nature of the research is qualitative, which conveys that the research focuses on investigating the topic from the perspective of the interviewees (Puusa et al., 2020). Therefore, it is necessary to take into account that the gathered data is based on the shared views and assessments of the case company's employees.

It is conventional for qualitative research to be based on the subjective experience of an individual. Due to the subjectivity of the experiences, qualitative research often strives to present phenomena in the context of their appearance. Differing forms of interviews are the most utilized data collection methods in qualitative research. Interviews are executed as an interaction between the interviewer and the interviewee, which can potentially affect the results due to the effect of an exchange between two individuals. Another conceivable issue of utilizing interview material is their nature of being potentially circumstantial, especially in research that aims to generalize. (Puusa et al., 2020)

The interview was conducted in April of 2023 through email. The interview questions were sent to the case company to be further distributed to a selected group of supply professionals. The interviewees were given five business days to respond to the interview questions by email. The total number of questions was ten. The interview questions are available for viewing in the appendices. Additional comments regarding the questions were encouraged on the assumption that the interviewees were willing to further discuss the topic. The final number of interviewees was four. Each interviewee has worked in either or both direct or indirect supply positions.

The utilized secondary data was provided by interviewees as well as public records. The secondary data provided by interviewees consisted of educational material used for training sourcing professionals. The other secondary data, the supplier code of conduct and the annual report, was gathered from public records.

3.3. Analysis of data

In this thesis, the research material will be reviewed with a qualitative content analysis. This research method enables the interview material to be reviewed in order to create relevant viewpoints regarding the case company and the industry. The purpose of the case company analysis is to identify patterns and themes from the gathered data, in order to develop a deep understanding of the interviewee's assessments regarding the topic. As the interviewees consisted of both direct and indirect supply professionals, the research allows a more broad understanding of the topic. However, as the sample size is relatively compact and the research lacks quantitative data, the generalization of the findings is jeopardized.

The content analysis process will proceed with comparing the different interview answers to each other and to the existing literature. The secondary data will be used to support the findings, but the analysis is mainly based on the interviewee's answers. Overall, the analysis will strive to identify patterns and differences in the interviewees' answers, which can differ as anticipated due to the difference in their positions as sourcing professionals.

4. Analysis of the case company

This chapter will focus on analyzing the results of the research. This conveys presenting and analyzing the interviewees' answers. Additionally, the research and its results are analyzed in this chapter. *Chapter 4.1 Current suppliers and a definition of supplier risk* will review the case company's views regarding supplier risks and insight into the current direct and indirect suppliers. *Chapter 4.2. Current critical supplier risks and identification* will discuss the current critical supplier risks as determined by the interviewees' answers as well as the identification methods utilized for these risks. *Chapter 4.3 Case company's supplier risk management practices* will discuss the supplier risk management techniques utilized in the case company.

4.1 Current suppliers and a definition of supplier risk

The case company retains a variety and a broad assortment of suppliers. For the purpose of this research, the suppliers and their supplier risks are categorized into first-tier and second-tier suppliers. As a result, the findings of this research will offer a better understanding of the two topics. As the interviewees have knowledge in their area of expertise, they answered the questions according to their position in the company, signifying the viewpoint of either indirect or direct sourcing.

The direct suppliers as of now consist of purely material suppliers, while indirect suppliers consist of a variety of material and service-providing suppliers. These service-providing indirect suppliers vary from factory maintenance to safety precautions. The size of these suppliers and their relevance for the company's operations also differ substantially. The interviewee in the position of direct sourcing experiences supplier risk as the situation in which the ordered materials do not arrive according to the appointed time, price or of satisfactory quality. Additional supplier risk is constituted through failures regarding sustainability and the environment. The risk of sustainability is especially highlighted due to the company's target of reaching carbon neutrality with supplier cooperation (Annual report, 2021).

The interviewees in indirect sourcing positions view supplier risk as different risks regarding availability and different payment risks along with other potential issues, which require to be anticipated. These unexpected situations that require anticipation include situations such as fires in the supplier's premises. In the situation of a lack of suppliers in a particular sector, there is the risk of not being able to ensure competitive pricing due to a lack of competition. Similarly, in this situation, availability can evolve into a problem due to the potential insufficient capacity of a single supplier. This situation is especially pivotal in case the service or material is critical for the company's operations. Person A in indirect sourcing takes the following view:

“The financial risk of the supplier and the aforementioned production problems etc. should already be identified in the stage of supplier selection” – Person A

4.2 Current critical supplier risks and identification

There are many critical suppliers and they pose a risk for the company's operations both in indirect and direct suppliers. The focal point of both subdivisions is the risk opposed by first-tier suppliers. In indirect sourcing, there is barely any allocation to first-tier or lower-tier suppliers, exclusively for the suppliers responsible for factory maintenance. As a way of mitigating this risk caused by subcontractors, indirect sourcing strives to assess the situation and its risks as well as possible. The supplier risk of failures in factory maintenance is especially vital as issues can lead to a production shutdown.

Direct sourcing views the most critical supplier risk in general to be a lack of availability. The reason behind this supplier risk has recently been due to the Covid-19 pandemic as well as the war in Ukraine. These circumstances have posed a challenge to resilience for companies in all industries, requiring the companies to adapt swiftly and change structurally. Various companies have been found to be deficient in the competencies that would have allowed them to respond robustly to the disruptions caused by the epidemic. The disruptions were especially highlighted in the department of logistics due to issues with deliveries. One reason behind this was the closing of national borders. Especially in the early stages of the pandemic, there were major issues with maritime transport causing shortages in vessel capacity and containers.

Additionally, the shutdowns in industry operations lead to extensions in lead-time among other issues. (Hohenstein, 2022)

These critical supplier risks are identified through different methods. Many risks can be anticipated through previous experiences with the suppliers. The delivery schedules and the reliability of delivery can be assessed by considering past projects and the experiences surrounding them. Additionally, the interviewees have personal experiences in knowing which individual suppliers potentially retain the most critical risks. Financial risks, however, can be assessed by analyzing the background information of each supplier. This background information can be obtained through different reports, for instance, through services that provide records of the supplier. The interviewee in direct sourcing utilizes the ABC-analysis method for assessing the suppliers in each stage of the process. This technique along with more information regarding company X's supplier assessment will be further explained in chapter 4.3. *Case company's supplier risk management practices.*

4.3 Case company's supplier risk management practices

The most standard way for the case company to attempt to mitigate potential supplier risks is by assembling routine meetings with the suppliers, especially with critically important suppliers. This is done as a way to stay informed regarding any potential current or future issues. Any risks that have been perceived by the case company will be discussed and mitigated in these meetings. Furthermore, supplier audits are held in order to ensure the supplier fulfills the company's set standards, for instance in quality.

The company further monitors any potential issues in quality by accomplishing a quality inspection of any incoming material. In case an issue with the material is noticed, the quality control team will appeal to the supplier to send a report of the instance. Further action will be determined according to the report. Current and potential risks caused by suppliers are constantly being monitored. The monitoring is especially detailed for the supplier risks that may lead to a production shutdown or issues with the end product. From time to time, issues are noticed through monitoring, and the issue is dealt with together with the supplier. Additionally, future proactive measures are set.

The suppliers are required to conduct reviews for the case company to ensure they are operating according to the supplier code of conduct. The supplier code of conduct affects all suppliers of the case company. The suppliers are expected to address any risks resulting in a code violation. Additionally, the suppliers are required to implement channels for communication for all of their business partners and employees in case an issue arises. If the case company feels its supplier breaches the code, the business relationship can be terminated effective immediately. The case company's supplier code of conduct strives to ensure operations are done in an ethical, ecological, safe and dignified manner. Additionally, the code requires suppliers to oversee that their sourcing is conducted in a responsible manner. Another area the code influences is the demand for operating in compliance with the law. All in all, the suppliers of company X are expected to continuously seek areas of improvement throughout their value chain. (Case company's Supplier Code of Conduct, 2021)

The case company strives to stay up to date regarding the latest trends in the industry and the best practices in supplier risk management. This is done in a variety of different ways. By being a part of industry associations, the employees of the case company have access to a diverse range of training courses regarding supply chain management. Through these continuing education provided for the employees, new ideas and methods are invented to further improve company X's operations. Furthermore, the employees frequently take part in industry exhibitions and other topical lectures. As a way of analyzing company X's operations in comparison with others, benchmarking is utilized. Furthermore, the case company often visits its suppliers to discuss areas of improvement and to trade ideas.

The identified most critical risk of lack of availability is mitigated through a variety of techniques. The process starts with the dispatch of a request for quotation, conveying a preliminary inquiry about the products or services the supplier is able to provide as well as their price (GEP, 2023). When the supplier commits to deliver the promised volumes for the agreed timeframe, availability is technically secured. However, due to the current state of the world and the fact that sometimes suppliers agree to deliver volumes, which they end up not being able to deliver, the risk of availability still exists. The risk can also be mitigated by comparing the volumes and capacity of the case company to the supplier's volume and capacity. The risk of availability is also often caused by issues with a tier 2 supplier. This often then demands a meeting with the tier 1 and tier 2 suppliers together to resolve the issue.

In case that a potential future issue of capacity, volumes or other matters is noticed in the stage of RFQ or afterward in the collaboration, the issue will be dealt with together with the supplier. Person B in direct sourcing states:

“The world situation being what it is, sometimes things don’t work out as they were supposed to, so we have to work it out together with the supplier” - Person B

The supplier risks are not categorized as a company-wide procedure as of yet but this feature will be implemented in the near future. However, some categorization of suppliers is done in a few systems, but this is not done in a predetermined manner or in every system. Nonetheless, as previously mentioned, the interviewee in direct sourcing utilizes the ABC analysis as a method to assess and identify any potential supplier risks. The suppliers are categorized into a category based on the total amount of points, which are determined by different criteria. The table used for the point determination can be viewed below in table 4.

Supplier criteria
Supplier assesment (new supplier, reliability of deliveries, overall reliability, sub-supplier management) Critical = 2, fairly critical = 1, not critical = 0
New product for the supplier Critical = 2, fairly critical = 1, not critical = 0
New supplier production location Critical = 2, fairly critical = 1, not critical = 0
Supplier project management Critical = 2, fairly critical = 1, not critical = 0
Problems with earlier deliveries Critical = 2, fairly critical = 1, not critical = 0
Total points =

Table 4. ABC analysis point determination

The total amount of points a supplier can score is 10, and the lowest is 0. The categories are A, with 5-10 points, B, with 3-4 points and C, with 0-2 points. Based on the category the amount of risk is determined and future measures are decided on. The criteria are the basic assessment of the supplier, whether the product is new for the supplier, a new location of production for the supplier, supplier project management and past problems that company X has encountered in business with the supplier. Category A signifies the suppliers which retain the highest amount of risk. These suppliers require more careful monitoring and more frequent meetings in order to keep the risks in check and to determine any actions to improve

the risk. Suppliers in category B contain a medium amount of risk and suppliers in category C have the lowest amount of risk.

The section on “supplier assessment” conveys the risk following the establishment of a new supplier relationship, previous experiences with reliability considering delivery, the overall reliability of the supplier and the view on how the first-tier supplier manages their own suppliers. The second criterion to evaluate is whether the product or service provided by the supplier is a new addition to their services. This conveys risk, as there is no certainty of reliability and quality. The same affects the next criteria of whether the location of manufacturing is new to the supplier. Additional supplier risk is added by the lack of certainty in delivery reliability.

The following criterion is the level of the supplier's project management. This conveys the supplier’s ability to achieve set objectives through an effective approach, signifying their capability to coordinate, control resources and deliver results as promised. The last criterion in assessing the total points to determine the risk category is any problems in delivery company X has experienced prior. This conveys problems of non-compliance with timetables, issues with carriers or problems with the packaging of the product among other matters.

5. Conclusions and discussion

This thesis discussed the most critical supplier risks as they currently stand as well as the foremost supplier risk management techniques in mitigating supplier risks from the perspective of the case company in the industry of technology. Several conclusions may be drawn after completing a thorough analysis of these topics.

The first equivalent research question was “What are the critical supplier risks in the industry of technology?”. As the case company focuses on the supplier risk management of first-tier suppliers, the defining of the current critical supplier risks will focus on solely those. The most critical supplier risk as of now is the risk of a lack in product availability. The potentiality of this issue has increased due to the worldwide pandemic and its effects as well as the war in Ukraine. The supplier risk management techniques used to mitigate this specific risk will be discussed in the following paragraphs.

This identified supplier risk of lack of availability has been recognized in the discussed prior literature. Zsidisin et al. (2000) recognized the risk of supplier’s not being able to meet the demands due to a lack of capacity. Similar to the findings of this research, Zsidisin et al. (2000) disclosed that the actualization of this risk is the main reason behind a company’s inability to produce products or services. The identified supplier risk can also be linked to the risk of being highly dependent on a supplier, as identified by Nguyen et al. (2017).

The second equivalent research question was “Which are the foremost supplier risk management practices used to respond to supplier risks?” Company X conventionally assembles routine meetings from time to time for both parties to be able to communicate any potential issues. Regarding most critical suppliers, meetings are held more frequently. In these sessions, any hazards identified will be reviewed and remedied. Furthermore, auditing and monitoring are executed. Supplier audits are conducted to ensure that the supplier meets the company's established requirements, such as quality. Company X furthermore checks any possible concerns in quality by performing a quality inspection on any incoming goods. If a problem with the material is discovered, the quality control team will request that the supplier provide a report on the incident. Follow-up measures will be planned in accordance with the report prepared by the supplier. Monitoring also signifies the constant observation of potential

issues. The monitoring is especially thorough for supplier risks that might result in a production halt or product faults.

The risk of lack of availability specifically is present even though the quotation from the supplier has presented the required volumes. Even though the supplier has committed to provide the volumes, issues can still arise as situations change for instance with sub-tier suppliers. Furthermore, occasionally suppliers commit to volumes they end up not being able to carry out. This risk is mitigated mostly through examining and communicating openly with the supplier to solve the potential or the actualized issues. Preliminary mitigation techniques involve comparing the capacity and volumes to those of the supplier. The foremost supplier risk mitigation technique overall is effective communication with suppliers in order to maintain better awareness and readiness.

The supplier risk mitigation techniques utilized by the case company is comparable to the supplier risk management practice suggested by Nguyen et al. (2017) for mitigating high dependency on suppliers. Nguyen et al. (2017) suggest that in order to minimize the risk conveyed from single sourcing, the buying company should strive for a high level of supplier visibility. Through this, the company is better aware of the strategic and operational issues of the supplier that may jeopardize the buying company's operations. The risk of experiencing a production shutdown caused by a supplier's volume issue can be also mitigated by practicing dual sourcing, especially on highly critical materials. Through this practice, the buying company is less dependent on a single supplier. (Warburton and Stratton, 2002)

It is evident that practicing and improving supplier risk management techniques is critical for companies to successfully identify, analyze and reduce risks connected to their suppliers. This is especially essential due to the growing complexity of international supply chains. This phenomenon has increased the number of potential risks in supply chains. This thesis emphasizes the need for identifying the critical supplier risks that a company faces, due to its ability to disrupt its operations. Companies may limit the likelihood of supplier risks and be able to lessen the effect of disturbances in their operations caused by supplier risks by prioritizing the execution of suitable supplier risk management practices. A coordinated approach in supplier risk management is required, which conveys working together with suppliers. Close collaboration with suppliers is required to ensure the comprehension of

potential risks and to determine suitable mitigation measures by both parties. This requires transparency, mutual trust and successful communication.

This thesis investigates the topic from the case company's point of view, which limits the analysis to a single company's perspective and management practices. Further limitation regarding the case company is that the company as of now focuses on B2B sales, which conveys the company sells their end products to another company. This thesis will also solely analyze the industry of the case company.

Considering potential future research, striving to raise the sample size of interviewees, investigating further secondary data and incorporating a more diverse variety of individuals could aid in overcoming the study's flaws and inability to be generalized. Furthermore, an approach that combines different approaches would allow the incorporation of both qualitative as well as quantitative data. As a result, a more objective assessment of the aspects contributing to supplier risk management and a more in-depth understanding could be achieved.

Despite these suggestions for improvement, the findings of this research are valuable for companies and other individuals interested in the topic who are searching for information regarding the foremost supplier risk management practices and the critical supplier risks as they currently stand.

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Appendix 1. Interview questions

1. Could you describe what kind of suppliers does your company have?
2. How do you define the term "supplier risk"?
3. What are the most critical supplier risks and why?
 - a. For first-tier suppliers?
 - b. Second-tier suppliers?
4. How do you identify and assess potential supplier risks?
5. What key supplier risk management practices do you use?
6. Could you describe the steps involved in implementing an effective supplier risk management programme?
7. What key challenges have you encountered in managing supplier risk?
8. How do you keep up to date with the latest industry trends and best practices in supplier risk management?
9. Do you categorize suppliers, if so, how?
10. Any other comments on this topic?