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RISK MANAGEMENT IN PROCUREMENT: CASE SPARE PARTS AND MAINTENANCE

Examiners: Professor Jukka Hallikas
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ABSTRACT

Lappeenranta-Lahti University of Technology LUT
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Risk management in procurement, case spare parts and maintenance

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The goal of this research is to study what type of risks the procurement of spare parts and maintenance services include and how these risks can be managed and reduced. The risks are studied from the procurement risks/risk management and supplier risks/risk management point of view. The research method used in this study is a qualitative single case study. The data for the empirical part was collected by conducting 4 semi-structured theme interviews with the employees of the case company's purchasing department. Based on the interviews, 2 survey forms were built up, which were used to prioritize the risks the case company faces, and to find potential weaknesses of the purchasing process of the case company. In this paper the main risks, that the case company faces based on the interviews and survey forms, are presented. In the results the buyer's dependency of the supplier, risks related to auditing process and delivery related risks for spare parts were highlighted. For spare parts specifically, the most important risks were identified to be the delivery and end of supply risks. Use of spot markets and back-up suppliers as a risk management method is highlighted with various risk types Additionally, it needs to be noted that despite of including the risk management in the purchasing process and decision making, the risk management process still needs further development which requires resources and work. The results show that the case company's purchasing strategy follows the same principles as discussed in theory.

TIIVISTELMÄ

Lappeenrannan-Lahden teknillinen yliopisto LUT
LUT School of Business and Management
Master's Programme in Supply Management

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Riskienhallinta hankinnoissa, varaosat ja huollot

Pro gradu -tutkielma

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Tämän tutkielman tavoitteena on tutkia minkälaisia riskejä varaosien ja huoltopalveluiden hankintoihin liittyy, ja miten näitä riskejä voidaan hallita sekä minimoida. Riskejä tutkitaan hankintojen ja toimittajien muodostamien riskien ja riskienhallintakeinojen näkökulmasta. Tutkimusmenetelmänä tässä työssä on laadullinen tapaustutkimus. Työn empiiriseen osaan hankittiin tutkimusaineisto tekemällä 4 teemahaastattelua, jotka tehtiin kohdeyrityksen hankintaosaston työntekijöille. Haastattelujen pohjalta koostettiin kaksi kyselylomaketta, joiden avulla priorisoitiin kohdeyrityksen kohtaamia riskejä sekä etsittiin hankintaprosessin heikkouksia. Työssä esitetään pääriskit, joita yritys haastattelujen ja kyselylomakkeen perusteella kohtaa. Tuloksissa riskien osalta korostui ostajan potentiaalisesti riippuvainen asema suhteessa toimittajiin, riskit liittyen auditointiprosessiin sekä toimitusriskit varaosille. Erityisesti varaosien osalta riskeissä korostui toimitusriski ja tuotteen toimituksen/valmistuksen loppuminen. Markkinoiden ja varatoimittajien käyttö riskienhallintamenetelmänä nousi esiin monien riskien kohdalla. Tämän lisäksi huomioitavaa on, että huolimatta riskienhallinnan sisällyttämisestä hankintaprosessiin ja päätöksentekoon, on riskienhallintaprosessi on vielä vaiheessa, joka vaatii lisää resursseja ja työtä. Kohdeyrityksen hankintojen strategia noudattaa esitettyä teoriaa.

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1 INTRODUCTION

In the logistics and transportation business the maintenance services are needed to ensure that the machines work, and operations can be kept running continuously. To perform the maintenance services, the spare parts are needed. The flow of spare parts needs to be managed to ensure that the maintenance services can be done efficiently and in time. In the literature managing the flow of spare parts is described to be crucial for companies to prevent financial losses, but the same time the management of the flow of parts is also described to be challenging for the companies (Huiskonen 2001, 125). These challenges in managing may arise from varying demand, challenges when forecasting the demand and additionally the spare parts can be expensive to purchase. Therefore, it is discussed that companies may face challenges when optimizing between availability of the parts and costs related to keeping sparts in the inventory. (Huiskonen 2001, 125; Turrini & Meissner 2019, 118.) It is also described in the literature that the situation where there are no available spare parts, the downtime of machinery caused by a failure might be long (Kian, Bektaş & Ouelhadj 2019, 342).

In the literature the importance of maintenance and spare parts support is described to be the very basic elements of product support process (Ghodrati, Benjevic & Jardine 2012, 438). Companies operating in industries where the purchased products have high costs and where the products are used for long periods, need to ensure that they are able to find the necessary spare parts for the purchased products and machinery. The supply of the spare parts may come to an end in example because of decreased demand of the parts or if the technology advances and the older machinery and parts become obsolete. To manage the risk of end of supply, it has been discussed that companies may keep large stocks of spare parts, of which the supply is estimated to stop. (Li, Dekkert, Heij & Hekimoğlu 2016, 374.) Should the companies face the situation where they won't get support in the form they need, the results may lead to problems like losses if the operations are stopped (Ghodrati et al. 2012, 448).

Overall, it is important to identify the potential risks in purchasing operations and be aware how these risks may be either completely avoided or mitigated. For the case company, it is important to know what type of risks it faces when purchasing the spare parts and maintenance services, and how to manage these identified risks. In addition, supplier

selection and supplier evaluation process need to be analyzed and defined for the case company. By combining information about various risk types linked to purchasing and supply chain, the risks can be managed in both reactive and proactive ways

1.1 Research questions, objectives and limitations

In this chapter the objectives of this research are defined, and the main research question and the sub questions are presented. Additionally, the limitations of this research are defined and discussed. The goal of this paper is to discuss and analyze the current state of risk management in the case company's spare parts and maintenance purchasing and how it could be developed. In addition, the aim is to discuss about the supplier and supply risk and identify what makes supplier evaluation successful, and also how the case company could implement these successful methods to their own supplier selection and evaluation processes. To conclude this, the goal is to find out how all these various parts and methods form a comprehensive risk management model for spare parts and maintenance procurement at the case company.

The main research question is defined for this research as follows:

"How is procurement risk management done at the case company in spare parts and maintenance purchasing?".

The sub questions for this research are defined as follows:

- What is supply risk?
- What is risk management?
- What are the relevant risk management tools?
- What is needed for successful supplier evaluation?

This paper discusses the risk management from the purchasing and supply management point of view and therefore the scope of the risk management is limited to procurement not the whole company-wide actions and strategies. Therefore, the organizational risk management is not discussed and analyzed in this paper. For this reason, the theoretical and empirical parts of the paper will discuss only risk management and its methods and tools

from the purchasing and supply management point of view. This paper also discusses the risk management only from the case company's point of view and the empirical data was collected by conducting interviews with the employees of the case company. Additionally, the risks are considered and discussed from the point of view where the result of the risk occurring is negative. These limitations are done to ensure that the focus of the research remains in the purchasing risk management and the supply and supplier risk management which were defined as an important topics for this research. In addition, the limitation is done to ensure that the results remain valid and answer the original research questions of this paper.

1.2 Methodology

Qualitative research method was chosen as a research methodology for this research. The research is done as a single case study where the aim is to understand what the current state of the procurement risk management in spare parts and maintenance category is and how it could be developed. The use of single case study leads to certain limitations as it's discussed that single case studies have limited generalizability (Voss, Tsikriktsis & Frohlich 2002, 201).

The empirical data was collected by conducting semi-structured interviews with the purchasing personnel of the case company. In addition, after the interviews a survey form was built based on the findings in the interviews. The survey form included a FMEA survey (appendix 3) about the purchasing process and a risk prioritization survey (appendix 2) about the likelihood and impact of individual risks related to purchasing, suppliers and sustainability identified in the interviews. The form was used to gain insight on what are the main risks the company has in its purchasing operations in the category of spare parts and maintenance services. Further discussion about data collection method and analysis is presented in the chapter 3 of this paper, where the research methodology is analyzed and discussed further.

1.3 Key concepts of the study

In this chapter the six key concepts of the study are identified, presented and defined. These concepts are further discussed in the theoretical part of this paper in chapter two.

Risk

March and Shapira (1987, 1404) describe risk the following way: "In classical decision theory, risk is most commonly conceived as reflecting variation in the distribution of possible outcomes, their likelihoods, and their subjective values". Additionally, Osipova and Eriksson (2011, 1150) define risk the following way: "A risk has a cause and, if it is triggered, a consequence".

Procurement risk

Hong, Lee and Zhang (2018, 1550) elaborate the risk the following way: "Procurement risk is the probability of variance associated with supply disruption in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to the subsequence process in the supply chain operation."

Supply risk

Supply risk occurs when there is a problem or a failure with the in-bound supply (Zsidisin, Panelli and Upton 2000, 187, 189.) To mitigate the supply risk, companies may use various actions varying from forming contingency plans, risk assessments, improve their processes and to using buffer strategies (Zsidisin et al 2000, 196).

Risk management

Manuj and Mentzer (2008, 141) state that "At the strategic level, risk management is focused on identifying and assessing the probabilities and consequences of risks, and selecting appropriate risk strategies to reduce the probability of, or losses associated with adverse events".

Supplier selection

The buyer has options on selecting the supplier depending on the product/service and the relationship with the supplier. In example, if the relationship is not collaborative and the

buyer chooses to operate from “arm’s-length”, the buyer may choose to be reactive and select the most suitable supplier from the markets. However, the buyer may also select suppliers in more proactive way and form long-term relationship with the supplier. (Cox 2004, 349.)

Supplier evaluation

Suppliers may be evaluated by different criterion. These evaluation criterions can be modified and tailored depending on the situation (Hawkins et al. 2020, 14.). Ho, Xu and Dey (2010, 21-22) describe the three most used criterion to be quality, delivery and price/cost.

1.4 The outline of the study

This paper outlines the risk management process in procurement. In addition, the risk management methods and tools are discussed in this paper. This paper follows the typical structure in the research. Eriksson and Kovalainen (2008, 281) describe that qualitative research and writing handles the following themes: introducing the research and its purpose, literature review, description of used methodology and how the analysis of data is done, analyzing, discussion and finally conclusions.

The structure of this thesis is presented below in the figure 1. At first in the chapter 1 the introduction and background of the study are presented and discussed. The chapter 1 also describes the key concepts of the study. This is followed by the chapter 2 where the theory related to risk management in general, procurement risk management, spare parts and maintenance procurement and supplier evaluation/selection is discussed. In the chapter 3 of this paper the research methodology is presented and discussed. This includes the chosen research method, data gathering and data analysis methods which were chosen for this research. After this, the empirical findings are analyzed and discussed in the chapter 4. In the chapter 5 of this paper, the results are discussed and presented. In the chapter 5 also the answers to the research questions are discussed. In the final chapter of this paper, findings and the conclusions are summed up and discussed.

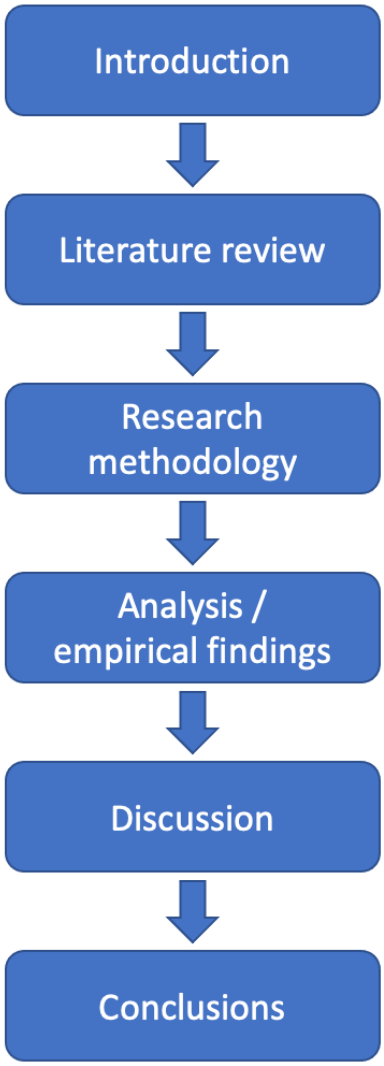


Figure 1. The structure of the thesis.

The conceptual framework of the thesis is presented in the figure 2. The goal is to discuss the procurement risk management and supplier risk and how the case company manages these risks. Therefore, the supplier risk management is discussed from supplier selection, supplier evaluation and supplier dependency point of view. Different purchasing methods and strategies are also discussed in the theoretical part of this paper. In addition, the risk management tools and methods are discussed as these will form the whole risk management process. The aim is to find how all these parts together result in one comprehensive risk management strategy for the company in the field of procurement.

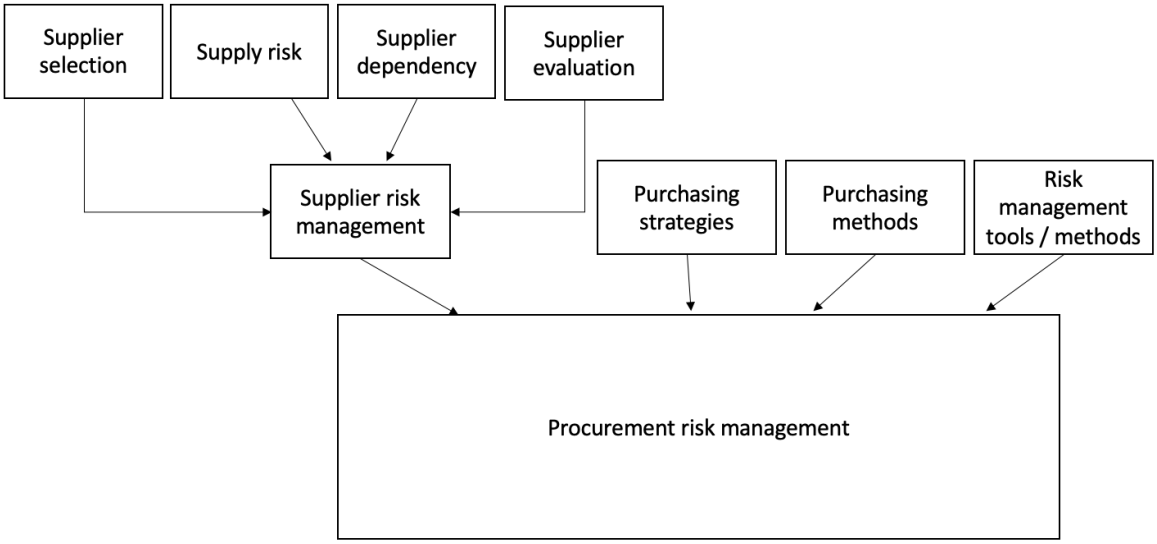


Figure 2. The conceptual framework.

2 LITERATURE REVIEW

In this chapter, the relevant academic literature related to the research question and sub questions is presented and discussed. At first the risk management is described and how the risk management process goes on is explained and discussed. Additionally, the common risk management tools and methods are presented and discussed. This is followed by presenting supply chain and supply risks. After this, the purchasing and purchasing risks are discussed. Additionally, the characteristics of spare parts and maintenance services are discussed which is followed by a chapter about the purchasing and supply risk management strategies and methods. The final part of this chapter discusses about supplier selection and evaluation processes.

In the literature it is discussed that for risk management to be successful, it must include both, the risk identification and analysis, in its process (Kwak, Rodrigues, Mason, Pettit & Beresford 2018, 373). In addition, uncertainty is discussed extensively in the risk management literature and how it's linked to risks. When discussing about uncertainty, it is described to lead to incorrect estimations and misjudgments and therefore uncertainty should be monitored closely (Abdel-Basset, Gunasekaran, Mohamed, Chilamkurti 2019, 489). Abdel-Basset et al. (2019, 489) state that "The risk increases due to increasing uncertainties and these uncertainties creates a gap among what happens and what company has planned". Therefore, to manage risks, it is important to identify and estimate the risk. To estimate the risk, it is important to understand the probability and impact of the risk. (Abdel-Basset et al. 2019, 489.) Finally, it is discussed that if one were able to anticipate the risk or react to the risk as soon as the risk has realized, the impact could be reduced or even avoided completely (Bradley 2014, 486; Hoffmann, Schiele & Krabbendam 2013, 203.)

Probability and impact of the risk are used as a measurement tool because these are explained to have a higher effect in the long run, as it's discussed in the literature that the risks with higher probability will occur more often and the risks with higher impact will have greater effect once occurred (Bradley 2014, 484). Zsidisin, Ellram, Carter and Cavianto (2004, 397) define probability to be how often a risk leading to a loss is realized, and impact to be how severe is that loss which has realized.

For companies the risks can be divided, in example, to external risks and internal risks. The internal risks contain all risks which are related to the company's own actions and operations whereas the external risks are described to be all the other risks the company may face. In the literature it has been argued that the company is able to control the internal risks more efficiently than the external risks. (Kwak et al. 2018, 374.) It's also discussed that the risks the companies face are linked to the goals and objectives the companies have (Hallikas, Karvonen, Pulkkinen, Virolainen and Tuominen 2004, 51).

2.1 Risk Management

In this chapter the risk management process and tools and methods used in risk management processes are presented and discussed. Matook, Lasch and Tamaschke (2009, 243) define that: "For firms, the creation of a comprehensive risk management system requires knowledge of the risk types to which it is exposed".

2.1.1 Process

The risk management process is described to consist of different steps or phases and in the literature, there are various ways to describe the risk management process including various number of steps. In the figure 3 the traditional risk management process and its four steps identified by Hallikas et al. (2004, 52-55) are presented. The risk management process is described to be dynamic, and additionally the process needs continuous monitoring and updating (Kirilmaz & Erol 2017, 56).

Figure 3. Risk management process. (Hallikas et al. 2004, 52-55.)

Blome and Schoenherr (2011, 50) give the phase of identifying of the risks the highest priority, because it's argued that the risk can't be managed if it's not identified first. The risk identification process is described to aim to manage proactively the risk by understanding what type of uncertainties may exist in the future. By conducting the risk identification process, one should understand what the reasons behind the uncertainties are. (Hallikas et al. 2004, 52.) It is also discussed that in the beginning of the process, companies should identify their internal and external operations (Abdel-Basset et al. 2019, 491). This is to be done because internal risks are related to companies' internal operations whereas external risks are linked to external operations and conditions (Kirilmaz & Erol 2017, 56-57). When discussing about identifying the risks, the risks that have happened in the past are described to be easy to identify by conducting interviews or by having a brainstorming session. However, these methods are described to be ineffective on identifying the risks that have not happened yet. (Bradley 2014, 485.)

Once the risks are identified, the risks need to be assessed, analyzed and ranked (Abdel-Basset et al. 2019, 491; Blome & Schoenherr 2011, 49; Osipova & Eriksson 2011, 1150). The risk assessment phase in the risk management process is needed to ensure that the company chooses correct methods to reduce or eliminate the risk depending on the situation (Hallikas et al. 2004, 52-53). Additionally, by prioritizing the risks, the company is able to concentrate on the most crucial risks it may face (Hallikas, Virolainen & Tuominen 2002, 54.) However, it is also discussed that for the risk management to be efficient, the companies should first define what criteria are important in their risk assessment process in order to determine which risks are included in the process and which are not. The risk analysis process consists of evaluating the probability and consequence of the risk. (Abdel-Basset 2019, 491.) When calculating the importance of the risk, the probability of the risk can be multiplied with the consequence of the risk and this way the importance of the risk can be measured and presented (Hallikas et al. 2002, 53). Hallikas et al. (2002, 53) also describe that the probability and the consequence of the risk are estimated in a subjective manner and therefore it is argued that the assessment model of the risks should be simple. The probability of the risks that have already realized in the past can be measured and judged by using historical data. However, in this case it must be ensured that the data used is adequate. (Bradley 2014, 485.)

Once the risks have been assessed, one should concentrate on choosing how to manage the risk (Manuj & Mentzer 2008, 146). Risk mitigation is an action taken to manage and counter the risk (Kirilmaz & Erol 2017, 58). The risk may be managed and mitigated in various ways. Hallikas et al. (2004, 54) have identified five strategies to consider in risk management: risk transfer, risk taking, risk elimination, risk reduction, further analysis of individual risks. The mitigation actions can be labeled as reactive or proactive (Kirilmaz & Erol 2017, 58). The reactive risk mitigation actions are actions that don't eliminate or stop the risk from happening but minimize the impact once the risk occurs. As the reactive term indicates, these mitigation actions are done when the risk realizes. These actions are described to include in example buffers or insurances. In contrast to reactive actions, the proactive mitigation actions are done to eliminate or mitigate the risk from happening in the first place. The proactive actions are described to include in example multiple sourcing. (Hoffmann et al. 2013, 203; Kirilmaz & Erol 2017, 58.) Gouda and Saranga (2018, 5822) describe that proactive methods also include selecting credible supplier, proactive maintenance and monitoring and inspecting suppliers.

Finally, the risk monitoring is an important part of the process, because by doing so, early warning signs of the risks can be detected in advance. By detecting the warning signs the companies are described to be able to react accordingly. Though it needs to be noted, that simply looking the probability and severity of the risks is not enough, as companies are described to need to monitor also other indicators to be fully aware if potential risks are about to be realized. In addition, it needs to be considered that the monitoring of risks is described to be resource intensive process and therefore it is discussed that companies should aim to delimit the number of risks they are monitoring. (Hoffmann et al. 2013, 202, 207.) Kirilmaz and Erol (2017, 59) state that risks are linked to the future and therefore continuous updating of data and monitoring of risks is needed.

Hoffmann et al. (2013, 207) describe that the successful supply risk management process includes high maturity in the process, performing regular risk assessment to individual suppliers and analyzing of the suppliers who have been identified as a problem. Additionally, companies should focus on evaluating their own risk management process continuously as well (Hoffmann et al. 2013, 207).

2.1.2 Tools

Various types of risk management tools exist, and these can be utilized depending on the risk and situation. The tools used may visualize the risks or then the risks may be further analyzed, and one can identify the reasons behind the risks and why risks occur. In this chapter three risk management tools are presented.

Risk management tool “Failure Modes and Effects Analysis” (FMEA) can be used in example when selecting suppliers (Li & Zeng 2016, 1310). The goal when using FMEA analysis is to identify potential failures and what is causing the failure. In addition, the FMEA can be used to evaluate the impacts the failures cause. (Abdelgawad & Fayek 2010, 1028.) When using FMEA tool, the risks can be prioritized by ranking up the risk priority numbers. The risk priority number is calculated by multiplying the following 3 categories: risk probability, severity and how likely the risk is detected. Often times each category has a 10-point scale where the criticality ranges between 1-10, which means that the final risk priority number may vary between numbers 1 to 1000. The results will show the risk priority number where the higher the number is, the higher is the risk as well. (Abdelgawad & Fayek 2010, 1028; Li & Zeng 2016, 1313.)

Abdel-Basset et al. (2019, 491) describe that risks can be measured and visualized also by using tool called “heat-map” where risks are presented according to their probability and severity. The higher the number, the greater the risk. By using this tool, the importance and criticality of the risk can be visualized for the viewer (Abdel-Basset et al. 2019, 491).

Companies may use a tool described as “Bow-tie method”. This tool is used to visualize the causes of identified risks and what are the impacts of the earlier mentioned causes. Additionally, one may decide what mitigation actions are used to minimize the likelihood and impacts of the risk. (Abdel-Basset et al. 2019, 491.)

2.2 Supply chain risks

The supply chains today are described to be complex and additionally, the outsourcing has been argued to create even more complexity to the supply chains (Juttner 2005, 121; Hong,

Lee & Zhang 2018, 1547). One example of this is that in today's markets the majority of goods are described to be manufactured overseas, in lower cost markets, resulting in challenges on monitoring the suppliers and also increased amount of uncertainty (Hong & Lee 2013, 67). Abdel-Basset et al. (2019, 490-492) describe that in the supply chain context risks can be divided to controllable internal risks (manufacturing, business, planning and control, cultural, mitigation and contingency risks) and uncontrollable external risks (demand, supply, environmental, business and physical plant risks).

If the supply chain faces disruptions, the result may be an inability to provide services or a failure in the flow of the goods leading to delays and finally revenue losses (Bradley 2014, 483; Juttner 2005, 121). These disruptions may be divided for example to minor and major disruptions. The minor disruptions are described to be, for example, caused by delivery problems or machine failures and the major disruptions are described to be, for example, natural disasters or production facility fires. (Bradley 2014, 483.) Juttner (2005, 120) describes that there have been various types of disruptions, such as terrorist attacks and diseases, in the supply chains lately. It's discussed that the already realized risks are described to show how vulnerable the supply chains can be (Juttner 2005, 120).

According to Juttner (2005, 122) it is challenging for companies to identify and manage the possible risks and also the impacts of the said risks. When the risk management is on the supply chain level, the companies are described to need to pay attention to not only their own operations but also on other companies' operations and links between the companies. It's discussed that the supply chains are described to have flows, which are identified as: "information, materials, products and money", between companies and supply chain risks are described to come from disruptions in these flows between companies. (Juttner 2005, 122).

2.3 Supply risk

Zsidisin et al. (2000, 187, 189) elaborate that the supply risk occurs when there is a failure with the in-bound supply. There are argued to be two main situations when it's critical to assess the supplier risk. These are described to happen when one is selecting a new supplier and also when companies are evaluating the suppliers who supply goods that are seen critical

for the buyer company. (Matook et al. 2009, 243.) It has been discussed in the literature that companies face a variety of supply related risks, which may vary depending on the situation. Zsidisin et al. (2000, 188-189) have identified six key risk types related to supply risks that the companies may face:

- Business risk
- Supplier capacity constraints
- Quality
- Production technological changes
- Product design changes
- Disasters

The business risk is related to suppliers of the buyer company. Especially supplier selection, when selecting small to medium sized suppliers, is linked to the business risk the buyers may face (Munnukka & Järvi 2008, 255). The supply risk is described to realize for example, if goods can't be acquired (Zsidisin et al. 2000, 188). Wagner, Bode and Koziol (2009, 150) elaborate this by describing this from manufacturing company point of view, where supplier insolvency leads to a situation where suppliers are not able to deliver the goods to buyer companies. It's discussed that the companies should not focus only on monitoring suppliers as isolated individuals, but also as a larger group of suppliers who are connected to each other (Wagner et al. 2009, 151). Zsidisin et al. (2000, 188) state that small companies, which have a strong central leader, can face problems if the person is absent from the company. When monitoring the insolvency risk of the suppliers, financial indicators, such as profitability, third party reports and credit reports, are described to be in a key role when measuring the risks related to supplier's insolvency (Bode, Hübner & Wagner 2014, 30; Jung, Lim and Oh 2011, 612; Munnukka & Järvi 2008, 255).

Supplier capacity constraints are described to arise if the supplier does not have enough capacity or ability to adapt to the changes in demand levels. This is described to lead to a situation where buyer can't acquire the needed goods or services from their supplier. (Zsidisin et al. 2000, 188.) The risk related to capacity constraints is reported to be high especially in industries where the number of demand of the goods or services alternates (Munnukka & Järvi 2008, 255).

The quality risk may arise in the supply chains. This is described to be problematic, because parties involved in the supply chain are dependent on other parties, and their ability to maintain the quality of goods or services provided. Reasons for quality risks are described to be in example the insufficient training or if there are problems with the transportation of purchased goods. It has been also argued that not only the producer of the goods needs to meet the quality related demands, but also the parties involved in the transportation need to achieve the desired quality requirements. (Zsidisin et al. 2000, 188.)

Production technological changes related risk may realize if the supplier can't adapt to the new technology and therefore, for example, their efficiency decreases. Once this risk occurs, it can result for example, in longer lead times. (Zsidisin et al. 2000, 188). Additionally, the lack of capability to adapt to the changes may result in lost competitive advantage in the buyer's perspective if other suppliers are managing to adapt to the new developing technologies. One way to measure this risk is described to be observing how much the supplier is investing in their research and development operations. (Munnukka & Järvi 2008, 255.) Product design changes risk can realize if the supplier can't make changes to their products if needed. This ability may be needed from the suppliers as the buyers may need to modify their products as the time goes on and product needs to be modified. (Zsidisin et al. 2000, 188-189.) Finally, the disasters are described to be events outside of control. These events are described to include natural disasters such as floods or earthquakes. In the literature it's discussed that the buyer or the supplier don't have control over these events and when these risks realize, the impact for companies is described to be potentially very severe. (Zsidisin et al. 2000, 189.)

There are of course other risks besides of these mentioned above as well. In example, if there is only one supplier for a specific product, the buyers could face a risk where their supplier may decide to use opportunistic measures. Because of this, it has been argued that the more there are suppliers on the market, the lesser risk the buyer faces in this context. However, it is also described that changing the supplier may bring additional costs and additionally the delivery times may grow because of the process of changing the supplier. (Jung et al. 2011, 612.)

Inman and Bhaskaran (2019, 3466, 3469) describe that distance plays a key role in delivery disruption related risk as the longer distance is described to increase the likelihood of the risk, and also the expenses that are caused of the risk. It is also discussed that the more there are phases in the supply chain, the more there is risk as it is described that each phase increases the risk of disruption in delivery. Because of this, it is also stated that the longer deliveries, include more phases, leading to more possibilities to face risk. The additional expenses are described to be caused by recovering the shipments that have faced a delivery disruption. However, it needs to be noted that the distance itself isn't described to be the sole reason for increase of probable risks but the overall more complexity of the supply chain. (Inman & Bhaskaran 2019, 3466-3467, 3476.)

Zsidisin et al. (2000, 196) describe that to avoid supply risks companies perform various actions such as risk assessments, contingency plans, process improvements and buffer strategies. However, it is also stated that the not all companies perform these risk mitigation actions even though they are well aware of the risks. The mitigation actions the buyer companies perform may be divided to process improvement actions and buffer activities. (Zsidisin et al. 2000, 195-196.)

2.4 Purchasing and purchasing risks

Hong et al. (2018, 1550) describes that even though the procurement is a part of the whole supply chain, the procurement related risks are mainly linked to the problems with the supply disruptions and contracts between the supplier and the buyer.

Nair, Jayaram and Das (2015, 6266) state that when defining the company's competitive advantage, the purchasing performance has a key role. This key role may be described to be a result from purchasing's role in creating added value and profitability (Matook et al. 2009, 243). Additionally, the purchasing affects other parts of company's operations as well, because negligent decision making when making purchasing decisions may have direct and indirect results (De Boer, Labro & Morlacchi 2001, 75).

Ellram, Tate and Billington (2007, 46-47) have identified 5 steps which define the standard purchasing process:

- Plan
- Source
- Order
- Receive and Pay
- Manage

When discussing about the purchasing process it's discussed that the number of steps may vary depending on the situation, but nevertheless it is necessary to have all these steps in the process included. (Ellram et al. 2007, 46.) Van der Valk and Rozemeijer (2009, 5) describe that the purchasing process ends to supplier/contract evaluation. The purchasing process when acquiring goods is described to be done often times with long and fixed-price contracts. However, the contracts are described to be done in a manner which leaves contracts vulnerable for breaches. This is described to be caused by ineffective breach clauses in the said contracts. (Haksöz & Kadam 2008, 7.) Hong et al. (2018, 1552) elaborates that when discussing about the purchasing process, five main risks have been identified, which are linked to uncertainties in yield, lead time, pricing, disruption risks and demand variation.

Munnukka and Järvi (2008, 257) mention that the key risks related to purchasing process were identified to be "delivery times, readiness for delivery, and quality". These risks were found in the purchasing processes of "new-buy situation and "modified re-buy situations". It's discussed that the uncertainties and risks of the purchases may be challenging for companies who don't endure the uncertainty well. To manage the uncertainties and risks in the purchasing process, it is discussed that having a competent person, in terms of expertise and field of purchasing, in the decision-making process helps. Additionally, by having internal collaboration the companies may further manage the risks. (Munnukka & Järvi 2008, 256-257, 260.)

Demand of the products may vary and cause uncertainty. In the literature it is discussed that companies need to be able to manage this type of uncertainty. (Hong et al. 2018, 1552.) Additional uncertainty may result from pricing and it's mentioned that the time of purchase has a key role in the pricing. By this the authors mean that the price varies during the time.

(Hong et al. 2018, 1552.) Sunil and ManMohan (2004, 57-58) describe that price increases and varying exchange rates of currencies result in risks in procurement. When discussing about the increasing prices, the risk is described to be more likely, if company is using only one source of supply (Sunil & ManMohan 2004, 58). According to Hong et al. (2018, 1566) the defective products or suppliers who don't possess the right capabilities may lead to yield uncertainties and risks.

There are argued to be two methods to acquire goods. These are described as "contracts" and "open market". These two methods both have their pros and cons. The main difference is described to be that by using contracts, the buyer may find themselves in a situation where they have a long contract and are required to purchase based on the contract whereas open market strategy is described to offer more flexibility to the buyer. However, it's also discussed that if one does not have a contract, they are vulnerable against price increases as well. To manage the risk and getting the most success out of these two methods, the companies may use both approaches simultaneously when purchasing. (Mahapatra, Levental & Narasimhan 2017, 34-35.)

Zsidisin et al. (2004, 397) describe that for companies to be successful, it is required to have understanding of the existing supply risk the company may face. In the literature the traditional purchasing process is described to be motivated by cutting costs and increasing profits short-term, whereas the strategic purchasing aims to decrease the number of suppliers and to form a cooperative long-term relationship with selected suppliers. In these days both, supplier and buyer, are described to be able to have a common goal together. (Ryals & Rogers 2006, 41-42.)

2.4.1 Spare parts

According to Hu, Boylan, Chen and Labib (2018, 398) the literature around the spare part management is concentrated around the two following themes:

- Maximizing the availability
- Minimizing the costs

It has been discussed that keeping the right number of spare parts is important for the companies to ensure that the operations are not stopped in a case of failure of a part or machinery (Turrini & Meissner 2019, 118). Having the correct number in inventory is also important because having too many parts will not only increase costs, but the spare parts may also degrade as the time passes (Kian et al. 2019, 342). However, it's discussed that the correct amount of spare parts in the inventory may be difficult to estimate because the demand of spare parts is described to vary (Turrini & Meissner 2019, 119).

The end of the supply of the spare parts may be a risk for buyers. Li et al. (2016, 375) describes that effective way to manage the end of supply risk is that the buyers could inquire the supplier when the supply of the spare parts is ending. However, it has been argued also that the suppliers may be reluctant to share this kind of information with the buyer (Li et al. 2016, 375). As discussed by Hong et al. (2018, 1552) the buyer can manage the risk by increasing the number of suppliers used. However, if the parts being purchased are specialized this type of approach can't be used (Li et al. 2016, 375).

There are potential signs that should be considered by buyers to estimate when the supply of spare parts is coming to an end. These signs are identified to be increased/longer prices, lead times, cycle times and smaller throughput volumes. If companies have been proactive by registering and updating the data related to these four warning signs, they could see the potential warning signs in advance and be in contact with their supplier and ensure that they have enough critical parts in their inventory. (Li et al. 2016, 388.)

To manage the spare parts and the inventories efficiently, the parts can be classified under different groups. The classification helps in inventory management as the most crucial parts can be identified and then the proper strategies may be chosen for the parts. In the field of spare parts, the classification is often times done to three groups (for example A, B and C). (Hu et al. 2018, 398.) Huiskonen (2001, 129) has identified the four important characteristics for spare part goods. These are presented and described in the table 1 below. It has been discussed that there are differences on how to acquire the parts depending on their characteristics. In example, the highly specified spare part may need to be ordered when needed which leads to longer lead-times and higher prices. (Huiskonen 2001, 130.)

Table 1. Characteristics of important spare parts. (Huiskonen 2001, 129-130.)

Characteristic of spare part	Description
Criticality	How critical it is that the faulty part can be changed. The more critical the part is, the faster it needs to be available.
Specificity	How specified the good is. The more specified good is, the more it needs to be stocked because it may be harder to acquire from the supplier.
Demand	The demand may vary between spare parts and it may lead to difficulties when acquiring the goods if the demand is low and suppliers' stocks are therefore low.
Value	The more valuable the part, the less willing different parties are to keep large stocks.

There are various ways to ensure the supply of spare parts. One example is described as "safety stocking" critical spare parts, which is described to be necessary in a case where the lead time of the needed spare part is longer than what the company is prepared to tolerate in a situation where spare part is needed (Huiskonen 2001, 131).

2.4.2 Maintenance services

Ellram, Tate and Billington (2004, 19) describe that "The service-producing sector is essentially defined as everything except manufacturing and farming". Therefore, it can be argued, that services are versatile and hard to categorize. This is described to lead to challenges when buyers are calculating spending in services. Additionally, it has been argued that in general, service purchasing is not done centrally leading to challenges when managing the services. The motive for purchasing services is described to be increasing the economic efficiency of the company (Ellram et al. 2004, 19, 28.) Another challenge when purchasing services is described that services can't be stored like physical goods, because services are described to exist only when they are being produced (Van der Valk & Rozemeijer 2009, 4).

Kian et al. (2019, 324) describe that maintenance can be defined either as corrective or preventive activity. They elaborate this by describing that when one chooses the corrective

approach, the equipment is used until failure whereas preventive approach means that the equipment's condition is continuously monitored, and maintenance is done if needed. It has been discussed that the preventive maintenance approach can be further divided to time-based, condition-based and predictive maintenance. The time-based maintenance is done periodically. The equipment is reviewed after a certain time has passed and then the decision to perform maintenance is decided. When one selects the predictive maintenance as a method, the equipment is monitored continuously by having real-time data about the equipment. This way one can choose correct maintenance method when needed. It is discussed that for example in the maritime industry, usually the majority of maintenance and spare part purchasing activities are outsourced by ship owners, because it is argued that third party suppliers are able to offer more flexible maintenance services and spare part purchasing. (Kian et al. 2019, 324-325.)

Ellram and Tate (2015, 64) describe that theoretically speaking the purchasing of services follows the same processes and steps as purchasing of physical goods. It's discussed that because the value in services is created by human labor, which makes managing and controlling the service challenging, it results in challenges in purchasing of services. In addition, the managing, finding and selecting suppliers to provide and produce services is described to be expensive. (Ellram et al. 2004, 17-18, 28.)

The problems in service purchasing may result in example from unclear specifications in the purchasing process. For example, the buyer may expect more from the supplier. To manage this, it's discussed that the buyer should have a clear service level agreement where all required things are documented. This is to be done to ensure that suppliers' performance can be measured and monitored accordingly. It is described that this helps also the supplier as the service level agreement helps the supplier to understand what is needed from them. (Ellram et al. 2004, 27.) However, it has been argued that because the services may be more challenging to visualize and define, the defining of appropriate service levels may be challenging (Ellram et al. 2004, 27; Ellram et al. 2007, 45).

2.5 Purchasing risk management

The purchasing department is described to be in a key role for company's risk management operations to succeed. It's discussed that the purchasing department needs to evaluate multiple different risks varying from poor quality in products or services to supplier failure. (Ryals & Rodgers 2006, 42.) It has been discussed that when the risk rises over the acceptable level defined by the company, the companies are described to start mitigating the risk accordingly (Munnukka & Järvi 2008, 255). Hong et al. (2018, 1566) mention that reactive risk management methods may be more practical than the proactive, as they discuss that for example, in case of supply disruption, it may be better to place an order and use alternative supplier than wait for the disruption to be solved.

Hallikas, Lintukangas and Kähkönen (2020, 2) describe that many customs and methods that are used in sustainable supply management work also with risk management in general. One example of this is given in a form of supplier evaluation, where the quality risk may be managed by auditing the suppliers. This type of sustainability practice is described to assist the risk management process of the company and therefore it can be argued that these practices don't only support the sustainability but also the other operations and overall performance as well. (Hallikas et al. 2020, 2, 7.)

Once the risks are identified, the purchasers and the company can manage it in example, by implementing improvement strategies for their processes. Additionally, the companies are reported to need to have alternative suppliers and inventories to choose from to manage the risk they may face. However, it has been discussed in the literature, that the improved processes can't reduce the risk entirely. (Zsidisin et al. 2000, 190.)

The companies need to consider when the risk assessment is to be done and when not. Zsidisin et al. (2000, 196) describe that it is important to calculate the cost of reducing the risk and compare it to cost of risk being realized. It is also discussed that the top management should be encouraging purchasers to perform the risk assessment processes. In addition, it has been discussed that companies who have already faced the supply risks are more likely performing the risk assessment processes than companies who have not faced these risks yet. (Zsidisin et al. 2000, 196.)

Price uncertainty may be mitigated by having contracts that are flexible and thus the contract doesn't require the buyer to purchase the goods at a given time with pre-determined volumes (Hong et al. 2018, 1554). In addition, it is discussed that the risk of increased costs in the procurement operations may be managed by having alternative suppliers, long contracts and inventories (Sunil & ManMohan 2004, 58).

To mitigate the risk of unreliable yield, it is advised in the literature to have a diverse set of suppliers available. This means that back up suppliers may be used if needed (Hong et al. 2018, 1554). Though it is also mentioned in the literature, that the back up suppliers may not be able to produce the required volumes of goods needed because they may not have enough capacity or resources to fulfill the needed volumes (Li & Li 2017, 167-168). Another method to use when mitigating the yield risk is described to apply supplier relationship management methods and aim to collaborate with the supplier. (Hong et al. 2018, 1554.)

Finally, it has been discussed that the lead time uncertainty may be also managed by having the backup suppliers. In addition, it's discussed that one way to manage the uncertainty is by making the order of the purchased goods in the right time. Though it's also discussed that knowing the right time to order requires the buyer to optimize the time in the first place. (Hong et al. 2018, 1554-1555.)

2.5.1 Purchasing strategies

The buyers have different purchasing strategies to choose from and these strategies are described to depend on the situation and also what type of product is being purchased. For example, there might be a situation where there are not many suppliers to choose from in the first place. This may result for example from the specialized technology needed in the production of the purchased units. The buyer may use many suppliers and select the multiple sourcing as their strategy, or the buyer may choose to use only one supplier. (Elmaghraby 2000, 350.)

However, it's discussed that by having multiple suppliers, the buyer may face higher expenses (Hong et al. 2018, 1555). It's also discussed that the trend is going towards reducing the number of suppliers instead of increasing the number. This is argued to benefit

the companies with their cost management, and supplier relationship management efforts. (Ellram, Tate & Billington 2007, 52.) By choosing single sourcing as a strategy the company may achieve cost savings because of economies of scale. Additionally, the administrative costs may be reduced as the number of suppliers is lower. The single sourcing may also be more secure according to the literature. This is explained to result from only one channel where information is to be shared between the buyer and supplier. (Namdar, Li, Sawhney & Pradhan 2018, 2234.) However, by decreasing the supplier base, the companies may face entirely new type of risks. One being the buyer's dependency on their supplier. To reduce this risk, it is advised that both, the supplier and the buyer, measure the risk and performance levels together. By doing this, it's discussed that both parties can reduce the dependency risk respectively. (Ryals & Rogers 2006, 42.)

When deciding the purchasing strategy, the buyer needs to consider what are important criteria when making the purchase decision. These criteria can include in example reliability of the supplier and cost. It has been argued that often times using only one criteria is not enough and therefore considering multiple criteria is advised and necessary. (Elmaghraby 2000, 351.) Hong et al. (2018, 1561) describes that cooperation between the buyer and supplier is one method to reduce uncertainty in the purchasing process. They elaborate that cooperation may be for example a flexible contract between the buyer and the supplier (Hong et al. 2018, 1561). When choosing the most suitable purchasing strategy, the buyer needs to consider how many purchases can be done and how many times the supplier can be chosen. This means that not all purchases are done in a single time and for example, to utilize the competition between the suppliers, the buyer may choose to have multiple times when they select the supplier who they use. Though it is mentioned in the literature that by having multiple supplier selection processes the purchasing process may not be as efficient as it could be. (Elmaghraby 2000, 354.)

To mitigate the risk related to demand and changes in the demand companies are described to need to perform a variety of mitigation tactics. One method to mitigate the risk is to update the information about demand regularly. Another method to mitigate varying demand is described to be, for example, having back up suppliers. (Hong et al. 2018, 1552.) In addition to these, the use of spot markets gives the buyer a way to manage and mitigate the demand related risk (Haksöz & Kadam 2008, 7). For example, the supplier who the buyer has a

contract with, may face difficulties with supplying and the buyer is forced to take reactive actions. These shortcomings can be managed by buying from the markets, but it needs to be considered that the market price may vary and be higher than the pre-agreed contract price. The other option is to use a so-called "option" to purchase the needed goods. This "option"-method is described as a flexible way to purchase goods as the buyer has a right to purchase the products, but the buyer is not obligated to do so. However, the buyer has to pay to have this option right in the first place. (Hong & Lee 2013, 67-68.)

Overall, it can be said that by having alternative supply channels and back-up suppliers the majority of uncertainties and also risks connected to purchasing may be mitigated. This method is especially suitable with demand and lead time uncertainties and in case the company faces a supply disruption risk. (Hong et al. 2018, 1564.)

2.5.2 Supply risk management

Companies have various ways to manage the risks. Hoffmann et al. (2013, 203) describe that when managing supply risk, one can perform reactive actions such as having insurance or buffers. The pro-active methods in supply risk management context are done to eliminate the risk before it occurs. These methods and actions include in example multiple sourcing. (Hoffmann et al. 2013, 203.) These tactics and actions can be described with various terms. Tomlin (2006, 640) describes that companies may use mitigation tactics, which are done before the risk occurs or contingency tactics which are performed once the risk has occurred. Companies may choose to use a combination of both mitigation and contingency tactics. However, implementing the risk management tactics brings costs and therefore it is argued that in some situation's companies may also seek to simply accept the potential risk and face it. (Tomlin 2006, 640.)

Blome and Schoenherr (2011, 50) describe that the dependency of the supplier defines the risk management methods the buyer is willing to do. It is also discussed about the methods that mostly the suppliers are monitored, and buyer will react only if the supplier were to become insolvent (Blome & Schoenherr 2011, 50). Bode et al (2014, 26) describe that the supplier facing insolvency shows warning signs which the buyers should monitor and detect in order to mitigate the risk. To monitor and mitigate this risk, buyers should collect both

qualitative and quantitative data about their supplier's financial information (Bode et al. 2014, 26, 38).

The risk of supply disruption may be minimized by developing the supplier's performance. Additionally, companies may seek new and more stable and also more competent suppliers and switch to use them. However, it is also discussed that if companies want to keep a larger supplier base and use multiple sourcing as their strategy while managing the insolvency risk, the companies should seek suppliers who are not linked closely to other suppliers the company is already using. (Wagner et al. 2009, 159.)

Inman and Bhaskaran (2019, 3469) discuss about mitigation tactics against disruption of delivery risk, and they state that in example, managerial control or preventive management of the delivery process may help to reduce the risk of delivery disruption. They also discuss about the complexity and the length of the supply chains and describe that the longer and more complex the supply chain is, the more controlling it needs (Inman & Bhaskaran 2019, 3469). Gouda and Saranga (2018, 5823, 5825) state that besides of having back up suppliers and using multiple sourcing, companies may manage the delivery risk by having buffer capacity and more flexible transports.

Tang (2006, 457) described the risks linked to suppliers and order allocation to be uncertainty in demand, supply yield, supply lead times and supply costs. In the literature it has been discussed that there are two types of supply, which are described as "regular" and "emergency". The difference between these two is that the "emergency" supply is available immediately whereas the "regular" supply follows the regular lead times. (Tang 2006, 457.) To conclude, by using a varying number of suppliers' companies may try to mitigate the risk related to uncertain yield. Though, this may increase the overall costs of the company. (Hong et al. 2018, 1556.)

Hajmohammad and Vachon (2016, 50) discuss about supplier sustainability risk and they list that there are four strategies to choose from when managing the supplier sustainability risk: "risk avoidance, monitoring based risk mitigation, collaboration-based risk mitigation and risk acceptance". They describe that the risk avoidance strategy may be utilized if the

risk is to be removed. In this context the risk can be avoided by simply changing the supplier. (Hajmohammad & Vachon, 2016, 50.)

2.5.3 Supplier selection end evaluation

The supplier selection process is important for the buyers because the wrong supplier selection decision may lead to various problems whereas selecting the right suppliers may help to reduce risks (Chen & Wu 2013, 635). Though the selection process and requirements may depend on what is being purchased. Cox (2004, 349) elaborates this by describing how majority of sourcing is done with short-term relationships where buyer operates from arm's-length in a reactive and non-collaborative way with the suppliers. In this context, the suppliers are chosen from markets as the buyers feel that the competition brings the best result for the buyer. (Cox 2004, 349.) It is important to define the goals for purchasing, because the supplier performance is described to be dependent on the selection and development of suppliers who support the purchasing goal. By having a proper criterion for supplier selection process, the company can ensure that the suppliers have correct roles. (Nair et al. 2015, 6264.)

As discussed earlier in this paper, it has been described that nowadays buyers are generally aiming to have fewer suppliers than before. However, the remaining suppliers are described to be more reliable, and the buyer's goal is defined as to form a long-term relationship with the supplier. (Ho, Xu & Dey 2010, 16.) When selecting the suppliers, it is important to first identify the selection criteria used to evaluate the supplier. Once the criteria have been selected, the suppliers can be ranked by their performance. (Li & Zeng 2016, 1312.)

De Boer et al. (2001, 77, 79, 84) presents a framework for supplier selection process, which includes 4 steps:

- Problem definition
- Formulation of criteria
- Qualification
- Choice

In the beginning of the process, the buyer should aim to have a list of potential suppliers, where all non-acceptable suppliers are removed from (De Boer et al. 2001, 80). During the supplier selection process, the aim is to have a reduced number of approved suppliers. The approved suppliers are reduced from a larger pool of potential suppliers by classifying the supplier pool to approved and not approved during the process of supplier selection. Once the suppliers have been approved and selected, companies need to define how they divide the orders and existing volumes with the pool of selected suppliers. This is an important step of the process, as there have been identified various risks related to this: uncertain demand, supply yield, supply lead times and supply costs. (Tang 2006, 456-457.)

It has been discussed that the last step of the supplier selection process, "choice", has received the most interest out of them all. This is explained to be a result from the fact, that the "choice" step is described to be the most visible of all these steps in the selection process. However, it's also discussed that to get the best result from the supplier selection process, all steps mentioned earlier need to be done in careful and thorough manner. (De Boer et al. 2001, 86.)

It is argued that the supply chains may face problems if they are not measured and monitored. One method to measure and monitor the supply chain is to perform supplier audits and evaluate in example, the cost structure and quality. This is done to evaluate that the quality of the service or the product meets the buyer's standards. (Chen & Jeter 2008, 2.) Ryals and Rogers (2006, 43) describe, that traditionally supplier performance evaluation can be described to be challenging. Ho et al. (2010, 21-22) found that the most popular supplier evaluation criteria is quality, the second is delivery and the third is defined to be price/cost. However, Elmagrhaby (2000, 351) describes that often times the buyer can't just simply rank and evaluate the suppliers based only on one criteria and most times more criteria need to be considered when selecting the proper strategy.

The supplier performance evaluation process may be used to mitigate and avoid risks from being realized. For example, it is described to happen if the purchaser avoids poor supplier selection or poor performance by the supplier. By forming data about the supplier's performance in the past, the purchasers are described to have information available which can be used, and this enables that the likelihood of risks can be minimized. For the evaluation

purposes, it is discussed that it's vital that the evaluated things are properly specified in advance to avoid any inaccuracies in the data. Additionally, the purchaser should communicate their requirements effectively to their suppliers to ensure that the supplier is able to achieve and deliver the requirements. (Hawkins, Gravier & Muir 2020, 3, 5-7.)

The suppliers may be evaluated also with other standards besides their performance. Klassen and Vereecke (2012, 105) mention that companies may expect their suppliers to report to them that required labor standards and practices are followed by the supplier. It is also discussed in the literature that companies may try to identify the potential sustainability risks the suppliers could face and develop their suppliers and to manage the sustainability related risks (Gouda & Saranga 2018, 5824).

Hawkins et al. (2020, 14) describe that it is important that the ratings in the supplier performance evaluation are done properly and also that they are justified. They also found that the justification efforts had the strongest effect when mitigating the risks with evaluation processes. The ratings may be customized depending on the situation and therefore it is argued that companies should not just use generic ratings for all evaluation purposes and situations. (Hawkins et al. 2020, 14.) Lastly, it is also discussed that supplier audits help managing and maintaining the relationship between buyer and supplier (Chen & Jeter 2008, 2).

3 RESEARCH METHODOLOGY

In this chapter the research methodology used in this research for data collection and analyzing is presented and discussed. Eriksson and Kovalainen (2008, 282) describe that the purpose of describing the research methodology is to answer what was done in the research and also how and why it was done. This goal can be achieved by describing the methods used in the research and collection of empirical data. Additionally, it's discussed that the data analyzing method should be described in the methodology chapter. (Eriksson & Kovalainen 2008, 282.) Finally, Farquhar (2012, 91) states that documenting the steps taken during the research process should be included and presented in the written report.

In this study the qualitative research method was used. Both, primary and secondary data was used. The secondary data used in this paper consists of peer reviewed journal articles. The primary data was be collected by conducting the semi-structured interviews with the employees of the case company. Additionally, a survey form was filled out by an employee of the case company to identify and prioritize the key risks in the procurement of spare parts and maintenance and supplier selection process. The survey form was made to assist with prioritizing the risks that have been first identified in the interviews conducted with the employees of the case company. In addition, the FMEA analysis was conducted with the case company to identify potential failure modes in the purchasing process of the spare parts and maintenance services. The FMEA analysis tool is used to evaluate the criticality of a failure mode. The tool also helps when the goal is to understand what kind of impacts the potential failure causes and how these impacts could be minimized. The evaluation is done by multiplying values of the impact, likelihood and detections. The results present what are the most critical failure modes, where higher the risk priority number (RPN) is, the more critical the failure more is. (Abdelgawad & Fayek 2010, 1028.) The risk prioritization survey form. FMEA analysis survey form and the interview form can be found from the appendices (appendix 1, appendix 2 and appendix 3) part of this paper.

3.1 The research methods and design

It has been described in the literature that the successful research is founded on the research design, which needs to be consistent and logical (Farquhar 2012, 30). Additionally, it's

discussed that the research process starts by defining the research question (Stuart, McCutcheon, Handfield, McLachlin & Samson 2002, 420). The research questions define what research method one should choose to use when conducting a research, because the chosen method should be suitable and usable when answering the research questions (Eriksson & Kovalainen 2008, 27). In addition, the importance of the research questions is high, because the goal of the research is defined in the research questions. When qualitative research method is used as a method for research, one can choose a case study as a research strategy. (Kähkönen 2011, 31-32.)

Voss et al. (2002, 195-196) discuss that case research is a useful method when answering how and why, and when one is aiming to develop a new theory. Stuart et al. (2002, 427) describes that when doing the case-based research, the data is acquired in multiple ways, including interviews, documents the case company provides and the observations done by the researcher. Eriksson and Kovalainen (2008, 126) describes that if there are more than one source of empirical data, the case study may be seen more accurate and also more convincing. In the literature it has been discussed that the analyzing of data in case studies has vulnerabilities, which are identified as an inability to find notable patterns, inability to simplify from descriptive information and lack of lateral thinking (Stuart et al. 2002, 427). Additionally, Voss et al. (2002, 195) mention that case research as a research method is time consuming and interviews and forming conclusions require skills to conduct them.

The research project is described to start by forming a preliminary topic or questions, but it is also discussed that during the process new topics and questions may arise (Eriksson & Kovalainen 2008, 127). When conducting a research, the case company for the research can be chosen once the research question and strategy have been founded (Kähkönen 2011, 33). Qualitative and quantitative data may be combined in case studies. For example, the term complementarity is used to describe when both methods are used in the same research simultaneously. (Eriksson & Kovalainen 2008, 127.)

In research, both primary and secondary data can be used. The main difference between these is that primary data is collected by the researcher to form new understanding about the topic, whereas secondary data exists already (Eriksson & Kovalainen 2008, 77-78; Farquhar 2012; 68). The researcher has various ways to collect empirical data for the research. One

method is conducting interviews. (Eriksson & Kovalainen 2008, 88.) An important aspect of qualitative research is that the data collection and analyzing methods are properly documented (Farquhar 2012, 91).

In this research, a single case study was chosen as a research method. The primary data was collected by conducting semi-structured interviews with the employees of the case company. The case company was selected because they have been developing their procurement processes in the past years and therefore it provided an interesting opportunity to study how the risk management is done at the moment and how it could be developed in the future.

3.2 The interviews

The interview process can be structured or be free and conversational. However, even if the structure of the interview is free, it is described that often times the interviewer is asking questions and guides the interviews. The most common interviewing style is described to be done face to face, but additionally the interviews can be done remotely by phone or computer as well. In the literature it is discussed that despite the conversational and free structure of the interviews, it is important that the interviewer prepares some questions in advance. In addition, the analyzing of the collected data must be done accordingly. (Eriksson & Kovalainen 2008, 78-79.)

Semi-structured interviews are described to be conversational and more freely structured compared to structured interviews. Semi-structured interview is described to result in thorough and deeper answers. However, it has been stated also that the interviewer needs to ensure that all required themes are covered when interview is done. In addition, the answering may be more variable leading to more challenging analyzing of the answers. (Eriksson & Kovalainen 2008, 81-82.) Voss et al. (2002, 205) describe that an important aspect in the case research is the number of people used to respond to research. They also discuss that in some cases the answers may be given by only one person who is reliable and capable respondent but then again in some cases where one respondent does not have all the answers, more respondents should be used in the interviews. Finally, it's discussed that by asking multiple respondents the same questions, one can build up the reliability of the data but the same time the research process may become time consuming. (Voss et al. 2002, 205.)

Despite what interviewing style is chosen and conducted, it is important that the interviewer has a clear plan for the interview to ensure that questions are asked logically. The proper planning of the interview also requires that the interviewees are selected so that they are able to provide relevant and reliable information for the research. Additionally, the interviewer needs to ensure that they understand what is answered and ask for clarification for in example, technical terms, if needed. Additionally, the documentation is important because the interviewer is advised to have clear information of who they have interviewed and how long the interviewee has worked in the position. (Farquhar 2012, 73-74.)

In the table 2 the interviewees are presented. The semi-structured interviews were carried out remotely by using Microsoft Teams program in February 2021. The interviews were done in Finnish and the quotes used in the empirical part are translated. In the table 2 the title of the interviewee is presented and also how many years they have been working in the current position at the company. The interviewees had a strong background in the industry and the company. Additionally, the duration of the interview is presented.

The interviewees were selected based on their knowledge and expertise in the field of purchasing spare parts and maintenance category and also the risk management process. In the beginning of the interview the goals of the study and the interview were discussed and how the interview process goes on. The interviewees were informed in advance that the interviews will be recorded. All interviews were recorded for the analyzing purposes. The duration of the interviews varied between 68 minutes and 85 minutes. The interviews were semi-structured and were based on the interview form (Appendix 1). The questions and themes in the interview followed the themes of risk management, purchasing and purchasing management, supplier evaluation and supplier selection.

The semi-structured interview was chosen as a strategy because the aim was to give the interviewees the possibility to discuss and describe the processes without any strict structure. The discussion was free flowing as there were no strictly formed questions that were asked during the interviews. In some interviews the additional, more clarifying, questions were presented whereas in the other interviews this was not as necessary.

Table 2. The interviewees.

Interviewee	Title	Years in the role at the company	Duration of the interview
A	Purchasing manager	1	85 min
B	Category manager	2	68 min
C	Buyer	2	80 min
D	Buyer	11	70 min

3.3 Data analysis

In the literature it is described that in qualitative research, the analyzing of the data can start the same time the data is collected. In addition, the semi-structured interviews offer the interviewer possibility to write down what has been discussed and what has not been said as soon as the interview has been done. (Farquhar 2012, 90.) Stuart et al. (2002, 427) describes that the data may be structured to patterns. Transcribing the interview is a method to understand the acquired data, but it is described to take time (Farquhar 2012, 92).

When analyzing the data, there are argued to be two methods which are described as deductive analysis and inductive analysis. When using the deductive analysis, the goal is to test the theory from the theoretical framework designed for the research. The deductive analysis process is described to consist of developing codes from theory and a schedule for coding. The following step in the process is to observe the data and to seek any key words or themes that either support or question the theoretical framework founded for the research. When selecting the inductive analysis, the data is observed, and the goal is to identify common themes that the interviews support. (Farquhar 2012, 92.) In this paper the aim is to observe how the risk management process of the case company is related to the relevant academic literature and discuss it.

Once the interviews were carried out the data analysis was started. At first the interviews were transcribed which resulted in approximately 46 pages. During the transcribing process the interviews were listened and transcribed. The font used in the transcribing process was arial 12 and linespacing 1. After transcribing the interviews, the next step was to analyze the data by finding common themes which were repeated in the interviews. The data was rich

and common themes were easy to find. At this point the data considered irrelevant were excluded from the data. In the figure 4 the main themes identified when analyzing the interviews are presented. There can be argued to be 3 main themes which are suppliers, purchasing and risk management and multiple sub-themes under each main category.

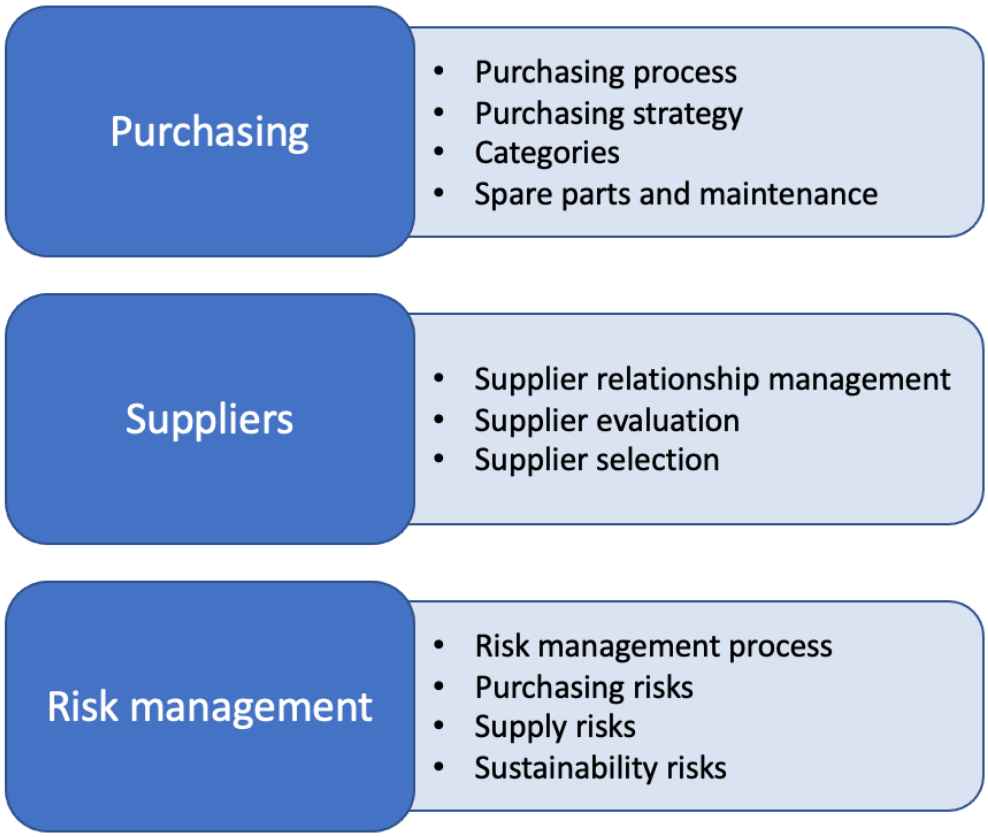


Figure 4. Themes identified in the interviews.

After the common themes were found, the themes were compared to the theory and similarities that support the theory and the empirical data were searched. Once the interviews were analyzed the survey form of risks was built up for risk prioritization purposes. The forms are presented in the end of this paper (appendix 2 and 3). The forms include FMEA analysis form and a form where the likelihood of risk and the impact of the risk are evaluated. The form was filled out by a member of the purchasing department. After the forms were filled out, the risk prioritization numbers were calculated. These results can be found from chapter 4.

3.4 Reliability and validity

Eriksson and Kovalainen (2008, 292) describe that there are differences in opinions between scholars about evaluating the reliability and validity in the qualitative research. The reliability means that if one were to repeat the study it would lead to same results as the first time (Farquhar 2012, 102). However, Eriksson and Kovalainen (2008, 292) discuss that there are disagreements among the literature whether, in example, the accuracy of an interview can be measured by the traditional standards of reliability and validity. To ensure that the study has high reliability, or to increase the reliability, it has been discussed that the case study protocol should be used and followed. Additionally, it has been discussed that by maintaining and having the data about the study stored, someone else could repeat the study with the same data. This is described to increase the reliability of the study. (Stuart et al. 2002, 430.)

With validity, one can measure whether the findings of the study result in an accurate explanation of the results and if there are evidence to support the results. However, as with the reliability of the qualitative research, there is also discussion among the literature whether validity is a good evaluation criteria when evaluating qualitative research. (Eriksson & Kovalainen 2008, 292.) Construct validity and internal validity are discussed as main concerns in the context of validity of the case studies (Stuart et al. 2002, 425). By documenting the steps and how the data was collected, the construct validity may be increased in the research. In addition, the construct validity may be increased by elaborating how the research process was done. (Stuart et al. 2002, 430.)

The generalizability is used to describe if the results of the study can be used in a larger context. The generalizability in the qualitative research results from properly formed and justified research case. (Eriksson & Kovalainen 2008, 293.) In the context of case studies, it has been discussed in the literature that the results may not be able to be generalized in a traditional and general statistical view of the generalization (Farquhar 2012, 103). The trustworthiness of a study can be described as credibility. It has been discussed that if the researcher has used recognized and suitable research methods and provided background information about the parties participating the study, the study has more credibility. (Farquhar 2012, 105.)

4 EMPRICAL ANALYSIS

In this chapter the current state of risk management process and methods of the case company are analyzed and discussed. At first the purchasing process and strategies are presented. After this the sustainability in purchasing, suppliers, supplier relationship management, supplier evaluation and supplier selection are analyzed and discussed. Finally, the risk management process and purchasing risk management and supply risk management are discussed. The aim is to analyze how the risk management methods are used and how they are related to the literature.

4.1 The case company introduction

The case company selected for this case study operates in the field of transportation and logistics. The company has operations in various countries across Europe and the core business of the case company is to provide transportation services across the Europe for its clients. Therefore, it's vital for the company that the machinery is continuously kept in good condition in order to be able to provide the transportation services. However, keeping the machinery in operating condition requires careful planning and strategy on purchasing functions. This includes finding effective and especially reliable and capable maintenance service providers and reliable supply of spare parts to ensure that the maintenance services can be done when needed. Lastly, once the proper suppliers are identified and found, it's important to maintain a long-term relationship and to find suitable supplier development methods to ensure that the supply is kept continuous and maintenance services are provided accordingly. Additionally, the long-term relationship with the supplier is seen as a crucial method to improve the processes and manage the risks.

The case company has suppliers who supply either the spare parts or maintenance services. However, in some cases, some suppliers are capable to offer both. The suppliers are located around the globe which makes managing of purchasing and supply chain important in order to minimize the risks caused by the complex supply chains. Though the majority of the suppliers are defined to be located within Europe and the most of these are located within the European Union (EU).

The purchasing of spare parts and maintenance service is centralized and located in the company's headquarters. This is done to ensure that the purchasing function operates efficiently. It is also done to ease the managing of purchasing, as all purchasers are located in the same location. The team managing the purchasing of spare parts and maintenance services is rather small. Therefore, the communication in the team is efficient but the same time arranging time for various risk management actions may be difficult in some cases as the processes are described to be time and resource intensive in the most cases. The purchasing department has gone through changes and the organization has been developed continuously in the past years.

4.2 Purchasing

The case company's purchasing operations and processes have been developed in the past years and the purchasing of spare parts and maintenance services is centralized. This means that all purchases are done centrally by the purchasing department. Based on the interviews, this method is seen as the most cost-efficient way to organize the purchasing of the spare parts and maintenance services. It is also seen as effective way to manage the purchasing overall. Though it needs to be noted that of course, the buyers are collaborating closely with for example, the technical department in case some specified, and highly critical parts are to be ordered but generally the purchasing is done centrally. The aim of the purchasing was seen as creating value with their own performance and support the operations of the case company.

All purchasers have their own specified areas they operate in and are responsible of. For example, the transportation units are divided between different buyers. This is not only seen as an effective way to organize the work and have more efficient purchasing operations but also this organizing style enables purchasers to have clear understanding of units and machinery, they are accountable of. Therefore, it can be argued that dividing the responsibilities is also a risk management method. The purchasing of spare parts and maintenance services was classified challenging in many interviews. This is because of the massive variety of spare parts that needs to be purchased. This is resulting from having such a large variety of machinery and transportation units to manage.

Inventories and parts purchased are categorized with a variety of categorization styles. One categorization style was described to be based on the criticality of the spare part. For example, the machinery and its maintenance and spare parts may be classified as critical. This classification was described to be done by technical department and it was informed to the buyers. Though it was pointed out in the interviews, that these critical parts are not listed in any system or program visible to the buyers. Other important classification criteria mentioned was delivery time. For example, if some spare parts are known to have long delivery times, it has been agreed that these kinds of spare parts need to be available in the inventory in case of failure of a part or machine break down. In addition to these, the laws and regulations require that certain spare parts are kept in the inventories. These parts are of course then the highest priority and it's ensured that these parts are always in the inventories.

However, the item categorization is not the only way to use categorization in the purchasing. There is also a business and dependency point of view as well. The case company has also categorized and classified their suppliers. The main criteria used in this is how difficult it is to change the supplier. This is linked to how dependent the buyer is of the supplier.

4.2.1 The purchasing process

The purchasing process is presented and visualized in the figure 5. The purchasing process of the case company is quite standardized and well-structured and there is not much difference between purchasing of spare parts or purchasing of maintenance services. The case company has a program where the purchases are done and where the information about the needed purchases is entered. There is also information about the spare parts and their specifications available. To ensure that information is shared inside the organization different departments may use this program and access it in order to find information about the needed and specified purchases.

However, the tracking and monitoring of the purchases was reported not be standardized and it relied heavily on each individual purchaser. Additionally, there was reported to be multiple people involved in the purchasing process, which may result as inefficient, risky and sometimes heavy process. In example the person approving the need for the purchase is different than the one doing the actual purchase order. This was seen as a potential risk as

there might be a possibility of information being incorrect. Also, it was clear that in some cases the information entered to the system might be incorrect leading to difficulties on estimating how many parts or what type of service is actually needed to purchase. This may lead to challenges when estimating how much a certain purchase should cost. Information risk is therefore present in the purchasing process.

"It's not necessarily known if it's a job of 1000 euros or 50 000 euros. There is room for improvement. Of course, then the buyer understands that, if the offer is 50 000, maybe it's worth to further investigate, what there needs to be done" (Interviewee B)

Additional problems identified in the interviews about the purchasing process included that sometimes the potential suppliers are not properly identified. This results in lesser qualified suppliers and also the quality of offers may be lacking compared to the ideal situation. The analysis and evaluation of all offers may possess risks as well. This is again linked and connected to problems in specifications of services and products and sharing of information. Overall, the risks related to information and sharing of it dominates the potential risks when discussing about the purchasing process of the case company.

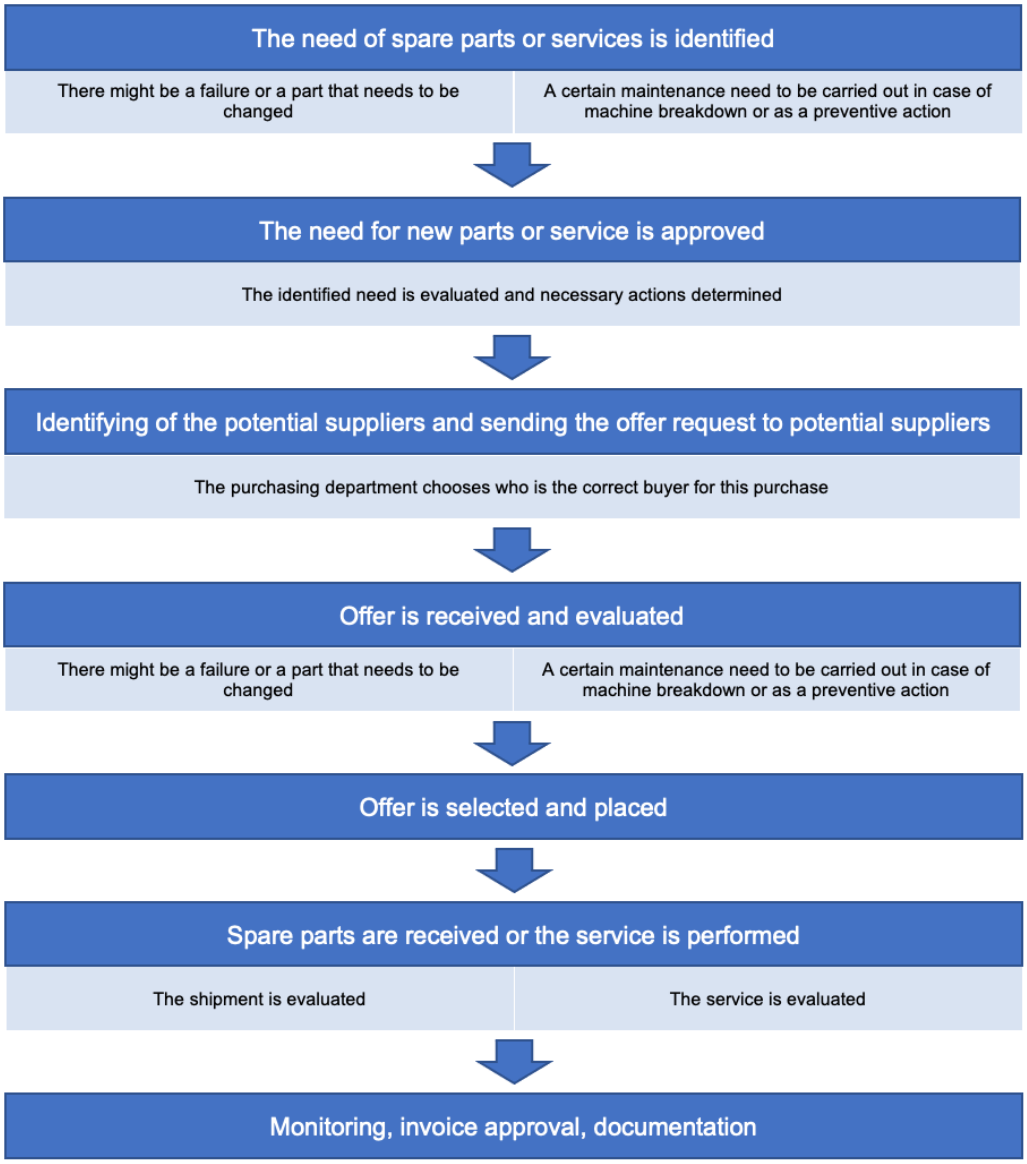


Figure 5. The purchasing process of spare parts and maintenance services.

A FMEA analysis of the case company's purchasing process was conducted based on a survey form filled by a member of the purchasing department of the case company. The goal was to identify the possible failure modes in the purchasing process. The results from the FMEA survey are presented below in the table 3. To visualize the most critical failure modes, the results in the table 3 are presented from the highest risk priority number (RPN) to the lowest. In the survey the impact, likelihood and detection of the failure mode were each given value between 1-10, which means that the risk priority number could vary between 1 – 1000 depending on how the failure modes are valued. Based on the FMEA survey the biggest risks in the case company's purchasing process lie in monitoring / invoice approval

/ documentation, identifying the potential suppliers, receiving and evaluating the offers and selecting and placing the offer. These finding are in line with the interviews and the results from the interviews as the same problems were identified and discussed.

However, it needs to be noted that this FMEA survey was about the purchasing process of spare parts and maintenance service in general and therefore the answers could vary depending on the nature of the purchase. For example, the answers could somewhat vary in case of how critical spare parts are being purchased. This was highlighted and discussed especially with the step "identifying of the potential suppliers and sending the offer requests to potential suppliers". The more common spare parts or maintenance services won't require as much effort when identifying the potential suppliers as the more critical spare parts or services would require.

"In the offer request phase, it could be that not all potential suppliers are identified. So not all, who could be good suppliers, receive an inquiry" (Interviewee A)

Overall, the failures in the purchasing process were determined to be detected very easily as the given answers for detection varied between 1-2. The most critical step and failure mode based on the survey was determined to be "monitoring, invoice approval, documentation" which resulted a RPN number of 60. It was followed by the three failure modes which were given the RPN of 36: "identifying of the potential suppliers and sending the offer request to potential suppliers", "offers are received and evaluated" and "offer is selected and placed". However, as discussed earlier the detection of these varied between1 and 2 based on the FMEA survey. Therefore, it can be stated that even though there was a problem with the monitoring step, the error would still be detected and corrected very easily.

The most unlikely failure mode to happen in the purchasing process was identified to occur with the "the need for spare part is approved". This failure mode was given the likelihood of 2/10 in the survey. This means that the impact of this failure mode would be moderate, but it would be quite unlikely and detected easily by the risk management process of the case company. To mitigate the risks in the purchasing process, it was discussed in the academic literature, that competent personnel making the purchasing decisions and collaboration within the company may help to reduce the uncertainty and risks (Munnukka & Järvi 2008,

260). This supports the findings in the FMEA survey as the case company uses quite a lot of collaboration between different departments and therefore there is expertise involved in the purchasing process and especially in the step where the need is identified and approved.

All in all, the purchasing process of spare parts and maintenance services is quite well structured, and the responsibilities are clearly divided within the purchasing department and the organization of the case company. The different departments work closely within the organization and assist if needed. This can be argued to reduce the uncertainties in the process and mitigate the risks. Additionally, the systems and applications support the decision-making process and purchasing personnel on their daily work. However, the process is described to be heavy and requires multiple people in the decision making.

Table 3. The Risk priority numbers from the FMEA analysis.

The step of the purchasing process	Failure mode	Impact	Likelihood	Detection	RPN
Monitoring, invoice approval, documentation	Invoices are not checked	5	6	2	60
Offers are received and evaluated	Offers are not matching the original need identified	6	3	2	36
Offer is selected and placed	Wrong offer is selected and placed	6	3	2	36
Identifying of the potential suppliers and sending the offer request to potential suppliers	Buyer identifies incorrect suppliers	6	3	2	36
The purchasing need is identified	Incorrect criteria is used	5	6	1	30
Spare parts are received/service is performed	The purchased goods or service don't match the need identified in the beginning of the process	7	4	1	28
The need for spare part or service is approved	Incorrect inquiry is approved	5	2	1	10

4.2.2 Purchasing strategy

The case company has built a purchasing strategy where single or multiple suppliers are used depending on what is purchased. To determine how many suppliers to use, the items may be

categorized by their criticality or feature. In the past the strategy has been connected to use of markets and finding the most cost-effective solution with proper quality features. However, nowadays the trend is towards more categorized model, where contracts may be used more if and when possible. This is not only because of the emphasis with stronger relationships with the selected suppliers, but the use of contract was described to save the buyers time since not all purchases need to be tested in the markets and tendering won't be needed for every purchase. The contracts were identified also as a risk management method because by using contract, one has a familiar supplier and understanding of their existing operations and abilities. Though, it was also stated that fully exclusive contracts with the suppliers are avoided.

Especially with critical machinery and equipment the aim is to utilize the contracts as a purchasing strategy. Though it needs to be noted that fully exclusive contracts are avoided as a risk mitigation method. By doing this it is ensured that not all purchases need to be done with a one selected supplier. In some situations, using the original equipment manufacturer (OEM) as a supplier of spare parts is seen as the important risk mitigation method. Use of OEM is described to result in higher costs but the same time the quality related risk may be reduced greatly. This is identified as a tradeoff between costs and quality control, and the case company has identified that in this decision lies also a large potential of possible cost savings.

The case company has a large number of various machineries which are not standardized leading to additional challenges for purchasing, and also on creating a standardized purchasing strategy and process. In the interviews it was discussed that there can be a lot of variation between the machinery and how they are installed resulting in a situation where some machines require certain suppliers and the other machinery other specified suppliers. Therefore, it can be argued that despite the goal of reducing the number of suppliers, it is not always possible for the case company.

4.2.3 Sustainability

Sustainability in the supply chains has received a lot of interest lately. The sustainability matters are considered when making purchasing decisions at the case company. The aim is

to check the background and operations of the potential suppliers and to identify sustainable suppliers. However, it was also discussed that it may be difficult to ensure that sustainability is always considered. When making the purchases the price was discussed to be always a key factor, but sustainability should be considered as well. However, it requires lots of resources and currently the buyers need to rely heavily on what the supplier informs about their processes and operations. Currently the case company does not require its suppliers to sign and follow a supplier code of conduct but implementing this was reported to be under consideration. However, one issue with this was that the supplier's sizes vary a lot, and it needs to be identified if all suppliers are required to follow it. The implementing of supplier code of conduct would require careful planning and it should be somehow allocated and divided with time. Despite the additional challenges the sustainability might bring, it was seen as an important aspect and in the interviews, it was discussed, that hopefully the role of the sustainability increases in the future.

Problems with sustainability may result in various risks. One being the problems with the brand image of the buyer. This is also considered when planning the purchasing process. Social sustainability is considered in supplier selection and sustainability reports of the suppliers are used to verify that all is in order. The purchasing department needs to also ensure that the business operations are sustainable and profitable to ensure that the company itself can continue its operations.

By selecting sustainable suppliers, the company may also ensure that processes run smoothly and efficiently. In the interviews it was discussed that if a supplier is sustainable, the supplier is likely also efficient as its processes are evaluated and improved continuously often times. The sustainability was also described to help continuity and it was stated that sustainable companies often times are also financially responsible and efficient. Therefore, the strategy is to invest in sustainability and to find sustainable suppliers as partners.

4.3 Suppliers

The case company has identified and estimated that they have various types of suppliers in this segment. The varying means that the suppliers vary in size, importance and what they offer. However, it needs to be noted that out of these suppliers, there are identified to be a

few larger suppliers who provide the majority of the goods and services. For example, in some categories there are identified few suppliers who provide most of the supply. This is argued to depend heavily on the part or service. Some suppliers are described to offer both, maintenance services and spare parts for the case company.

The suppliers are located around the globe, but in the interviews, it was identified and discussed that the most are located in the Europe. There are no strict given guidelines which state that the suppliers should be chosen within Europe or EU but from the risk management point of view it was noted that there may be additional risks if the spare parts are sourced outside of EU. These risks may be the longer delivery times and additionally it was noted that the quality control could be harder to manage if the parts were to be sourced outside of Europe. In addition, the networks and knowledge about the markets outside of Europe may bring additional risk as it may be harder to identify the correct suppliers. Also, it was stated that when sourcing services, it is easier to use the suppliers who are located nearby.

Some of the machinery the case company uses are produced outside of Europe but in this case the goal is to change the supply of the parts to come from Europe. One way to prepare for this in advance is to select carefully what type of parts are used in the original machinery when it's ordered and manufactured. However, in some cases the only possibility is to acquire the goods from outside of Europe.

The case company has identified that their supplier base for this segment is quite large and it was stated that there could be seen some benefits if the supplier base were to be reduced. The benefits include better cost-efficiency because of lower administration costs in example. This approach is also supported by the academic literature, as the reducing of the number of suppliers was seen as a trend. (Ellram, Tate & Billington 2007, 52.)

4.3.1 Supplier relationship management and development

The common theme in the interviews was that supplier relationship management and developing of the suppliers and the relationship was seen very important. This was also seen as a great method to reduce risks and uncertainties related to suppliers and finally purchasing. The case company is developing their strategy towards supplier development and the aim is

to consider the relationship with the suppliers more. This strategy is especially applied in situations where single sourcing is adapted as a sourcing method for parts of maintenance services. There are various reasons for companies to do so, but the common theme was that the closer relationship brings many benefits for both, the buyer and the suppliers. The suppliers are seen as important channel to identify new and more efficient methods to work and as a source of innovations. Though it was also identified that with more generic suppliers the company may use a more arm's-length approach and use markets as a way to find the parts and services in the more cost-efficient way.

However, there are risks in the close relationships with the suppliers as well. In example it was stated that sometimes the relationship may be close but very connected to certain employees and if the employee were to resign, the knowledge and expertise could be hard to replace. This type of risk has not realized yet, but it was a concern, nevertheless. Another risk which may come up in close relationships between buyer and supplier is that the other party shows signs of opportunistic behavior. The case company has not yet faced any signs of this risk, but it is something that the company monitors. Contracts were seen as a risk management method as the price level can be set for long time by having the contracts. Other method to manage risks is to monitor the current market prices of the spare parts and maintenance services.

4.3.2 Supplier audits and evaluation

In the interviews, the supplier evaluation and audits were seen as one the most efficient risk management method in procurement by the case company. The company has set a guideline for their employees to audit a given number of suppliers comprehensively in a year. This is done by visiting the supplier's locations in order to see the environment they operate in and to get to know the employees of the suppliers. The visits were also identified as a great method to strengthen the relationship with the supplier as it was easier to get to know each other.

The auditing process is continuous and regular in a way that the aim is to do a certain number of audits annually by having both on-site and web-based audits. The goal is to have different suppliers to be evaluated so not all suppliers are audited continuously and annually. Though

it was discussed that the company has not achieved their target to audit the required number of suppliers in every year. This was seen as a common development goal by the employees in the interviews.

The goal and motive of the audit is to get a clear understanding of the suppliers' operations and understanding if there exist any potential risks. This was discussed by all interviewees during the interviews. Risk management in general is identified to be a big reason for conducting the supplier evaluations. Additionally, the one motive for auditing results from the company's strategy of supplier development with the key suppliers. By auditing and evaluating their suppliers, the company gets clear view and understanding of their supplier's operations which in turn helps when planning the development of the relationship and processes together with the supplier.

"Well, in my opinion the motive is to evaluate their business, to be sure that there have not been any major changes since the last time" (Interviewee C)

With the existing suppliers, who the company has a history with, the goal is to identify if there are any changes in their operations. Quality was brought up in all interviews as an important criterion when evaluating the supplier and its performance. The person performing the evaluation checks if there are any risks if the case company uses this supplier. This includes for example the financial information and also sustainability of the supplier. With new suppliers the auditing process was described to include checking that they have proper liability insurances in case something happens. This is done to ensure that the suppliers' operations won't stop, and the flow of goods or services won't be in danger. However, the insurance requirement is also reported to be included in the contracts often times as well. When conducting the audit, the information is described to be acquired mainly by performing an interview with the supplier. The visiting and evaluating is not necessarily done alone by the individual buyer, as it was discussed that the buyers may have additional help from the technical or finance department with them when performing the supplier evaluation. During the evaluation a pre-determined form will be filled out.

The visits to supplier are not the only way to perform the evaluation. One alternative way is to conduct an online survey where the suppliers fill out the asked information by themselves.

The online survey may be done also before visiting the supplier's location as a complementary survey. The evaluation of the supplier may concentrate on different themes like environmental aspects or quality depending on the supplier. However, it was clear that if one supplier has many complaints, the buyers are more likely to perform a comprehensive supplier audit. Additionally, it was discussed that in case of a larger contract, the supplier is likely audited beforehand. This is also seen as an efficient and preventive risk management method in purchasing.

The common theme in the interviews was that the buyers are not doing the evaluation only to find negative aspects from suppliers' operations and something to complain about. The evaluation and audits were seen as an efficient tool in developing and strengthening the relationship with the supplier. Even if there were some inefficiencies in the processes of the supplier, the reaction was described to be more towards developing that lacking process together instead of immediately switching suppliers. Overall, the supplier relationship and development are seen as a win-win situation for the buyer and the supplier.

Based on the interviews it came obvious that selecting the potential supplier for the audit was not based on any strict guidelines and the selection process relies on the individual employee of the purchasing department. Additionally, it was discussed that the selection criteria are based on individual suppliers and how complex operations they have. Much relies on the expertise and knowledge of the employees of the case company and their ability to identify potential suppliers for auditing and evaluation.

Overall, the suppliers are generally described to react more positively than more negatively to the evaluation and audits. It was also discussed in the interviews that often times the term "supplier audit" has a negative and quite official meaning which can be seen somewhat threatening from the supplier point of view. It was also discussed that the audit may be seen as an official inspection performed by some official party. Therefore, the clear and honest communication between buyer and supplier was seen important method to reduce any negativity towards the auditing process. It was also discussed that it's important to communicate that the overall of the audit goal is to develop the relationship and processes. Generally speaking, the audits were reported and described to be more popular nowadays and quite expected by the suppliers, so this also reduces any negative impact towards

evaluation purposes. Of course, some suppliers were reported to be more cautious but overall, the tone to supplier evaluation is described to be positive and suppliers were described to be delighted that the buyers visit their locations.

The results of the evaluation are filled-out in a pre-determined supplier audit form which is saved to a company database and access is provided to all employees of the purchasing department. The report is to be also shared with the supervisor of the buyer. This is done to ensure that information is shared and this way also the potential risks may be identified and also mitigated. The results so far have been quite successful in that regard that there have not been any major issues or misdemeanors in the supplier's operations.

The report form includes sections for remarks about supplier's performance. These remarks may include minor remarks such as that the invoicing is done with incorrect information, but they can also be remarks about major problems or information about supplier that could endanger the case company's core operations. An example was given about the remarks field, that in example there could be information if the supplier has not paid wages to their employees which would require immediate action from the purchasing side. This has not been case so far as most of the remarks are discussed to be about incorrect invoicing. However, it was brought up that if needed the supplier may be changed or asked to correct their processes if needed. It was also stated that the buyers will monitor that the potential issues are corrected in a given time period.

4.3.3 New suppliers and supplier selection

The case company has already quite large supplier pool for the spare parts and maintenance segment and therefore finding of new suppliers is done but it's not seen as the most crucial part of the procurement operations. The goal of the procurement is also defined and seen in reducing the number of suppliers instead of increasing, which supports this approach. Though it was also discussed in the interviews that the new suppliers are seen important and also with the new suppliers the case company feels that they may find new innovations, solutions and ways of working. The technology of the spare parts and maintenance services is described to develop quickly and sometimes the new suppliers may be able to offer solutions for this advancing technology and requirements it leads to. Therefore, it was

discussed in the interviews that the case company has identified a continuous need for new suppliers in order to ensure that new technology can be used and purchased. When selecting and using new suppliers some will remain as long-term suppliers but also some will be used only once.

As it was discussed in the literature by Ho et al. (2010, 21-22) the criteria when selecting new suppliers revolves around price, delivery and quality. So is the case with the case company and their supplier selection process as it was discussed that the main criteria in supplier selection is price, reliability and quality. When discussing about quality, ensuring the desired quality may be challenging. To compete this the case company has identified that using references is a great tool. Especially in the case of purchasing services the quality may be difficult to determine beforehand and also to evaluate. When acquiring new service providers, the buyers often times rely on the references. The references may be in example, a statement that the suppliers have previously worked with a well-known company or if the supplier has some sort of recommendations.

It was also determined that it is important to ensure that the selected supplier has a solid financial situation in order to prevent that the supplier faces insolvency and the operations end suddenly. Because of this the financial data about the potential suppliers was seen crucial when making decision. If the supplier were to be a new, even in a start-up phase, one identified possibility was defined to use bank guarantees. The key interest in these situations is to manage the risk from the buyer point of view. The background checking includes also checking that the potential supplier is registered in a pre-payment register. In addition, the case company checks reports required by law when evaluating potential new suppliers. This includes also sustainability reporting. Sometimes the buyer may ask about the already existing insurances from the suppliers. However, it was also stated that the contracts often times include clauses about insurances. Especially the liability insurances were defined to be important when discussing about potential suppliers.

Once the potential pool of suppliers is selected the selection can be done. If the new supplier is used to perform maintenance services and there are any concerns about the abilities of the supplier, one reported method to check the quality was assigning a less critical maintenance to be done and then evaluating what type of quality the supplier is able to provide. When

discussing about new spare parts, some sample parts may be ordered in advance and then the technical department will check the suitability of the parts.

The needed part or service defines if one or more suppliers are selected and if the volumes are divided between new suppliers. In example, in maintenance services it is important that there are various maintenance service suppliers who can operate in various locations. This ensures that the downtime in case of a machine failure is as limited as possible. Dividing the volumes in case of spare parts is highly dependent on the situation. In some highly critical categories, the OEM is often times seen as the most reliable and fitting supplier for the case company.

The supplier selection process is important but requires some development. The selection is highly dependent on the person conducting the selection. It was brought up that there is no standardized process on how to select potential suppliers. Additionally, it was discussed that there are no pre-determined criteria what all new suppliers need to meet. This was seen as an area which needs development as it was stated that the process could be more efficient if there were criteria that can be used in every situation.

Chen and Wu (2013, 635) described that by selecting right suppliers the risk may reduce and that the supplier selection is an important decision. In this regard the case company's operations follow the theory as they have identified the selection of new potential suppliers to be important from the business perspective.

4.4 Risk management

In this chapter the most critical risks identified in the interviews with the case company are presented. In addition, the findings of the risk priority survey are presented and discussed. The most important risks are listed and visualized in the heat map. In addition, this chapter also discusses about the current state of the risk management process at the case company.

4.4.1 Risks

In the table 4 the main risk categories and risks in each category are presented. The themes and individual risks were identified in the interviews conducted with the employees of the case company. Further risks priority analysis, where the likelihood and the impact of the risk are analyzed, is presented further in this chapter. Quality is an important factor and a common theme with almost every risk type. Though measuring the quality may be more difficult when measuring services and service suppliers compared to physical products and suppliers who supply those.

Table 4. The main risks in case company's purchasing, supply and sustainability.

Risk type	Risks
Purchasing	Delivery time Delivery quantity End of supply Unreliable demand Price Purchasing process Quality Unsecure supply Unspecified purchases
Supply	Capacity End of supply New technology Suppliers' knowledge Supplier insolvency Quality
Sustainability	Brand Financial sustainability Suppliers

Based on the interviews the quality was a common theme when discussing about risks related to purchasing. In this context the quality may be defined either as a quality of a product or

quality of the service. Other risk themes that were identified are related to uncertainties on what type of maintenance is needed as in some cases the maintenance need is described to be unknown until the maintenance has started. The price risk was also identified as a common theme.

In addition to these, in the survey form conducted based on the interviews, the most important risks to consider were identified to be related to the delivery times, prices and problems with sharing information leading to incorrect purchases. The likelihood of all main risks was considered to be 3 out of 5 but the largest impact lies on the delivery time being too long causing delays in the maintenance process. All the rest main risks presented in the table 5 had likelihood and impact 3/5.

Table 5. The main purchasing risks of the case company.

Risk	Likelihood	Impact	RPN
The delivery time is too long causing delays in maintenance	3	4	12
The delivery time is too long causing extra costs	3	3	9
The supplier is not able to deliver the needed number of parts	3	3	9
The price of the spare parts rises considerably	3	3	9
The price of the subcontractors rises considerably	3	3	9
There are problems with sharing the information and wrong parts/services are ordered	3	3	9

When discussing about the risks related to supply and suppliers, the financial stability of the supplier was discussed by many interviewees. One of the main risks concerning the financial status of the supplier was that the supplier won't face insolvency and that their operations remain active. Though this risk has not realized with highly critical suppliers yet. Based on the survey form this risk is given quite minor likelihood and also only moderate impact resulting in risk priority number 6.

"*Well yes that type of suppliers exists, but they are more in categories where we have more options to choose from. It is not that risky for us, but it exists of course*." *(Interviewee B)*

The four most important supplier related risks based on the risk survey are listed below in table 6. Based on the findings the most important risk concerning the suppliers is that the supplier shows any opportunistic behavior resulting in extra costs. This theme is also seen with the risk of being too dependent of the supplier. These are interesting findings as the company has found a strategy where the collaboration with the suppliers is seen important and desirable, but the same time the case company is aware of the severe impacts of the risks that the close collaboration may possess. Other important themes are about end of supply of spare parts or that a larger company acquires the original supplier. The end of supply may lead to a situation where a new machine or product needs to be purchased. Though it was stated in the interviews, that often times it's possible to find a new alternative spare part from the markets and in some cases, the new supplier can make a completely new part if needed. However, this type of sourcing tactic relies on good knowledge of the markets and well-established networks. Another risk related to suppliers was identified to be the quality and capabilities of the suppliers. This type of risk exists especially with the maintenance services, where the quality of work will have large impact. Measuring and evaluating of the maintenance services was also described to be challenging

Table 6. The main supplier risks of the case company.

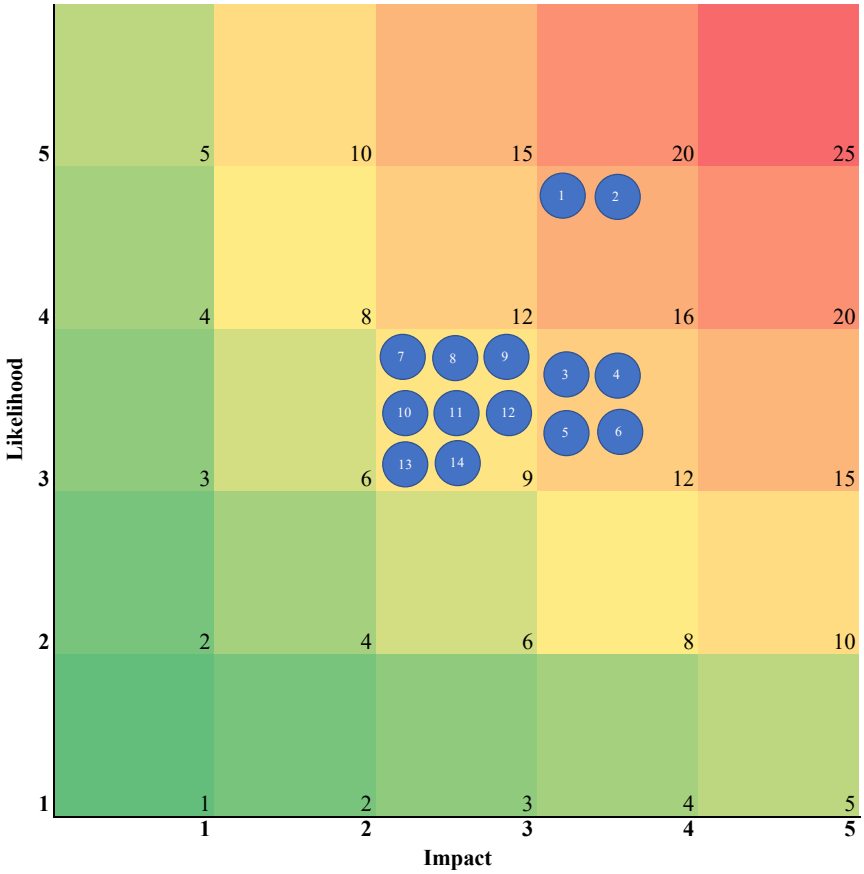
Risk	Likelihood	Impact	RPN
Supplier shows opportunistic behavior causing extra costs	4	4	16
Supplier stops producing the needed spare parts	3	4	12
Supplier is acquired by a larger company, causing problems in supply	3	4	12
The company is too dependent of the supplier	3	4	12

Sustainability risks related to purchasing and suppliers are seen important by the company. The sustainability risks and their likelihood, impact and RPN are presented below in the table 7. Based on the survey form, it can be argued that the main concern relies on supplier audit and its ability to spot the problems with suppliers' operations. The likelihood and impact of "sustainability risks are not found in the supplier audit" were both given 4 out of 5 resulting 16 as the risk priority number.

Table 7. The sustainability risks in procurement.

Risk	Likelihood	Impact	RPN
Sustainability risks are not found in the supplier audit	4	4	16
Supplier has problems with social sustainability	3	3	9
Supplier has problems with environmental sustainability	3	3	9
Supplier has problems with economic sustainability	2	4	8

In the figure 6 the main risks identified in the survey form are presented in the heat map, where the more severe and likely risk has a higher risk prioritization number. This is also highlighted with the color coding where the green color is used with less severe and likely risks whereas the red color is used with the most severe and likely risks. The risks were prioritized by their likelihood and impact. The prioritization was done by multiplying the likelihood with the impact of the risk. For this figure all risks with risk priority number of 9 and higher were considered. This limitation was done to ensure that only the risks that possess likelihood and impact over moderate are presented. Based on the figure 6, the two biggest risks the company identifies are “Supplier shows opportunistic behavior causing extra costs” and “sustainability risks are not find in the supplier audit”. Especially the first risk needs to be considered when planning the future risk management process because the company has identified the need for further developing the relationship with their key suppliers, who supply the most critical parts.



1. Supplier shows opportunistic behavior causing extra costs
2. Sustainability risks are not found in the supplier audit
3. The delivery time is too long causing delays in maintenance
4. Supplier stops producing the needed spare parts
5. Supplier is acquired by a larger company, causing problems in supply
6. The company is too dependent of the supplier
7. The delivery time is too long causing extra costs
8. The supplier is not able to deliver the needed number of parts
9. The price of the spare parts rises considerably
10. The price of the subcontractors rises considerably
11. There are problems with sharing the information and wrong parts/services are ordered
12. Supplier can't achieve the needed quality levels
13. Supplier has problems with environmental sustainability
14. Supplier has problems with environmental sustainability

Figure 6. Heat map of the main risks.

4.4.2 Risk management process

The company has many ways to mitigate and identify potential risks. However, there is a lack of standardization and specified process on how to do the risk management. All actions taken are described to be dependent on the individual employees and how they arrange the risk management process in their daily work. Much of the risk management is dependent on

the supplier evaluation and its findings. Additionally, the evaluation of new possible suppliers is seen as a key method to manage the risks. However, this is not done continuously and therefore the risk management process is not continuous process.

Risk identification process relies on the supplier audits and checking the claims the company has with their suppliers. In case of supplier insolvencies, the buyers may find warning signs from financial records though this relies on the buyer to check the records. The financial department helps the purchasing department with the financial data if needed. However, there is no continuous process of checking the financial stability of the suppliers. One method to identify the financial risks is described to follow the news and see if there are any warning signs. The company follows continuously the claims they have with their suppliers. There is historical data available to see if there are claims racking up with certain suppliers resulting in a warning sign that something needs to be done. It is also possible to compare the number of claims to the number of orders from the supplier. The data about claims is described to include the reason for the claim and the reason why the claim was closed. This claim process and number of claims is monitored monthly.

Risk prioritization is not done by the case company by calculating the likelihoods or impacts of the risks. The prioritization is based on the knowledge and capabilities the buyers have and how they feel what are the main risks in each category. In addition, the prioritization relies on discussion within the team and identifying what could be the most severe risk. Though, the technical department is described to have their own risk analysis process where the technical aspects of the parts are considered. However, during the tendering process the company may require the suppliers to perform a risk analysis and present it with the offer. However, this depends on the situation on what is being purchased.

Risk mitigation tactics are utilized depending on the situation and what is being purchased. These include both proactive and reactive mitigation tactics. Though the majority of tactics are on the reactive side of the available tactics. In the literature Hallikas et al. (2004, 54) identified and described five risk management methods: risk transfer, risk taking, risk elimination, risk reduction, further analysis of individual risks. The case company is utilizing the risk taking especially with service purchasing where the quality may be difficult to measure and define. One method is to assign a less critical maintenance task first and inspect

the quality of the service there. Additionally, a trial periods may be used in case a continuous maintenance service is being purchased. The trial period may be in example few months after the service level and quality can be evaluated and the decision made if the contract will be continued. Monitoring of the risks relies again heavily on the claims the company has with their suppliers. This includes the current claims and claims that have happened in the past. The claims are monitored continuously though other monitoring activities are not done systematically.

4.4.3 Purchasing risk management

In the figure 7 the purchasing risk management methods used by the case company are presented. To manage the risks in purchasing the company uses spot markets. The spot market may be used in example, if the contractual supplier faces problems and can't supply the goods or services. Though this requires that non-exclusive contract has been agreed with the supplier. Generally speaking, the company avoids being too dependent on any supplier and this way mitigates the risk related to purchasing. With situation where single sourcing is utilized as a strategy, the aim is to develop the relationship with the supplier. These development actions include process improvement together and possibly volume discounts.

There are many suppliers in the markets who specialize on this kind of transportation business and supplying spare parts to the machinery used in the industry. Certain suppliers may concentrate on very specific brands and parts. These specialized suppliers were labeled as a mix between an agent and supplier, which was described to result from having extensive contact networks and ability to perform also maintenance services. These specialized suppliers were seen very important because it eases the buyers work as the buyer don't need to find and build an extensive supplier network around the globe as they can use the supplier to do this. These suppliers were described to be used often-times as a back-up supplier who will get the job done if there are any problems with the original supplier.

Spare parts may be needed quickly, and one identified risk is long delivery times. This could cause harm if a faulty part can't be changed. This risk may be managed and reduced by having buffer inventories. The company also aims to have common spare parts that can be used in various units across the fleet. In some cases, the risk management tactic may be

asking the supplier to keep a specified number of inventories in their inventories to reduce the risks related to deliveries.

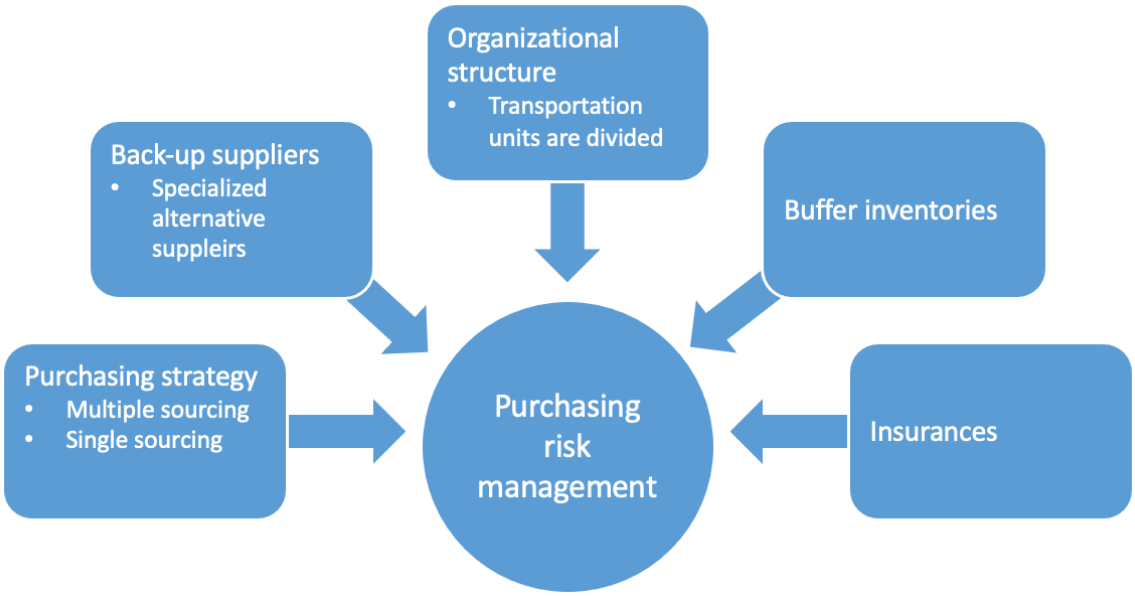


Figure 7. Purchasing risk management in spare parts and maintenance services.

When discussing the potential risks when purchasing spare parts, the common theme revolved around the end of supply of spare parts. This means that there are no suitable spare parts in the markets in case of a machine failure or break down. This is caused by technological development as new machinery is produced and is entering the markets and because of this the production for older spare parts is run down. This was described to result in additional work for the buyers because they have to start finding new alternative supply channels. To mitigate this risk the case company relies on the knowledge and competence of their buyers. In the interviews it was discussed that often times it's possible to identify and use an alternative supplier if the original supplier says that they don't have a specified spare part anymore and that the case company should invest on new system or machinery. Additionally, sometimes certain parts may be repaired and this way the life cycle of the machinery can be prolonged as it can be used for a longer time period. However, as stated earlier this is time consuming and resource intensive work.

The maintenance services are described to be harder to measure and manage compared to the spare parts. First of all, the maintenance service needs to be arranged to a specific time

slot where the transportation unit is present for the maintenance. This also requires planning on what location is the most cost-efficient for the maintenance. When purchasing the services, it was said that often times the buyer has information about the price per hour, but then again, the buyer may not know in example how many workers the supplier uses in the maintenance. Also, in some cases there is no information about what equipment the supplier uses and for how long the maintenance should last. Therefore, it can be stated that there are many uncertainties currently when purchasing maintenance services resulting in various types of risks varying from price risk to quality risk. At the moment the case company manages the risks by using familiar suppliers who they trust. Additionally, one method is to check for references of new suppliers and giving less critical maintenance jobs first and checking the quality. Overall, much relies on the knowledge of the supplier base and their capabilities. Though for this approach to be effective, this requires sharing of information between the technical department and the buyers.

Service level agreements are not used widely at the moment with maintenance service purchasing. However, in large maintenance projects there are given timelines in which the job needs to be completed or then sanctions agreed in the contract will be placed. Though this is reserved for only the large maintenance operations and the common, smaller, ones are done without any penalties. In some safety appliances, such as fire safety there are some agreements utilized where the service supplier takes care of the regular inspections and ensures their condition to be ok. The service level agreements were not seen that useful in the smaller maintenance operations. Time and cost related risks may be managed in some cases by having a fixed price for a maintenance work. This was described to benefit the suppliers also because sometimes the schedules may change rapidly, and the suppliers may have limited timeframe to perform the maintenance service.

4.4.4 Supplier and supply risk management

The risk mitigation tactics and methods vary depending on the risk. In example the criticality of the service or part purchased plays a role when deciding the proper approach when managing the risk. In addition, the costs of the purchase affect the efforts used in managing the risks. With critical problems the supplier may be visited, and the situation will be discussed further during the visit and evaluation. One given example of possible critical

problem was described as a case of a severe case of negligence with safety. These kinds of severe problems would result in immediate action from the case company. Additionally, the liability insurances are identified as a tool to mitigate the risks.

With the business risk related to suppliers, one method to mitigate the risk is to work together with the finance department and ask for their knowledge and capabilities on evaluating the suppliers' financial situation. When evaluating the capabilities of the suppliers, the case company uses especially the references. In case of a new supplier, the references can be asked and evaluated. The evaluation of references includes for example, checking who the supplier has previously worked with. This was described to be an effective way as the networks in the industry are described to be close. Other risk mitigation method with the quality and suppliers' capabilities is to ensure and demand that the supplier has proper insurances, which helps in case something goes wrong with maintenance services.

To ensure and strengthen the sustainability, one method was identified to be long-term and collaborative relationship with the supplier. This was explained to help in the sustainability efforts as the knowledge of the suppliers' operations is often times better in long-term relationship.

4.4.5 Risk management in the future

In the interviews the role of the risk management in purchasing was seen important by the interviewees. The proper risk management process was seen beneficial for both, the company and buyers as it was described to bring additional safety and sense of security for the purchasing process and operations. Also, it was seen important by some of the interviewees that the individual buyer could check the process and follow certain steps in the risk management process. In other words, the structured and documented risk management process could assist buyers in their daily operations as they could check how to proceed with the risk management efforts.

In the future, the aim of the case company is to include more risk management methods to the contracts between the buyer and supplier. These include remarks about the delivery times and possibly service levels. Additionally, the risk management is seen as a big part of

sustainability and therefore the role of risk management can be seen increasing in the future as the role of sustainability grows.

Hoffmann et al. (2013, 207) stated that maturity in the risk management process, continuous evaluation of the risk management process, regular risk assessment actions with the suppliers and analyzing of suppliers who have been identified as a problem are included in the successful risk management process. Some of these requirements are met when observing the case company's risk management process. However, the continuous evaluation of the process is lacking, and the process is not standardized and in this regard the maturity is lacking as well. There are clearly some parts that need development and further analyzing.

5 DISCUSSION

In this chapter first the results from the empirical findings and the academic literature are presented and discussed. This is followed by a chapter where the research questions of this study and answers to these questions are discussed.

5.1 Results

In the literature it was discussed that purchasing department needs to consider various risks from poor quality to supplier failure (Ryals & Rogers 2006, 42). Additionally, companies need to consider and compare what are the costs of reducing the risk and the cost of the risk realizing (Zsidisn et al. 2000, 196). For the case company, opportunistic behavior by the supplier and ineffective auditing process, where sustainability risks are not identified, were categorized as the most critical and important risks by the case company in the risk prioritization survey. This was followed by theme of problems caused by risks occurring in the deliveries. In addition to the risks mentioned above, the price risk was identified to be important for the case company. Hong et al. (2018. 1554) discussed that flexible contracts are a useful method to mitigate the risks and uncertainties related to prices. Additionally, to manage the risk of increased costs, companies may also use long contracts, inventories and alternative suppliers (Sunil & ManMohan 2004, 58). To control the risk of increased prices, the case company could utilize more contracts as their sourcing method. Though this was also already identified by the case company as well. The case company has also identified that the use of contracts also helps with the strengthening of the relationship with the supplier and quality control. The suppliers are located mainly within the EU and this way the risk of currency fluctuation is managed already by having the suppliers located near and within the EU. Overall, the case company has implemented same methods to mitigate risks and uncertainties as discussed in the literature.

Klassen and Vereecke (2012, 105) described that companies may expect that their suppliers report that required labor practices and standards are followed. Gouda and Saranga (2019, 5284) also discussed that the companies try to identify the potential sustainability risks their suppliers face, and then try to develop the supplier in order to manage the potential risk. This is also the case with the case company, as they expect their suppliers to report that required

standards are followed and reported. Additionally, the case company invests on the supplier audit process in order to identify any potential risks or development targets. The auditing process was identified as one of the key risk management methods, as it is described to be the most efficient method from the case company's point of view to identify potential new risks with the suppliers. The efficient auditing and evaluating process enables the purchasers to see what type of uncertainties and possible risks the suppliers' operations include. The visits to suppliers' locations help identifying the potential problems and risks efficiently. At the moment the existing or new suppliers don't have to sign and follow supplier code of conduct. Having a specified code of conduct could help with the auditing and sustainability matters as the companies would have a structured rules and information which to follow. This would also help the auditing process as the buyers would have a given tasks and steps that have to be considered when evaluating the supplier.

Additionally, structuring and standardizing the supplier evaluation and risk management processes could be beneficial for the case company and also help with organizing the workload of the employees in the purchasing department leaving more time to evaluate and identify potential risks compared to the current situation where there is not much standardization and manual labor is needed more. Hawkins et al. (2020, 14) described that it's important that the ratings used in the evaluation are well justified. They also mention that the ratings could be customized depending on the situation, and therefore the generic evaluation criteria should not be used in all situations (Hawkins et al. 2020, 14). The case company has identified that at the moment they have not met their goal for the certain number of supplier audits per year. Therefore, it can be argued that despite investing on supplier evaluation processes, this would require more resources to achieve the goal and have enough suppliers audited annually.

The use of OEM as a supplier for certain spare parts is an important factor for the risk management purposes as it was described as an efficient method to mitigate risks related to the quality and quality control process. However, by switching to alternative suppliers, the company could potentially save money and increase the profits. This would require future research to evaluate the tradeoff of quality control and possible cost savings.

Overall based on the risk prioritization survey the impacts of the supplier related risks were seen more critical than the risks in the purchasing operations. The most critical supplier related risks were given an impact of 4/5 where 1 is the least and 5 is the highest impact on the scale. One reason for this could be that the company has identified that being dependent on supplier could lead to critical risks. In addition, the survey shows that if supplier were to show opportunistic measures, the impact could also be critical as it was given 4/5 for the impact. This risk also received 4/5 for the likelihood of the risk occurring resulting in one of the most important risks to consider by the case company. Additionally, the spare parts are needed to ensure that the operations can be kept running and therefore if the supply of critical part were to be ended, the impact could be critical for the case company.

The purchasing related risks were given mainly 3/5 for the impact of the risk, though the "The delivery time is too long causing delays in maintenance" was identified to have the impact of 4/5. The high value for the impact could result from the urgent need of critical parts in some cases. The failing of the quality control of the purchased goods and services were both also given an impact of 4/5. To mitigate these risks the company utilizes supplier development and audits.

The sustainability related risks in the context of procurement were seen important in the risk priority survey. The risk of sustainability risks that are not found in the supplier audit were given RPN of 16 which means that the likelihood of the risk occurring was determined to be 4/5 and the impact to be 4/5 as well. This is an interesting finding because it was discussed in the interviews that the case company has not achieved their target of auditing a required number of suppliers every year. Additionally, the economic sustainability risk of supplier was given impact of 4/5 though the likelihood was seen only as 2/5. However, the case company has identified that the sustainability is an important topic, and they are constantly developing their evaluation and audit methods to improve the likelihood of finding potential risks in advance and to mitigate the risks in advance. Overall, the sustainability risks are considered to be important to manage and the aim is to strengthen the process.

The purchasing process was discussed and analyzed with a FMEA-tool. The purchasing process was divided to different steps identified in the interviews conducted with the employees of the case company. Based on the FMEA survey it can be argued that the

detection of possible failure modes and risks is on a very good level, as the detection was given low values ranging between 1 and 2 out of 10, where lower the value, the more likely the failure mode is detected. The most critical risks in the purchasing process relied on the monitoring, invoice approval and documentation which was followed by identifying potential suppliers, evaluating the offers and finally selecting and placing the most ideal offer. In the interviews it was discussed that overall, the purchasing process is quite heavy and demanding as the purchasing decisions require often collaboration between different departments. However, the close collaboration and internal expertise helps on managing the purchasing process and the least critical risk in the FMEA survey was identified to be "the need for spare part or service is approved" with the failure mode of "incorrect inquiry is approved". For example, the parts or services needed may need technical evaluation resulting in need to ask for assistance from the technical department. Though it needs to be also considered that the purchasing process and the needed collaboration is depended on how critical parts or maintenance services are being purchased. Additionally, it was discussed that sometimes the technical department is not aware of all costs which results in problems in the process.

Overall, the purchasing process was described to be demanding and in certain steps too formal. However, in the literature it was discussed that having collaboration within the company and having people with expertise working with the purchasing helps managing the risks (Munnukka & Järvi 2008, 260). Therefore, it can be argued that even though the purchasing process is sometimes felt and described to be demanding and complicated, it's done and built to manage various risks and uncertainties by ensuring that the different departments work together and collaborate.

In the literature it was discussed that the difference between the traditional purchasing and strategic purchasing is that the traditional purchasing process is described to aim for cutting costs and increasing short term profits whereas with strategic purchasing the aim is to decrease the number of suppliers and building cooperative relationships with the suppliers. Additionally, it's discussed that both, supplier and buyer can have the common goal. (Ryals & Rogers 2006, 41-42.) The cooperation between supplier and buyer is described also to be a method to reduce uncertainties what may come up in the purchasing process (Hong et al. 2018, 1561). Though, it was also discussed that use of spot markets helps when managing

the purchasing related risks, such as demand risks (Haksöz & Kadam 2008, 7). Finally, it was discussed that with alternative supply channels and back-up suppliers the majority of the uncertainties and risks related to purchasing can be mitigated (Hong et al. 2018, 1564). The case company uses these methods discussed in the theory to manage the uncertainties and risks in their procurement. The strategy is to build long-term cooperative relationships with key suppliers in order to gain more efficient and reliable processes and reduce uncertainties and risks. Additionally, spot markets and back-up suppliers may be used by the case company as a risk management method.

The spare parts and inventories may be managed by classifying the parts to various groups. This is argued to help with the inventory management as the companies are described to be able to identify the most crucial parts and choose proper strategies for the parts. (Hu et al. 2018, 398.) For the case company, the most critical spare parts are classified based on their criticality. The criticality may result from the need of a specified part for maintenance purposes or if the spare part is needed for a critical machinery. In addition, the spare parts may be categorized based on if certain parts are required to be in inventory by law and regulations. In addition, the technical department has their own technical specifications and classifications for different parts. Additionally, the suppliers are classified based on the relationship and dependency of the suppliers.

To further classify the suppliers in the risk management context, it would be beneficial to identify the suppliers who possess the most risk in important risk categories for the case company. For example, all relevant risks could be listed and then the suppliers could be ranked based on how many risk categories they result in. At the moment this kind of classification is not done. For example, the delivery risk was seen important and most critical for the company. Therefore, by ranking and prioritizing the suppliers who result with the most delivery risk, the company could make decisions in advance if the risky suppliers is to be replaced or not. At the moment the only risk prioritization method is connected to the number of claims and therefore it could be beneficial to expand the risk prioritization to cover more risks and problems the suppliers face. This type of categorization could be implemented also for the spare parts inventories as well.

5.2 Answers to the research questions

In this chapter the research questions are once more presented, and the findings are discussed. In the beginning of this paper, the main research question for this study was defined to be:

"*How is procurement risk management done at the case company in spare parts and maintenance purchasing?*"

The answer to this question is that the risk management process at the case company relies heavily on the competence and capabilities of the individual employees in the purchasing department. However, the other departments with expertise in technical, financial or legal fields assist the purchasing department in their risk management and purchasing efforts. The purchasing risk management process lacks structure as the actions to mitigate the risks are dependent on the individuals and their capabilities and know how. Additionally, the risk identification process is dependent on the purchaser and what type of risks they are aware of in the first place, and also what type of risks they are interested on identifying.

The main criteria in risk identification and monitoring phase were reported to be the claims process where the number of claims is monitored continuously. This method is an efficient way to identify the risks that have already happened in the past. Additionally, the claims report is an efficient tool to follow and monitor if certain suppliers are repeatedly involved in large number of claims. This way the corrective measures can be implemented in time and if needed. However, this method is very reactive approach and if one relies too much on this mitigation tactic, the risks are treated only after they have occurred already. In the literature, it was discussed that prioritizing risks helps companies to concentrate on the most crucial risks they face (Hallikas et al. 2002, 54). It was also discussed that the risk assessment process includes the evaluation of the probability and the consequence of the risk (Abdel-Bassed et al. 2019, 491). At the moment the case company is not using probability and consequence calculations for their risk prioritizing. Therefore, it can be argued that implementing this, could bring additional benefits to the risk management efforts of the company. Bradley (2014, 485) described that by using historical data, the probability of the risks that have already realized in the past can be measured. Finally, the risk management

process is described to be a dynamic process, which should be continuously monitored and updated (Kirilmaz & Erol 2017, 56). The company uses the claims report as a risk management tool, so for the case company, the claims process as a tool could be further used to measure the risks. However, overall, the process would benefit of more continuous monitoring which was discussed in the theory.

Even though the process is lacking structure, the risk mitigation tactics used by the company are relevant to the theory. In the table 8 the main risks and the risk mitigation tactics used by the case company are presented. From the table 8 one can see, that certain mitigation tactics, such as spot markets or back-up suppliers, may be used to mitigate various types of risks. The company uses buffer inventories for critical spare parts. The criticality is evaluated based on the specifications, delivery time and criticality of the spare part. Additionally, the company categorizes their suppliers and uses proper methods depending on the supplier and what is being purchased. Despite of these proactive methods, the main methods to mitigate the risks in purchasing and supply are reactive. The reactive methods also rely heavily on the knowledge and capabilities of the individual employees.

In the literature mitigation tactics to prevent or reduce the delivery related risks were described to include having back-up suppliers and multiple sourcing channels. Additionally, it was discussed that flexible transportation arrangements and buffer capacities could assist when mitigating the delivery risks. (Gouda & Saranga 2018, 5823, 5825.) In addition to this, Inman and Bhaskaran (2019, 3469) stated that managerial control and preventive management in the delivery process may be helpful when reducing the delivery disruption risk. Therefore, it could be beneficial for the case company to implement these tactics, as the delivery risk was seen important based on the survey. Though some of these mitigation tactics are already in use at least in some level. For example, the majority of the suppliers are located near in the Europe and buffer inventories are used as well.

Table 8. The case company's main risks and mitigation tactics.

Risk	Mitigation tactic
Delivery risk	Buffer inventories Back-up suppliers
End of supply risk	Spot market Back-up supplier
Price risk	Contracts Sourcing strategy Spot market
Supplier risk	Spot market Supplier development Audit/supplier evaluation
Sustainability	Audit/supplier evaluation Supplier development

The figure 8 presents how the risk management process is followed by the case company. The risk management process framework follows the risk management process which has 4 steps including risk identification, assessment, management actions and monitoring identified by Hallikas et al. (2004, 52-55.) The steps of the risk management process are presented on the left and on the right the actions done in each phase of the process are presented.

Abdel-Basset et al. (2019, 491) described that efficient risk management process requires companies to define important criteria in their risk assessment process to be able to choose what risks are included in the risk management process. This is somewhat lacking for the case company, as there aren't any structured and pre-determined criteria in their risk management process as the process relies more on individual employees and their capabilities and knowledge about the spare parts and markets. In addition, in the literature it was discussed that the efficient risk management process is mature and continuous process and companies should be evaluating and measuring their own risk management process continuously (Hoffmann et al. 2013, 207). In this regard the case company's risk

management process can be argued to not be as efficient as it could be, as the case company is not monitoring and evaluating their own risk management process at the moment. In addition, as discussed above the mitigation actions rely on individual employees to use them.

Hallikas et al. (2004, 54) described that in risk management there are five strategies to consider: risk transfer, risk taking, risk elimination, risk reduction, further analysis of individual risks. The case company's risk management process follows these strategies. For example, risk taking method is utilized in the form of trial periods in service purchasing where a less critical maintenance service is done with a new unknown supplier, whose capabilities are not fully known. In addition, for example the delivery disruption risk is reduced by having buffer inventories for common spare parts that can be used in various places.

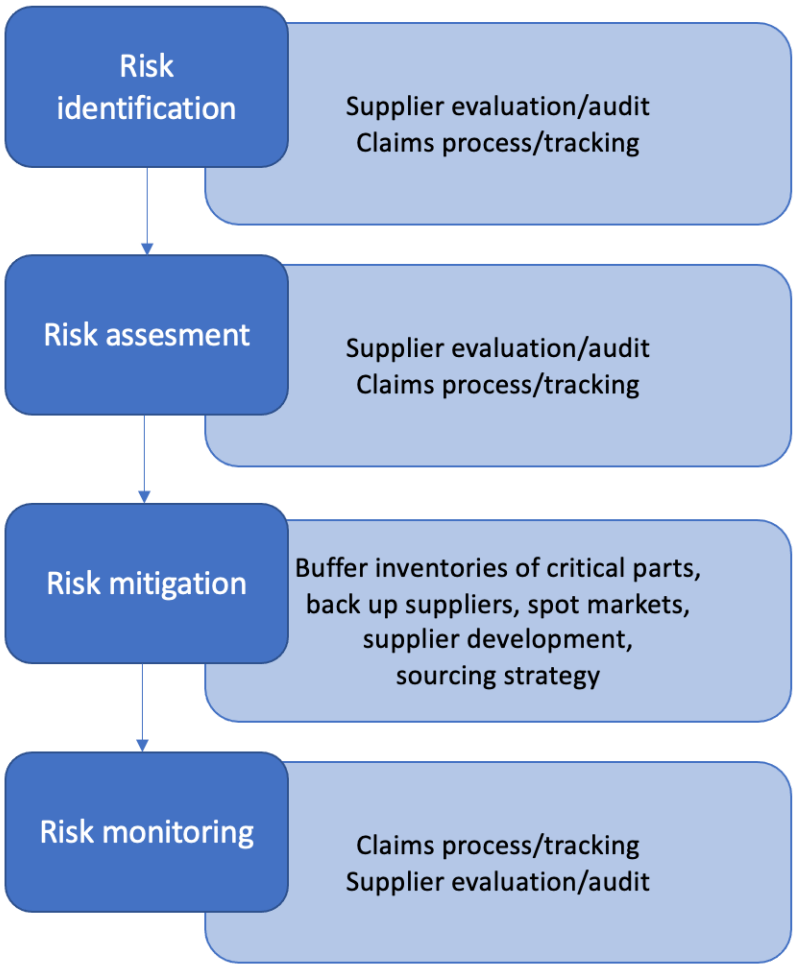


Figure 8. The risk management process and actions of the case company.

The answers to the sub questions in this research are discussed below.

What is supply risk?

Zsidisin et al. (2000, 187-189) identified six key risk types related to supply risk and they also described that supply risk occurs when a failure occurs in the in-bound supply. For the case company the risk in the supply and with the suppliers relies heavily on the relationship and dependency between the supplier and the buyer. Munnukka and Järvi (2008, 255) discussed that supplier selection, especially with small and medium sized suppliers, is connected to the business risk the buyer may face. Therefore, the case company's efforts on using trial periods and assigning less critical maintenance work for new suppliers can be seen as a risk mitigation action which is supported by the theory. In the literature the supplier insolvency was discussed also as an example of the business risk. For example, Wagner et al. (2009, 150) described how supplier's insolvency could result in a situation where the suppliers can't deliver the purchased goods to the buyer. The case company also considers the business risk in this regard, as they evaluate the financial data about the potential suppliers.

The main concern based on the risk priority survey is that the supplier shows opportunistic behavior. Additional important risks were identified to be that the production of a critical part is ended or that a larger company acquires the supplier. Therefore, it can be argued that the supply risk is present in the case company's scope of the possible risks. Li et al. (2016, 388) described that there are signs that the supply of a part is coming to an end, and by detecting these in advance the company could react and for example, contact the supplier and ensure that the inventory levels of the parts are sufficient. This could be useful in case the case company finds itself in a situation where the supply of a certain part ends. Additionally, Huiskonen (2001, 131) described that "safety stocking" is a useful way to mitigate the risk of long lead times.

What is risk management?

In the literature the risk management is described to be a process of identifying and evaluating the likelihood and impact of risks and then managing the risk with a suitable approach (Manuj & Mentzer 2008, 141). From the case company's point of view, the strategy to manage the risks depends on the type of risk. Mainly the strategy is to use reactive tactics in the form of spot markets and back up suppliers. Though the pro-active strategies are used in some cases as well, in a form of buffer inventories and insurances and supplier evaluation. Overall, the risk management process is lacking structure and the process relies on competent employees and their networks and knowledge.

Delivery related problems were identified as one of the most important risks the company has, and these are managed by having suppliers located near. In the interviews it was discussed that the goal is to have the suppliers located in the Europe and European Union as the delivery times are shorter and processes around the deliveries are easier as no customs operations need to be done when parts are delivered from European Union. Additionally, the maintenance service providers are easier to manage and use when they are located near and can perform the maintenance services where needed and with shorter lead times. In the literature it was discussed that optimizing the ordering time and by having back-up suppliers the uncertain lead times could be managed (Hong et al. 2018, 1554-1555).

To manage the supply risk, the case company uses alternative sourcing channels and back up suppliers. With certain spare parts, which are classified critical, buffer inventories are used either by the supplier or by the case company. Additionally, the supplier development is seen as a crucial method to mitigate these risks.

These efforts are in line with the academic literature where the multiple sourcing, insurances and buffers were described as methods to mitigate the supply risks (Hoffmann et al. 2013, 203). Zsidisin et al. (2000, 196) described that supply risks may be avoided by conducting risk assessments, contingency plans, process improvements and buffer inventories. In addition, the supplier development was described in the literature to be an effective method to reduce and manage the risk of supply disruptions. Although it was also discussed that

companies may also seek alternative suppliers who are more competent switch to use them instead of the old suppliers. (Wagner et al. 2009, 159.)

What are the relevant risk management tools?

As discussed in this paper, the case company relies heavily on supplier evaluation/audits as their main risk management tool. This is done continuously, though it was reported that the company does not meet their goal of desired number of audits per year. The case company also uses claims reports as a tool to measure the risk and to identify potentially poor suppliers. The claims process is an important tool for the company to visualize and identify potentially risky suppliers. It's used continuously and this way the company has information about the suppliers who have the most claims and this way the reactive actions can performed if needed.

In this paper the FMEA risk analysis tool was used to identify the main risk areas in the purchasing process. In the academic literature it is discussed that the FMEA-analysis can be used in example when selecting new suppliers (Li & Zeng 2016, 1310). The Heat-map tool was also used to visualize the main risks the company identified. Abdel-Basset et al. (2019, 491) described that bow-tie method may be used to identify risks and impacts of the risks.

What is needed for successful supplier evaluation?

In the literature it is discussed that supply chains may face problems if they are not measured and monitored, and one method to do this is to perform supplier audits (Chen & Jeter 2008, 2). Ryals and Rogers (2006, 43) mentioned that supplier performance evaluation is traditionally seen challenging. The same was discussed in the interviews as the evaluation/auditing process of suppliers was described to be ineffective in some areas in the interviews. Mainly the inefficiencies were reported to result from auditing too few suppliers annually. The company has set a goal of auditing a certain number of suppliers, but this goal has not been achieved so far. One reason for this may rely on the high number of suppliers the company has compared to the number of employees on the purchasing department.

However, the company uses multiple ways to audit the suppliers, as the purchasing personnel utilizes both, on-site visits and audits done online.

In the literature the evaluation criteria were discussed. Ho et al. (2010, 21-22) described that the most popular evaluation criteria is quality, which is followed by delivery and price. Though it needs to be noted that simply ranking the suppliers based on one criteria can't be done and often times more criteria's need to be considered (Elmaghraby 2000, 351). For the case company, the main motive for the supplier evaluation is to improve the processes and collaboration with the supplier. In the interviews it was also identified that quality is an important criteria for the evaluation, which is supported by the theory.

Especially when selecting the new suppliers, the references are used as a method to filter out and choose the most potential suppliers. Additionally, by assigning a new supplier to perform a maintenance service which is not critical for the case company, they can evaluate how the supplier operates and what is the quality they are able to achieve and provide in the maintenance operations.

To have an effective supplier evaluation process, it was discussed in the literature, that it's important to ensure that the rating criteria is well justified and done properly. Additionally, it was discussed in the literature that the criteria and ratings used in the auditing process may be customized if needed and therefore so-called generic ratings, which could be used with all suppliers, may not be the most ideal option to be used in all situations. (Hawkins et al. 2020, 14). The case company has built an evaluation form which is used when evaluating the suppliers. However, more customizations could be used depending on what type of supplier is being evaluated.

6 CONCLUSIONS

In conclusion the risk management process needs work and investing both, resources and time, from the case company. The whole process relies heavily on the competence and capabilities of the individual employees in the purchasing department, which could lead to an increased risk if the employees were to leave their current position and current employer as the knowledge of the risks and mitigation methods would leave the same time. However, despite the lack of structure, the identified risks are managed and considered when making the purchasing decisions. The strategy change in case company's purchasing operations aims to have stronger relationships with the selected suppliers, which can be described also as a risk mitigation method because it is done to ensure the availability of the needed spare parts and maintenance services. Additionally, it is seen as a great method to ensure that the quality is adequate and can be controlled.

Some development targets were identified in addition to the structure of the risk management process in general. The supplier categorization and managing the delivery disruption risk can be labeled as goals for further development because of their high importance for the case company. Additionally, implementing the continuous evaluation of the risks and the risk management process could help the risk management process. The supplier auditing and evaluation were repeatedly mentioned as one of the most effective ways to find and monitor supplier related risks. Therefore, investing more on the supplier evaluation process could be beneficial for the company. The evaluation process is well built in a way that there is an evaluation process and form that can be followed, but the number of evaluations could be higher.

Overall, the case company's purchasing strategies and risk management methods follow the same principles that are presented in the academic literature and therefore the risk management process can be described to follow the relevant theory. However, there are clearly aspects that need to be further developed and some risk management methods would be beneficial to implement to the current processes. In the context of spare part and maintenance purchasing, the delivery times and the end of supply of a certain spare part were identified to be critical risks. These are in line with the theory where the need of spare parts was described to alternate, and the deliveries need to be fast.

The reliability and validity in this research are limited in a way that this research is a single case study, which means that the results may be challenging to replicate in another context. This study follows the ethical guidelines in research. The interviewees were informed in advance that the interviews will be recorded and also that the interviewees will remain anonymous. In addition, they were informed that the recordings of the interviews will be deleted once the transcribing process is done. In this study the number of interviewees was rather low, but they represent the employees who are responsible of the purchases of the spare parts and maintenance and have knowledge about the topic. Additionally, the chosen research method has some limitations, as the study is done as a single case study. Because of the low number of interviews and single case study chosen as a research method, the generalizability of the results is not as high as it would be with larger number of interviews or multiple cases. Therefore, it can be argued, that the results of the study could vary depending on if other case company were to be selected. The size and the industry of the case company could change the results also.

The risk management itself is quite extensively studied topic. However, the spare parts have certain characteristics which could be researched more in the future. For example, concentrating on the differences between various spare parts could create better understanding on how to manage the risks related to the purchasing of spare parts. In addition, for further research it would be beneficial to conduct a research where more case companies are interviewed and studied in order to gain understanding on how the risk management in spare parts and maintenance procurement is arranged and managed in a larger scale and industry wide.

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APPENDICES

Appendix 1: Semi structured interview themes:

General

1. How many years have you worked at the company?
2. How many suppliers the company has in this segment?
3. Does the company have large suppliers who supply the most out of the spare parts/maintenance?
4. How do you define purchasing risk and supplier risk and what causes these risks to occur?

Purchasing

11. Is purchasing of spare parts and maintenance centralized?
12. Where are the suppliers located?
13. Is purchasing done with contracts or are the markets used as well?
14. How would you describe the current purchasing process?
15. What is the current goal of the purchasing of spare parts and maintenance?
16. How is the purchasing managed?
17. What are the most important risks in purchasing?

Suppliers

18. How is the relationship with the suppliers?
19. What is the main focus and motive in the current supplier evaluation process?
20. How is the evaluation done?
21. What are the main criteria when selecting new suppliers?
22. What is the current state of the supplier selection process?
23. How is the selection done?
24. What are the most important supplier risks?

Risk management

25. Please describe the current state of the risk management process?
26. How do you identify the risks?
    What are the risks you have identified:
    - Purchasing
    - Suppliers
27. How do you asses the risks?
28. How do you analyze the risks?
29. How do you manage the risks?
30. How do you monitor the risks?

Appendix 2: Risk prioritization survey

The impact of the risk for the case company:
1 = No impact
2 = Minor impact
3 = Moderate impact
4 = Significant impact
5 = Very large impact

The likelihood of the risk to occur:
1 = Very unlikely
2 = Minor
3 = Moderate
4 = Significant
5 = Very likely

Purchasing	**Likelihood**	**Impact**
The delivery time is too long causing delays in maintenance	1 2 3 4 5	1 2 3 4 5
The delivery time is too long causing extra costs	1 2 3 4 5	1 2 3 4 5
The supplier is not able to deliver the needed number of parts	1 2 3 4 5	1 2 3 4 5
The demand varies and wrong amount is ordered	1 2 3 4 5	1 2 3 4 5
The price of the spare parts rises considerably	1 2 3 4 5	1 2 3 4 5
The price of the subcontractors rises considerably	1 2 3 4 5	1 2 3 4 5
The quality of purchased spare parts is low and the parts can't be used	1 2 3 4 5	1 2 3 4 5
The quality control fails and defective parts are used	1 2 3 4 5	1 2 3 4 5
The quality of purchased maintenance service is low and machine can't be used	1 2 3 4 5	1 2 3 4 5
Maintenance can't be arranged in the needed location	1 2 3 4 5	1 2 3 4 5
There are problems with sharing the information and wrong parts/services are ordered	1 2 3 4 5	1 2 3 4 5

Suppliers	**Likelihood**	**Impact**
Supplier does not have capacity to produce enough spare parts	1 2 3 4 5	1 2 3 4 5
Supplier stops producing the needed spare parts	1 2 3 4 5	1 2 3 4 5
Supplier can't adapt to new technology and can't produce new parts	1 2 3 4 5	1 2 3 4 5
Supplier can't adapt to new technology and can't perform new maintenance service	1 2 3 4 5	1 2 3 4 5
Supplier faces insolvency causing supply disruption	1 2 3 4 5	1 2 3 4 5
Supplier loses key person causing supply disruption	1 2 3 4 5	1 2 3 4 5
Supplier is acquired by a larger company, causing problems in supply	1 2 3 4 5	1 2 3 4 5
Supplier can't achieve the needed quality levels	1 2 3 4 5	1 2 3 4 5
Supplier shows opportunistic behavior causing extra costs	1 2 3 4 5	1 2 3 4 5
The company is too dependent of the supplier		

Sustainability	**Likelihood**	**Impact**
Sustainability risks are not found in the supplier audit	1 2 3 4 5	1 2 3 4 5
Supplier has problems with social sustainability	1 2 3 4 5	1 2 3 4 5
Supplier has problems with environmental sustainability	1 2 3 4 5	1 2 3 4 5
Supplier has problems with economic sustainability	1 2 3 4 5	1 2 3 4 5

Appendix 3: FMEA-Analysis

Please choose the severity, likelihood and detection for each step / criteria.

Impact (how severe the impact is): range from 1 to 10, where 1 is the no effect and 10 is catastrophic effect

Likelihood (how likely the risk occurs): range from 1 to 10 where 1 is very unlikely and 10 is very likely

Detection (how likely the cause is detected): range from 1 to 10 where 1 means that the potential failure is detected almost surely and 10 means that the potential cause is very likely undetected.

Purchasing process								
The step of the purchasing process	**Failure mode**	**Effect**	**Impact 1-10**	**Cause**	**Likelihood 1-10**	**Current controls in the process**	**Detection 1-10**	**Risk priority number**
The purchasing need is identified	Incorrect criteria is used	Wrong information about the need is entered in to the system		The need is not identified properly		Communication between the person entering the inquiry and person identifying the need		0
The need for spare part or service is approved	Incorrect inquiry is approved	Buyer receives incorrect inquiry		Unclear or incorrect specifications		Communication between the person entering the inquiry and person approving it in the system		0
Identifying of the potential suppliers and sending the the offer request to potential suppliers	Buyer identifies incorrect suppliers	Wrong supplier is chosen		Unclear specifications and therefore improper tendering		Communication and sharing of information		0
Offers are received and evaluated	Offers are not matching the original need identified	Wrong offer will be selected		Unclear specifications and terefore poor sourcing of potential suppliers		The need is specified correctly to the system and communicated between different departments		0
Offer is selected and placed	Wrong offer is selected and placed	Wrong products or services are delivered		Unclear communication		The offers are checked comprehensively		0
Spare parts are received / service is performed	The purchased goods or service don't match the need identified in the beginnig of the process	Parts can't be used or maintenance is not done properly		Wrong supplier is selected		Communication between the departments		0
Monitoring, invoice approval, documentation	Invoices are not checked	Incorrect amount is paid		Unclear specifications and communication		Communication and clear documentation		0