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Supply Risk Management at a Large Manufacturing Company: Identified Issues and Areas of Improvement

Master's thesis in the Supply Chain Management Programme

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Gothenburg, Sweden 2017
Report No E2017:098

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Chalmers Reproservice
Göteborg, Sweden 2017

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ABSTRACT

Supply risk management is important for all companies, but even more so for manufacturers. They operate in an environment where they often have many suppliers, and the supply of raw material and parts is vital to keep production going. Supply chains have become more complex in recent years, but also more sensitive due to globalization and JIT practices, meaning that supply risk management is more important than ever.

The thesis is based on a case study of a large, global manufacturing company, which has production in 20 countries and is doing business with over 30 000 suppliers. The data is collected mainly at the purchasing department of the company through interviews and internal documents.

The data and information collected at the company is evaluated using a model for supply risk management effectiveness of a company is the direct result of the supply chain's warning and recovery capabilities. These capabilities are based on the supply chain's resources and their coordination and interaction, and gives the supply chain members the ability to share information about disruptions and to put actions in place to prevent or mitigate these disruptions. The model also states that these capabilities can be strengthened by focusing on three factors: internal integration, information sharing and training.

What is found is that the company has plenty of resources and routines for supply risk management, but that the coordination and information sharing is not always working properly. There are also gaps in the knowledge of employees of these resources and routines. The internal coordination is analyzed with a basis in different coordination mechanisms, and suggestions is given for how these coordination mechanisms can be used to improve the supply risk management work at the company. For information sharing the data is analyzed using a model of six barriers to information sharing. And finally, the training aspect is analyzed by using a model for tacit and explicit knowledge and how this is transferred between persons.

The result of the study is that there are several problem areas at the company that affect the warning and recovery capabilities, with the most important ones being a lack of training for employees and a lack of IT-support for information sharing. A conclusion that can be drawn from the study is that the model used for analyzing the case company can be an important tool for improving the supply risk management effectiveness at large and complex companies, where this otherwise can be a challenge.

Keywords: Supply risk management, Purchasing, Warning capabilities, Recovery capabilities, Manufacturing,

PREFACE

This master thesis was performed as the conclusive part of the master programme in Supply Chain Management at Chalmers University of Technology. The study has been realized in collaboration with a large manufacturing company during the spring semester of 2017.

First of all, we would like to thank our supervisor at the company, for having dedicated us time and shared with us wisdom and insights about the company, its supply risk management process and the issues related to it.

Secondly, we would like to thank all the employees of the company that took part to the study, without your help and knowledge it would have not been possible to carry out this work.

Finally, we would also like to express our gratitude to Dan Andersson, our supervisor at Chalmers University of Technology, for his precious inputs and patience. His broad knowledge about the subject, together with his support and guidance, have helped us immensely during the study process.

Gothenburg, June 2017

Erik Dybeck and Matteo Levy

LIST OF ABBREVIATIONS

DA: delivery analyst
QA: quality analyst
CA: capacity analyst
FA: financial analyst
OB: operations buyer

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1. INTRODUCTION

This section will present the case company together with the problem identification. The subject is also introduced, highlighting the relevant characteristics related to the topic of the study. Then, the purpose of the study and the questions necessary to reach it are presented. The chapter ends with the limitations of the study, together with the implications of those limitations on the study itself.

1.1 Problem Description

The buyers at a company have found themselves facing several crises connected to suppliers lately, despite having extensive supply risk management processes in place. These processes are however spread out over several functions making it difficult for any one employee to get an overview of the entirety of them. This has made it difficult for them to see where it is not properly working and how it could be improved.

The study is performed in collaboration with a large, global manufacturing company. They have production in 20 countries and sales in more than 190. Purchased goods and services amounts to a yearly spend of around 20 billion euro, which is equal to 70% of their revenue. So, the impact of purchasing activities is large on the company's bottom line. It also makes them sensitive to disruptions of supply, as the production is very dependent on externally sourced parts. They have a single-source strategy and are actively working on reducing their supplier base, but are still working with more than 30.000 suppliers (Case company, 2016).

1.2 Theoretical Background

Risk management is an important factor for a company's or a supply chain's odds of survival in the long run, but it is in practice often neglected. Companies are used to succeed often with few failures, otherwise they wouldn't still be in business. So, they underestimate the likelihood of adverse events and the consequences they will have if they happen. This is an example of survivorship bias that can prove catastrophical for a company if they do not recognize it and take steps to constantly improve their risk management process (Pritchard, 2015).

Not only is risk management often put in the shade, but at the same time the risks that manufacturing companies face has increased in recent years due to more complex and interconnected supply chains. Some reasons for this can be traced back to the increase in globalization, lean strategies, JIT production, outsourcing, decrease in the number of suppliers and a shorter lifecycle for products. These trends have all led to supply chains that are more sensitive to disruption (Juttner, 2005; Zsidisin, Ragatz and Melnyk, 2006; Kırılmaz and Erol, 2017).

The consequences of a supply disruption for a manufacturing company could range from operational, such as the shutdown of a production plant for some days, to more strategic ones,

such as the necessity to entirely quit a business segment, depending on the sensitivity of the supply chain and the severity of the disruption.

One example of the consequences this can have is when in 2008, Chrysler was forced to shut down four of its production plants for a day after a dispute with Plastech. Plastech was a supplier of plastic components to Chrysler, but when Plastech filed for a chapter 11 restructuring Chrysler decided to pull their business. Since Chrysler made up 15% of Plastech's sales, this would have jeopardized their ability to secure new funding. To prevent this Plastech held the tooling necessary for producing the components hostage and held deliveries until Chrysler agreed to costly interim agreements. The situation threatened to stop Chrysler's entire production (Beene, 2008). The dispute went to court with Chrysler demanding the tooling, where the courts after several months ruled in Plastech's favor. This meant that even after this costly and messy endeavor Chrysler would have to continue to source from Plastech. The aftermath to this conflict was that Plastech was sold out in pieces to cover their outstanding debts, and Chrysler began the work of making their supply chain less vulnerable by increasing their supplier base (Mayne, 2008).

Another example is the Nokia Corporation and Ericsson LM case of 2000. A fire took place at a plant owned by Royal Philips Electronics in New Mexico, which was supplying semiconductor chips to both Ericsson and Nokia. This fire stopped production entirely and came at a critical moment where both companies were launching new models and needed the chips provided by Philips to make them. When being reached with the news of the factory fire, Nokia quickly put together a task force that investigated re-designing and finding alternative sources, while the information didn't reach the management of Ericsson until several weeks into the disruption. Due to this Nokia could properly manage the issue and launch the new models as planned, while Ericsson was forced to postpone the launch of its new phones. The foothold that Ericsson had on the mobile phone market was already weak and this delay cost them additional market shares, leading to them ultimately giving up on the market (Walker, 2013).

1.3 Purpose

The study will map out the company's supply risk management processes in order to analyze them using existing theoretical models on supply risk management. These theoretical models should cover both the process phases the risk management should have and factors for a successful practical use of them.

The purpose is then to present the company with identified areas where they can improve their current supply risk management work. These areas should be specific enough that the company can either act directly on them, or at least use them as a starting point for further studies.

To support the study and reach this purpose, five questions have been identified that needs to be answered:

1. What is identified in literature as necessary steps to be done in an effective supply risk management process?
To have a theoretical basis for the thesis, a model with the necessary steps a supply risk

management process should have needs to be found. This will also be used for analyzing the company's current supply risk management processes.

2. Which factors are pointed out in literature as important for a supply risk management process to work well in practice?
It is not enough for a company to have a process in place that follows a working supply risk management model. In practice, there are many pitfalls that can diminish the effectiveness of this process. For an evaluation to be done there needs to be a theoretical basis on which factors are important in the practical use of supply risk management.

3. How does the supply risk management process in place at the company look like and how is this work done in practice?
After a theoretical basis for the study has been established, the way that the company is currently working with risk needs to be found and mapped out. This will involve both how the company wants their supply risk management processes to work and how it is actually used in practice.

4. Does the supply risk management process in place at the company follow the recommended steps of the model chosen from literature?
When the theoretical base is established and the information has been collected from the company, a comparison of the two can be done. Here, any discrepancies between what the theory says should be done and the steps that the company wants to do should be found.

5. Which areas of improvement can be identified with respect to the factors for effective use of the supply risk management process?
To reach the purpose of the study, an analysis needs to be done based on the information gathered at the company and using the model from literature. The result of this analysis will show how the company's current risk management practices are being supported or held back, with the result being organized according to the factors that was found in question 2.

1.4 Limitations

The study will be carried out only at the manufacturing company. Considering a simplified model of a supply chain, as shown in Figure 1, the study will be done at only one of its members, i.e. the manufacturing company. Since the other actors in the supply chain are not directly included in the study, the information regarding risk management related to them (e.g. relationship and communication in place and related perceptions about them) will be explored indirectly, from the manufacturing company's point of view. This could lead to biased opinions in relation to these aspects, as only one side of the story will be told.

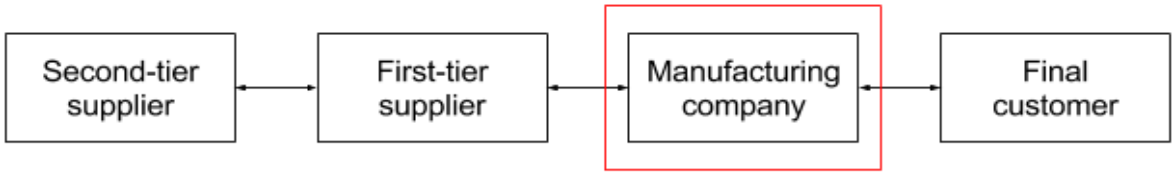

Figure 1. Focus of the study in relation to a simplified supply chain.

The study will also be limited inside the manufacturing company. As shown in Figure 2, the information for this study will gathered mainly at the purchasing department, without having direct contact with the other departments or the company's production plants.

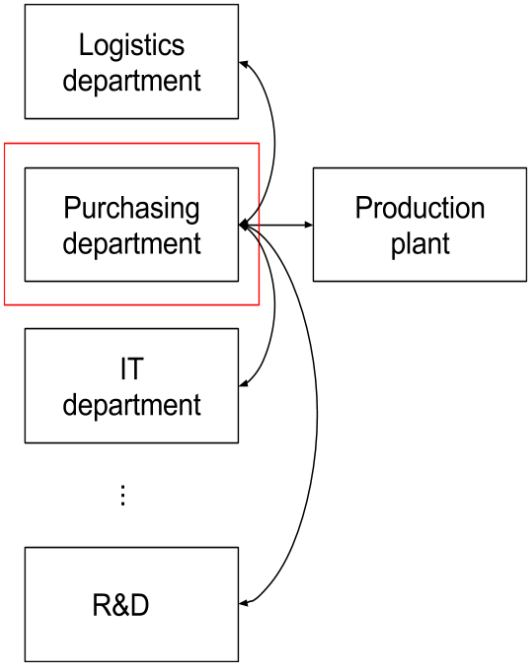

Figure 2. Focus of the study in relation to the departments of the company.

Therefore, supply risk management and related activities (e.g. information exchange in between different departments and functions) outside the department will be investigated indirectly, from the information gathered in the purchasing department and from their point of view. Biased opinions in relation to these aspects can result from this, as only the purchasing department's perspective about the other functions and employees inside the same organization will be used.

The last point related to the limitations of the study is connected to the broadness of the subject. The subject of supply risk management and the factors affecting its effectiveness in practice is very broad and complex. Since almost every position in the company is related to supply risk management, and different employees from different functions have an influence on it. Based on this, the need to limit the gathered information has arisen. To do so, the authors decided to gather a wide range of information rather than going in depth. This means however that the resulting analysis will be broad and could in some cases not be sufficiently detailed to be practically useful.

2. METHOD

This chapter presents the methodology that has been used for conducting the study. The first part introduces the study design and strategy, and why a case study approach has been chosen to carry it out. Then, the different phases of the process of the study is presented, together with a description of each of them. After that, the different sources that has been used to collect the information to carry out the study are presented. Following this, a discussion related to the reliability and validity of the study is given. A brief section then presents criticism in relation to the adopted literature for the study. The chapter ends with a general discussion about the method and choices made during the study.

2.1 Study Design and Strategy

When the goal of an investigation is on the pervasive and detailed analysis of a specific environment and context, a case study is a common method used to perform the research (Bryman and Bell, 2003).

Given the fact that the study is performed inside a specific department, inside a specific company with the purpose of investigating a subject in a pervasive and detailed way, the case study approach then appears as an appropriate method to be used.

Bryman (2004) says that a quality approach is used when the authors of a study do not have a clear picture of what the answers might be and want to get a deeper understanding of the studied subject. It is a more exhaustive way to approach the study questions and can give a deeper, more nuanced knowledge of the studied subject.

The study aims at analyzing and giving suggestions for improvement regarding the current supply risk management process at the company. This is a complex and nuanced subject with a limited number of potential respondents, whose views and thoughts need to be gathered and analyzed. Given this fact, a qualitative approach in data collection is considered as the preferred method by the authors.

2.2 Study Process

In this section, a description of the different phases of the study process will be presented. A graphical representation of the study process is given in Figure 3, while in the following sections a more thorough description of the different phases is given. During the entire study process information was also collected from other sources than the interviews, which will be presented in chapter 2.3.

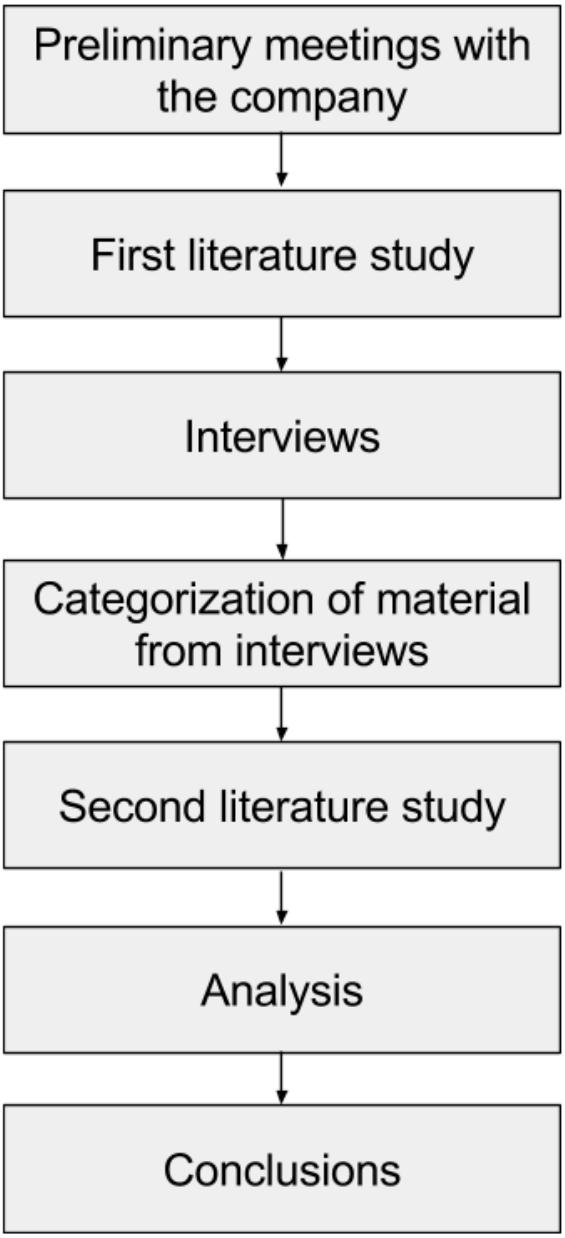

Figure 3. Outline of the study process.

2.2.1 Preliminary Meetings with the Company

Initial meetings with the company's representative were held as a starting point for the study process. These meetings have been conducted with an operations buyer. During the first meeting, the company in general was presented to give an understanding of the environment in which the company operates and its complexity. This was followed in the second meeting by a general discussion about the supply risk management process in place at the company. This meeting gave an understanding of some of the issues faced by the company regarding their supply risk management process.

2.2.2 First Literature Study

Following the initial meetings with the company, a literature study was performed. This was carried out to gain better understanding of the concepts related to risk management and more specifically supply risk management. Sources used in this phase were books and articles found through Chalmers Online Library and Google Scholar, with keywords for the research such as *risk management*, *supply risk management*, and *crisis management*. Physical books related to supply risk management have been an additional source of information, provided by the supervisor at Chalmers and found by the authors in Chalmers Library. This phase also had significant value since it was used to gather material on which the interviews were based. This allowed for a smoother, easier, and more thorough generation of interview questions. This also made it easier to understand the subject in the discussions with the employees of the company.

All this material that was gathered during the first literature study represents what Bryman and Bell (2003) call secondary data. This means that the information that was found was not collected by the authors in the first place through direct observation, but elaborated and produced by other scholars.

One of the findings was that, according to Norrman and Lindroth (2006), the different phases that together form the supply risk management process are labelled in slightly different ways. However, a common red thread can be identified in the actual tasks being carried out. After having analyzed different supply risk management processes suggested by different scholars, the authors themselves realized that a red thread can be identified among all these. A model proposed by Hallikas et al. (2004) has been chosen as representative for this red thread.

2.2.3 Interviews

Since the subject of this study was clear, i.e. the supply risk management process of the company, but exactly which information could be found in the interviews was not, a semi-structured interview approach was chosen. This was done to keep the interview subjects from straying too far off topic while at the same time giving them the opportunity to share additional information considered relevant from the interviewees point of view (Bryman, 2004).

When planning an interview for a qualitative study, making use of a semi-structured approach means preparing a list of questions that should be asked during the interviews, and these questions should remain as similar as possible between the different respondents to ease the finding of patterns or consensus in the group. It is however important that the respondent is allowed to talk freely without being interrupted and about areas not planned by the questions, to be able to get as broad a picture as possible (Bryman, 2004).

Ten semi-structured interviews were carried out inside the company with ten different employees after the first literature study. The interviewees have been selected with help of the supervisor at the case company, who evaluated from her experience the most relevant buyers and functions to include. To have a perspective about the supply risk management of the company as broad as possible, interviewees with different roles and experience in the purchasing department have been chosen. Even if the interviewees all belong to the same

purchasing organization, they have different roles, therefore bringing different perspectives about the subject and the work being done at the company in connection to supply risk.

A theoretical preparation for the interviews was done based on the literature study previously performed. From this theoretical basis and information collected from the internal documents and informal meeting, questions for the interviews were formulated in accordance with the chosen semi-structured approach. The interview questions were meant to cover different aspects, ranging from the role and responsibility of the interviewee, to their knowledge about the supply risk management processes in place at the company, issues that they personally had faced regarding it, and more. A copy of the interview template is provided in Appendix A.

The interviews have all been held at the purchasing office of the company. Eight of them were conducted in person, while two interviews were performed through Skype. The chosen semi-structured approach meant asking the same questions to all the interviewees. However, they were also given the possibility to expand on different areas in accordance with their specific knowledge and experience. Each interview lasted around an hour.

The recordings of the interviews contained a large amount of information and this needed to be transcribed to ease the handling of it. The transcription also allowed a smoother analysis of the collected data, having all the collected information down on paper. The main aim of the interviews was to collect qualitative information and opinions of the interviewees in relation to the supply risk management of the company, and the transcribed material amounted to a total of 116 pages.

2.2.4 Categorization of Material from Interviews

Among the different possible styles of organizing the data for this analysis, Miller and Crabtree (1999) describe the editing model as a good method for investigative studies with deeper reaching questions. The reader should, like an editor, identify important segments of data and gather these. The gathered segments are then separated into categories and a picture is put together. The reader should here start with a naive view and after the gathering phase is finished draw conclusions. The process is repeated until an exhaustive view of the material's common and independent points have been created and put in context. This is a time-consuming method where each segment demands a thorough reading and the classification is done simultaneously with the classes themselves (Miller and Crabtree, 1999).

Even if time consuming, the editing method has been chosen for this study as the style to organize the collected data, which was performed after the transcription of the interviews. The reason lays in the fact that the examined subject is complex and extensive, and that the authors of the study did not fully know what the results of the interviews would be before performing them. Thus, this method lowers the probability of having a classification that is too broad or incorrect, which might in turn lead to a lower relevance of the results. This is because the classification is not pre-established, but it is reviewed and improved with each round of going through the collected data.

This categorization was done in parallel and independently by the two authors, where they

identified segments present in the collected material and divided it in different categories. This classification was carried out by analyzing the transcripts of the interviews and finding common themes brought up by different interviewees. After this was done, the two results were compared and fused into one. This was done to increase the reliability and validity of the resulting categories and quotes. In this way, different opinions were discussed in the attempt to find the most objective possible solution related to the analyzed material. The outcome of this can be found in Appendix B.

2.2.5 Second Literature Study

A second literature study has been performed after the interviews were concluded and the information coming from them categorized. This was performed to gain more in-depth knowledge about themes in relation to ideas and opinions that the interviewees brought up during the interviews, in relation to the factors affecting the effectiveness of the supply risk management process of a company. The source of information during this second literature study has been represented by Chalmers Online Library and Google Scholar, searching for keywords such as *supply risk management enablers*, *supply risk management barriers*, *coordination, information sharing*, and *training*. An important discover during this second literature study has been the work by Riley et al. (2016), related to the capabilities necessary for supply risk management effectiveness and the enablers of these capabilities, together with in-depth literature material connected to it.

As for the first literature study, all the information found in the second literature study belongs to secondary data, following the classification by Bryman and Bell (2003). This means that the authors did not collect this information directly by themselves, but made use of information coming from the work of other scholars.

2.3 Other Sources of Information

In addition to the interviews, several sources have been used throughout the study to collect the information necessary for the analysis. All these sources contributed to give the authors a picture of the supply risk management process in place at the company and has been used as the basis for the empirical findings presented in chapter 4. This collection of information has been done continuously throughout the study.

The authors of the study have taken part in several of the weekly meetings that operations buyers take part in. These meetings are a gathering of different operations buyers and the topics of the meetings are connected to their job, ranging from the communication of the targets set by the higher levels of management of the company, to the follow up in relation to them, to alignment on goals, to presentations of initiatives related to improving processes with the suppliers, and more.

Another source of information was the bi-weekly risk meetings, where employees belonging to the different functions discuss identified risks and/or actions to take to mitigate them. These meeting are explained in more depth in chapter 4.5. The authors of the study took part in one

of these meetings, where several cases on risky suppliers were presented.

The authors also got information from two additional employees of the company, a capacity analyst and an internal development consultant, two roles presented in chapter 4.2. These two employees have not been interviewed following the semi-structure interview as the other interviewed employees. They have been consulted in a more informal way and this allowed the authors to get access to additional information related to the supply risk management process of the company.

The last source of information is the IT-system and internal documents of the company. Here are all the processes that should be used by the employees stored, as well as organizational charts, description of the roles, and more. This source was particularly useful in getting information on the different processes connected to risk management. The process itself is described in chapter 4.1, as well as explanations of the different phases composing it.

2.4 Analysis

After the empirical data had been collected and grouped, it needed to be analyzed using the models by Hallikas et al. (2004) and Riley et al. (2016), and the supporting literature. This was done by starting with the different areas describes in theory, such as the coordination mechanisms, and going through the empirical data looking for quotes of process descriptions that could point to a problem or an advantage in the area. For the risk management process the focus was on the process description found in the internal documents and was a purely comparative analysis. For warning and recovery capabilities both the resources and their interaction was scrutinized with the regard to their impact on the company's abilities. The analysis done with a basis in the three factors, internal integration, information sharing and training, the analysis was more detailed than the previous ones, as the theory described more precise areas to look at.

2.5 Reliability and Validity

For a qualitative study to be trustworthy, Lecompte and Goetz (1982) define four important areas that need to be considered: internal reliability, external reliability, internal validity and external validity. These aspects will be covered in this section.

Internal reliability handles how the results may have been affected by the specific circumstances a study has been conducted in (Lecompte and Goetz, 1982).

Several interviews with employees having different roles in the purchasing organization have been carried out during the process. This variety of sources of information should increase the internal reliability of the study and give an aggregated view of the situation at the company.

What needs to be considered, however, is that the interviewees all belong to the same department (i.e. purchasing). This factor can limit the understanding of the risk management work being done in other departments and therefore the internal reliability.

External reliability measures to which degree the study could be replicated with the same result. To reach a high external reliability is considered difficult in qualitative studies, due to the many subjective variables (Lecompte and Goetz, 1982).

Since a lot of the data comes from internal documents or processes that are generally accepted at the company, similar results should be found if someone was to replicate the study. The supply risk management process which is underlying the supply risk management work is well established and should increase the external reliability.

The aspects that lowers the external reliability would mainly be based on the persons being interviewed, as it was found that the level of knowledge they had of the processes differed and that they had some influence on how they wanted to perform their risk management work.

Internal validity describes how well the ideas that develop during the execution of the study correspond to the observed reality (Lecompte and Goetz, 1982).

Since the study is carried out through a case study method, the collected data reflect the resources and the processes of the company. Therefore, the information used to develop the study is based on a real case scenario. This aspect of the study being grounded in a real situation, and not being a purely theoretical work, will increase the internal validity of the study itself.

What is obtained is a representation of the reality, based on the combination of the employees´ intra-organizational perspective and the comparatively impartial one of the documents and processes accessed by the authors. This combination of several types of sources should improve the internal validity of the study.

The information gathered during the study was always subjected to a reality check by the authors. If some information was doubted or considered biased, it was double checked with other sources at the company. This is to ensure that the study will be properly connected and grounded in the reality of the organization where it is carried out.

External validity deals with how well the findings can be generalized and used in different situations (Lecompte and Goetz, 1982).

From one point of view it is true that the findings of the study will depend on the qualitative information collected by the employees of this specific company. Their opinions and experiences will reflect the environment in which they operate, which in turn might undermine the external validity of the study and make it harder to generalize the findings.

However, manufacturing companies of the same kind as the one examined, characterized by being large and having a complex supply risk management process, might possibly face the same issues. This is mainly because the issues related to the subject in this study seem to be dependent on the two above-mentioned characteristics of the company, i.e. being large and with a complex supply risk management process. Thus, other companies with the same characteristics can benefit from the findings of the study, increasing its external validity.

The findings are gathered and analyzed with a basis in two models that are general for supply

risk management. This means that any company working with supply risk would face similar issues and could learn from the case company, which increases the external validity of the findings.

2.6 Method Discussion

In relation to the adopted method to carry out the study, one point needs to be discussed. This relates to the available material before the interviews were carried out with the different employees of the purchasing department. After having gone through them, the authors realized that they were missing some information beforehand. For example, the escalation process, presented in chapter 4.5, touched during the interviews, was accessed after the interviews were concluded. Even if understood during the interviews, having the knowledge of this material beforehand could have potentially lead to a different discussion with the employees during the interviews.

In addition, the model by Riley et al. (2016), presenting the factors influencing the effective practical use of risk management in a company, was found after the interviews were concluded. Having this information before the first round of interviews could have potentially lead to a different kind of discussion with the employees.

Something that should also be noted and that Riley et al. (2016) themselves brought up in their article is that their model is only a first suggestion and would need more research to confirm or broaden it. This represents a fact to take into account in this study as well. Other factors than the ones brought up in the model might have influence towards the effectiveness of the supply risk management of the company, but will then not be covered in the analysis.

3. LITERATURE REVIEW

In the literature review the theoretical base for the interviews and the analysis will be built. The first part relates to the supply risk management process of a company and should answer the first question presented in the purpose. Here, the chosen model by Hallikas et al. (2004) will be presented together with a description of the different phases forming it. Then, the chosen model by Riley et al. (2016), describing the factors influencing the effectiveness of the supply risk management process of a company will be presented as it relates to the second research question. In the final part, these factors will be presented in more depth, making use of selected literature related to them.

3.1 Supply Risk Management Process

A model for the supply risk management process is presented by Hallikas et al. (2004), which represents the theoretical principles that literature points to as important. The model includes the following stages:

- Risk identification;
- Risk assessment;
- Identification and implementation of means for risk reduction (this is sometimes called risk mitigation by other researchers);
- Risk monitoring.

A graphic representation of the process is presented in Figure 4. In the following sub-chapters, a more in depth explanation of the different phases of the supply risk management process will be given.

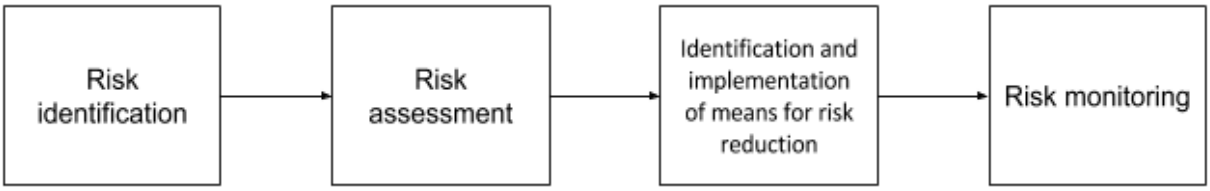

Figure 4. The supply risk management process (adapted from Hallikas et al., 2004).

3.1.1 Risk Identification

Identifying the potential risks that can undermine the business of a company is a critical step in the supply risk management process (Pritchard, 2015). Through this phase, events negatively affecting the company are recognized by decision-makers and brought to awareness (Norrman and Lindroth, 2006).

The following are some of the possible methods that can be used in identifying risks, as proposed by Tummala and Schoenherr (2011):

- Checklists or check sheets (for example documenting the frequency of failures caused by a specific event, like the number of times a supplier has not delivered according to agreement);
- Event tree analysis and fault tree analysis (obtained by representing graphically the potential and related consequences caused by a certain event);
- Failure mode and effect analysis (performed through an analysis and assessment of what potentially can go wrong, together with the ensuing effects);
- Ishikawa cause and effect analysis (also called fishbone diagrams, obtained by brainstorming the potential connections between causes and failures).

What is important is that at the end of this phase different risk scenarios are played out, to find out which consequences an event might have. This is done so that they can be further analyzed in the later phases of the supply risk management process (Hallikas et al., 2004).

3.1.2 Risk Assessment

Hallikas et al. (2004) state that after the identification phase, an assessment of the risks is necessary to give priorities to the actions to take. However, before talking about this phase in more detail, it is necessary to introduce two concepts related to risk, called probability and business impact, as by Norrman and Lindroth (2006) define them. The first is defined as the likelihood that a determined event will take place, while the second as the severity of the potential effects caused by the event on a company. They explain how risk can then be quantitatively determined as the product of the two above-mentioned factors, as:

$$Risk = Business\ impact * Probability$$

When these two elements are determined for each of the identified risks, a useful tool is to organize them in a risk matrix. This matrix, resembling the one shown in Figure 5, is useful for giving an overview and helping with the prioritization process of the identified risks. Risks with both high probability of occurrence and high business impact should have a higher priority, and the main focus and efforts should be on them (van Weele, 2010).

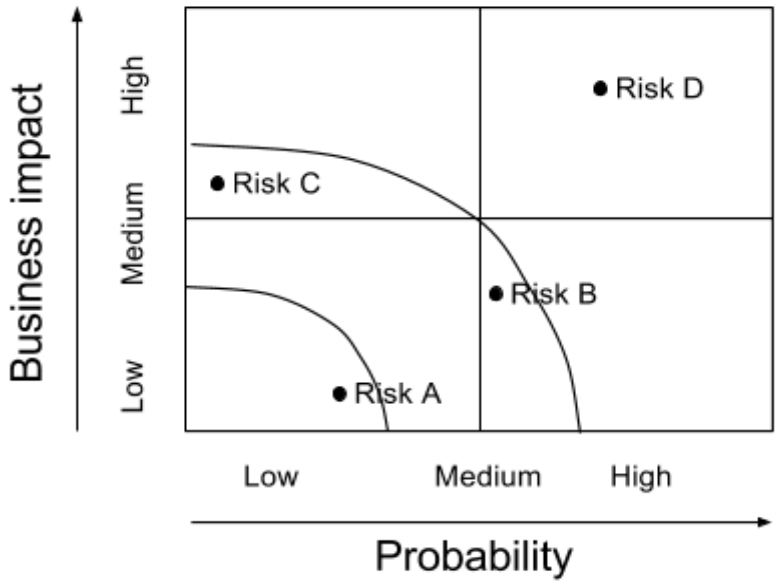

Figure 5. Risk matrix (adapted from van Weele, 2010).

3.1.3 Risk Reduction

In this phase, the company takes decisions about how to proceed with the assessed risks. As presented by Hopkin (2014), a company usually has the following strategies to choose among regarding how to treat risks:

- Tolerate (accept/retain), implying that no action will be taken, since the exposure is considered tolerable;
- Treat (control/reduce), implying that risk is reduced to a satisfactory level through taking some form of action;
- Transfer (insurance/contract), implying that insurance companies or third parties can be paid for taking the risk instead of the company, transferring it to them;
- Terminate (avoid/eliminate), implying that determined activities need to be stopped completely so that the risk can be brought to an acceptable level.

Hopkin (2014) also goes further, stating that each of these strategies should be used for a specific position on the risk matrix. In particular:

- Tolerate applies to risks with low probability of occurrence and low business impact;
- Treat applies to risks with high probability of occurrence and low business impact;
- Transfer applies to risks with low probability of occurrence and high business impact;
- Terminate applies to risks with high probability of occurrence and high business impact;

Figure 6 presents graphically the relationship between the risk management strategies that can be adopted during the risk management phase and the position of the identified risk on the risk matrix.

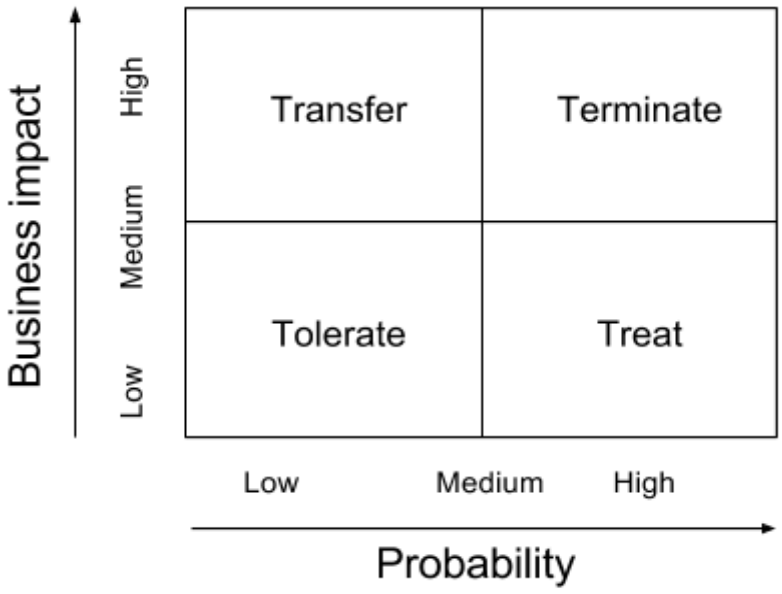

Figure 6. Relation between risk strategies and position of identified risk on the risk matrix (adapted from Hopkins, 2014).

3.1.4 Risk Monitoring

The last phase of the supply risk management process is the risk monitoring phase. During this phase, the strategic actions put in place in the previous phase to manage the identified risk and the risks themselves are followed and controlled. If the expected results are not achieved, other measures should be put in place. At the same time, communication of disruptions, abnormalities, and deviations need to be performed to improve the process (Tummala and Schoenherr, 2011).

3.2 Factors Influencing the Supply Risk Management Process

Different aspects, internal and external, can be identified as influencing the effectiveness of the supply risk management processes both of a company and of a supply chain as a whole. A model proposed by Riley et al. (2016), as shown in Figure 7, is here used as a starting point for the literature review concerning these aspects. According to the scholars, the performance is mainly based on the warning and recovery capabilities that a company or supply chain has. These capabilities are in turn supported by three factors. Developing these factors enables a company to improve its supply risk management process, enhancing its ability to recognize a risk or disruption and recover from it. They also add that the ability to identify potential disruption, i.e. its warning capabilities, in turn improves the recovery capabilities of the firms in a supply chain.

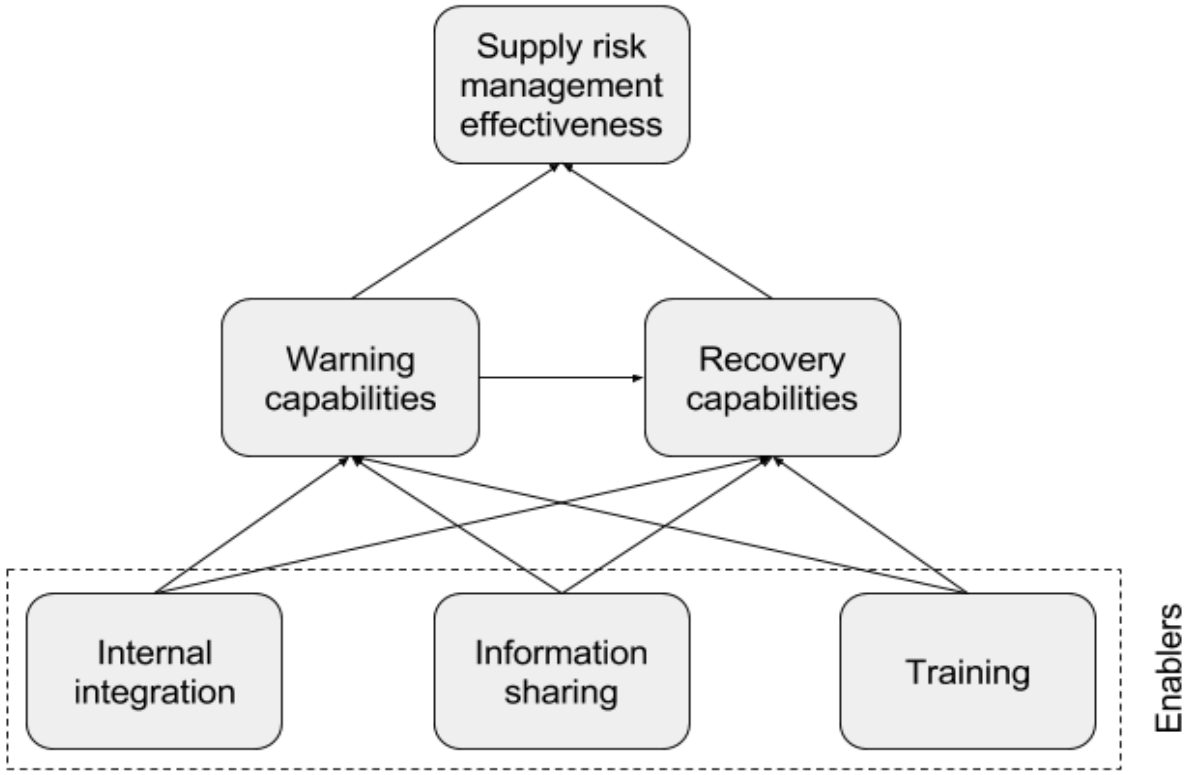

Figure 7. Factors affecting the effectiveness of the supply risk management of a firm (adapted from Riley et al., 2016).

3.2.1 Warning Capabilities

Warning capabilities refer to the coordination and interaction of supply chain resources to detect a potential or realized disruption, and the timely sharing of this information to the affected members in the supply chain. This identification and sharing would preferably be done before any disruptions even occur. This is however not always possible, and as long as the warning capabilities help a supply chain member to receive information earlier than it would have done otherwise it is seen as value adding (Craighead et al., 2007).

Warning capabilities consists of two parts, namely identification and communication. With the first, sources of possible risk are scanned, together with the determination of the impact of the possible disruption. And this information regarding the identified risks and the relative consequences is then communicated to the members in the supply chain that are affected by them (Riley, 2013).

The warning capabilities of a supply chain can work to effectively limit the severity of disruptions. In principle, the quicker a possible or incipient disruption is detected and communicated, the more time the supply chain members have to prepare for and mitigate potential negative effects. The basis of these warning capabilities sometimes has to be signals from complex IT-systems handling billions of data points, but sometimes it can be as easy as one member sending an e-mail to another (Craighead et al., 2007).

Before a crisis takes place, it almost always sends out warning signals that need to be captured

by the firm to take action towards them. This is one of the most important components in preventing a crisis from happening. These signals can come from both inside and outside of the firm, and trying to detect them is something that needs to be done at all times. In this way, an organization has the possibility to act upon the identified warning signals before the disruption happens (Mitroff and Anagnos, 2005).

There is in almost every crisis a person inside the organization who had knowledge about the impending crisis. The problem is that this information often rests with a person who has no power to act on it and no clear way of bringing it to the attention of a person who can act on it. This makes it very important that information sharing, both within the company and with outside actors, is well regulated and thought out in advance (Mitroff and Anagnos, 2005).

After having caught a warning signal, the next step is to decide is the risk is large enough to warrant further action. This means that certain criteria need to be set up that any signals can be measured against. When the severity of the risk is known, the information needs to be transmitted to the right person, and that person needs to know what action to take in response to this signal. If the signal does not connect to the everyday, standardized work, there is a risk that it goes ignored, as the persons responsible do not know what to do with the information. So it is important that the organization has decided beforehand on what action to take, or in the case of unusual crises has procedures in place for figuring out what to do after the fact (Mitroff and Anagnos, 2005). This also connects to the next chapter.

3.2.2 Recovery Capabilities

The recovery capabilities make it possible to prevent or minimize the effects of a slowing or stoppage of the product flow in the supply chain. The actions taken in response to a risk or disruption could be either proactive or reactive. A proactive action is done before a disruption takes place, anticipating potential problems and implementing solutions such as rerouting or substituting sources. A reactive action would be done first after the disruption has already occurred (Craighead et al., 2007).

In the ideal scenario, the recovery capabilities are mainly proactive. To cultivate a proactive approach, a company can put in place planned actions with several options that are triggered by specific events. This approach is especially useful in situations with low complexity and severe consequences, such as at a nuclear power plant. In these cases, the potential disruptive events can be completely enumerated and mapped out, with preplanned actions and quick responses for each warning signal (Craighead et al., 2007).

A less ideal scenario is to have reactive capabilities in place, which allows for a mobilization of supply chain resources to respond to disruptions after they have happened. An example would be a material controller noticing that an important shipment has not arrived on time and tries to solve the situation. This approach is less effective than the proactive approach, but is better than having no recovery capabilities at all. Having reactive capabilities could however be preferable in situations with high complexity and minor consequence, where a complete mapping of possible disruptions and the proper response to each warning signal is too resource-

demanding to be prudent (Craighead et al., 2007).

Few companies have purely proactive or reactive recovery capabilities, but rather most have a mix of the two. The company could, after an identification and assessment of the faced risks, decide that for some of the risks a proactive action would be needed in handling them, while reactive capabilities are enough for others. If a company lacks a supply risk management process they could end up completely without recovery capabilities, becoming paralyzed in the face of a disruption (Craighead et al., 2007).

A study done by Mitroff and Alpaslan (2003) found that only a small number of firms are properly preparing and planning for crises, thereby strengthening their recovery capabilities, even though the benefits of doing so are great. A first benefit is the fact that the number of crises a company has to deal with is reduced if the company prepares beforehand for the possible crises they could phase. The reason for this is that they are better at spotting the warning signals that comes before the crises and put actions in place for preventing it. A second positive outcome that was found was that the companies preparing for crises beforehand had been in business for far longer than the companies who did not. If this is a reason for longevity or an effect of it is not delved into deeper though. A third positive aspect is the fact that the financial results of crises prepared companies are higher, compared to the ones that are not. One of the reasons for this is that it is often very expensive to handle a crisis, both monetarily and from a public image perspective. A fourth and final aspect in favor of preparing for a crisis is that it translates into a better corporate reputation, with these companies scoring higher on a "most admired companies" list.

3.2.3 Internal Integration

Internal integration is the extent to which a company possesses the capability of integrating and collaborating across its distinct functions. Considering a single function within a firm, carrying out its different duties often requires the engagement of one or more of the other functions inside the enterprise. A lack of internal integration will lead to difficulties reaching the goals a company is aiming for (Chen and Paulraj, 2004).

Even though a company is internally divided into different functions, it appears clear how important collaboration is among them. To achieve better performances for the firm, a combined effort to overcome the internal silos division, resulting from how the firm is structurally organized, needs to be achieved. What can be found at the core of this collaboration is not so much related to formal agreements and requirements, as to eagerness and cooperation among different functions in an attempt to create a positive and useful connection among the individuals belonging to them (Chen and Paulraj, 2004).

Without interdependence among tasks from different functions, there is no reason for internal integration. In practice however, it is not the activity and result of one single employee or function that will lead to the satisfaction of the company's customer. This will rather happen when the entire system works together and is internally integrated, not through the optimization of single functions (Chen and Paulraj, 2004).

Coordination and Coordination Mechanisms

According to Malone and Crowston (1994), coordination is defined as managing dependencies between activities and is the basis of internal integration. The starting point for this is the presence of interdependencies among different individuals and functions. Without interdependencies, the need to coordinate does not exist.

A similar point is given by Van De Ven, Delbecq and Koenig (1976), stating that what defines coordination is the integration and connection of distinct employees and functions within an organization, in a way that an aggregated assortment of tasks is carried out. They also go further, presenting three different mechanisms that can be found in a firm to coordinate its activities:

- Impersonal coordination modes;
- Personal coordination modes;
- Group coordination modes;

Impersonal coordination modes imply the use of a codified blueprint, without human decisions determining what should be done in a certain situation, where to perform it, when to do it, and how to execute it, with verbal communication kept to a minimal level. Practical examples of impersonal coordination modes are standardized information and communication systems, formalized rules, policies, procedure, and so on (Van De Ven, Delbecq and Koenig, 1976).

Regarding personal coordination modes, these see the single employee as the primary mechanism of communication, vertical or horizontal, in order to achieve a proper adjustment of the assigned tasks. In particular, vertical communication implies the presence of a hierarchy, while the horizontal one does not, through a direct and non-hierarchical communication between two employees on a one-to-one basis (Van De Ven, Delbecq and Koenig, 1976).

Lastly, group coordination modes consider a group of employees as the tasks adjustment mechanisms. Group coordination can be pursues through two procedures, namely scheduled and unscheduled meetings. Scheduled gatherings involve routine and planned communication (e.g. staff or committee meetings), while unscheduled gatherings concern non-routine and unplanned communication (e.g. informal meetings relative to a job issue, involving three or more members of the company) (Van De Ven, Delbecq and Koenig, 1976).

Another useful classification to better understand the possible mechanisms a company can put in place to affect the coordination of its activities is presented by Mintzberg (1979). More specifically, these coordination mechanisms are:

- Mutual adjustment, where tasks are coordinated by informal communication among different employees;
- Standardization of work processes, where tasks are coordinated by standardized guidelines, such as rules and regulations;
- Standardization of outputs, where tasks are coordinated by standards regarding performance measures or outputs;
- Standardization of skills and knowledge, where tasks are coordinated by standardized skills and knowledge possessed and/or taught to the employees.

A further coordination mechanism has been added to the previous five by Glouberman and Mintzberg (2001), called standardization of norms. In this type of coordination mode, common values and beliefs are established among employees. This means that they perform their activities according to shared expectations.

3.2.4 Information Sharing

A key aspect to having an efficient supply chain is the sharing of information. This information can be strategic or tactical, and range from different areas such as logistics activities to general market and customer data. For example, one of the key aspects of creating a seamless supply chain is the availability of undistorted and timely market data for each supply chain member. This sharing of data in the supply chain can be an important part in creating a competitive advantage for the both the supply chain itself, and the members in it (Li et al., 2005).

The information that is shared needs to be assessed on both the amount and the quality of the information that is shared. Quality is here referred to as the accuracy, timeliness, adequacy and credibility of the information that is shared. Without the quality aspect, the information becomes noise. This can even become harmful and produce a negative impact on the supply chain's performance (Li and Lin, 2006).

Kwon and Suh (2005) found that the information sharing in a supply chain has impact on the trust and commitment that exists between the members, as open and honest communication will minimize uncertainty and the risk of misunderstandings. They go as far as claiming that this open and honest communication is not just a privilege, but a requirement for competitiveness in the market. This information sharing should not only be restricted to operational data and financial information, but also include forecasting data and value-added propositions.

There is however a reluctance to sharing information with suppliers, as companies perceive this as giving up power. Companies often strive to give away a bare minimum of information to suppliers to avoid the suppliers having the upper hand in negotiations. This fear of opportunistic behavior can be necessary for companies to survive in the short term as mistakes can be costly, but in the longer run it can make the supply chain lose its competitive advantage (Berry, Towill and Wadsley, 1994).

Barriers to Information Sharing

Even if the potential benefits coming from information sharing among supply chain partners are substantial, Khurana, Mishra and Singh (2011) say that barriers towards the achievement of this practice are often in place. In their article, they argue that identifying and recognizing them is an important first step that a company should undertake if it wants to overcome them. The following six areas of information sharing barriers emerged as the result of their literature study:

- Managerial barriers;
- Organizational barriers;
- Financial barriers;
- Technological barriers;
- Individual barriers;
- Socio-cultural barriers.

Managerial barriers are present when the managers do not recognize positive aspects related to information sharing and lack trust in these practices. This lack of leadership and managerial direction, or even outright opposition, then makes it very difficult for employees to implement information sharing practices. Connected to this are also the problems of lack of training, experience, and literacy about information sharing systems, which makes the sharing of information difficult. Lack of trust between the supply chain actors is also a factor regarded as a managerial barrier. This lack of trust could have its basis in either a caution about sharing information without insurance from the other supply chain members that it will be protected, or even experience from previous cases of opportunistic behavior from the supply chain members (Khurana, Mishra and Singh, 2011).

Organizational barriers are connected to the internal structure of the supply chain actors. This structure and the organization of the persons involved in information sharing has a direct effect on the information that is being shared (Khurana, Mishra and Singh, 2011). Tsai (2002) found that a centralized and hierarchal organization hampers the information sharing, both internally and externally, as the interest of employees to share information is greatly reduced when they lack freedom and need to get authorization for every decision they want to make. Social interactions with members of the other organization was on the other hand found to greatly increase the information sharing because of the informal relations it builds. This is also connected to another aspect that Khurana, Mishra and Singh (2011) found in their literature study: that the amount of rules, procedures and regulations can affect information sharing negatively. In an organization with few rules the employees have more flexibility and freedom to share information without repercussion while a highly formalized organization will reduce this information sharing.

Financial barriers are connected to the cost of building and maintaining the infrastructure and the manpower requirements for information sharing in the supply chain. More advanced IT-systems are costly to buy and implement, and it is time consuming for employees to share information. There are also costs connected to redesigning the organization to promote this information sharing and the training of staff to use the new processes. These are costs that the organization would have to bear to have efficient information sharing, but it is something that many organizations are reluctant to spend money on. These costs also increase in supply chains with many members, as the information sharing gets more complex (Khurana, Mishra and Singh, 2011)

The technological barriers are mostly based on the different standards for storing and retrieving data that companies have, and the challenges in connecting different IT-systems with each other. It could also be the lack of an IT-system needed to store or transfer certain information.

This could be because of different hardware, software, data standards, or programming language. As the IT-systems get more complex, the task of overcoming these barriers gets more difficult. When implementing new IT-systems there are also barriers to overcome, such as a lack of trust in IT-tools, a fear of breakdown in these tools, and a general lack of technological capabilities in the supply chain members (Khurana, Mishra and Singh, 2011)

Individual barriers originate from the behavior of individuals and groups within the various business functions. Since information is often scattered among these individuals and groups, the specific information that other supply chain members need might be held by just a single individual. An organization can have all the managerial and technical support in the world, but it will be useless if the individuals don't want to share the information they have. The reason for holding back information could be based in a general dissatisfaction with the company, or it could be that they would lose power when they share the information. Another reason could be that the individuals have not received enough training to understand which information should be shared and how it should be done. This need for training is even more important if the company is using complex information systems to facilitate information sharing. Another common barrier is that the employee fears that they would make a mistake or be ridiculed for sharing wrong information (Khurana, Mishra and Singh, 2011)

Socio-cultural barriers are connected to how culture affects the way supply chain members act and interpret information. There are many definitions of culture, but one by the Merriam-Webster Dictionary (2017) seems to be useful in this situation: "[culture is] the set of shared attitudes, values, goals, and practices that characterizes an institution or organization". For information sharing to work in an organization, the company culture needs to promote it. If the norm is for employees to share valuable information both within the company and with the other supply chain members, they will to a much larger extent than if the norm is to share as little information as possible. There is also the corresponding point of national cultures, which are the shared attitudes, values, goals and practices that categorize the citizens of a nation. This is a separate but closely connected issue to the corporate culture, and will also affect the information sharing behavior of employees (Khurana, Mishra and Singh, 2011).

3.2.5 Training

Training implies the transfer of knowledge, through which risk identification and insight about how to treat them is taught to the employees of the firm. Training involves both managers and employees, as they both need to learn how to identify various supply chain risks and to use appropriate mitigation resources and strategies. This is important so that they avoid finding themselves approaching risk in a solely reactive way, instead of a proactive one (Riley et al., 2016).

When facing a disruption in the supply chain, the amount of training that the key persons have received is a crucial aspect of how fast the organization can respond to it. This could include stress risk management training to improve the performance in all phases of a crisis. Because the opportunity for practicing real cases are often seldom and far apart, one method is to use assessment centers that simulate a real crisis to build the skills necessary in the case of a real

one (Hale and Moberg, 2005).

There are also less stressful ways that everyday risk management can be improved. One of the basic ways is to give the employees access to information about their own performance, as this lead them to aspire to higher goals. Feedback from managers and other external evaluation has also been reported to increase performance. In short, a constant flow of information from different sources lead to improved results (Flynn, Schroeder and Sakakibara, 1994)

Knowledge management and transfer

As argued by Hong Telvin Goh and Hooper (2009) knowledge management has been recognized by a number of companies as an important aspect to take into account. Knowledge management can be used by firms to increase their competitive advantage. The scholars say that this can be achieved, among the many aspects knowledge management has an influence on, through quicker decision making, greater ability in coordinating activities, and improved flexibility in response and dealing with risks and unexpected events, and much more.

According to Polanyi (1967), knowledge can be classified according to two categories, namely:

- Tacit knowledge, which is individual and internal to the individual. It is difficult to put into words or other means of communication, and hence difficult to share and transfer. It is learned through experience and practice, and can be transferred through observation, apprenticeship, and guidance of the knowledge owner;
- Explicit knowledge is knowledge which is already codified in books, articles, memos, or similar. This knowledge is easier to communicate and spread than the tacit one.

Based on these two definitions, Nonaka and Takeuchi (1995) go deeper into the topic of knowledge transfer, presenting the process through which knowledge is transformed from one kind to another. As shown in Figure 8, they argue that knowledge can be transferred in four different modes, called:

- Socialization;
- Externalization;
- Combination;
- Internalization.

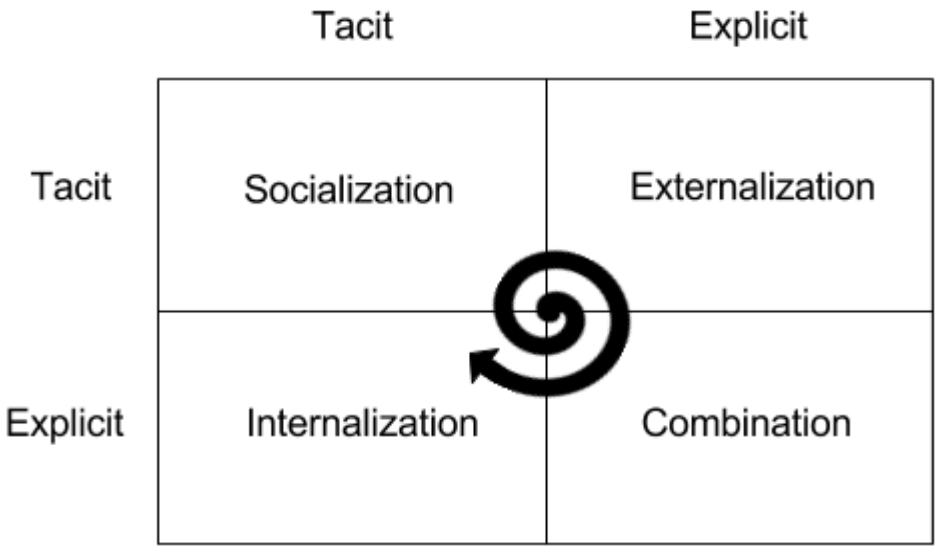

Figure 8. The knowledge transformation model (adapted by Nonaka and Takeuchi, 1995).

Since the focus of their study is on tacit knowledge, they start the process with the socialization transformation mode. In this mode, knowledge is transferred from tacit to tacit. This implies that tacit knowledge from an individual is transferred to another individual, who makes it tacit knowledge for himself/herself, through observation, imitation, guidance, experience sharing, and practice.

The next mode is transforming tacit knowledge into explicit knowledge, through the externalization mode. During this phase, tacit knowledge is articulated in a comprehensive format, which can go from writing it down, to creating metaphors and analogies, to building a model.

Next, explicit knowledge can be transformed into explicit knowledge, through the combination mode. In this phase, explicit knowledge can be gathered, sorted, categorized, combining pieces of explicit knowledge to create a new one. For example, two authors can write different chapters of a book putting into an explicit mean their tacit knowledge. Then, combining these different chapters a book can be created, generating a new, combined mean of explicit knowledge.

The last phase, internalization, implies the transformation of explicit knowledge into tacit one. In this phase, explicit knowledge is transferred to individuals, giving them access to codified knowledge, from books, manuals, databases, and so on, making them internalize it.

4. EMPIRICAL FINDINGS

This chapter will present the empirical findings from the company. The first part relates to the supply risk management process in place at the company, presenting its general structure and a description of the phases it includes. The second part deals with a description of the owners and contributors of the different areas of risks inside the company. These areas of risks are themselves described in the following part. The last part of the chapter presents some of the sub-processes the company has in place for identifying, assessing, mitigating and monitoring risks.

4.1 The Supply Risk Management Process at the Company

The company has a structured supply risk management process in place, available to all its employees in the company's internal database. The process is illustrated in Figure 9, and a description of the phases is given in the following section.

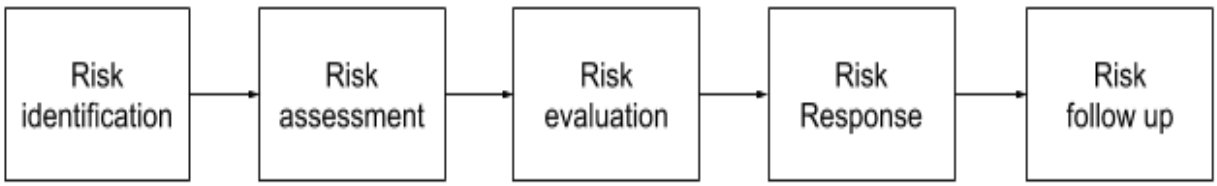

Figure 9. The supply *risk management process in place at the company.*

The purpose of the risk identification phase is to identify all the risks that are seen as significant for the company. This is performed through two main actions:

- Gathering all the relevant observations, events and incidents;
- Take a decision whether the gathered observations, events and incidents have to be considered as a risk or not.

The information to identify the significant risks mainly come from two sources:

- Employees, as they can make observations and detect events and incidents in their day-to-day work;
- Internal audits, where they can find issues that could be considered as risks.

When the specific risks have been identified, an evaluation is done in the risk assessment phase to determine which parts of the company might be affected by this risk.

The next step is to determine the probability of the identified risks and the consequences they would have if they would happen, which is done in the risk evaluation phase. In this phase, it is crucial for the outcome to use the appropriate risk knowledge for evaluating and/or creating the expected risk scenarios.

The first step in the risk response phase is to decide if the risks that were identified and evaluated in the previous phases need to be mitigated or not. If they do not, no further actions will be

taken, but the risk will continue to be monitored. If a risk needs to be mitigated, a risk owner will be designated and a timeframe for the resolution of the risk will be put in place.

After a response has been decided on, they monitor the decided strategies put in place and the identified and evaluated risks with the risk follow up phase. Here they follow up on the implementation and the evolution of the risk, and return to the risk response phase if considered necessary.

4.2 Risk Ownership and Support

The supply risk management at the company is divided into categories, where different functions have the responsibility of handling the supply risk management process according to the division seen in Table 1. More specifically, some functions are the owners of a determined area of risk, meaning that they are the ones directly involved in that area given their function in the company. Others are supporters, meaning that do not have the main responsibility for the area of risk. They do however contribute and take charge in the different phases of the supply risk management process when they are the ones spotting a warning signal connected to the specific area of risk.

Input	**Finance**	**Delivery**	**Capacity**	**Business**	**Quality**	**Company caused**
FA (financial analyst)	O			I		I
Operations buyer	I		I	O		O
CA (capacity analyst)		I	O	I		I
QA (quality analyst)			I	I	O	I
DA (delivery analyst)		O	I	I		I
Legal council (on demand)	I			I		I
O = owner of and consolidating risk I = gives support with input to risk area						

Table 1. The categories of responsibility at the company

For example, the financial analyst is the owner of financial risk. This means that the direct responsibility for this type of risk is in the hand of the financial analyst, since they belong to the finance function and has the knowledge to deal with this type of risks. However, the operations buyer and the legal council can find warning signals in their day-to-day work and give their input in helping the financial analyst to deal with this risk. An operations buyer, detecting a financial issue with a supplier during a meeting and communicating this information

to the financial analyst, gives help in detecting a financial risk. The legal council can help with determining which actions can be taken from a legal standpoint in dealing with a financial risk.

4.3 Risk Owners and Their Roles

The financial analyst is the role in charge of evaluating the financial health of the suppliers. This could be done by performing an analysis of the balance sheet of the supplier, looking at specific parameters, and assigning them a score that is representative of their financial health. If a company gets a bad score or if there are other reasons for uncertainty, more in-depth analyses can be done, for example cash flow analyses.

The operations buyer is the buyer in charge of the day-to-day operations with the supplier, ensuring that components of the right quality, at the right time, at the right cost and at the right place are received by the company. They are also the first point of contact for suppliers in case there are any potential disruptions that needs to be communicated.

Capacity analyst is the role in charge of verifying that the capacity of the supplier is sufficient to be able to produce the quantities required by the company, both currently but also with the projected future demands. This is done by field visits to the supplier facilities to determine if there are any issues undermining their capacity, or if the supplier is seen as able to produce the required amounts.

Quality analyst has the aim of determining if the quality of the components of the supplier is in line with the requirements of the company. This is performed by analyzing the components produced by the supplier, determining the number of defects, and comparing it with the level required by the company for production. They also look directly at the supplier's production lines to see if there are any potential problems or opportunities for improvement.

Delivery analyst is a role in charge of guaranteeing that the components required by the company are delivered. This is a role that connects the material controller, a role that will be presented in chapter 4.3, and the supplier. When issues related to deliveries are reported by material controller, the delivery analyst examines if other plants have had issues with the same supplier, and then proceeds to contact the supplier to ask for clarifications and solve to the delivery issues.

The role of the legal council is to handle all the possible legal issues in relation with the supplier. This could range from contract questions and other day-to-day work, to preparing court cases and litigation. This function is only involved when asked for by one of the other functions.

4.4 Other Significant Positions Related to Risk

Aside from the risk owners and contributors presented in Table 1, there are several other roles also contributing to the risk management work. Some of these roles will be described briefly in this section.

The sourcing buyer is the buyer in charge of finding a new supplier when requested for a new

project or in case an old one is not able to provide according to the requirements. They remain the host of the supplier for duration of the relationship, meaning that the sourcing buyer is the point of contact for the management of the supplier. However, after a part has been sourced, the relationship between the supplier and the company is transferred to the project buyer.

The project buyer is the buyer in charge of specific projects related to updates or the launch of new products. The project goes from when the supplier is chosen, up until the production of the component is started. When this happens, the day-to-day relationship with the supplier is transferred to the operations buyer, presented in chapter 4.3.

The internal development consultant is in charge of cutting costs by improving and aligning the processes in place at the supplier and the company. They collaborate with the supplier, trying to find ways for them to improve their internal processes and the processes surrounding shipping and receiving to improve the performance of the supply chain.

The material controller has the responsibility for stock levels and deliveries at their specific plant. They control all incoming deliveries to make sure that the goods received are the ones that were ordered, and they are also the ones who should notice and take action if a delivery did not show up as expected.

External consultants are in place at the company on a need basis, when they need a specific skill or just extra manpower. During the time of the study two external consultants were helping the financial analyst with cash flow analyses and similar for a current crisis.

4.5 Areas of Risk

As seen in Table 1, the company has chosen to divide the supply risk into six segments: finance, delivery, capacity, business, quality and company caused.

Financial risk is the risk connected to the financial health of the suppliers. If a supplier has made losses for several consecutive years, they might be running out of equity and will be forced to declare bankruptcy. This would put the supply flow to the company in danger. Other financial issues could be connected to issues of liquidity, where a supplier is making a profit but does not have enough money to pay their suppliers. This could create a situation where the sub-suppliers stop delivering to the supplier, creating disruptions in the production.

Delivery risks are connected to the timely delivery of parts or raw material from the supplier to the company's production facilities. Issues here could range from a supplier’s lack of understanding of the importance of timeliness in the deliveries to malfunctioning trucks and port strikes.

Capacity risks are the risks that a supplier will not be able to meet demand swings from the company or a future growing demand. When the supplier does not have the equipment or space to create the amount of parts or raw material the company needs, there is a risk that the company will have to scale down production due to a lack of these parts.

Business risks are connected to the price of the parts that the company buys. These prices could

be increased in negotiations, for example if the supplier would engage in opportunistic behavior or if the original price was set with faulty parameters. An example would be if the supplier expected to get orders of 50 000 parts/year, set prices and invested accordingly. If the actual demand then ended up being 10 000 parts/year, the supplier would need to increase the price of the parts to get a fair return on investment.

Quality risks are connected to parts delivered from suppliers that do not measure up to the specifications set in the contract. These parts are in best case found and scrapped during assembly at the company, but could end up being installed and delivered to customers. When this faulty part breaks prematurely it could cause great financial and reputational costs for the company. There is also a risk that such a large amount of the delivered parts need to be scrapped that there are not enough parts left to support production.

Company caused risks are connected to the previous five risks, but are caused due to some action that the company itself took. This could for example be when they do not transfer information on future demand or miss to pay a supplier for delivered goods, causing capacity or financial risks in the process.

4.6 The Risk Escalation Process

When a department has found a risk that they themselves cannot mitigate, or when they want to spread awareness of a risky supplier, they use the risk escalation process as shown in Figure 10. The first input, i.e. the identification of the risk, is therefore brought up by the single functions. As shown in Table 1, each risk has an owner and some contributors. At the first level risk meetings, the identified risks are assessed. This is done by representatives of the different risk owning functions, who weigh in on the different suppliers and collectively decide if it should be brought further up in the risk escalation process.

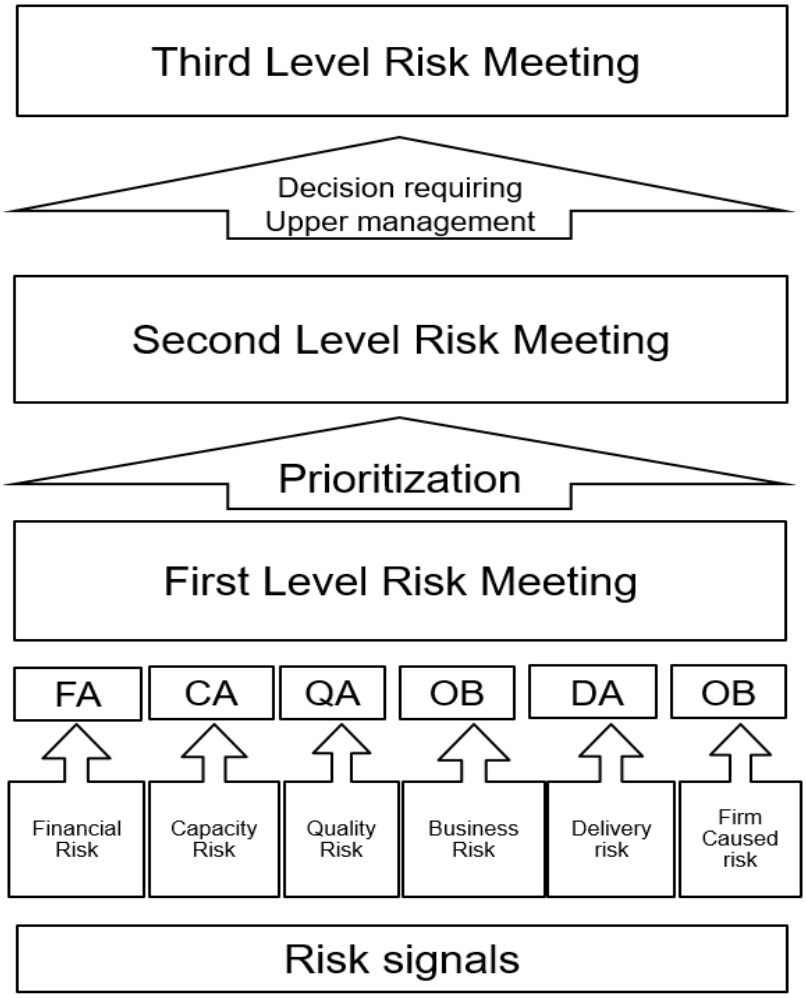

Figure 10. The risk escalation process at the company.

The next step is to bring it up in the second level risk meeting. Here the prioritized suppliers and relative risks are discussed further, coming up with mitigation strategies to counteract the identified risks. The actions which have already been put in place are also monitored, where the involved functions give updates about the follow up with the suppliers and the status of the implemented actions. This is a gatekeeping phase as well, where it is decided which cases are the most crucial and therefore need to be brought up with the VP of projects and operations. This situation happens in the most severe cases, where there is the need for the intervention of the VP, who has the authority to take important decisions regarding a supplier. These can range, for example, to resourcing of a produced component, to the allocation of additional resources to countermeasure the supplier's negative performances. Figure 10 shows the entire escalation process in a flow diagram.

4.7 Delivery Risk Escalation

A point that has been brought up in the interviews is that in the end, all types of risk lead to delivery issues. This is because no matter what is the issue and its related risk, when a supplier faces a disruption in that area, it will not be able to deliver what it is expected to. This can happen when it is not able to deliver the right quantity, either for capacity or quality issues. In

the same way, if a financial disruption is in place, the supplier will not be able to produce the components and in turn deliver them to the company. The same way of reasoning applies to business and company caused risks, leading as an end result to disruptions in the delivery of the required components. Therefore, they have a separate escalation process for delivery risks, which is shown in Figure 11. This process is used to catch disruptions that otherwise might have gone unnoticed and elevate them to the level in the company where decisions for mitigation can be made.

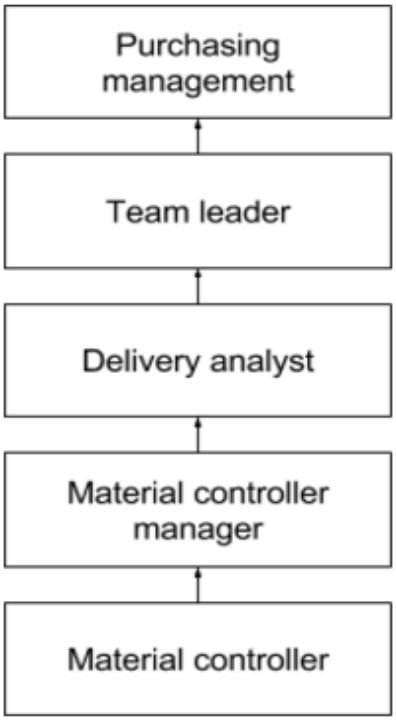

Figure 11. Delivery risk escalation process at the company.

The escalation process about delivery risk starts with the material controller. When an issue related to a delivery is detected, for example a delivery is missed or it comes with a large delay, the material controller starts to investigate the root causes of the problem and tries to solve it. If more of these issues happen from that moment on, then the material controller contacts their own manager to inform them about these continuous issues with deliveries. If these issues keep coming and can potentially have or actually have an influence on the production of the company, then the delivery analyst is contacted and take responsibility of the case. They contact the supplier to understand the reasons deliveries have been missing or delayed on a continuous basis with a potential or actual influence on the production of the company, and how the supplier can get back on track. If further issues take place and affect the production of the company's plants on a continuous basis, then a team leader is nominated as in charge of the case. This leader can be the delivery analyst themselves, but also one of the other roles presented in chapter 4.3. The nomination of one of these roles depends on the identified cause of the delivery issue. For example, if the issue relates to quality, then the quality analyst is chosen as the team leader, if related to capacity the capacity analyst takes charge, and so on. Thus, even if connected to delivery, this does not translate into the fact that the delivery analyst is always the nominated

team leader of the case. The last step of this escalation process is the intervention of the purchasing team. This is the last and most severe step of the process in relation to delivery risk, where the purchasing management takes responsibility of the case and takes action to solve the delivery issues with the supplier in question. If the issue needs to be escalated further, the regular escalation process described in chapter 4.6 is used.

4.8 Low Performing Suppliers List

If a supplier is low performing, the company has a process for branding them as a low performing supplier and put them on a watch list. This list is currently used to address quality and delivery issues and a supplier is put on it if they are showing poor quality or delivery results for a certain period of time. Before a supplier is placed on the list the quality analyst/delivery analyst discuss the issue with the responsible purchasers and decide if it is warranted. There are no standard criteria for being put on the low performing supplier list. Suppliers on this list are then closely monitored and given criteria they need to reach in order to be taken off this list. The list has three levels, with increasingly severe consequences for the supplier. The first level of the list implies that the supplier is seen as low performing in the given area, but the risk of direct impact on the production of the company or on its final customer is low. In this first level, the supplier will not be allowed to send in any quotations for new business. The second level means that the supplier is seen as having a high impact on the production of the company or on its final customer in the short term. This translates into the fact that the supplier cannot get any volume increase on orders. The third level implies that the supplier has had a direct impact on the production of the company or on its final customer, so if it does not reach the exit criteria it will be phased out and replaced with a different supplier.

4.9 Supplier Evaluation

Before giving a contract to a new supplier, the company is doing a supplier evaluation covering ten to twelve parameters. These parameters are ranging from quality, corporate social responsibility, and finances to environmental certifications. For each of these parameters the supplier is giving a score that in the end is summed up. If the sum is below a certain threshold or if a score on a single parameter is too low, the supplier will be excluded from receiving business. This evaluation is quite thorough, with quality analyst and capacity analyst visiting the supplier site to gather data for scoring their capabilities. This supplier evaluation is then supposed to be done again every three to five years during the business relationship.

5. ANALYSIS

This chapter will start with an analysis of the supply risk management process in place at the company through a comparison with the chosen theoretical risk management model, as presented in the literature review section.

Next, the connection between the supply risk management process and the model by Riley et al. (2016) will be presented. More specifically, the above-mentioned connection will be shown by relating the warning and recovery capabilities to the different phases of the supply risk management process that they support, explaining in which ways they contribute to the outcomes of these phases.

Following this, the focus of the analysis will shift to the assessment of the warning and recovery capabilities of company. Given the fact that the concept of capability itself is hard to grasp on a more practical level, the warning and recovery capabilities of the company will be analyzed focusing on the factors forming them, i.e. different resources and their coordination and interaction. Together with these concepts, the issues that the authors identified in these areas will be also presented.

The chapter will be concluded by analyzing how the areas of enablers presented in the model by Riley et al. (2016) are managed at the company and how these support or undermine their warning and recovery capabilities. The areas that will be analyzed are internal integration, information sharing, and training, and it will be based in part on the issues identified in the analysis of the warning and recovery capabilities of the company.

5.1 The Supply Risk Management Process

The starting point of the analysis is verifying that the supply risk management process in place at the company, as presented in chapter 4.1, is in line with the theoretical model presented in chapter 3.1. Figure 12 shows how the supply risk management process of the company connects to the same phases proposed by the model presented in the literature review section.

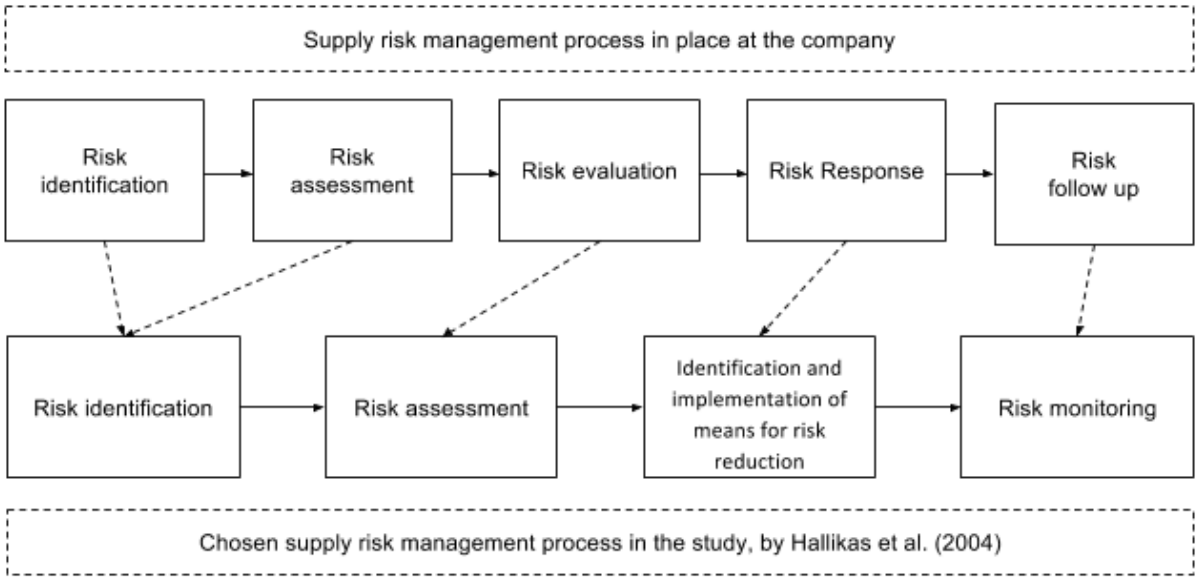

Figure 12. Comparison of the supply risk management process at the company with the chosen theoretical model by Hallikas et al. (2004).

The first phase, called risk identification in the theoretical model, has the goal of identifying the possible sources of risks that could undermine the performances of the company. The area of impact is also determined in this phase. The supply risk management process of the company has this phase as well. What should be mentioned is that this first phase of the company only aims at identifying risks, and thus not fully covering the outcome of the risk identification phase of the theoretical model. What is missing is the identification of the areas of the company that would be affected by this risk. This is a step further than only identifying the risks. The second phase of the process at the company is called the risk assessment phase and examines which part of the company would be affected. Here it becomes clear how the combination of these first two phases in the company covers the outcome of the risk identification phase of the theoretical model.

Next, what is called risk assessment in the theoretical model. In this phase, the likelihood of occurrence and magnitude of the identified risk is determined. The corresponding phase in place at the company is called risk evaluation. Comparing the outcome of this phase with the risk assessment phase of the theoretical model, it is found that the aim is the same. This phase at the company has the goal to determine the probability and consequences of the identified risks, which is the equivalent of determining their likelihood and magnitude.

Following that is the risk reduction phase in the model, what is also called risk mitigation phase by other scholars. Here decisions are taken about how to proceed with identified and assessed risks. What the company calls the next phase of its supply risk management process is the risk response phase. There it is stated that the outcome of the phase is to find and put in place the most adequate strategies to respond to the identified and assessed risks. The parallel in between the two phases is therefore evident.

The last phase of the theoretical model is the risk monitoring. Here the implemented actions are

followed and controlled, as well as the risks themselves. This last phase is corresponding to the follow up phase in place at the company. Here a monitoring of the decided strategies to mitigate risks and their development takes place. This shows a clear connection to the risk monitoring phase presented in the literature review section.

What emerges from this first analysis of the supply risk management process in place at the company is that the outcome of the different phases is in line with the ones of the theoretical model. Therefore, no changes to the way they organize their supply risk management process should be necessary.

5.2 Capabilities and the Supply Risk Management Process

The two capabilities belonging to the model by Riley et al. (2016), warning capabilities and recovery capabilities, will be analyzed in connection to the different phases of the supply risk management process. The aim here is to show in which way the capabilities in the model support each phase of the supply risk management process in reaching its goal. This will pave the way for the second part of the analysis, where important aspects of the enabling factors for the effectiveness of the supply risk management of the company are identified and discussed. The following chapter will only analyze these connections from a theoretical point of view, without going into details regarding the empirical findings at the company.

5.2.1 Warning Capabilities and Risk Identification, Assessment, and Monitoring Phases

The first of the two areas of capabilities that will be discussed here are the warning capabilities. It will be shown how warning capabilities support three of the supply risk management process phases, specifically the risk identification, the risk assessment, and the risk monitoring phases.

The goal of the risk identification phase, as seen in chapter 3.1.1, is to identify possible risks affecting the company. Warning capabilities have been defined as the ability of discovering a disruption, either one that has already happened or one that is on the way. Warning capabilities, allowing the detection of possible disruptions, before or after they've happened, hence give support to the risk identification in achieving its purpose, giving information regarding possible risks.

As seen in chapter 3.1.2, the risk assessment phase aims at defining the likelihood of occurrence and the magnitude of an identified risk event. Warning capabilities allow to determine how probable the occurrence of a determined event is, together with its impact on the company, or the consequences of a disruption in terms of business impact. Thus, warning capabilities support the risk assessment phase by providing this information about how probable an event is and which consequences it would have.

Risk monitoring aims at keeping a close eye on the identified risks and their development over time, communicating this information in a timely manner. Warning capabilities allow the detection of disruptions and the timely sharing of this information. In this way, warning

capabilities support the goal of the risk monitoring phase, allowing the detection of a disruption related to a monitored risk and the timely communication of this information.

5.2.2 Recovery Capabilities and Risk Reduction Phase

The goal of the risk reduction phase is to take decisions toward identified and assessed risks to reduce or mitigate their likelihood or consequence, putting different actions in place to achieve that. These actions could be to tolerate, treat, transfer or terminate the risk.

In the way they have been defined in chapter 3.2.2, recovery capabilities are the abilities a company already has or can put in place aiming at minimizing or preventing supply disruptions. This can be done in a proactive way, before a disruption has taken place, or a reactive way, after a disruption has occurred.

Therefore, recovery capabilities, through the actions and resources constituting them, aiming at avoiding or diminishing the occurrence of foreseen or already in place disruptions and their effects, support the risk reduction phase in its aim of putting actions in place towards risks.

The support of warning and recovery capabilities towards the different phases of the supply risk management process are summarized in Figure 13.

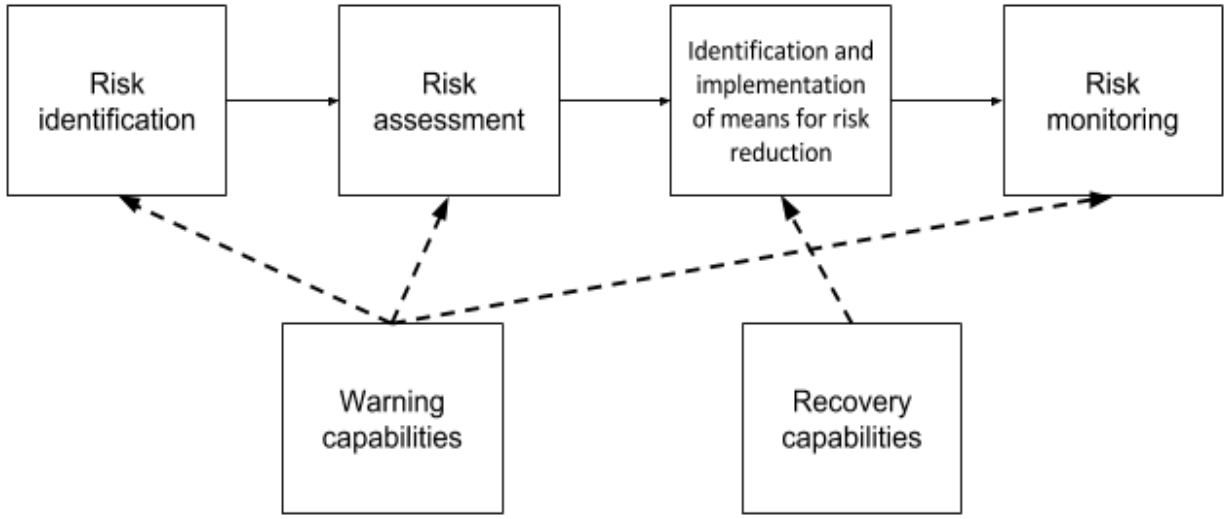

Figure 13. Support of warning and recovery capabilities towards the different phases of the supply risk management process.

5.3 Warning Capabilities

In this chapter, the warning capabilities of the company will be assessed. This will be done by looking both at the resources the company has access to and their coordination, and the actions taken in regard to the detection and sharing of information on disruption. An illustration of this can be seen in Figure 14. There is also a shorter investigation based on this as to which resources or coordination mechanism the company is missing that could strengthen the warning capabilities.

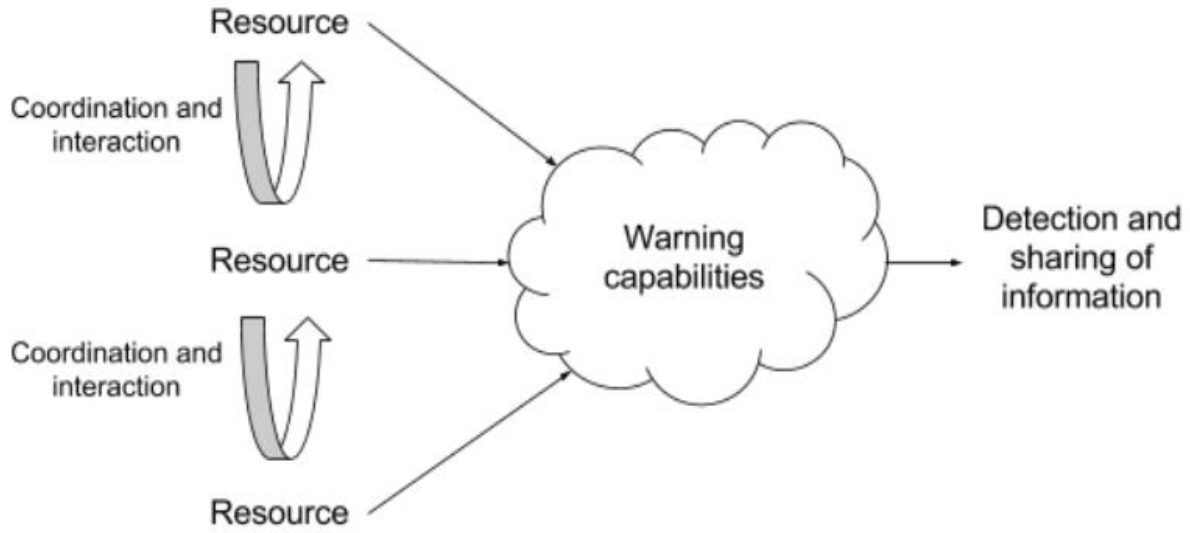

Figure 14. Coordination and interaction among resources, warning capabilities, and detection and sharing of information.

To allow a better understanding of the presented concepts, the resources discussed in the following sections are divided into two categories, called internal resources and external resources. The meaning of this classification is self-explanatory, but to avoid misunderstanding it is here specified that the first are resources that the company has inside its organization, while the second are resources outside of it. The actions taken to detect and share information on disruptions are presented as well.

5.3.1 Internal Resources and Actions

The company possesses, inside its organization, resources contributing to its warning capabilities. These resources could be formed by human resources, represented by the employees inside the different functions, or technical resources, represented by the internal IT-system (specifically, the scores related to the suppliers´ performances contained in it) and the materials lab.

As seen in chapter 4.2, different roles inside the company's functions are owners or supporters of the six types of risks. These roles are some of the human resources that contribute to the ability of the company to detect warning signals. These different roles perform evaluations of the suppliers, which can lead to the identification of potential or incipient disruptions and the consequent sharing of this information inside the company to other functions.

Any warning signals detected by the different risk owners and contributors can be communicated to the other stakeholders either through informal communication channels or more formally at the first level risk meetings, which is part of the escalation process presented in chapter 4.3. These represent some of the ways the different resources coordinate among each other, contributing to the ability of the company to detect and share warning signals. The sharing of information on warning signs of the companies being investigated can give these other stakeholders the opportunity to find other warning signs connected to their area of risk.

This shows how the roles contribute to the warning capabilities not only through their direct actions, but also through interactions with other roles.

In this communication between roles, some issues have been identified, both from taking part to the risk meetings and from the interviews. A problem that was identified taking part to these risk meetings is that there is a limited amount of time available for each member to present his/her case, so the functions are not able to share all the risky suppliers they are working with. This could keep important information unavailable to other members of the organization. This would mean that the warning capabilities can be improved by improving the internal integration and information sharing practices of the company.

The sharing of the information related to risks and disruptions among different roles outside these meetings has also emerged as an issue during the interviews. What was identified is a problem related to the sharing of information related to warning signals among different functions, as expressed by a financial analyst, stating that "we do not usually get that information [talking about warning signals] unless a buyer says something." Even if a warning signal is detected it needs to be communicated with the function who have use for it, otherwise it affects the warning capabilities. Again, this points toward problems with internal integration and information sharing.

What has been identified as an issue here from the interviews is the lack of knowledge about what a relevant warning sign for another function is. Referring to the information financial analysts might need from them as a warning signal, an operation buyer expressed the willingness to give this kind of information to them. However, to be able to do that they would need to "meet them even once a year to discuss what they are struggling with or what kind of help they might need, [so the buyers] would remember that." This was stated in the context of not being aware about what a relevant warning signal for another function might be. Thus, this points toward issues of internal integration and the training that employees receive.

Different buyers brought up concerns in relation to understanding the output of the other function. In particular, the financial score emerged as a concern for most of the interviewees. What has been mentioned about it is that buyers "need to translate the score to understand [it]". To do that, they need to see "what is behind [the score]", but at the same time, they are "not very familiar with [its] calculation." This lack of knowledge is on purpose, as the formula for calculating the financial score is secret even to other employees within the company, but the lack of knowledge could still affect the ability of the buyer to determine if a supplier is risky or not. This is therefore both an information sharing and a training problem.

It has also been mentioned, in relation to the three above-mentioned scores, that "it would be good to have a standard [related to each of them] in order to consider the supplier a risky supplier." Thus, there is a lack of a common agreement related to when a score makes a supplier risky, which undermines the warning capabilities of the company, since the buyer is not able to determine from reading the score if a supplier is risky or not. This is a problem mainly of internal integration.

Another issue is related to the lack of time several interviewees argued as the cause why they

cannot meet with the suppliers more often. They have responsibility for a large amount of suppliers, but they have time to meet only with a few. To prioritize they often then meet with the biggest ones in their portfolio or with the ones that are currently having problems with disruptions. Since meeting suppliers has been explained as a way to detect warning signals, not having the time to do that in turn diminishes the warning capabilities of the company.

As mentioned in the beginning of the chapter, a technical internal resource is the internal IT-systems of the company. This resource stores and communicates different types of information, for example the output on performance from the different functions that can be related to risk. This output is often expressed as scores and are related to quality, logistics, and finance. These scores are based on different parameters in relation to the performance of the supplier in the considered area. If these scores are above or below a certain threshold, then this can represent a warning sign for the buyers. For some of these results, such as quality and delivery, there is also a color code to ease the interpretation of them, where green means the supplier is well within the threshold, yellow that they are close to underperforming, and red that a problem is present.

Another internal technical resource is the materials lab that the company has on its premises. This lab conducts test on chosen incoming parts to see if they meet the necessary criteria set up for the part. In this lab, they have access to several state of the art methods for determining the characteristics of tested parts, meaning that no testing needs to be done by outside labs. In this way, a warning signal for quality issues can be detected and communicated to other functions.

On a more general note, when asked if there is any score about suppliers "specifically related to risk", an operations buyer stated that "there is nothing connected to risk." Thus, the IT system does not contain a score that explicitly expresses the overall risk connected to the considered supplier. Not having this kind of information in place in the IT-system does not help the buyer in detecting a potentially risky supplier, undermining in turn the warning capabilities of the company.

5.3.2 External Resources and Actions

The company has access to different resources from outside the organization that contribute to the warning capabilities of the company. These resources could be formed by human resources, represented by the employees belonging to the company's suppliers, which take action by communicating to the case company's employees information regarding foreseen risks or disruptions. But also technical resources, such as news articles and public databases with information related to industrial sectors or commodities, can be used by employees inside the case company to find warning signals.

The source of warning signals is an external human resource when the person working at the supplier is the one detecting and sharing this information with the company. These warning signals that can be communicated from the supplier can range from information about a fire in the production plant, to the need for unplanned maintenance, to loans taken by the company for making investments. This information coming from the suppliers can be shared through

different communication channels, ranging from emails and other written media to phone calls and live meetings.

In this aspect, the general idea that was brought up by buyers during the interviews regarding their suppliers is that, even if "sometimes they are open" about their internal issues, "sometimes they are scared" to share information regarding the any problems or disruptions they are facing. The interviews did not bring up specific categories of suppliers related to these specific behaviors, but some practical cases were given. One case of a disruption that was not communicated came from a project buyer. A supplier had had a fire in its production plant and did not communicate this disruption to the company, but rather they had to discover it themselves when deliveries stopped showing up. In that case, the owner of the supplier had explicitly told its employees not to mention the disruption that took place. These examples show how a lack of information sharing in the supply chain is affecting the company's warning capabilities.

Regarding external technical resources, the company mainly makes use of two of them. The first is represented by news articles, where information regarding the industry the company operates in can be found. The second is represented by public databases, where financial information related to public companies is available. The information coming from these two technical sources can generate a warning sign for the company in relation to its suppliers, but it is then required that a human being acts upon that.

For example, if an operations buyer reads an article on a port strike about to happen, he/she can see a risk of delays in delivery. This is information and warning signals that are difficult to get in other ways.

External databases could be used by the financial analyst to request or buy credit checks. These documents often contain information that the company otherwise would have to spend much time to collect or that they would be forbidden by law to collect in the first place. This information can then be used to find potential warning signals of the supplier.

However, an external technical resource that emerged during the interviews as missing in the purchasing department is represented by analyses carried out by external actors related to specific sectors and/or commodities. These analyses are often made by banks or external consultants and go further than news articles, because they are going more in depth on the details and are often written by someone with extensive experience on the subject. This information can then be used to detect warning signals by the company, as affecting the business of its suppliers. What emerged from an operations buyer is that "years ago [she] received a report by a bank about [a specific] market, where they did a market analysis on the financial status of all [the] suppliers [in that] market." This was seen as "advanced market knowledge", helping buyers to detect important warning signals related to suppliers and markets. These analyses have been mentioned by the same operations buyer as "something to invest in", since they give help "to capture and analyze better future market trends." However, this source is not in place at the company anymore. The reason has been identified as the high price of these analyses.

5.4 Recovery Capabilities

In this chapter, the recovery capabilities of the company will be assessed. This will be done by looking both at the resources the company has access to and their coordination, and the actions taken in regard to the plans put in place to prevent or mitigate disruptions. An illustration of this can be seen in Figure 15. There is also a shorter investigation based on this as to which resources or coordination mechanism the company is missing that could strengthen the recovery capabilities.

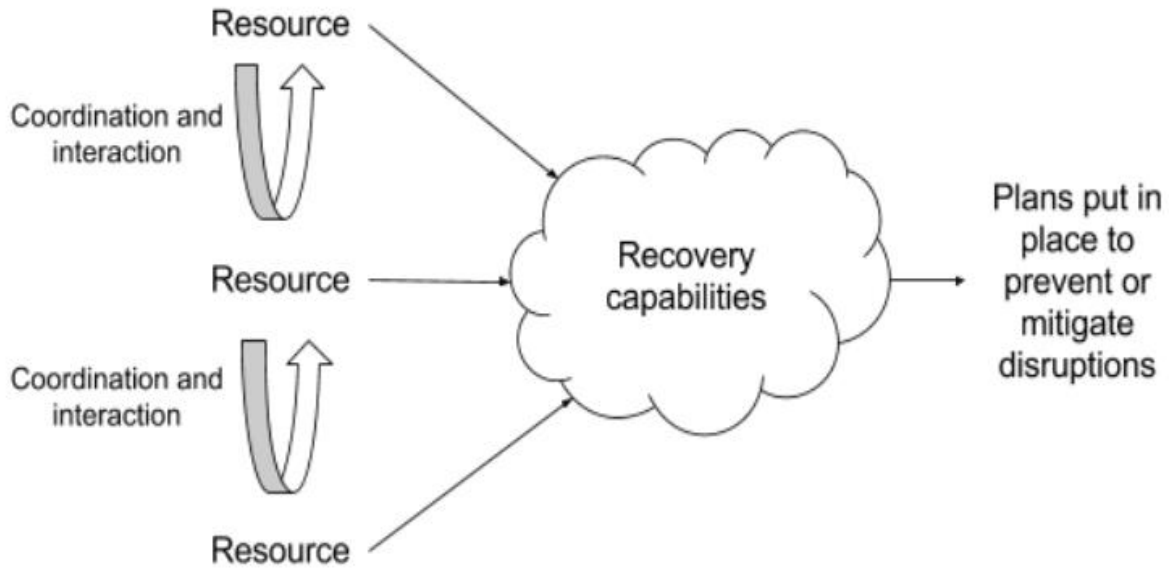

Figure 15. Coordination and interaction among resources, recovery capabilities, and actions taken to prevent or mitigate disruptions.

Craighead et al. (2007) divide the recovery capabilities of an organization into two main categories, namely proactive recovery capabilities and reactive recovery capabilities. In the following sections, these two categories will be used to classify the recovery capabilities of the company.

5.4.1 Resources and Actions Related to Proactive Recovery Capabilities

The company has different resources and their coordination and interaction contributes to the recovery capabilities of the firm. These can be internal resources or the resources of other supply chain members.

Two practical examples in regard to resources forming the proactive recovery capabilities of the company are the quality analyst and the capacity analyst. What emerged from the interviews is that these two roles possess a particular importance for the proactive recovery capabilities of the company.

The quality analyst can, after having inspected the production facilities of the supplier, take actions to avoid quality disruptions before they happen. What is usually put in place as an action is either point this issue out to the supplier asking to work it out, or work in collaboration with

the supplier to solve the issues. The capacity analyst can in the same way take action in regards to potential capacity issues found at the supplier.

Both the cases of asking the supplier to fix the issue or to collaborate with it to find a solution before a disruption takes place are proactive ways to prevent a possible future disruption, which would lead to negative consequences for the company itself. Putting these actions in place to prevent a risk from materializing is showing a part of the proactive recovery capabilities of the company.

An issue that was brought up in connection to this was the fact that buyers are not always aware of which activities related to risk prevention other functions are already doing. This was summarized by an operations buyer, saying to be "surprised to see the feedback with all the actions they are already doing connected to the supplier, [...] I think we are not aware of that, because [...] everyone is covering their own scope, and doing a lot of activities that other functions are not aware of." Therefore, this shows how this lack of knowledge undermines coordination between resources. This lack of coordination impairs the company's ability to take actions to mitigate risks, and therefore decreases its proactive capabilities.

When the identified issue is considered to have a larger impact on the company and involving other functions, risk meetings are used. The actions decided on during these meetings, to counteract a foreseen disruption, is one of the results of the proactive recovery capability of the company. Single functions that have identified risks can then bring them up through this process together with the foreseen consequences related to them. After priority has been given to the different suppliers and related risks, actions to counteract these risks are decided on. Employees and managers can therefore proactively use this process to make decisions and decide on actions to prevent possible disruption before they take place.

Several buyers brought up the point that, even if the steps of the escalation process are known, what is lacking is when and how to use them. Related to this point, an operations buyer summarized the issues related to the escalation process, saying that "I do not really know exactly what kind of cases should be presented, who should present the case, what has to happen in order to use this [process], what kind of events are good enough or not good enough to be presented. So, I think we are missing knowledge about this process." This points towards issues with the training that the employees receive.

5.4.2 Resources and Actions Related to Reactive Recovery Capabilities

The company also has resources in place that, through their coordination and interaction, build up the capabilities of the company to counteract a disruption after it has happened. They are basically the same as the ones presented in the previous chapter about proactive recovery capabilities, but the actions taken as a result of them are different. The escalation process is also useful to decide on actions to take after a disruption has happened. When the disruption is discovered, it is communicated in the first level risk meetings to the other functions. Depending on the severity of the disruptions, it is given priority and further discussed during the second level risk meetings. For severe disruptions that risk stopping the production lines, the case it

brought up to the third level risk meeting, where the upper management can decide on more severe measures, such as resourcing or emergency loans to the supplier.

Another result of these meetings is that the company is quick in forming cross-functional teams to work on the disruption, with different functions giving their contribution in respect to their area of competence, as shown in chapter 4.2.

A resource for reactive recovery that the company has is the external consultants. During the period the study was conducted, consultants were actively working on a crisis in place at the company, with the aim of monitoring and trying to find solutions regarding the suppliers´ cash flow. This was performed in collaboration with the buyers directly involved in the crisis.

However, some issues also emerged that could affect the reactive recovery capabilities of the company. As stated by a buyer, referring to the first crisis he was involved in, "it was nothing already in place, it was brainstorming and ideas from colleagues with experience with crises, telling me who to contact, why to contact them, what help I could seek". This shows an issue of lack of training that is affecting the recovery capabilities of the company.

Referring to disruptions already in place, buyers might also lack relevant information coming from other departments about the supplier, which they then will have to spend time on finding. As stated by one buyer: "sometimes the struggle is getting the information, you lose a lot of time if you do not have that information at hand." This aspect shows how issues related to information sharing can lead to a longer response time in a crisis, where time is of high importance, as more time is needed to get access to the needed information.

Another factor that was brought up by several buyers is the long decision chains in place when dealing with crises. It is described as a long process, consisting of "really bureaucratic procedures", with "so many processes and so many levels of approval." When a disruption occurs, the buyers can only take limited decisions on their own while many decisions will need approval from higher positions. Sometimes they will have to go all the way up to the VP-level to get clearance. As a buyer said referring to the change of payment time: "it has to go all the way up to VP of business control for him to give the approval before we change it in the system." This is something that can be time-consuming in situations where time is of the essence, and the buyer in charge will have to both spend a lot of time presenting the issue to upper management and wait decisions from them. This shows a potential problem with the internal integration and information sharing at the company.

A project buyer expressed the idea that to speed up the process in handling crisis, the buyers should be given a greater authority to make decisions. This is something that has been used in practice during previous crises in one of the countries they are operating in, resulting in a quicker and more flexible crisis management process. However, the downside would be that the buyers might take actions that have unexpected consequences on the rest of the organization. This is a trade-off that should be carefully evaluated by the company before any changes to the process is made.

5.5 Enablers of company´s capabilities

In this section, the enablers of the capabilities in the model by Riley et al. (2016) are used as a basis for analyzing the current situation at the company. These enablers are internal integration, information sharing, and training, and they work by improving the resources and the coordination and interaction between them. Thus, for the company to improve their warning and recovery capabilities, they will need to focus on these enablers.

The aim here is to identify issues and determine how these enablers can be used to improve the warning and recovery capabilities of the company, which in turn have been shown to be supporting the outcome of different phases of the supply risk management process of the company. Figure 16 presents a visual representation of the components of the overall analysis and their connection.

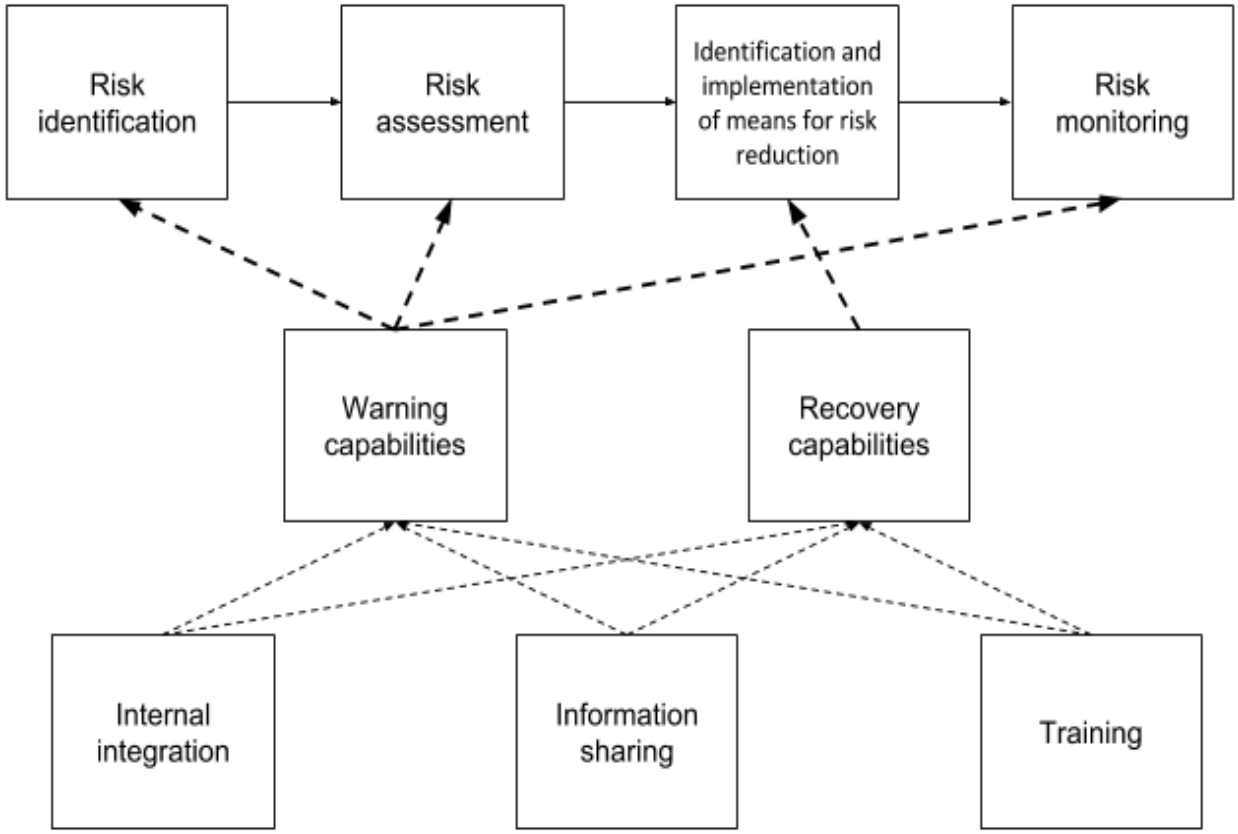

Figure 16. Elements composing the overall analysis and their connection.

5.5.1 Internal integration

In this section, an analysis of the coordination mechanisms related to the resources involved in the supply risk management process of the company is made, as this is the basis of internal integration. This is achieved showing both how these coordination mechanisms are present in the company today, but also identifying the areas where they could be made better use of to improve coordination. This identification is performed connecting the issues related to warning and recovery capabilities with the different types of coordination mechanisms. Improving

coordination among the resources involved in the supply risk management process will lead to improving the warning and recovery capabilities of the company itself, which in turn will improve the effectiveness of the supply risk management of the company.

Standardization

As chapter 3.2.3 shows, standardization is one of coordination mechanism presented by Mintzberg (1979) and Glouberman and Mintzberg (2001). This standardization can be realized through a standardization of work, output, skills and knowledge, and norms.

Standardization of work is currently used at the company, for example when different functions, working independently, contribute to provide different performance indicators which are uploaded in the internal IT-system of the company. These evaluations are carried out in a standardized. For example, if buyers see that certain suppliers have a low financial score, they should know the financial analyst is already working on this issue. In this way, different functions can still work independently, knowing what the other function are doing. Issues have not been identified in this area as the tasks of the different functions have all been well standardized.

Regarding standardization of outputs, it can be seen in the performance scores that the suppliers get and that is the output of some of the functions. An example is the financial analysis, which is based on a standardized model giving a score in the internal IT-system of the company in relation to the financial status of the considered supplier according to a set formula. The outcome of this measurement is, therefore, standardized. However, an issue connected to this area is the lack of an agreed way of defining when a supplier is considered at risk in a certain performance area. The determination of whether a supplier is considered a risk in a certain performance measurement is up to the different function. This can be seen as an issue because the other function will then not be able to interpret what a certain risk level means. This lack of a standardized way of assessing risk is therefore a factor that undermines the company's warning capabilities.

The standardization of skills and knowledge can be seen when employees of the company are aware of the knowledge and skill levels of other employees. For example, a buyer knows that a quality analyst has knowledge related to quality, a financial analyst to finance, and therefore knows how to perform their jobs. A problem found here was that there is a lack of standardized knowledge about what relevant warning signals for other functions are, in particular for the financial one. A second problem is lack of standardized knowledge about how to use the escalation process in a proactive way. Not knowing if the identified warning signal is worth sharing with other employees from other functions, other than not being fully aware about how to make use of the escalation process in a proactive way, could have its basis in a lack of standardization of knowledge related to these areas. The lower coordination resulting from that undermines in turn both the warning and recovery capabilities of the company.

The standardization of norms is not easy to analyze, since the sharing of values and beliefs is something instilled inside the different employees of the company and a rather difficult concept to grasp in practice. However, the interviewees all gave answers showing they understood the

importance of supply risk management and the sharing of information. They also pushed the point that helping each other is crucial for success. There seems however to be a lack of trust internally to the company, that could affect the supply risk management performance. Some examples of this is the financial score calculation, that is kept secret also from other function, and the control tower, that contains more detailed financial data on suppliers and is only accessible for the financial analysts and upper management, two aspects that could give buyers signals of warning towards their suppliers. Thus, even if a difficult aspect to analyze not being fully part of the company, these issues with internal trust suggest problems with the shared values and beliefs inside the company, with negative consequences for coordination. And this undermines, consequently, the warning capabilities of the firm.

Mutual Adjustment

Mutual adjustment can be seen where the buyers coordinate with each other, freely giving and receiving their output or input one to the other and taking decisions accordingly. This is achieved through informal communication in their day-to-day work. For example, referring to how he found solutions in the past to better manage risk with suppliers, a buyer stated that "all this comes [...] from talking with other buyers, [...] talking to people in the company." This shows that the employees of the purchasing department understand the importance of this coordination mode, and try to use it to gain advantage in the different phases of the supply risk management process.

Mutual adjustment is a mechanism that also emerged as an important way to coordinate with colleagues from different functions in an informal way. Information about suppliers is exchanged with other colleagues to give and receive outputs and inputs about them. One factor that seems to affect this is the proximity of the employees that need to exchange information. If there is a large geographical distance this informal information sharing becomes more difficult. This could be seen at the company, where the employees sitting in the same building had frequent contact and exchange of information, while the financial analysts were sitting in a different building with almost no exchange of information with the buyers beside situations of active crises. This was particularly a problem for the buyers, as they are not always fully aware of all the actions other functions are taking towards suppliers in relation to risk, lacking coordination with them to have insights about that aspect. This shows how not fully exploiting informal contact and thus not properly mutually adjust with employees of different functions represents an issue that undermines the coordination between these resources. This, in turn, has a negative effect on the recovery capabilities of the company.

Group meetings

Where a group of more than two actors need to coordinate among each other, two coordination mechanisms are suggested by Van De Ven, Delbecq and Koenig (1976) called scheduled and unscheduled meetings. This coordination mechanism can be seen, for example, with the risk meetings, which take place on a regular basis. Thus, actors have the possibility to coordinate with one another when taking part in these meetings. One issue found here was the lack of time to present all the risky suppliers during these meetings, which shows how those are either not long or frequent enough. Another problem was that there is no set meeting between the financial

function of the company and the buyers, to discuss warning signals they might need from the buyers related to risks connected to suppliers. Not fully exploiting or lacking formal meetings undermines the coordination among the resources involved in the supply risk management of the company. The consequence of this is that the warning and recovery capabilities of the company are weakened.

In relation to unscheduled meetings, no major issues have been identified. Unscheduled meetings are mostly used when there are continuous disturbances over a period of time, which require a lot of emergency meetings. More critical situations are thus related to this type of meetings. An issue that was found here is more relating to the composition of the groups rather than the informal meetings themselves. When a buyer is dealing with a disruption they need to get authorization from several different upper management positions. Currently these meeting are often done separately with each of the different positions of the upper management, potentially leading to a waste of time in a situation of crisis, thus undermining the recovery capabilities of company.

Summary of coordination

A brief summary of the results of the analysis about the coordination mechanisms of the company related to its supply risk management process is given in Table 2.

Coordination mechanism	Identified as an issue and undermining which capability	Brief explanation of the issues
Standardization of work	No	-
Standardization of outputs	Yes; warning capabilities	Lack of agreed way to define when a supplier is considered at risk in a certain performance area looking at its scores.
Standardization of knowledge and skills	Yes; warning and recovery capabilities	Lack of knowledge about what relevant warning signals for other functions are. Lack of knowledge about when to use the escalation process.
Standardization of norms	Yes; warning capabilities	Lack of trust, both internally and externally
Mutual adjustment	Yes; warning and recovery capabilities	Lack of awareness about what other functions are doing in relation to suppliers. Lack of coordination with functions that are geographically distant
Scheduled meetings	Yes; warning capabilities	Lack of time to present all the risky suppliers. Lack of set meeting with the financial function to discuss with them about what warning signals they might need from buyers.
Unscheduled meetings	Yes; recovery capabilities	Potentially wasted time when holding separate meetings with upper management

Table 2. Summary of the analysis related to coordination mechanisms

5.5.2 Information sharing

This section deals with the information exchanged both intra- and inter-organizationally at the company. The six barriers to information sharing presented by Khurana, Mishra and Singh (2011) in chapter 3.2.4, called managerial, organizational, financial, technological, individual, and socio-cultural barriers, will be here used to identify the ones found in place at the company in relation to its supply risk management process. Some of the issues identified in chapters 5.3 and 5.4 in relation to warning and recovery capabilities will here be connected to these barriers, to show where and how they undermine these capabilities of the company.

Managerial barriers

Managerial barriers are in place when the attitude of managers regarding sharing information inside the organization or with the supply chain partners of the company is adverse or at least not supportive regarding this practice. Just one case emerged of a significant managerial barrier to communication of information. The case was related to the owner-manager of a small supplier and a fire at its production plant, which caused a disruption of the production lasting for several weeks. What emerged from the interview with the buyer is that the owner-manager of the company explicitly told its employee in contact with the buyer not to mention about the disruption that took place. The owner-manager thought that they would have been able to solve the problem quickly by themselves, without needing to share this information with their customer. This clearly emerges as a barrier coming from the management of the supplier company, who willingly tried to hide the disruption, not communicating the information. This, in turn, undermines the warning capabilities of the company.

To clarify, this is the only case that emerged during the interviews as a managerial barrier from the supplier's management. However, this does not translate into the fact that the issues might be more common than it seems. Even if possibly an isolated case, it is representative of the influence of managerial barriers in the information sharing process. Even if the employees of the supplier are willing to share information, if the management is not supporting it or pushing against it the barrier towards information sharing is evident.

Inside the company no managerial barriers were found, neither in the interviews nor from their processes.

Organizational barriers

Organizational barriers are based on the way a company is organized, if its structure impedes the sharing of information or supports it. The structure at the company is quite hierarchal and bureaucratic, which was showed in several ways in the interviews in the section *Decision chains and authority* in Appendix B.

This aspect can be connected to one of the issues that emerged in relation to warning capabilities. The issue was a lack of access to information by employees not belonging to the higher levels of the company, such as access to the control tower financial database. It can also be connected to the complaints about the long decision chain in place when action needs to be taken towards risk. These organizational barriers, in turn, undermine the reactive recovery capabilities of the company.

The structural organization of the suppliers was not mentioned by any of the interviewees as a concern regarding the information sharing process. This aspect is therefore not considered as a relevant barrier to information sharing with suppliers. It would also have been a concern that the company would have little influence on.

Financial barriers

Financial barriers are connected to the lack of resources related to sharing of information. These resources have mainly an influence on two aspects: information systems and manpower. Both

points emerged in chapter 5.3 as issues connected to recovery capabilities. Lack of financial means was brought up as a possible reason why the company does not use analyses carried out by external parties, as a buyer stated during the interviews. These could add value in detecting relevant warning signs related to the future evolution of specific markets, industries, or suppliers, thus a resource contributing to the warning capabilities of the company.

Manpower can be also identified as a possible cause undermining information sharing for the company. This aspect emerged as an internal problem for the company, which can be linked to the expressed lack of time that several interviewees brought up during the interviews in the section called *Time aspects* in Appendix B. Lack of time to meet with suppliers, to communicate and detect eventual warning signals from them can be traced back to the lack of manpower to do so. And taking a further step back, lack of manpower can be linked to the lack of financial resources to acquire that. This in turn undermines the ability to detect important warning signals coming from suppliers, and thus the warning capabilities of the company.

Technological barriers

Technological barriers can be found in a lack of information systems in place to share information, the support given and complexity related to them, and the possible incompatibility between different information systems of different companies. This barrier was found to be a problem at the company, as several buyers complained about a lack of support from the IT-system in different ways. From one point, it contains scores related different performances of the suppliers, which can help in detecting if something is not right with them. On the other hand, as mentioned among the issues related to warning capabilities in chapter 5.3, the financial score emerged as often being confusing, since it needs further interpretation, other than a lack of a score explicitly expressing the risk related to a supplier. Moreover, the IT system does not store and retain vital information connected to suppliers or what work other functions are doing in connection to them. The information that exists is also spread over several systems such as excel spreadsheets, their own intranet, a supplier portal, and several other systems only available to a select few within the company. This lack of support from the IT-system in turn undermines the warning capabilities of the company, since it makes more difficult for the employees making use of it to detect a risky supplier and communicate this information.

Issues relate to the IT-systems of suppliers have not been brought up by any of the interviewees, and is not considered as a concern for information sharing.

Individual barriers

Individual barriers are represented by the adverse attitude of employees of a company to share information with the ones belonging to the same organization or from another partner in the supply chain. As seen in the section *Communication within the company* in B, employees inside the firm recognize the importance of information sharing with other functions. Individual barriers related to the personal propensity to share information with other colleagues has not been mentioned by any of the interviewees, therefore it is not considered as a concern.

However, issues emerged in this regard when the information sharing has to take place with the contact persons belonging to the suppliers. Relevant information regarding disruptions or

possible future risks was not shared by the contact person at the supplier. As the section *Relationship with suppliers* in Appendix B shows, this could be related to aspects connected to trust and fear of repercussions for the business of the supplier. Knowing this information in advance, or at least as soon as possible is fundamental to prevent and/or diminish their likelihood of occurrence or their business impact. It thus negatively influences the warning capabilities of the company.

Socio-cultural barriers

Socio-cultural barriers are in place when differences in culture of the individuals belonging to different organizations, and the social environment in which the information exchange happens, undermine the sharing of information. Inside the company, neither cultural nor social barriers have been identified as a problem undermining its intra-organizational information sharing.

For the external side of the organization, cultural barriers emerged as a concern in the exchange of information with some suppliers. What the *Internal and external transparency* section of Appendix B highlights is that companies belonging to certain countries, with a different culture relative to retaining and sharing information, represent a possible barrier in the process. Referring to information sharing, a financial analyst stated that "some countries are not transparent at all." Some suppliers appear to have less transparency in this regard, with the idea in their mind that internal processes and eventual problems are their own business, which do not need to be shared with their clients. This mentality appears to be associated with cultural differences, which is then an aspect to possibly take into account in the selection of suppliers.

Summary of information sharing

Table 3 gives a brief summary of the results of the analysis regarding the barriers to information sharing.

Information sharing barrier	Identified as an issue and undermining which capability	Brief explanation of the issues
Managerial	Potentially, externally; warning capabilities	Only one case emerged during the interviews of a supplier's manager explicitly telling its employees not to share information about a disruption in their production; however, it might potentially be a more extended issue. No issues from the internal managers of the company.
Organizational	Yes, internally; recovery capabilities	The bureaucracy and hierarchy of the company could potentially hamper information sharing, while the social interactions are a great resource in promoting it. No issues from the suppliers' organizations side.
Financial	Yes, internally; warning capabilities	An issue emerged related to not using one source of external information for warning signs, connected to lack of resources to spend for it. Moreover, lack of resources for investing in more manpower emerged as a potential problem.
Technological	Yes, internally; warning capabilities	The IT-systems of the company are both complex, fragmented and unsupportive of the needs of the buyers. No identified issues from the suppliers' IT-systems.
Individual	Yes, externally; warning capabilities	Issues related to unwillingness of individuals belonging to the supplier to share information about possible risks and disruptions for lack of trust and fear of losing business. No issues from the internal side of the company.
Socio-cultural	Yes, externally; warning capabilities	Issues related to suppliers belonging to countries with different cultural backgrounds with less transparency towards sharing information, but the culture of the company supports information sharing. No issues from the internal side of the company.

Table 3. Summary of the analysis related to intra- and inter-organizational information sharing barriers

5.5.3 Training

Training implies the transfer of knowledge. The concepts presented in the literature review in chapter 3.2.5 are here connected with the empirical findings. In this section, training and knowledge management at the company are analyzed to find areas in which the company can improve its practices. This is achieved by first illustrating what knowledge has been identified

as necessary to include in training programs for employees. This knowledge derives from the issues related to warning and recovery capabilities presented in chapter 5.3 and 5.4. After this first step, it is then presented how this knowledge can be transferred, identifying in this regard where the company is already putting an effort and where improvements can be achieved.

Relevant knowledge inside the company to include in training programs

Polanyi (1967) identified two categories through which knowledge can be classified, called explicit knowledge and tacit knowledge. The issues related to knowledge about warning and recovery capabilities, shown in chapter 5.3 and 5.4, are here connected to these two types of knowledge. In particular, the section highlights which knowledge buyers are missing in relation to supply risk management. If the human resources of the company do not possess this knowledge, the warning and recovery capabilities are undermined.

Explicit knowledge is represented by all the norms, rules, and processes expressed in a formal way inside the company. These are mainly the risk escalation process itself and its steps. This kind of knowledge is present inside the company and it is expressed in an explicit way, which allows its communication and spread among the employees in an easier way. However, the interviewed employees expressed the idea that they know which the different phases of the process are, what they lack is knowledge about when to use it. This has been explained in the section above.

Another type of explicit knowledge that was found to be lacking in relation to warning capabilities, as seen in chapter 5.2, is knowledge about how the scores related to suppliers in the IT-system of the company are calculated. This was especially true for the financial score, about which buyers stated "it is good to know how the score is calculated, [...] but I am not very familiar with [its] calculation." Knowing this could allow them to be able to better identify if a supplier is at risk or not, with positive consequences for the warning capabilities of the firm.

A first type of tacit knowledge that emerged as an issue related to recovery capabilities, as seen in chapter 5.4, is knowledge related to how to manage a crisis that already has taken place. This knowledge is possessed by individuals that have already been involved in this kind of situations. Tacit knowledge belonging to individuals that have handled one or more of them in the past can be identified as key knowledge to be transferred to other individuals, which more specifically have been here identified as new buyers. This would allow them to better handle these situations when they take place, leading to better recovery capabilities for the company.

As seen in chapter 5.4 as an issue related to recovery capabilities, an important source of tacit knowledge inside the company that emerged as lacking is for buyers to know when to use the escalation process to proactively prevent a disruption from taking place. This is knowledge possessed by the more experienced employees of the company in this area, dictating in which circumstances it is appropriate to use this process and which cases are relevant to be presented at these meetings. Without this knowledge, important information might not be shared and the possibility to come up with plans to counteract a foreseen risk before it materializes is undermined, with negative consequences for the recovery capabilities of the firm.

Another type of tacit knowledge that emerged as lacking is knowledge regarding which warning

signals are relevant to be communicated to other functions, especially for the financial one, as emerged as an issue related to warning capabilities in chapter 5.3. This knowledge is possessed by the employees belonging to the different functions inside the firm, who thanks to their experience, know which signs are relevant for their area and which are not. Without knowing if a signal is relevant for another function and, therefore, a warning for the company, all the possible ways of communication can be in place, but the right information will not be shared. Making other employees aware of which these warning signals are can have a positive effect towards the warning capabilities of the company, since then it is known which information is important and should be communicated to other resources.

Transfer of knowledge and employees´ training

Employees at the company missing the knowledge presented in the section above need to get access to it and make it theirs. This is when training reveals its usefulness, since it implies the transfer of this knowledge to employees. Different types of knowledge follow different paths to be transferred. Following the work by Nonaka and Takeuchi (1995), it will be here presented which issues regarding knowledge transfer, and therefore training for employees to teach them these notions, have been identified as in place at the firm. This will allow the company to identify where this transfer of knowledge is already going in the right direction, and where an effort needs to be put in place to improve it.

Starting with transfer of explicit knowledge, the interviews showed how the employees possess knowledge about the processes inside the company related to risk management. This is codified knowledge stored in the internal IT-system of the company, which employees have access to. They also followed introduction training where they have been taught about these processes and the different phases forming them. Therefore, the transfer of this explicit knowledge to employees, who then make it tacit within themselves, emerges as in place, since the employees are aware of these processes and their phases.

However, an issue emerged, as shown in chapter 5.5.3.1, regarding another type of explicit knowledge, connected to how the scores related to the suppliers (specifically, the financial score) are calculated. Even though the score follows a mathematical model taking into account different parameters contained in the balance sheet of the suppliers, buyers do not have knowledge about it. What Nonaka and Takeuchi (1995) suggest as the way to transfer explicit knowledge and transform it into tacit for the receiver, is called internalization. This can be something as simple as giving the receivers the model through which the score is calculated, which would allow them to become aware of how it is carried out and close this knowledge gap. Since buyers do not possess this kind of knowledge, an issue in its transfer through the internalization mode is identified. However, what also emerged from the interview with the financial analyst is that the way this score is calculated is kept secret from the buyers, because it is sensitive information and they could transfer it to the suppliers, in the attempt to improve their financial score. However, whether the information should be transferred or not for these reasons is not part of the study.

Other issues emerged related to the transfer of tacit knowledge. Chapter 5.5.3.1 showed how new buyers do not possess the knowledge about how to handle a crisis after its happening. This

kind of knowledge is possessed by individuals that have already been involved in a crisis. What emerges is that this type of knowledge is not transferred to new buyers when they start their job. Following the model of Nonaka and Takeuchi (1995), this tacit knowledge can be transferred to another individual in two ways. The first is from tacit to tacit knowledge, directly transferred from the individual possessing the tacit knowledge to the other individual, through "observation, imitation, guidance, experience sharing, and practice" (Nonaka and Takeuchi, 1995). This emerged as in place at the company, where a buyer reported his experience with his first crisis, during which "the plan was more based on experience [...] from colleagues with experience with crises, telling me who to contact, why to contact them, what help I could seek." However, this transfer of knowledge only happens after a disruption has taken place, not before. Therefore, new buyers feel unprepared when a disruption arises.

The other way to transfer this knowledge, related to how to behave when a disruption happens, is first through what Nonaka and Takeuchi (1995) call externalization, which means transforming tacit knowledge into explicit one. Then, different sources of explicit knowledge can be combined, going through the mode called combination. The outcome of these two phases are manuals, books, and models where the initial tacit knowledge is made explicit and can be absorbed by the receiver of it. This is an aspect on which buyers with experience with crises are actively working on at the moment. The aim is to create a white book with the experience gained through the past crises they have been involved into, with general guidelines that people with no experience with crises can follow. Therefore, even if not already in place at the moment, the company is already on the right track to improve facilitate the transfer of this type of knowledge to new buyers. This will translate in improved recovery capabilities for the firm, since new buyers will be able to act more quickly knowing which steps they should follow when handling a crisis for the first time.

The other issue related to tacit knowledge is when to use the escalation process in a proactive way. This is in line with the considerations just made for the transfer of knowledge related to how to handle a disruption. Tacit knowledge possessed by more experienced employees, related to when to use this process before a disruption takes place, needs to be transferred in an informal way if willing to achieve so in a tacit to tacit way. Alternatively, this knowledge needs to be made explicit and integrated in the training material buyers receive in the beginning of their career at the company, or in the internal IT-system of the company where the description of this process is stored. Since this knowledge emerged from the interviews as lacking among several buyers, none of these ways of transferring knowledge emerged as properly exploited inside the company. This aspect then represents a treat for the warning capabilities of the firm.

Lastly, transfer of tacit knowledge about warning signals. Here, this type of tacit knowledge can be transferred in the same two ways as for the previous two cases. Tacit to tacit knowledge transfer was explicitly addressed by a buyer, expressing the willingness to collaborate in providing these warning signals, is this case referring to the financial department, saying that "we would forward them the information that we have that we think might be of value to them." But at the same time, to be able to do that, they might need to "meet them even once a year to discuss what they are struggling with or what kind of help they might need, [so they] would remember that." Without having the possibility to meet and exchange this kind of knowledge,

employees are not able to acquire it from other functions. This knowledge could also be transferred in the other way explained above, making it explicit through manuals, books, and models. However, no effort in this direction has been detected in the company at the time the study was conducted. Thus, trying to involve the different functions in transforming this tacit knowledge into explicit one, generating, for example, a white book, as in the case of knowledge about how to handle crises, would be of help to make employees of other functions aware about which should be considered warning signals of relevance for the different functions. Since these are not ways of knowledge transfer seen as exploited by the organization, the warning capabilities consequently suffer from that.

Summary of training

A summary of the results of the analysis about the training and knowledge transfer is given in Table 4.

Type of knowledge to be transferred	Identified as an issue and undermining which capability	Brief explanation of the issues
Explicit knowledge about the steps forming the risk escalation process and their description	No	-
Explicit knowledge about how the scores related to suppliers in the IT-system of the company are calculated (in particular, financial score)	Yes, warning capabilities	Buyers do not have access to explicit means (mathematical model) to gain knowledge about how the financial score of the suppliers is calculated.
Tacit knowledge regarding which warning signals are relevant to be communicated to other functions	Yes; warning capabilities	Lack of tacit to tacit knowledge transfer means to understand which warning signals are considered relevant for other functions. Lack of explicit means (books, manuals, etc.) to transfer this knowledge.
Tacit knowledge about when to use the escalation process to proactively prevent a disruption	Yes, recovery capabilities	Lack of tacit to tacit knowledge transfer to gain knowledge about this aspect. Lack of explicit means (books, manuals, etc.) explaining how to use the process in a proactive way.
Tacit knowledge related to how to manage a crisis that took place	Partially, recovery capabilities	Knowledge transferred in a tacit to tacit way, but only after a crisis has taken place. Lack of explicit means (books, manuals, etc.) explaining which general steps need to be followed after crisis takes place. However, employees are already actively working on this.

Table 4. Summary of the analysis related to different types of knowledge and its transfer

6. CONCLUSIONS

This chapter will present the study questions stated in the beginning of the study and the related answers to them. This allows to wrap up all the information presented in the study and get an overall view of it, together with some conclusions that the authors of the study drew from the different study questions and their answers.

What is identified in literature as necessary steps to be done in an effective supply risk management process?

According to Norrman and Lindroth (2006), and after the authors of this study verified this aspect themselves going through different models by different scholars, there are several models that recommend different steps for an effective supply risk management process. However, most of them follow the same red thread. Thus, a model embodying this red thread has been chosen by the authors, represented by the one by Hallikas et al. (2004). This model divides the supply risk management process into four phases: risk identification, risk assessment, identification and implementation of means for risk reduction, and risk monitoring. A thorough explanation of each of these phases is given in chapter 3.1.

This model covers the phases that a supply risk management process should follow to work effectively. Adopting this model or a similar one, following the same red thread, would be the first step for a company to be able to better manage the risks coming from their supply side. This, in turn, would be the first step to allow a more stable and timely supply of the goods they need to carry out their activities.

Which factors are pointed out in literature as important for a supply risk management process to work well in practice?

Riley et al. (2016) present a model where two areas of capabilities lead to effective supply risk management: warning capabilities and recovery capabilities. Warning capabilities represent the ability to detect and share information on possible or upcoming disruptions in the supply chain to the relevant actor. These warning capabilities are supported by resources that can be either internal or external to the company. Recovery capabilities are the way the supply chain can muster resources to continue operations after a disruption or prevent it from happening, and they are called reactive in the first case or proactive in the second. The model by Riley et al. (2016) goes further, explaining how these two areas of capabilities are in turn supported by three enablers: internal integration, information sharing, and training. The major parts of internal integration are the interdependencies of resources and the coordination of them. This coordination can be done through standardization, mutual adjustment, direct supervision, or through meetings. Information sharing has six areas where barriers to information sharing can be found: managerial, organizational, financial, technological, individual, and socio-cultural. Training can be done in several practical ways, but it is in essence knowledge management and transfer of knowledge. Chapter 3.2 presents a deeper description of the model, the capabilities and the enablers.

This model presents important aspects to consider for the effectiveness of the supply risk management of a company. The emphasis here is not on the process itself and its phases, but more on the interdependencies and interactions among the different resources involved in it. Thus, it is interesting to see how it is not sufficient to only have a proper supply risk management process in place. It is also necessary to consider aspects related to the resources forming it and their coordination and interaction, in a way that the supply risk management of the company can work effectively.

How does the supply risk management process in place at the company look like and how is this work done in practice?

The company has a theoretical model for the supply risk management process in their internal IT-system containing five phases: risk identification, risk assessment, risk evaluation, risk response, and risk follow-up. This risk work is divided into six areas with one function having ownership of the risk and other functions giving their contribution. For sharing information on risky suppliers and escalating decisions up the company hierarchy, the risk escalation process exists. Information is also shared through more informal channels. Before a supplier is given business, a supplier evaluation is done with an estimation of their performance on 10-12 key parameters, including finance, quality and environment.

The fact that a large manufacturing company has extensive supply risk management process in place should not come as a surprise, but it means that there are also a large amount of resources and the coordination and interaction between them to perform these processes. This leaves a lot of room for using the supply risk management effectiveness model for analyzing the situation.

Does the supply risk management process in place at the company follow the recommended steps of the model chosen from literature?

Even if the phases forming it have different names and are more in number, the outcome of the phases of the risks management process in the company was found to follow the phases suggested by the chosen model by Hallikas et al. (2004). This shows that the current model used by the company does not have any obvious gaps, and there are therefore no improvements available in this regard.

Which areas of improvement can be identified with respect to the factors for effective use of the supply risk management process in practice?

The warning and recovery capabilities of the company could be strengthened by improving the resources of the supply chain and their coordination and interaction. For warning capabilities, the internal human resources could benefit from improved information sharing between and within the different areas of risk owners and contributors. This could be done by improving the lacking or not fully exploited coordination mechanisms inside the company, other than receiving training about which warning signals are considered relevant to be communicated to other functions. Internal technical resources are well developed with gathering of data and visualization of this, but might be improved by providing a score summarizing how risky a supplier is. The external human resources are based largely on the relationship that the buyers have with the suppliers, this relationship is in some cases suffering from managerial, financial,

individual and socio-cultural barriers, leading to less information sharing in the supply chain. Working on these barriers is a way through which the company might improve its warning capabilities. The external technical resources consist of access to financial databases, data sent from the suppliers, and news articles. One way of strengthening the external technical capabilities would be to invest in external analyses of suppliers, supplier markets and segments.

The proactive recovery capabilities could be improved by increasing the information sharing between the individuals belonging to the different functions owning and contributing to risk. This could be achieved improving their coordination with more informal communication, which would increase their abilities to prevent disruptions before they happen. Another way is to increase the knowledge regarding when to use the escalation process in a proactive way. What was found is that this is currently not fully used to put actions in place to counteract foreseen risks. Reactive capabilities could be strengthened by increasing the training that buyers, especially new buyers, receive on crisis management and having easier access to information needed to handle a crisis, such as contact information to different personnel at the supplier. The long and bureaucratic decision chain during crises could be made more flexible to allow faster taking of action towards disruptions already in place, contributing to improve the recovery capabilities of the firm.

This shows some of the findings of the report where the company can improve the effectiveness of their supply risk management work. Some solutions to these problems will be simple and can be done to a lower cost, such as implementing basic training for employees, while others could be costly and require herculean efforts of the organization, such as implementing a unified internal IT-system. What is found is also that, even if the risk management process follows the suggested steps and there are extensive processes in place, there can still be plenty of room for improvement in areas that are not obvious.

7. DISCUSSION

The object of the study is a large manufacturing company. This means that they can have very extensive resources for supply risk management, such as dedicated experts on selected areas of risk and extensive IT-systems. However, it also brings challenges that smaller companies do not face, mainly based on the coordination of these resources and the handling of the massive amounts of information that they collect and analyze. It also creates the situation where the person ultimately responsible for the decisions and consequences for the risk are separated from the people working day to day with it by several steps in the hierarchy.

The company has also been in business for around a century, meaning that many of the supply risk management processes have been developed organically over time. Some of these processes might have had problems expanding when the company expanded. This would explain the problems of sharing all the information the different functions have on suppliers in the current risk meetings.

Areas of further study for the company could be to investigate in more detail the separate factors affecting the abilities. That could be looking into the specific tasks that are performed in the supply risk management process and which coordination mechanisms would be best suited in each case, focusing on each of the barriers of information sharing, or investigate in which cases it would be beneficial to transfer knowledge in a tacit-to-tacit way or to externalize it. Another area that could be of interest for the company is the review of which cases merit a proactive response to risk and in which cases a reactionary approach is the most suitable.

From a theoretical point of view, the research area regarding factors affecting the effectiveness of the supply risk management of a company is still in its early phases of development and merits further investigation. The model suggested by Riley et al. (2016) is not a fully functioning model, but rather a first suggestion. Studies investigating if there are further factors that influence the supply risk management capabilities, and if there are other capabilities needed, would add to the base of knowledge in this area. There is also still limited support to how much impact these factors and capabilities have on the performance of a company, and further studies could be done to strengthen or disprove these connections.

One aspect that was not included in the model by Riley et al. (2016) is the effect of recovery capabilities on warning capabilities. Here they see it as warning capabilities supporting recovery capabilities but not the other way around. But as other authors have suggested and as we could see to some extent in the analysis, it is important to know which actions will be taken in response to a warning signal to know which person needs the information. This points towards the importance of having recovering capabilities in order to have effective warning capabilities.

Lastly, how a more effective supply risk management of a company can have an influence on sustainability. The effect of financial sustainability is fairly obvious and was also presented in the theoretical background of the thesis. An improved supply risk management will lead to fewer and less severe disruptions, which will be less costly and poses a smaller existential risk

for a company. The social aspects are covered by the training and personal development of employees that will need to be done to have effective supply risk management processes in place. Supply risk management is also a team effort that requires cooperation within a supply chain, something that should lead to a decrease in dog-eat-dog attitude and therefore improve the social situation. And finally, a more effective supply risk management for a company translates in the fact that a decrease in supply risk can be achieved. This, in turn, has the potential to reduce the amount of express deliveries that need to be performed due to disruptions of supply. What usually happens is that most express deliveries are made with air freight, which put a lot more strain on the environment than their usual modes of transportations. Therefore, the conclusion is an improved supply risk management effectiveness will have a positive impact on all three aspects of sustainability.

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Appendix A - Interview template

General questions

1. What are the main tasks connected to your job?
2. What are the main functions you work with?
3. What are the main processes connected to your job?

Supplier relationship

4. Do you categorize your suppliers? If so what are the criteria?
5. How do you evaluate your suppliers? What are the criteria and sources of information?
6. What is your communication structure with suppliers? Do you have regular contact with all suppliers in your scope?

7. How do you follow on performance of your suppliers? How often and what exactly you look at?
8. Do you work proactively on improving suppliers´ performance? If so, do you focus on biggest suppliers or all of them?

Risk management

9. Do you have knowledge about risk mitigation process at the company? Have you ever used it?
10. How do you work with risk mitigation in your position?
11. How can the risk mitigation process improve?
12. Which functions you work with and how, to mitigate risks?

Crisis management

13. Have you been involved in any crises connected to your suppliers?
14. If so, what was the root cause? How was it managed? Which functions were involved and how? What did you learn from it? What was your meeting structure both internally and externally?
15. How would you improve crisis management process at the company?
16. Is there something you were missing that could have supported you during the crisis?

Appendix B - Interview results

As mentioned in the method section, ten interviews have been performed with different employees all belonging to the purchasing department of the company. The transcript of the interviews totals 116 pages, and so for brevity and confidentiality reasons we will present a summary of the findings below. The results are grouped according to the categories found when using the editing method.

Access to information

An aspect that several interviewees brought up was a lack of access to information related to the processes within the company. The most common complaint was about the process and information regarding the financial health and risk of a supplier. The buyers have access to a score that ranges from 0 to 3 and is supposed to represent the financial health of a company, but they do not know what the score is based on, what the reason for a bad score is or if someone is acting on this information.

“In terms of finance for sure [...] this rating for me is not enough, for me it is too light actually. We need to have a better way to report, to track the different financial ratings, they are not necessarily updated. And you know, when you see that three [out of three for the score], you say okay, but what is behind that? You need to translate the score to understand it.” -Operations buyer

“One thing that unfortunately by us cannot be accessed is the control tower, which is kind of a platform for evaluating suppliers financially. And I think buyers, not only buyers maybe also managers and directors also do not have access to it, it is a more higher level executive kind of platform.” -Aftermarket buyer

This lack of information is also present in handling an active crisis.

“But sometime the struggle is getting the information. You lose a lot of time if you do not have that information at hand.” -Operations buyer

“Right now we get the CSL (Critical Supplier List) on a monthly basis, but if it can be done, if we can get access to the CSL team place itself where the file is stored, and they say that because of this reason supplier is in CSL, and then we get regular updates let us say in a biweekly time or a weekly with only a report that says this supplier is in CSL and then we can see what is the reasons for it. That would probably also help going forward.” -Sourcing buyer

Knowledge about processes

Another point brought up by several of the interviewees is a lack of knowledge about the processes. This could be a lack of knowledge about in which circumstances to use them, for example the escalation process, or how a process is carried out, for example the calculation of the financial score related to a supplier.

“When it comes to the risk, I know a little bit because I was involved in that, with all these risk

mitigation committee. And then these three different steps. I am aware of that, but I do not really know exactly what kind of cases should be presented, who should present the case, what has to happen in order to use this, what kind of events are good enough or not good enough to be presented. So I think we are missing knowledge about this process" -Operations buyer

"[Referring to the risk escalation process] I think for me knowing this process that we already have would be a good improvement. Because I think we already have the tools, but we do not know how to use them." -Operations buyer

"Sometimes it is good to know how the score is calculated. For example, with a financial crisis, you need to calculate the cash flow and it can be useful. But I am not very familiar with this calculation though" -Sourcing buyer

"I do not know if there is a process. If someone gets a bad score, maybe it is time to secure a second source. I have not really seen a process around that, that is the way it is handled" -Crisis management intern

Communication within the company

The communication with colleagues within the company was another area that was brought up in every interview. From one perspective, the opinion is that this is a great resource of information, as managers and colleagues inside the same or from other functions possess information, knowledge and experience.

"In the end, for me all this comes more from talking with other buyers, with whom have more experience or more experience. It is based on case by base. For me it is more talking to people in the company and learn from them than to follow a formal process" -Operations buyer

"[Referring to information coming from buyers] this is the best type of information because buyers get much more information from suppliers or sometimes from supplier competitors. If you are in this segment or industry, then you get much more updates." -Financial analysts

"The plan was more based on experience, the three options were suggested by my manager at the time. It was nothing already in place, it was brainstorming and ideas from colleagues with experience with crises, telling me who to contact, why to contact them, what help I could seek. There is a lot of experience in the team, but you need to ask for it." -Operations buyer

"[Referring to warning signals] we do not usually get that information unless a buyer says something. So if a buyer has that information it is worth gold." -Financial analysts

"Most people are related to risk I would say, they can either measure it or report it to me or I can report to them" -Project buyer

"Sometimes other functions give you a head up if a supplier can present some risks. This is the time when I would take the supplier seriously." -Operations buyer

"We can also give that information to the operations buyer, especially if it is a new supplier it is important, because I have started to build that relationship so I can tell them, hey guys, their

delivery is great, their quality is crap, the behavior of this guy is great, but the rest of the team is lacking here and here, so we try to categorize where the risk is in that aspect" -Project buyer

At the same time, several interviewees brought up the point that communication is also a problem when it does not work properly.

"[Referring to communicating information gathered during meeting with suppliers about financial aspects] yes, right now we do not have this kind of communication [with the financial analysts]. It is something that is missing" -Operations buyer

"And if you get the financial statements you have the score, but you cannot really see that from the score. You need to always communicate, to always get this information. In order to be proactive." -Financial analysts

"We do not have this kind of reasoning in the back of our heads that some actions that we know about [related to the suppliers] might affect different functions. So [the communication of] this is something that can be improved." -Operations buyer

"Sometimes like here if I manage a crisis or if I took one in [a market], I had to make presentations all the time every single day I was being asked to make a new presentation. I was making so many presentations I was essentially unable to focus on my KPIs for that task." -Project buyer

"Collaborate with the cross-functional team would be very important to see how fast we can do, [...] that is probably something where we can work something out and make it better." -Sourcing buyer

Communication with suppliers

The communication with suppliers was an important aspect of identifying and preventing risk that several of the buyers mentioned. When proper communication is in place between the suppliers and the company, then waning signals related to foreseen or already in place disruptions can be detected more easily by the employees of the company.

"Having a meeting with them to know what exactly is going on. This is more proactive. In these meetings, it is an option for you to detect some warning signs, which typically are always present for crises, but you also have to be perceptive. So, these meetings allow you to be perceptive and get these signs. [...] When you speak with them and you feel that they are a bit holding information or hiding some kind of problems, then you can be proactive about that." -Operations buyer

"You know, you [...] go there, to notice what is wrong, [...] to inform them correctly, and just like that, [...] you explain, and you share, regularly, and where they are, that is key." -Operations buyer

"The best way to prevent it is upfront communication. You need an honest supplier first of all, one who is willing to be open to working with you because I will be open to working with them. When you have that kind of relationship it is much easier to manage and forecast how bad the

potential crisis will be and how to avert it." -Project buyer

"[Referring to a supplier whose delivery performance went suddenly down] I saw it and I asked questions, I realized that they have a capacity issue, so that is something that can give us indication when the supplier has an issue on their side as well." -Operations buyer

"I mean I can say that I see a big, a good feedback. And also when I send it to suppliers and they start to ask question how they can reach, how they can change the status, because every supplier wants to be a performing one, so they start to ask how they can improve on the different audits, how can they can fulfill it, they start to ask for the person that can help them with that" -Operations buyer

"I mean that is the best way, open communication, open and often just a follow up, so status follow ups, advance notification, even if the information for you is trickling in, you can trickle it to them and they can start to build a picture piece by piece. But communicate often, follow up often. I have seen that if you tend to let things go too long they tend to drop the ball. But the more often you are calling them, you are following up, the more often you're forcing them to stay on top of your project, your scope" -Project buyer

"With risk mitigation, following up and working more proactively is a way for me to prevent the risk. [...] And basically I think it is just keep the communication ongoing with supplier to get the information, what is happening" -Operations buyer

At the same time, it also emerged as a point that, if not properly in place, communication with suppliers could lead to risks taking place. When open communication is not in place, then the company is not able to capture the warning signals coming from the suppliers, which in turn can possibly lead to crisis for the company.

"[Referring to not having proper communication in place with suppliers] because otherwise you would miss [warning signs], you do not talk with the supplier, you do not know what is happening there." -Operations buyer

"[Referring to a crisis], there we failed in the communication, there we failed in properly pushing [the supplier]. It is hard to say, but that is to me what we could have done better." -Project buyer

"At least if there had been good communications between the operations and the supplier this [crisis] could have probably been avoided. If he was in regular contact with the supplier [...], that he was not supporting them, then he should have brought this up earlier than what he did" -Sourcing Buyer

"If a supplier has bad communication it can be the difference between a risk and a crisis and it does not have to be a crisis. I have seen this many times" -Project buyer

Time aspects

Almost all the buyers brought up the point that they did not have time to do things that would have improved their proactiveness towards risk, mainly when it comes to the aforementioned

communication with suppliers. They complained about the fact that the time they have available is not enough to have a proper communication in place with all the suppliers in their scope.

“I don’t really have the time to focus on the small [suppliers].” -Operations buyer

“Communication with suppliers, one of them I have weekly meeting by phone, we document all the open actions and we follow upon that. Some others are just called when needed. There is not something really planned. I would like to do that, but [...] for lack of time from my side [I am not able to do that]” -Operations buyer

“I work proactively just with the one main big supplier, reactively with the rest. Sometimes other functions give you a head up if a supplier can present some risks. This is the time when I would take the supplier seriously. But if not I have not the time for doing that.” -Operations buyer

“Yeah, but when I say proactive it is more that you know you have time also to go there, to notice what is wrong, to take time with the supplier.” -Operations buyer

Routines and standardization

A lack of routines and standardization was a problem that was voiced by several of the buyers. This could relate to their work processes or to how to report or interpret information.

“When you deliver to some plants, some plants want to be more aggressive regarding tolerances, other are more flexible. Sometime the supplier is subject to different treatments. So I think as a company we need to have one standard toward the supplier, for him to operate more smoothly.” -Operations buyer

“Today I am handling a crisis in projects and we have not really developed a way to report this because we do not know how, we have to re-evaluate the entire strategy, we have to go back to step one and until we can have something to bring forward we cannot kind of request or try to develop a process to work with management or reporting structure or something like that” -Project buyer

“But remember I think I said earlier in the beginning we do not have a way to define what a crisis is, so a crisis on one person's desk may not be a crisis to another person. Each person views their crisis level at every different area. One person might be quite autonomous and not involve a manager till something is really bad and others might involve them much sooner because they are getting jumpy or something like that. It depends and say it is not objective, it is more subjective” -Project buyer

“It would be good to have a standard, for example how many defects per million or inspection reports there need to be in order to consider the supplier a risky supplier. Or what is the delivery precision that we consider risky as well” -Operations buyer

“But we do not have a clear process, or consequence if supplier is not performing according to our targets” -Operations buyer

Reactive approach to problems

A basic theme in all the interviews was that most of the supply risk management process was often done reactively rather than proactively. What the interviewees brought up is that actions and plans towards a supplier to counteract the risk related to them are mainly taken after a disruption has already taken place.

"Maybe the action plan is good, but we need a timely action plan, something that is ready, that we can immediately act upon. Have an already made plan, not having to make a plan. What happened is that we did not have an action plan in place on time, so when we see the danger we kind of start preparing the plan, losing time. Instead, if you already have an action plan, you can directly jump on it and act simultaneously, then minimize the risk. This is more a reactive approach." -Operations buyer

"And sometimes you know you have an alarm that pops up and you say oh, okay, so you try to set up a battle plan, action plan, to find an alternative. We try to anticipate a bit, but I think it is always too late" -Operations buyer

"And I think the problem was that if these points coming from the suppliers, because they had red figures for few years, that if they were addressed properly, at least we could have smoothed the process. We did not do any action until we actually were in this situation where the supplier just closed the plant and then we were in this hard crisis" -Operations buyer

"Since this was a historic supplier we did not have too much control over him, and also since the spend itself was very low it was not on our radar, and it suddenly came up saying that this is a crisis. More proactiveness would have been the case." -Sourcing buyer

Relationship with other functions within the company

Relationships with other functions was an area brought up in every interview. From one side, buyers interact with different functions in the supply risk management process, giving and receiving help from them regarding risky suppliers or active crises.

"So we had to hash out why it was there, why was delivery performance so low, and when I took them out then their delivery performance obviously skyrocketed and then it was really no issue. This is where the cross functional meetings are really quite important to understand the risk of the relationship." -Project buyer

"I had support from quality analyst, which is an area I cannot take over for lack of expertise." -Operations buyer

"About my crises, I am now supported by a team. [...] Now you have a team, so you do not feel stressed, because you have people that help you, before you were following your deliveries by yourselves, you were organizing meetings, placing orders for this or that. Now with these responsibility split you are not alone." -Operations buyer

However, at the same time, several buyers expressed how they had had troubles getting support from other departments of the company when facing a risk or a crisis.

“We did not have all the functions involved, and we did not have 100% priority. I had to handle tasks of other functions by myself. For example, the functions of the material controller, the interactions with the supplier. [...] It was not a priority, so I had to cover other functions.” -Operations buyer

“In any crisis you should ask for safety stocks, even if it will be solved. We have internally to check to do this, because no one wants to take them, because it is a budget, it takes money. Plants do not want them because they occupy space and impact the cash flow, purchasing wants them, but there is a need for money to keep them in a warehouse.” -Operations buyer

“Okay product development, what can we do here, you know it is too complicated to change this kind of parts, [...] you continue to push, we do not have budget, you continue to push, to push, to push, and end of the year crashplan, no more deliveries, product development will work now” -Operations buyer

Relationship with suppliers

This was an area that was touched upon in several of the interviews, how suppliers was often viewed as opponents rather than as partners in the supply chain. They are often pushed hard to reach the targets of the company, in the attempt to reach the required savings, and this in turn makes them less open in the relationship with the company itself. Smaller suppliers in particular emerged as often scared of the company and more keen on hiding information, because of fear of losing business with the company.

“It is difficult to get access to suppliers, because we sometimes squeeze them too hard after an evaluation. We press for a big part of the savings, and then they are wary of letting us into the company again after that” -internal development consultant

“You need to chase them to get results.” -Operations buyer

“But afterwards we should consider the shape of the suppliers and I think with all task we have done until now we have done most of all the big saving possible” -Operations buyer

“Sometimes they are open, sometimes they are scared, even if it is the company’s fault, for example for a blocked invoice, especially smaller suppliers. The company is a big customer, so the suppliers may think that how they act may influence the way they are treated afterwards.” -Operations buyer

“I think that if they had problems with their daily operations they would not really contact me, especially smaller suppliers seems scared of the company.” -Operations buyer

“[Suppliers] do not want to lose face for a problem, so it is harder to being open. I feel that they would rather hide something for fear.” -Operations buyer

“The most important is communication. Since it is sensitive and nothing should be said to suppliers regarding the crisis, we are keeping a lot of thing internally, but we see that nevertheless it spreads outside. So I think we should educate people internally that when it is confidential it should be confidential, because it can impact the future of the company.” -

Operations buyer

At the same time, however, several buyers also pointed out how important the relationships they have with their suppliers is. They take into account how suppliers behave and try to build long term relationships with the ones they are going to have a long term interaction with.

“I will come right to that. But, you have this cost preference, one of the aspects is relationship, what is my feeling with the key account manager, in this kind of business it is key, because it is long term business. So with my supplier we deal with them over a long time, because the production [of our products] runs [several] years, so this aspect is very important” -Operations buyer

“Of course we work with the optimization of the supply chain, we work on strengthening our supply base, securing long term relationships and long term agreements” -Aftermarket buyer

“But I think in the end is all about communication and create these situations of cooperation mode. I am with this portfolio since two years and I just now started to send [to the suppliers] these performance reviews. And even if they are performing well, it is also a way for them to see that they are recognized by the company” -Operations buyer

Mandate and responsibilities

Several of the buyers expressed that they were, or had been, unsure of what their responsibilities and authority to make decisions in a situation with a crisis or a foreseen risk.

“Sometimes it should have been clear from the beginning that my rule was not explained or written correctly. For example, now I am pushing with sourcing when I need it. But before I did not know it was part of my responsibility. If you are in this crisis as a leader you should push sourcing. So it was not clear the mandate. When you assign someone the mandate should be clear, what are the responsibilities.” -Operations buyer

“And I think also the main issue is that we always assume that someone will take the lead on the crisis or solve the situation before us, because usually we going to have not so many contact with the suppliers, that’s our target you know, so maybe we have this feeling, okay, [someone else] will deal with it, it will be fine” -Operations buyer

“I really do not know how to act, for example sometimes I go through my supplier’s scorecard and I see that their score is not the best. But I do not really know if somebody is already taking any actions on that, or maybe I should step in and start any communication” -Operations buyer

“No, it is like I said with the financial aspect, I am not sure how that is. And I was talking to some of the other buyers and it is not really clear how that is escalated like the financial situation. You know they have these improvement strategies that are very much connected to potential savings and supply chain analysis, and things like that. But I do not think anybody is really looking through their financials to check how they are doing” -Crisis management intern

A crisis management position

A handful of the interviewees expressed their views that a separate function or team for crisis management would improve the situation.

“But for the first crisis I had, there were too many entities involved. I think there is the need for some kind of structure, someone who is leading it, who is communicating the information, who is the link between you and the external supplier or legal or whatever it is and the internal stakeholders” -Operations buyer

“How to be more structured, that there should be a team inside which roles and responsibilities are split.” -Operations buyer

“Because you can be buyer but you are not necessarily a project manager, and sometimes crisis becomes project management, then it is another job. And that requires some skill, lot of skill to be a good project manager.” -Operations Buyer

“What I do know is that some of the other large companies like [names of the companies] have dedicated crisis teams/risk mitigation teams working full time with this. Whereas in our case the director for operations purchasing has a full time job aside the crisis management and both are suffering in a way, because when there’s no crisis he’s full time on the regular job and continuous improvement and all that stuff, and when there’s a crisis it’s all about that and there’s no time for the regular job” -Crisis management intern

“And I think if you want to be more proactive I think you need it as a full time job actually. Both the proactive work and the crisis management I definitely think is a full-time job.” -Crisis management intern

Decision chains and authority

The lack of authority to make decisions on their own and the long decision chain to take actual decision have been identified as roadblocks by numerous interview subjects. They see the process related to risk management as too long and bureaucratic, since it often requires the involvement of the upper management to take relevant decisions regarding risky suppliers. More autonomy and decentralization of power have emerged as a winning solution from the experience with suppliers from a specific country, as a way to improve the flexibility of the supply risk management process and make it faster.

“[Referring to the long process] sometimes it takes us six months to a year to close [a crisis]. I had a crisis [...] from a supplier, it took us two years to close it” -Project buyer

“For crises in general we should have a more flexible approach, because for every penny you need you need to go through a long process.” -Operations buyer

“I think that when we have a crisis we have, even in general, we tend to have so many processes and so many levels of approval that it takes a lot of time and when you have a crisis especially it’s delivery time equals money, so if you have to lose a week or two weeks to get decisions made in order to knock a hurdle out you’ve lost a lot of money” -Project buyer

“What I think is the problem is the lack of budget for these kind of things. It took at least from

September to end of January to have a budget decision. Really bureaucratic procedure." -Operations buyer

"Well, faster approval for one. Because normally the approval process itself will take some time, and you will have to go through all the different levels to get approvals. But in a crisis normally happens fast, but it could have been faster" -Sourcing buyer

"For example, for reducing the payment time. It has to go all the way up to VP of business control for him to give the approval before we change it in the system. But if it is an extreme crisis situation probably an operations manager or sourcing manager, or sourcing director could take a decision saying that it will stop the line and we need to have this approval right now." -Sourcing buyer

"And also if there is some one-time payment again it goes to the VP of business control for his approval, before that nothing happens" -Sourcing buyer

"For instance [name of a country] is a market crisis so they have altered the process to allow faster decision making for that market so maybe normally in risk mitigation process when it comes to decision making maybe the people that can make the decisions are in [other parts of the globe]. In [name of a country] we got permission to localize the decision making to speed up the process, meaning I can go from one building to the other instead of waiting twelve hours overnight waiting someone in [another far country] to authorize it" -Project buyer

"I think because we also waited for the supplier to send the official letter, official information that they are changing something. And we cannot trigger many thing inside the company without those official statements." -Operations buyer

"If at that time when we knew that something was going to happen, if we already involved the risk mitigation team I think at least we might get some kind of things that could be done then or at least have a close follow up from the financial risk team, because I think they were already able to say that that plant is bankrupt, so you have to start looking for an alternative" -Operations buyer." -Operations buyer

Coordination among functions

An issue that different interviewees brought up relates to coordination with other functions. The point that emerged is that they are not fully aware about what other functions are doing in relation to dealing with risky suppliers in their area of competence. What emerged is a lack of knowledge in regard to the actions that these other functions are putting in place to manage a foreseen risk.

"But this year they are quite often in contact because of the position on their side, and quality analyst also have this performance review with them. So it is like we have each and every function when they have a job, they share it. We are not necessarily aware and that maybe is a pity" -Operations buyer

"And that is because in that process we were part of [name of department] at the time and [name

of department] was doing a study, but they would not allow us any information in the study. Just kind of keep waiting, keep waiting and this is unacceptable because I do not know if it has being prioritized and the company was losing a lot of money on the table leaving a lot on the table" -Project buyer

"Material controllers, we talk to them when we have a problem, when we have a question, but I think it would be good to have some kind of communication with them on how they perceive certain suppliers, because they are the one dealing daily with the suppliers and might have good knowledge of them" -Operations buyer

"I think that if this would be more imposed to this team of financial risk, and if we could meet them even once a year to discuss what they are struggling with or what kind of help they might need at least we would remember about that and then we would forward them the information that we have that we think might be of value to them." -Operations buyer

"Another output I was surprised is that before sending the performance review to the supplier I sent them to my team connected to the supplier, so quality analyst, delivery analyst, and capacity analyst, for their feedback. And I was actually surprised to see the feedback with all the actions they are already doing connected to the supplier. Because I think we are not aware of that, because we don't have this kind of commodity approach at the company, everyone is covering their own scope, and doing a lot of activities that other functions are not aware of" -Operations buyer

"I think right now we do not interact with [the financial analysts] unless we have crises, we forget that they are actually there and that this might be some useful information to them" -Operations buyer

Phase out process when switching to new supplier

When switching to a new supplier, there is often a long process involved to get this done.

"But also in terms of lead time, because if it has a high criticality in terms of quality, such, it will require more testing, and more testing means longer lead times, so you need to start with those first to secure that you have enough time and testing available" -Crisis Management intern

"I mean it is first sending out the requests for quotation and then reviewing the technical specifications, then there needs to be an agreement, after that you need to do all of the testing. The suppliers need tooling, because we cannot take out the tooling in the lead time." -Crisis management intern

"Many of the parts need re-testing which takes a lot of time. Then you need to start building up safety stock. And then it is a year minimum. With vacation in between, nobody is going to do anything" -Crisis management intern

Categorization of suppliers

From the interviews it emerged that the most common focus of all the interviewees was to focus on the suppliers with the largest spend. The focus is on these few big suppliers because they

represents the higher influence in terms of costs for the company. What was followed by almost every interviewee is a 80/20 categorization, where the main focus is put on the 20% of the suppliers, which usually represent around 80% of the spend. However, it also merged how making use of this categorization is something that a few buyers also pointed out as a problem. In this way the smaller suppliers, which can be producing components that can lead to a stoppage of the production line, are not under the radar of the buyer. This can therefore cause issues related to unforeseen disruptions, leading to negative consequences for the company.

"It is up to you but you always focus on the big [suppliers]" -Operations buyer

"Well, since the number of suppliers is pretty high. So we more or less concentrate on the spend. So we try to cover as much as possible, the number of suppliers, but it is physically not possible. So we normally categorize based on spend." -Financial analysts

"So again I maybe focus on three to four biggest suppliers, but on my scope four suppliers cover 83- 84% of the spend, then I have 15 that are the remaining 20%, so I focus on those four suppliers" -Operations buyer

"I think it is normal to focus on biggest spend, but sometimes we also see that issues that we have come from those smaller suppliers that maybe are not that visible because they have just a few part numbers and limited spend. But they are also delivering the parts that might stop the production or have severe consequences" -Operations buyer

Internal and external transparency

The transparency, or rather lack thereof, was a problem that was mentioned in most of the interviews. This is a problem that exists both internally in the company, where some information is not but also in relation to the suppliers.

"Yeah, they basically go through the supplier portal. If for some reason the supplier doesn't do that then we go and ask. So it's quite challenging with some suppliers to get the information because it's a question of transparency. What I experienced so far is that with some countries they are not transparent at all, with some it's pretty easy to go to the public database to get the information" -Financial analysts

"This is only internal. That's why it brings, some suppliers they start with the questions but… It's actually very sensitive information, financials and such, so it's very limited people in the organization who has access to the financial scorecards. So it's mainly supply financial analysts… I don't think even host buyers have access to the financial scorecards and such. I mean you see the scores but there's never any details. That's why it's always the cooperation you know" -Financial analysts

"Yeah exactly I think closer follow up. And I think more visibility on the financial statement would be really helpful, or at least focusing on the most, how to say, our eighty percent, to evaluate and have a recent update how are they doing right now, do we foresee any potential crisis, any distress. But only the financial department can give us this information" -Aftermarket buyer

“So it can definitely be improved, the process can be improved, access of the information can be more shared within the organization, better visibility of our suppliers” -Aftermarket buyer

“I had a crises [...] from a supplier, it took us two years to close. And that is because in that process we were part of [name of department] at the time and [name of department] was doing a study, but they would not allow us any information in the study.” -Project buyer

Retaining information in the organization

The problem with information disappearing was brought up in a few interviews regarding how information is stored and shared, and the high staff turnover of some of the departments.

“Another aspect is that we take in these consultants now who are quite expensive and when the crisis is gone they are out of here, and I am only here on an internship [...], so I will be gone and the director of operations purchasing maybe will switch position and then the expertise that we have gained from them is gone.” -Crisis management intern

“But we are a lot of new buyers and we don’t have the experience, and in the beginning it is hard to realize all those connections, then that’s where it’s actually maybe also a problem, so that might be something that can be in the new comers introduction” -Operations buyer

“If you had had a dedicated team the knowledge would survive within the team” -Crisis management intern

“What I was maybe missing during my hand-over was the information really about the supplier, because I think we have a lot of material internally that we collect during the time, but when a new person comes, I felt like I had to find everything myself from the supplier” -Operations buyer

“So this information I was missing, like what is their production process, who is who, what is the escalation at the supplier, who reports to whom, what is their supply chain for example the value stream mapping, things like that, those very detailed information of the supplier.” -Operations buyer

“The history, all the communication with the supplier. Because right now I think all the email are actually stated as agreement as well, and sometimes the supplier can trick us saying that they had agreed on something with someone, but we do not know, because we do not store these kind of information” -Operations buyer