

# Risk Analysis for Strategic Sourcing

## Risk Identification and Treatment of Late Deliveries

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Lund, June 2018

Marcus Pola & Gustav Reingsdahl



## ABSTRACT

|                    |   |
|--------------------|---|
| <b>Title</b>       | Risk Analysis for Strategic Sourcing – Risk Identification and Treatment of Late Deliveries   |
| <b>Seminar</b>     | 2018-06-07  |
| <b>Course</b>      | Degree Project in Engineering Logistics, MTT820, Master Thesis, Postgraduate Level  |
| <b>Authors</b>     | Marcus Pola & Gustav Reingsdahl   |
| <b>Supervisors</b> | Lund University: Professor Dag Näslund<br>Case company: Fredrik   |
| <b>Key words</b>   | <i>Supply chain risk management, procurement risk, purchasing risk, late deliveries, traded goods, global sourcing, risk management, risk process, risk mitigation, risk identification, risk analysis, risk mapping.</i>   |
| <b>Background</b>  | The supply chain is the functions that manages the delivery of goods from suppliers via the company and to the end customers. If something were to interfere with that chain the consequences could be severe, in some cases even deadly. Therefore, it is important that risks within the supply chain are being identified and attended to. This might be one of the reasons for the increase of interest, both academic and professional, in supply chain risk management.   |
| <b>Problem</b>     | The company has recently experienced supply shortages from Asian suppliers and was forced to take costly actions to secure the continuous supply. This combined with the non-existing risk mapping of their supply chain has open up the interest in the field supply risk and supply risk management.  |
| <b>Purpose</b>     | To conduct a supply risk analysis. This by first identifying the risks that the company are subjected to and assess how critical these risks are. Secondly, to identify the most critical risk and find mitigation strategies for the given risk.   |
| <b>Theory</b>      | First some fundamental concepts were described and defined to better understand risk and risks within the context of supply chain. Then a literature review was conducted to better understand how to identify risks within the supply chains and how to categorize and analyze those risks. Common ways to identify risks are through brainstorming or conducting interviews while the categorization of risks often begins with an initial broad classification and then divide the risks further. To analyze the risks normally two categories, impact and probability, are used as a ranking reference. A smaller second literature review was performed to find which mitigation strategies that exists for risks within the supply chain. The mitigation strategies vary dependent on the risk and there is not a single strategy that will solve any given risk. |
| <b>Method</b>      | The aim will be achieved by mapping the risk situation of the company, by interviews and meeting. Followed by a ranking of the identified risks, based on probability and impact, to choose the most critical risk for the company. Finally, finding the causes,  |

by mapping the process, that makes the risk occur and to find corresponding mitigation strategies that help solve these causes. Due to a strong practical orientation a case study with predominantly qualitative approach were chosen.

**Conclusion** The result consists of a visualization of the risk environment for the company, currently there exist 15 different risks with corresponding 30 risk causes. When ranking the identified risks, the risk *late deliveries* received the highest weighted score and thus can be seen as the most critical risk for the company. Finally, causes and solutions for *late deliveries* were developed. The most important causes were *visibility of goods* and *information exchange*. The solutions were divided into three different time horizons were horizon one was between 6-12 months with solutions *SRM system*, *New measuring point* and *Article management*. Horizon two was between 1-3 years with the solution *Department improvement*. Horizon three was more than three years with the solution *Warehouse in Asia*.

## SAMMANFATTNING

|                   |   |
|-------------------|---|
| <b>Titel</b>      | Risk Analysis for Strategic Sourcing – Risk Identification and Treatment of Late Deliveries   |
| <b>Seminarium</b> | 2018-06-07  |
| <b>Kurs</b>       | Examensarbete I teknisk logistik, MTT820, Examensarbete, Mastersnivå  |
| <b>Författare</b> | Marcus Pola & Gustav Reingsdahl   |
| <b>Handledare</b> | Lunds Universitet: Professor Dag Näslund<br>Fallföretag: Fredrik  |
| <b>Bakgrund</b>   | Logistik är den funktionen inom ett företag som hanterar godsflödet från leverantören via företaget till slutkund. Om något skulle inträffa i det flödet kan konsekvenserna bli ödesdigra, ibland till och med dödliga. Därför är det viktigt för företag att identifiera och hantera risker inom logistikflödet. Detta kan vara en av de underliggande orsakerna att det har skett en intresseökning, både akademiskt och professionellt, för styrning av risker inom logistikflödet på senare år.   |
| <b>Problem</b>    | Nyligen har fallföretaget upplevt leveransstörningar från några av sina produkter från Asien och varit tvungna att ta till kostnadsintensiva metoder för att säkerhetsställa sin fortsatta produktleverans. Detta kombinerat med företagets icke existerande riskkartläggning har öppnat upp intresset för risker inom logistikflödet och styrning och kontroll av dessa risker.  |
| <b>Syfte</b>      | Att genomföra en analys av företagets risker relaterat till logistikflödet från leverantör in till företagets lager. Detta skall genomföras via att först identifiera vilka risker företaget är utsatta för och hur kritiska dessa risker är. Nästa steg är att identifiera vilken risk som är den mest kritiska risker för företaget och hitta strategier som förebygger och minimerar denna.  |
| <b>Teori</b>      | Inledningsvis beskrivs och definieras ett par grundläggande begrepp för att bättre förstå risker och risker inom logistik. Fortsättningsvis genomfördes en litteraturgenomgång för att förstå hur man kan identifiera risker inom logistikflödet, hur man kategoriserar de identifierade riskerna och hur man analyserar dem. Vanliga tillvägagångssätt för att identifiera risker är genom brainstorming eller intervjuer medans kategoriseringen av risker oftast sker via en initialt bred klassning som sedan delas in ännu mera. För att analysera riskerna används vanligtvis två kategorier, verkan och sannolikhet, för att kunna rangordna dem. En mindre litteraturgenomgång genomfördes för att identifiera vilka strategier som fanns för att mitigera risker inom logistikflödet. Strategierna varierade beroende på risk och där fanns ingen strategi som kunde lösa en given risk. |
| <b>Metod</b>      | Målet kommer att uppnås via att kartlägga risksituationen hos företaget, via intervjuer och möten. Detta följs av en ranking av de identifierade riskerna,  |

baserad på sannolikhet och verkan, för att hitta den mest kritiska av riskerna. Slutligen att hitta de underliggande problemen, via att kartlägga processen, som får risken att uppkomma samt att hitta motsvarande mitigeringsstrategier som kommer att lösa de underliggande problemen. Då vår ansats är av det praktiska slaget valdes en fallstudie med fokus på ett kvalitativt angreppssätt.

**Sammanfattning** Resultatet består av en visualisering av vilka logistikrisker som företaget är utsatta för, nuvarande finns det 15 olika risker med motsvarande 30 identifierade riskorsaker. Följaktligen rankades de identifierade riskerna där risken *late deliveries* fick högst avvägd poäng. Slutligen togs de underliggande problemen och lösningarna för försenade leveranser fram. De viktigaste underliggandeproblemen var *visibility of goods* och *information exchange*. Lösningarna blev uppdelade i tre olika tidshorisonter där horisont ett var mellan 6–12 månader med lösningar *SRM system*, *New measuring point* och *Article management*. Medans horisont två var mellan 1–3 år med lösningar *Department improvement*. Horisont tre var mer än tre år med lösningar *Warehouse in Asia*.

# Table of Contents

|  |    |
|--|----|
| DICTIONARY.....  | 1  |
| CHAPTER 1 INTRODUCTION .....                                 | 3  |
| 1.1 Background.....  | 3  |
| 1.2 Practical Background .....                               | 5  |
| 1.3 Problem Discussion .....                                 | 6  |
| 1.3.1 Risk analysis.....                                     | 6  |
| 1.3.2 Risk treatment.....                                    | 6  |
| 1.4 Purpose & Research Questions .....                       | 7  |
| 1.4.1 Risk analysis.....                                     | 7  |
| 1.4.2 Risk treatment.....                                    | 7  |
| 1.5 Delimitations .....                                      | 8  |
| CHAPTER 2 THEORY .....                                       | 9  |
| 2.1 Fundamental Concepts.....                                | 9  |
| 2.1.1 Purchasing Organization.....                           | 9  |
| 2.1.2 Risk and Uncertainty .....                             | 10 |
| 2.1.3 Supply Chain Vulnerability.....                        | 10 |
| 2.1.4 Defining Supply Chain Risk Management.....             | 11 |
| 2.1.5 Risk Management Process.....                           | 11 |
| 2.2 Risk Analysis.....                                       | 13 |
| 2.2.1 Risk Identification .....                              | 13 |
| 2.2.2 Risk Areas .....                                       | 14 |
| 2.2.3 Risk classification framework .....                    | 16 |
| 2.2.4 Risk assessment.....                                   | 19 |
| 2.3 Risk Treatment .....                                     | 23 |
| 2.3.1 Risk Control and Risk Financing.....                   | 23 |
| 2.3.2 Flexibility and Redundancy.....                        | 25 |
| 2.3.3 Mitigation strategies related to late deliveries ..... | 27 |
| 2.4 Framework Synthesis .....                                | 29 |
| CHAPTER 3 METHOD .....                                       | 31 |
| 3.1 Research Methodology .....                               | 31 |
| 3.2 Risk Analysis.....                                       | 33 |
| 3.2.1 Research design.....                                   | 33 |
| 3.2.2 Respondents.....                                       | 35 |

|   |    |
|---|----|
| 3.2.3 Data Collection .....   | 35 |
| 3.2.4 Data Analysis .....   | 38 |
| 3.3 Risk Treatment .....  | 42 |
| 3.3.1 Research design.....  | 42 |
| 3.3.2 Respondents.....  | 44 |
| 3.3.3 Data Collection .....   | 44 |
| 3.3.4 Data Analysis .....   | 47 |
| 3.4 Reliability and Validity .....                                    | 49 |
| CHAPTER 4 RESULT .....  | 50 |
| 4.1 Risk Analysis.....  | 50 |
| 4.1.1 Risk identification .....                                       | 50 |
| 4.1.2 Risk areas.....   | 50 |
| 4.1.3 Risk Assessment .....   | 56 |
| 4.2 Risk Treatment .....  | 59 |
| 4.2.1 Suppliers, Inputs, Process, Outputs and Customers (SIPOC) ..... | 60 |
| 4.2.2 Process mapping.....  | 61 |
| 4.3.3 Swim Lane mapping.....  | 66 |
| CHAPTER 5 ANALYSIS.....   | 69 |
| 5.1 Risk Analysis.....  | 69 |
| 5.1.1 Risk Identification .....                                       | 69 |
| 5.1.2 Risk Assessment .....   | 70 |
| 5.2 Risk Treatment .....  | 72 |
| 5.2.1 Background to Late Deliveries.....                              | 72 |
| 5.2.2 Identified Problems .....                                       | 73 |
| 5.2.3 Identified Solutions .....                                      | 79 |
| 5.2.4 Evaluating & Ranking of Solutions.....                          | 86 |
| CHAPTER 6 DISCUSSION & FINAL CONCLUSION.....                          | 90 |
| 6.1 Risk Analysis.....  | 90 |
| 6.2 Risk Treatment .....  | 93 |
| 6.3 Contributions & Further Research .....                            | 96 |
| 6.3.1 Academic contribution .....                                     | 96 |
| 6.3.2 Practical contribution .....                                    | 96 |
| 6.3.3 Further research.....   | 97 |
| References.....   | 98 |

APPENDIX ..... 106  
Analytical Hierarchy Process ..... 106

# DICTIONARY

## Abbreviations

|             |   |
|-------------|---|
| <b>3PL</b>  | Third Party Logistics relates to a company's use of a third-party business to outsource elements of the company's distribution and fulfilment services. |
| <b>4PL</b>  | Fourth Party Logistics is similar to a 3PL but can run complete supply chain solutions.   |
| <b>AHP</b>  | Analytic Hierarchy Process is a structured way of deciding between various alternatives   |
| <b>BA</b>   | Business Area relates to the business area at the company were this thesis were conducted   |
| <b>ERM</b>  | Enterprise Risk Management relates to methods and processes used to manage risks and opportunities within an organization.                              |
| <b>ERP</b>  | Enterprise Resource System can be described as the integrated management of core business processes and is typically integrated in software.            |
| <b>ESI</b>  | Early Supplier Involvement relates to involving the supplier early in the production development phase.   |
| <b>MOQ</b>  | Minimum Order Quantity is the minimum amount that can be ordered from a supplier.   |
| <b>PO</b>   | Purchase Order is the order that a company places to a supplier.  |
| <b>SC</b>   | Supply Chain is a system involving the movement of a product or a service from point of origin to end customer.   |
| <b>SCM</b>  | Supply Chain Management is the management of the flow of goods and services.  |
| <b>SCRM</b> | Supply Chain Risk Management is the management of risks along the supply chain.   |
| <b>SRM</b>  | Supplier Relationship Management is a system that manages all interactions with suppliers.  |
| <b>TCO</b>  | Total Cost of Ownership is when you consider all direct and indirect cost associated with a purchase.   |

## Clarifications

|                  |  |
|------------------|--|
| <b>Anonymity</b> | Due to a non-disclosure agreement between the company and authors neither company specific information nor surnames of employees will be exposed in this thesis. |
|------------------|--|

**Chapter Parts** The study follows the risk management process, but chooses to divide it into two parts, risk analysis and risk treatment. Therefore, the majority of the chapters are divided in two major parts, namely risk analysis and risk treatment.

**Silo mentality** Here it is used for describing a strong functional focus within a company. That is departments are working by themselves and optimizing their own function.

**Throughput** Refers to the maximum rate at which something can be produced.

## Defined Roles

**Authors** Consisted of two master students at the faculty of engineering at Lund University. The Authors were responsible for partly outlining the project, conducting the study, presenting the study's findings and writing this thesis.

**Project owners** Consisted of two employees at the firm, one commodity manager and one senior commodity manager. Together with the authors they outlined the project and set the ground principles. The project owners were also part of the steering committee which was the committee that the authors presented for and whom helped the project move forward.

**Steering committee** Consisted of the operations director and the business area director. Together with the project owners they created the steering committee which the authors presented their finding and the emergence of the project.

# CHAPTER 1 INTRODUCTION

---

*The introduction will cover background, theoretical as well as practical, to the topic and areas discussed in this paper. Further, it will outline the problem discussion as well as clarify the purpose and research questions. Lastly, it will clarify the delimitations of the study.*

---

## 1.1 Background

Throughout the history of mankind, we have taken a lot of risks, e.g. finding new places to hunt or where to settle down. Bernstein (1996) states in his book that the first serious investigations of risks were performed during the Renaissance. Gorzeń-Mitka (2017) follows Bernstein by stating that it was during the twentieth century that real progress with risk measurements and control were made, for example, studying risks in the economical field (Dowling & Staelin, 1994) or developing the modern form of risk management as we know it today (Dionne, 2013).

Moreover, people are assumed, by behavior studies, to be risk adverse (March and Shapira, 1987; Hintze, Olson, Adami & Hertwig, 2013), i.e. when faced with two alternatives one where the outcome is fixed and one with variable outcome but both alternatives have the same expected outcome value, people tend to choose the alternative with a fixed outcome. Further, people tend to be more risk seeking when the scenario emphasis losses (Tversky & Kahneman, 1981; Lakshminarayanan, Chen & Santos 2011), e.g. people who have their house out for sale will keep their house on sale for a longer period when the market price is below their original purchase price (Genesove & Mayer, 2001). Even though taking risks are a natural part of life there is no definite definition of risk (Aven & Renn, 2009). But, numerous researches such as (Pratt, 1964; Kaplan & Garrick 1981; March and Shapira, 1987; Sitkin and Pablo, 1992) has described risk as the variance of the probability distribution of outcome, i.e. there is uncertainty whether there will be positive or negative outcome of a given scenario.

Vasvári (2015) states that risk drives innovation and development and Cettolin & Tausch (2015) as well as Kenneth (1996) claims that people are more prone to take risks if they can share the responsibility and the possible detrimental consequences. Thus, it is interesting to investigate risks from an organizational perspective where employees and managers undertake risks without being personally liable (Greenlaw & Taylor, 2014). Another reason for the interest of risk and risk management, from an organizational perspective, is the possible negative consequences of a risk occurring, e.g. the quality risk with Ford's firestone tires resulting in a cost of \$2.1 billion for Ford and 203 people losing their lives (Truett, 2001). The possible severe negative consequences are one of the drivers why we today see an increasing interest in risk and risk management (Gorzeń-Mitka, 2017; Sitkin & Pablo, 1992; Olayinka, Emoarehi, Jonah & Ame, 2017) and organizations nowadays views enterprise risk management (ERM) as a key function within the company (Nocco & Stulz 2006; Bangaan, Janor, Hamid & Yatim, 2017; Ai, Brockett & Wang 2017).

An effective enterprise risk management is, apparently, becoming increasingly important in today's dynamic risk environment (Bangaan, Janor, Hamid & Yatim, 2017; Nocco & Stulz, 2006) and according to Zsidisin (2003) there has been numerous investigations in the past regarding the field of organizational risks in various business functions. For example, risks within managerial decision making where managers view the monetary consequences rather than assessing or accepting the risks (March

& Shapira, 1987; Shapira, 1993; Riabacke, 2006). Or financial risks, such as the financial crisis back in 2008 (Bartram, Brown & Waller, 2015). However, in today's global environment with both internal and external risks together with more emphasis on lean processes which consist of cutting buffers more pressure is put on the supply chain to operate smooth and flawless (Aqlan & Lam, 2015; Chen, Sohal & Prajogo, 2013; Zhu, Krikke & Caniels, 2017). Thus, it is of vital importance that the supply chain operates without disruptions and continuously to operate with a stable flow of goods.

This has opened an interest for the field supply chain risk management (SCRM) which has in the last two decades been an emerging area and subject within both the academic and business professional focus. There is no standard and not a consistent and explicit way of how to define supply chain risk management. A reason for this might be the quite broad definitions of the terms 'supply chain management' as well as 'risk' and 'uncertainty' (Brindley, 2004; Manuj & Mentzer, 2008; Wu & Blackhurst, 2009; Wieland & Wallenburg, 2012). However, there are several academics that have defined the area throughout the last decades including Norrman & Lindroth (2002), Jüttner, Peck & Christopher (2003), Tang (2006), Manuj & Mentzer (2008) and Wieland & Wallenburg (2012). The essence of SCRM is that it relates to managing the decision-making process on different levels with regards to risks and uncertainties.

Further, today's modern supply chain, with focus on higher efficiency and cost reduction, together with the increasing globalization and outsourcing, has increased its number of exposure points and thus environment risks (Stecke & Kumar, 2009; Brindley, 2004). This has resulted in supply chains that are susceptible and vulnerable to disruptions that can happen at a remote geographical location relative to the main business operations of a company (Stecke & Kumar, 2009). In 2015 there was 198 recorded natural catastrophes and 155 man-made catastrophic events (Swiss Re, 2016), these events, frequent as well as rare, affects the companies and subject them to major losses (Stecke & Kumar, 2009). There are also studies showing that an adoption of quality management as the concept of lean and buffer reduction can make the firm more vulnerable to disruptions. Hendricks and Singhal (2005) found that companies suffering from supply chain disruptions experienced 33–40% lower stock returns relative to their industry benchmarks over a 3-year time period that starts 1 year before and ends 2 years after the disruption announcement date. Risks can also be found at sub-suppliers which increase the importance of mapping over several tiers in the supply chain; an example of this is for instance Ericsson who reconsidered their supply chain from a risk perspective (Norrman & Jansson, 2004).

Thus, SCRM stretches over the entire supply chain, from supply related parts and the inbound flow of resources to sales and the outbound flow of resources to end customer. Because all purchasing organizations are subjected to risk, and approximately 50% of the cost of goods sold are related to the purchasing value (Weele, 2015), supply risk management is an area that has gained interest (Zsidisin, 2003). There have been different attempts to define supply risk, Kraljic (1983) defined it relatively early but then with a narrow market focus with supply as a scarcity. From practice and literature Zsidisin (2003) gives the definition "...the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety". Trying to combine this with management, thus looking at the supply part of SCRM, the field supply risk management as a sub-field to SCRM has emerged. Whilst there have been done several studies within SCRM Hoffmann, Schiele & Krabbendam (2013) identifies supply risk management as being in its initial phase.

## **1.2 Practical Background**

Since the company wishes to be anonymous the practical background will be kept rather small, but for understanding purposes this study will develop some areas that are important for this study. The company headquarter is located in Sweden, but the company has facilities and warehouses around Europe. One warehouse is located in Germany, this warehouse will be referred to later on. Further, the company operates as a supplier of tableware concepts as well as packaging and take away solutions. The suppliers of the company are located around the world but with a growing supplier base in Asia, which is a relatively new market for the company since they, originally, only operated in Europe. Since that time the company has grown and has now market presence in over 40 markets.

The company consists of different business areas (BA) but this study only investigates and works with one BA. This BA is within the trading part of the company and operates in an area that creates concepts and trades items related to serving and packaging food within take-away, fresh ready-to-eat food as well as catering.

The company has the ambition to advance in the Purchasing Development Model by Weele (2015) were the company today is on a lower level with focus on transactional purchasing. In this advancement together with earlier supply crises the company has expressed an interest in risk management within the purchasing department. Further, the company is experiencing low inbound delivery performance from suppliers in Asia, this while trying to maintain or increase the outbound delivery performance towards end customers.

## **1.3 Problem Discussion**

### **1.3.1 Risk analysis**

The company find itself today in an early phase of Weele (2015, p.68) purchasing model and are working actively to develop the maturity of their purchasing department to move to a higher phase of the model. The company has also recently experienced supply shortage from an Asian supplier of an important article due to lack of risk awareness from the company. This has brought up the area risk management and the questions about how to work actively and proactively with risk management. Further, it has made the company understand that a first step is to understand their risk environment, i.e. the risks that the company are exposed to and the severity of these risks and thus also be able to classify the risks properly. Another important area is to understand what risks that is worth dealing with and what risks that the company can bear. This has opened up the interest in, what this study calls, "risk analysis" which aim is to map the risk environment of the company and ranking these different risks after the situation of the company. By doing this it also opened up the need of a system to classify the risks at a company which is something this thesis aim to contribute with a perspective on.

### **1.3.2 Risk treatment**

The company is today focusing strongly on outbound deliveries towards customer which comes from a history of a European business model with short lead time, reliable suppliers and an inbound delivery performance that did not show an urgent need of attention. As the company grew over the last decade the procurement started to source products from low cost countries such as China but kept its European trading model and focus on outbound deliveries. This created a low inbound delivery performance and probably led to high stock levels to keep up the outbound delivery performance. It also created problems with goods not arriving and problems with the notification of goods running late due to a lack of traceability over long lead times for products sourced from Asia. This opened up the interest to understand why inbound delivery is relatively low and how to mitigate the risk for *late deliveries* to the company from its suppliers.

## **1.4 Purpose & Research Questions**

### **1.4.1 Risk analysis**

The purpose of the thesis is to map the risk situation of the company as well as rank the relative importance and severity of risks that the company are subjected to. To better understand and divide the risks a risk classification was necessary. This led to the need of creating a risk classification framework. Further the aim is to determine the company's top risks and to choose one risk to investigate further in the risk treatment phase.

*Research question 1: Which procurement risks are the company exposed to?*

*Research question 2: Which are the most critical risks that the company is subjected to?*

### **1.4.2 Risk treatment**

The purpose of the risk treatment phase is firstly to understand why the company is experiencing a low inbound delivery performance and the causes for this. Further, the aim is to find solutions that will increase the inbound delivery reliability and to evaluate these solutions relative each other with regards to impact and feasibility.

*Research question 3: What are the causes for the low inbound delivery reliability?*

*Research question 4: What should be done to increase the inbound delivery performance?*

## 1.5 Delimitations

Below are the delimitations this study has taken presented and explained.

**Business continuity.** The chosen process of risk management consists of 4 steps, risk identification, risk assessment, risk mitigation and business continuity. The fourth step, business continuity, is not considered in this study since there was limited time to conduct the study and the study, in its nature, were more practical rather than theoretical.

**One company.** This study only investigates one company, i.e. does not benchmark or compare to how other companies are working with risks. This, since the problem was formulated as a company specific problem and not a general problem.

**Procurement.** Only the procurement is considered in this study. Hence, procurement starts with a purchase order and ends with goods being delivered to company warehouse. Nothing before the purchase order or after the goods has been delivered has been considered in this study. Reasoning behind this is that, with the given time frame, it is not feasible to conduct a bigger study. Also, the given scope was in purchasing, i.e. procurement.

**Traded goods.** This study investigates risks related to procurement and traded goods. I.e. procurement for e.g. own production or indirect goods are not considered. Consequences of this is e.g. when it is stated "general" means, in this study, traded goods.

**Germany Warehouse.** The company has several warehouses but to make this thesis more comprehensible and feasible only the German warehouse was considered.

**Business Area.** The company has more business areas, but this study only focuses on one business area. This, since the project owners for the thesis are within that area and the study will be better manageable with only investigating one business area.

## CHAPTER 2 THEORY

This part is divided into four major sections, where the first section, fundamental concepts, will present and clarify terminology and concepts used. The second section, risk analysis, has the goal to identify and prioritize risks. The third, risk treatment, has the aim to outline a strategy for mitigation of the risk identified (Antonio & Gaudenzi, 2013). In the fourth and final section the theoretical synthesis is presented.

Figure 2.1 below describes a graphical representation of this chapter.

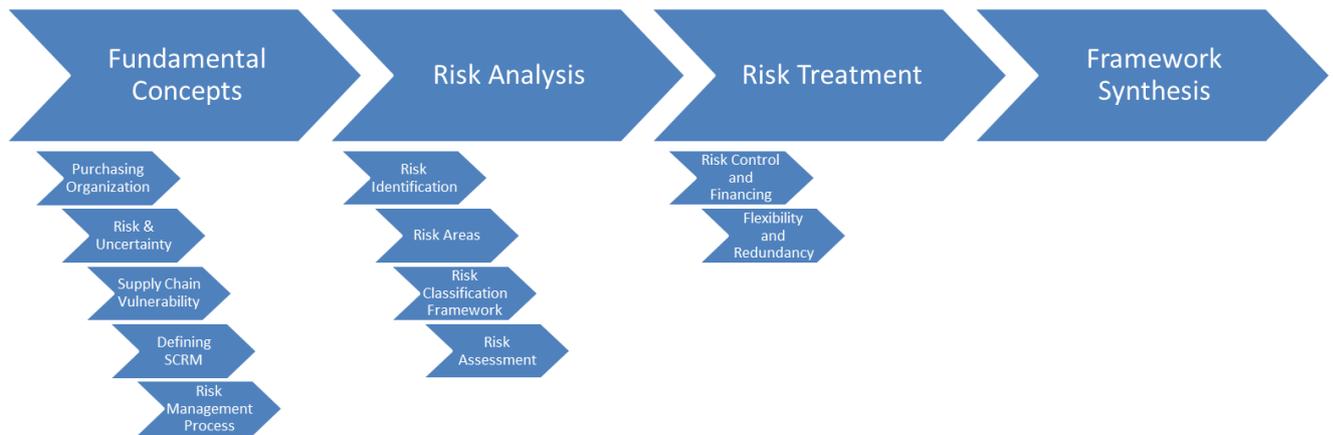


Figure 2.1: The disposition of chapter 2 theory

### 2.1 Fundamental Concepts

#### 2.1.1 Purchasing Organization

The purchasing organization is a function within the organization and it has, in recent years, received increased research attention (Glock & Hochrein, 2011). Possibly, this is due to that there is more focus on strategic purchasing where the key is to align the purchasing function with the organizational long-term goals (Glock & Hochrein, 2011). However, according to Ellram & Carr (1994) the purchasing organization was considered a passive and administrative role during the early 1970s. It was not until early 1990s that the purchasing organization started getting attention and organizations started to understand the importance to align the purchasing organization with the organizational strategic goals.

Weele (2015) describes purchasing as everything that encompasses an invoice, i.e. if the company is buying anything that generates an invoice it is classified as purchasing. Weele continues this by distinguishing between two different groups of purchasing, direct and indirect purchasing. Indirect purchasing is consisting of supporting goods or services that are not part of the business core focus. He develops purchasing organizations by introducing four different ways that the purchasing organization can be structured: (1) Decentralized, (2) Centralized, (3) Hybrid & (4) Cross-functional sourcing teams dependent on the company strategy.

### **2.1.2 Risk and Uncertainty**

To understand risk, it is also necessary to understand uncertainty and to which degree these two terms are different. Knight (1964) makes a distinction stating that an uncertainty phenomenon is unmeasurable while a risk is measurable. Dani (2008) builds on this stating that a risk is an “uncertainty based on a well-grounded (quantitative) probability”. This is in-line with Norrman & Jansson (2004) definition that risk is the product of the probability of an event and the business impact of that event, while the uncertainty is genuinely unknown. Also, Kaplan & Garrick (1981) gives a more quantitative approach and define risk on two levels as a set of triplets, where the first and more intuitive definition says that risk is the answer to the questions, what can happen? How likely is it that that will happen? And, if it does happen, what are the consequences? This is in essence the same idea of risk being the product of probability and impact which is a definition that the literature overall seems to agree on. Ritchie (2004) also emphasize that viewing a risk in isolation from other organizational aspects might provide a distorted view of the real situation which is in line with the statement that “risk must always be considered within a decision theory context” (Kaplan & Garrick, 1981). Defining risk as a product of probability and impact implies that risk will not be an exact point, but rather a curve (Kaplan & Garrick, 1981), or as Zsidisin, Ragatz & Melnyk (2004) explain it as a risk frontier.

Paulsson, Bartholdi, Norrman & Tehler (2013) describes the term disruption risk as a change in a stable flow, which could be an interruption in production from a delayed delivery for example. It will then take a certain time before the flow is back to being stable again. If one observes the events before the interruption until the flow is stable again after the interruption, this sequence can be defined as a risk scenario (Paulsson et al, 2013). Asbjørnslett (2008) when talking about the importance of resilience in the supply chain, for it to be able to fulfill its mission also cover this phenomenon. He states that in a given stable situation, an accident or disruption will reduce the mission of the system, i.e. lower performance for the supply chain, measured by a business indicator. After a while the supply chain will, probably, be stable again. The time between the two stable situations are called the disruption time.

### **2.1.3 Supply Chain Vulnerability**

The supply chains have today become extremely complex with both physical and virtual relationships, which according to Asbjørnslett (2008) is due to the global networks of supply and demand nodes interlinked with logistic systems combined with the high demand on quality and availability. For supply chains to be able to survive in this dynamic and changing environment it is important to understand how to deal with the external and internal forces of change (Chakravarty, 2014). Addressing these changes is the main theme of vulnerability (Asbjørnslett, 2008). Understanding the vulnerability of the supply chain and dealing with this proactively helps the decision maker uncover new areas of risk (Asbjørnslett, 2008). This is reached by understanding the threats and risks to the supply chain’s long and short-term goals, understanding the scenarios where these threats and risks may evolve, and understanding how to reduce and manage the likelihood and consequence of the threats and risks (Asbjørnslett, 2008). The degree to which a system is vulnerable can be seen as corresponding to the lack of robustness of the system and manifested in its infrastructure. Here the robustness can be seen as the system’s ability to resist threats or accidental events (Asbjørnslett, 2008). Asbjørnslett (2008) distinguish between vulnerability and risk analysis, stating that vulnerability analysis is focused on the survivability of the system while the risk analysis focus on the human, environmental and property impact. In this study, and what we later will call procurement risk, we will take in to account aspect from both the risk and vulnerability.

### 2.1.4 Defining Supply Chain Risk Management

There are several academics that have defined the area of Supply Chain Risk Management throughout the last decades including (Norrman & Lindroth, 2002; Jüttner, Peck & Christopher, 2003; Tang, 2006; Manuj & Mentzer 2008; Wieland & Wallenburg, 2012). Out of these definitions all but the one from Wieland & Wallenburg (2012) states that a part of SCRM is that it regards some kind of collaboration with partners in the supply chain. The emphasis on strategy or a process to deal with risks is presented by Norrman & Lindroth and picked up in the later definitions by Manuj & Mentzer and Wieland & Wallenburg which both builds on the definition by Norrman & Lindroth. Further, the most detailed definition is the one by Manuj & Mentzer, but this definition also tends to be a bit too complicated and inelegant and talks about global SCRM. We find that the areas Wu & Blakchurst (2009) states as the main aspects in the definitions are and should be: (1) Risk Identification and Modeling (2) Risk Analysis, Assessment and Impact Measurement (3) Risk Management (4) Risk Monitoring and Evaluation (5) Organizational and Personal Learning including Knowledge Transfer, they also describe the importance of interactions with other supply chain members. But we would like to add an emphasis on the strategic and process approach that an important aspect in SCRM is the development of strategy or processes to deal with risks continuously and not ad hoc. Further, in line with a company's goal to make profit and survive in the long-term, we find that ensuring the continuity is of importance and that reduction of vulnerability can be seen similarly. Also, because we do not see the importance of the limitation in the definition that it must include collaboration with partners this study will work from the latest definition by Wieland & Wallenburg (2012) shown in table 2.1 below. With this said we do agree with Agrell, Lindroth & Norrman (2004) as well as other academics (Cooper & Ellram, 1993; Motwani, Larson & Ahuja, 1998) the importance of the ability to work across inter-organizational borders and share risk among different actors.

SCRM thus relates to, among others, risks and uncertainties within decision making, strategically and managerial, (Ruefli, Collins & Lacugna, 1999; March and Shapira, 1987; Shapira, 1995), operations, distribution, demand, lead-time and costs (Pagell & Krause, 1999; Celly & Frazier, 1996; Lassar & Kerr, 1996). These risks can have severe consequences for the company both economically and reputational, for instance business interruption (including supply chain disruption) was highlighted as the most important risk for companies for the sixth executive year (Allianz Risk Barometer, 2018). See table 2.1 for a representation of definitions with related coverage.

Table 2.1: Definition and their relative coverage

|                                   | Partner collaboration | Reduce vulnerability | Apply processes tools or strategy to deal with risk | Risk identification | Ensure profitability/continuity | Risk and consequence evaluation |
|-----------------------------------|-----------------------|----------------------|---|---------------------|---------------------------------|---------------------------------|
| Norrman & Lindroth, 2002          | x                     |                      | x   |                     |                                 |                                 |
| Jüttner, Peck & Christopher, 2003 | x                     | x                    |   | x                   |                                 |                                 |
| Paulsson, 2004                    |                       |                      | x   |                     |                                 |                                 |
| Tang, 2006                        | x                     |                      |   |                     | x                               |                                 |
| Manuj and Mentzer 2008*           | x                     |                      | x   | x                   | x                               | x                               |
| Wieland & Wallenburg, 2012        |                       | x                    | x   |                     | x                               | x                               |

\*Talks about Global SCRM

### 2.1.5 Risk Management Process

There have been put forth plenty of different models explaining how the risk management process should be done. These models are ranging from more perspicuous (Norrman & Lindroth, 2004; Hallikas & Virolanien, 2004; ISO31000:2009) to more detailed models (Berg, 2010). To get a holistic view of the field as well as insight of how to structure and categorize this field a study of the different

recommended model alternatives was conducted. From this it was decided that a more perspicuous model would be beneficial for the study since it would bring a better overview and more outlined concept that in themselves will be described to cover the entire risk management process. Thus, the areas used by Norrman & Lindroth (2004) and ISO31000 were further investigated, where the ISO31000 are grouping risk identification, analysis and evaluation into risk assessment. We have chosen to move the risk identification outside of this group to separate it from assessment phase in line with Norrman & Lindroth (2004). Further, we have chosen to call the first two steps, the risk identification and risk assessment, for risk analysis and the third step, risk mitigation, for risk treatment. A fourth step, business continuity, will not be considered in this study but can also be seen as a part of the risk treatment part. The model and its areas are presented below followed by table 2.2 describing the scope of different risk management process descriptions. In table 2.2 the different numbers relate to the different step in an author’s process. For example, Berg (2010) has a seven-step process starting with (1) establishing goals and context, (2) risk identification analysis, (3) analyzing identified risks, (4) risk assessment/evaluation, (5) risk management, (6) risk monitoring and (7) continuously communicating with stakeholders.

- 1) Risk Analysis
  - Risk Identification
  - Risk Assessment
- 2) Risk Treatment
  - Risk Mitigation

Table 2.2: Scope of various risk management processes

|                             | 1<br>Risk Identification       |                              | 2<br>Risk Assessment      |                            | 3<br>Risk Management: Mitigation Strategies |                 |                          |                | 4<br>Business Continuity Management and Risk Monitoring |                 |  |                  |
|-----------------------------|--------------------------------|------------------------------|---------------------------|----------------------------|---|-----------------|--------------------------|----------------|---|-----------------|--|------------------|
|                             | Establishing Goals and Context | Risk Identification Analysis | Analyzing Identified Risk | Risk Assessment/Evaluation | Risk Mgmt.                                  | Risk Mitigation | Means for Risk Reduction | Risk Treatment | Business Continuity Mgmt.                               | Risk Monitoring | Continuously Communicating with Stakeholders | Process Planning |
| Norrman & Lindroth, 2004    |                                | 1                            |                           | 2                          | 3   |                 |                          |                | 4   |                 |  |                  |
| Hallikas & Virolainen, 2004 |                                | 1                            |                           | 2                          |   |                 | 3                        |                |   | 4               |  |                  |
| Berg, 2010                  | 1                              | 2                            | 3                         | 4                          | 5   |                 |                          |                |   | 6               | 7  |                  |
| Emmons et al, 2018          |                                | 1                            | 2                         |                            |   | 3               |                          |                |   | 4               |  | 5                |
| Borghesi & Gaudenzi, 2013   |                                |                              |                           |                            |   |                 |                          |                |   |                 |  |                  |
| ISO31000, 2009              | 1                              | 2                            | 3                         | 4                          |   |                 |                          | 5              |   | 6               |  |                  |

## 2.2 Risk Analysis

The risk analysis consists of a theoretical review of risk identification, risk areas, risk classification framework and risk assessment. The process is presented in figure 2.2 below.



Figure 2.2: Risk analysis process

### 2.2.1 Risk Identification

The identification phase is the initial stage in the risk management process. This stage lays the foundation that the continuous stages relies on and therefore it is considered to be one of the more important stages (Haifang, Shimiao & Danfeng, 2010; Maytorena, Winch, Freeman & Kiely, 2007; Antonio & Gaudenzi, 2013). This hypothesis is supported by the ISO31000:2009 5.4.2 definition that emphasizes the importance:

*“The aim of this step is to generate a comprehensive list of risks based on those events that might create, enhance, prevent, degrade, accelerate, or delay the achievement of objectives. It is important to identify the risks associated with not pursuing an opportunity. Comprehensive identification is critical, because a risk that is not identified at this stage will not be included in further analysis”* (ISO31000:2009, 5.4.2).

In their book Antonio & Gaudenzi (2013) identifies 4 different stages that the risk identification process can be broken down into:

- 1) *Identify the unfavorable event*: Looking for risk areas within the company that is capable of creating losses for the company.
- 2) *Hazards correlated with the event*: Identifying causes or sources that might create the risk event.
- 3) *Investigating the related contingencies of the event*: Determine the conditions that build up the probability of the event occurring.
- 4) *Determining the effect on the enterprise from the event*: Search for the potential damage and impact on the enterprise.

Antonio & Gaudenzi (2013) continue this process by establishing seven methods to identify the above-mentioned risk events and risk event causes:

- 1) *Organizational charts*: To prevent the “silo mentality”, that has for a long time been the reality for companies working with risk management, companies can create organizational charts. The purpose is to visualize how the company is oriented when it comes to risk management, e.g. how is the cross functional collaboration when it comes to risk management?
- 2) *Flow charts*: To depict the activities or processes in the company to potentially identify exposures, bottlenecks, or hazards (Dinu, 2012). The flow chart can be broad, e.g. the production outline or narrower, e.g. one specific process.
- 3) *Vulnerability analysis, matrix of interdependencies*: Deriving the organizations most valuable assets, both tangible and intangible, and the potential hazards or vulnerability connected to

the assets. Resulting in a matrix where the risk managers can evaluate the possible existence of the risk, for example, see figure 2.3.

|                         | Fire | Theft | Liability | Sabotage | Breakdown | Strike | Illness | Economic trends | Market trends |
|-------------------------|------|-------|-----------|----------|-----------|--------|---------|-----------------|---------------|
| Buildings               |      |       |           |          |           |        |         |                 |               |
| Equipment               |      |       |           |          |           |        |         |                 |               |
| Vehicles                |      |       |           |          |           |        |         |                 |               |
| Finished products       |      |       |           |          |           |        |         |                 |               |
| Components              |      |       |           |          |           |        |         |                 |               |
| Semi-processed products |      |       |           |          |           |        |         |                 |               |
| Warehouses              |      |       |           |          |           |        |         |                 |               |
| IT systems              |      |       |           |          |           |        |         |                 |               |
| Human resources         |      |       |           |          |           |        |         |                 |               |
| Records                 |      |       |           |          |           |        |         |                 |               |

Figure 2.3: Vulnerability analysis, matrix of independencies (Antonio & Gaudenzi, 2013)

- 4) *Checklists*: Generating checklists to have a structured way of viewing risks within the organization. Examples could be first to identify consequence categories where the organization list unfavorable events that could happen. Followed by dividing the risk exposures and threats, connected to the event, between external and internal to the company.
- 5) *Event chain diagrams*: Used to identify and manage detrimental events in a process. Similar to Fault Tree Analysis (FTA) where you break down a situation to find the root causes and connected risks (Hong, Lee, Shin, Nam & Kong, 2009).
- 6) *Methods based on intra- and inter-company data exchange*: Brainstorming, interview/focus group discussions; surveys, questionnaires. More general and organizational specific investigations that are commonly used when identifying risks within an enterprise (Emmons, Mazzuchi, Sarkani & Larsen, 2018; SCRLC, 2011)
- 7) *Strengths, weaknesses, opportunities, and threats (SWOT) analysis*: The SWOT analysis is commonly used when formulating organizational strategy. However, when analyzing risks, the organization needs to pay more attention to the weakness and threats of the organization and in those two categories possibly identify various risks elements (Dinu, 2012)

Antonio & Gaudenzi (2013) finishes by stressing the importance to notice that undertaking these steps will not guarantee that the hidden risks to the enterprise are exposed. Rather, based on professional and industry knowledge enterprises should pick a few of these methods and apply them on their organization.

### 2.2.2 Risk Areas

There exist several ways to classify and group risks within the supply chain (Ho, Zheng, Yildiz & Talluri, 2015; Sodhi & Tang, 2012). Various attempts have been made to classify risks in a convenient way and some of them are described and further developed below.

Arguably one of the more popular way of dividing risks is to do an initial broad classification where a distinction between different risks dependent on two categories, e.g. between macro or micro risks

(Ho, Zheng, Yildiz & Talluri, 2015). It is observable when viewing table 2.3 that many of the distinctions that are made are basically the same, even though the authors are naming them differently, e.g. macro and micro vs external and internal which roughly describes the same things. Moreover, some authors seem to first do the initial classification where a broad distinction is made which then are followed by further dividing of the risks into smaller categories. For example, Paulsson et al (2013) further develops their initial risk categories by introducing two more subgroups for intellectual property risks and six more subgroups for physical risks, see table 2.3. This approach is seen across various authors (Ho, Zheng, Yildiz & Talluri, 2015; Wu, Blackhurst & Chidambaram, 2006; Yang, 2007; Kumar, Tiwari & Babiceanu, 2010) who conduct the initial classification and then continue with classification in subgroups.

Table 2.3: Examples of initial broad risk classification

| Classification                              | Description  | Author/s   |
|---|--|--|
| Value at Risk (VaR) & Miss the Target (MtT) | <i>VaR</i> : less frequent events that has major impact, e.g. terrorist attacks<br><i>MtT</i> : more frequent with lesser damage, e.g. late deliveries                             | Ravindran, Bilsel, Wadhwa & Yang, 2010; Tang, 2006   |
| Macro & Micro                               | <i>Macro</i> : rare major external events, e.g. earthquakes<br><i>Micro</i> : events from internal activities, e.g. supplier risk  | Ho, Zheng, Yildiz & Talluri, 2015  |
| Physical & Intellectual property            | <i>Physical</i> : physical factors in the supply chain, e.g. product design<br><i>Intellectual property</i> : e.g. brand name that could be affected negatively due to disruptions | Paulsson, Bartholdi, Norrman & Tehler, 2013  |
| External & Internal                         | <i>External</i> : events that are external to the company, e.g. earthquake<br><i>Internal</i> : internal to the company, e.g. quality of a product                                 | Wu, Blackhurst & Chidambaram, 2006; Kumar, Tiwari & Babiceanu, 2010; Trkman, McCormack, 2009; Yang, 2007 |

Possibly, some researchers prefer to have a wide starting point and then narrowing down into specific risk categories while other researchers prefers to only work with broad risk categories, see table 2.4. Regardless of strategy, there seem to be the same risks occurring in the supply chain throughout the literature. It seems that based on how you define the risk categories the same risk will appear in various categories but the risks itself does not change. This is confirmed when deep diving into one specific risk. For example, for product quality risk one can observe that Borghesi & Gaudenzi (2013) classify the risk as hazard risk while Musa (2012) names it as a sourcing risk and Paulsson et al (2013) states it as physical risk whilst Tang & Tomlin (2008) refers the risk as supply risk. Apparently, the risk exists but the scope of the categories varies. This is in line with what Sodhi & Tang (2012) states in their book that there are many ways to classify risks and every organization needs to work out which way works best for them.

Table 2.4: Examples of further various ways to classify risks

| Initial Classification           | Classification  | Comment   | Author/s                                    |
|----------------------------------|---|---|---|
| External & Internal              | Controllable<br>Partially controllable<br>uncontrollable  | Controllable, partially controllable and uncontrollable on both external and internal                                 | Wu, Blackhurst & Chidambaram, 2006          |
| Physical & Intellectual Property | Product design<br>Production process design<br>System support<br>Risk management system<br>Human resources &<br>Business idea<br>Brand name | Physical: group products design to group human resources.<br>Intellectual Property: business idea and brand name      | Paulsson, Bartholdi, Norrman & Tehler, 2013 |
| Macro & Micro                    | Demand risk<br>Manufacturing risk<br>Supply risk<br>Infrastructural risk  | No macro subgroups<br>Infrastructural risks consist of information technology, transportation and financial risks     | Ho, Zheng, Yildiz & Talluri, 2015           |
| No                               | Strategical<br>Financial<br>Operational<br>Commercial<br>Technical  | General business risk classification  | Hiles & Barnes, 2001                        |
| No                               | Supply risk<br>Process risk<br>Demand risk<br>Intellectual property risk<br>Behavioral risks<br>Political/social risks                      |   | Tang & Tomlin 2008                          |
| No                               | Physical network<br>Financial network<br>Informational network<br>Relational network<br>Innovational network                                | Physical network relates to the flow of physical goods  | Cavinato, 2004                              |
| No                               | Supply risks<br>Process risks<br>Demand risks   | Groups oriented after how the supply chain organization is structured, i.e. supply side, process side and demand side | Sodhi & Tang, 2012                          |

### 2.2.3 Risk classification framework

We propose a framework that is inspired and constructed by reviewing various ways of classifying risks within the supply chain with more emphasis on procurement, since this thesis aim, versus the entire supply chain. Our proposed framework is a 3-dimensional construction which has potentially not yet been presented in theory context of supply chain risk management. The framework consists of three different axes. For each axis it is possible to determine where the risk should be placed, see figure 2.4. This will enable our model to effectively place and organize risks, resulting in that the organization can focus on specific risk groups accordingly. The three axes are (1) external or internal risks, (2)

controllable, partially controllable & uncontrollable risks and (3) Operations & Quality; Infrastructural; Financial & Monetary Flow; Human Assets; Cultural, Political & Legal; Severe Events, the axes are more thoroughly described below. Furthermore, we recommend that when an organization identifies a risk the organization should follow our above-mentioned framework or process, i.e. first identify if the risk is internal or external to the supply chain, followed by whether the company can control it or not and finally which category the risk falls into.

*Axis 1:* The purpose is to make an initial broad distinction between external and internal risks. This initial distinction will help organizations to quickly identify if the risks are internal or external to the company and therefore if the risk can be investigated merely by the company or if outside resources are needed. Based on this organizations can divide the risks further and treat them accordingly.

*Axis 2:* This axis will further divide the risks into controllable, partially controllable and uncontrollable. This will result in that the risks are divided further, and the organization gets a hint of whether it is possible to control and manage a certain risk or if they must accept and prepare for the risk. The various subgroups, dependent on if the risks are either external or internal, are described below.

- 1) *External Controllable:* Risk factors that are external to the origin company but most likely controllable from partners in the supply chain, e.g. risks related to tier two suppliers.
- 2) *External Partially Controllable:* External risks factors that are partially controllable by the origin company, such as demand for specific products, e.g. a good promotion plan will probably affect the sales of that product.
- 3) *External Uncontrollable:* Uncontrollable events such as earthquakes or a tsunami.
- 4) *Internal Controllable:* Internal risks that can be controlled and managed by the company, examples are quality or quantities of the product.
- 5) *Internal Partially Controllable:* Risks that is partially controllable by the company, i.e. a fire in the production facilities can be partially managed by proper fire extinguishing systems, thereby it is partially controllable.
- 6) *Internal Uncontrollable:* Risks that emerge from sources that cannot be managed by the company.

*Axis 3:* This axis makes the final classification. It will divide the identified risks further by placing them in risk areas of either: (1) Operations & Quality, (2) Infrastructural, (3) Financial & Monetary Flow, (4) Human Assets, (5) Cultural, Political & Legal and (6) Severe Events, see descriptions and table 2.5 below. These fields were chosen due to that even though authors generally use different names it is still the same types of risks that the supply chain are exposed to. Therefore, based on that it is the same type of risks that occurs in the supply chain and given our scope of procurement we conclude that the following areas covers the various risks that the company can be exposed to.

- 1) *Operations & Quality:* This category covers risks that occur due to operations or quality uncertainty at the supplier. For example, it could be a risk for the organization that the inbound product they receive does not live up to the specifications. This would be a risk related to product quality. Moreover, this area will mostly cover supplier related physical problems.
- 2) *Infrastructural:* This area will cover infrastructural risks that occur in the area between the supplier and the organization, e.g. asymmetric information between the supplier and the organization. Infrastructural risks can either be physical flow of goods, i.e. uncertainties with

the goods when in transit or information flow, i.e. risks related to information flow between the supplier and the organization

- 3) *Financial and Monetary flow*: Economical risks between the supplier and the company. For example, it could be problems with the supplier liquidity or that raw material prices go up for the supplier, leading to increased prices.
- 4) *Human Assets*: Human related risks, such as human errors that cause problems.
- 5) *Cultural, Political & Legal*: Risks related to for, example, different legal systems or cultural norms. This can also relate to new regulations affecting a supplier's operations.
- 6) *Severe Events*: Could be non-human disasters such as earthquakes or human disasters such as terrorist attack or major market changes.

As described, we define risk as an event with a probability that a negative impact will emerge, therefore we only take up risks that if they occur have a negative impact. E.g. single or multiple sourcing could be a risk but since the company first chooses, not a probability, either single or multiple sourcing this "risk" is not considered a risk for our purpose. Furthermore, when we sort risks into various categories we state risks where they occur not where they are derived from, e.g. quantity uncertainty is placed under *Operations & Quality* area, but the risk could be derived from faulty information or human errors.

Table 2.5: Axis 3 and final classification of risks

| Classification              | Examples   | Comment  |
|-----------------------------|--|--|
| Operations & Quality        | Product quality and design<br>Quantity uncertainty<br>Production<br>Capacity   | Relates to mostly supplier related product risk.                         |
| Infrastructural             | Transportation errors<br>Supply chain visibility<br>Information accuracy<br>Supplier relations<br>System security and disruption | Infrastructural risks that occurs between the supplier and the company   |
| Financial & Monetary Flow   | Currency and exchange rate<br>Raw material<br>Supplier cost<br>Supplier bankruptcy<br>Supplier liquidity                         | Risks with the financial flow between the supplier and the company       |
| Human Assets                | Employee capability<br>Human error   | Risk with people in the procurement process                              |
| Cultural, Political & Legal | Supplier contract<br>Supplier collaboration<br>Labor shortage<br>Laws and regulations<br>Cultural and ethical problems           | Risk the relates to cultural norms, political decisions or legal aspects |
| Severe Events               | Fire<br>Earthquake<br>Terrorist attacks  | Relates to non-human disasters or human disasters                        |

Finally, below in figure 2.4 our proposed framework is presented.

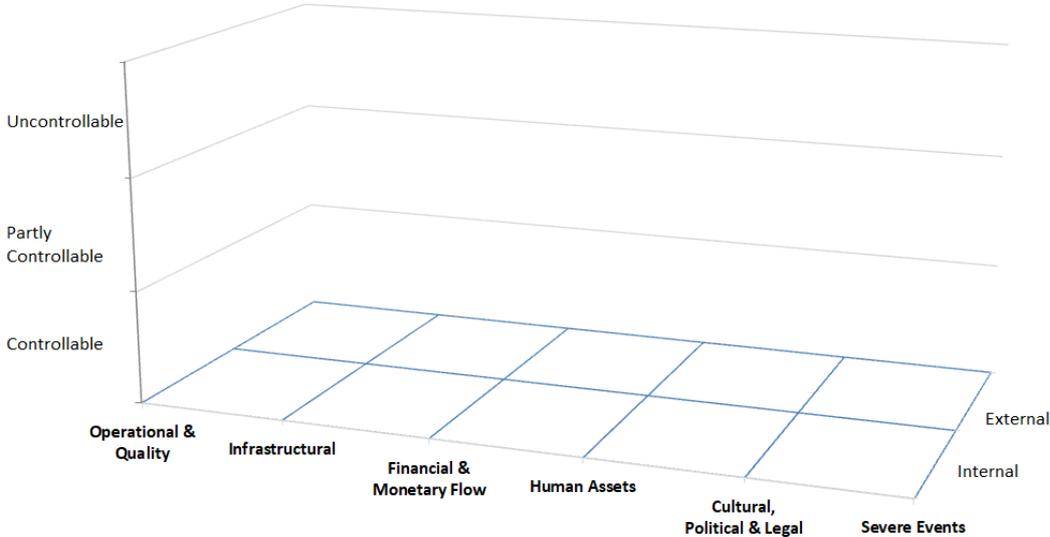


Figure 2.4: Proposed framework for risk classification

**2.2.4 Risk assessment**

From section 2.2.1 above, risk identification, the identified risks will be collected and work as the input in this stage (Paulsson et al, 2013).

Sodhi & Tang (2012) state that risk assessment is a critical process in assisting top management in making informed decisions. They also state that the intention of risk assessment is to create a sense of urgency about the identified risks. When the company has identified risks and potential risk causes there is a need for protection against these identified risks, thus it is important to assess and evaluate the risks (Norrman & Lindroth, 2004). A commonly used technique is to try and estimate the probability and the consequence of a risk, either quantitatively or qualitatively, and then placing it in a two dimensional risk map (Rice and Caniato, 2003; Zsdisin, Panelli & Upton, 2000; Norrman & Lindroth, 2004; Dani, 2008), where qualitative is to prefer if the risk level is relatively low and data driven analysis to costly, and quantitative analysis is preferred when information about risks is shared by many functions (Sodhi & Tang, 2012; Borghesi & Gaudenzi, 2013). There is also a semi-quantitative analysis which, according to Borghesi & Gaudenzi (2013), often is identified as the best trade-off between subjective and objective techniques. In these cases, the goal is the same, “to provide a ranking of inherent and residual risks” and with this information select risk treatment and mitigation strategies (Borghesi & Gaudenzi, 2013).

There is no consistency in how the risk assessment process is conducted, where Paulsson et al (2013) talks about two steps, establish an acceptable risk and analysis of different handling alternatives while Borghesi & Gaudenzi (2013) gives a more thorough explanation of different approaches and tools. Sodhi & Tang (2012) on the other hand focus on a risk mapping while Gaudenzi (2008) presents a five-step model. Paulsson (2007) encircle this when explaining that risk assessment is a general concept describing decisions subjected to uncertain consequences and says that it can be divided into risk estimation and evaluation.

To proactively deal with risks and vulnerabilities in the supply chain is a wise decision if one wants to secure the prospects of the supply chain (Asbjørnslett, 2008).

The five-step model according to Gaudenzi (2008).

- 1) Definition and selection of the primary objectives
- 2) Prioritization of objectives, according to the perception and evaluation of managers
- 3) Selection of “areas” where risks should be measured
- 4) Selection and evaluation of risk indicators in these areas
- 5) Graphic representation of risk indicators as a basis for decision-making

In risk assessment Gaudenzi (2008) states that it is important to understand the four drivers of success in projects and processes, the first one is project and process objectives, where it is important to prioritize the objectives and goals to be able to define management priorities. Secondly, project and process change management, which point out proactive work with change management to be prepared on changes that may occur and introduce risks. The third driver is stakeholder interest; even though each stakeholder and supply chain member have specific goals Gaudenzi (2008) mean that each process in the supply chain is demand driven and that it makes sense to share end-customer focus throughout the supply chain. Because of this it is logical to link supply chain risk assessment to different objectives in the supply chain such as quality, flexibility, efficiency and more, and further it is important to share common objectives throughout the supply chain with regard to the end customer (Gaudenzi, 2008). Lastly, performance and risk measurement states that it is important for organizations to see the risk management as an activity overlapping processes and projects.

At the start of the risk assessment part Paulsson et al (2013) state that it is very important to know where to set the limit for how much risk the firm can accept. As supply chain networks is getting more and more complex with unlimited amount of supply branches that can be mapped it is more or less impossible to avoid all risks. Instead one must decide what is critical and what is not critical and then focus on the more critical areas and accept the risks in the less critical spectrum so that the supply branches to be investigated gets more feasible. What is critical or not is then up to the organization to decide, but Paulsson et al (2013) describes two different types of criticalities that could be good to consider. The first one is to find what information is critical and how precise the information needs to be to be able to reach the objectives set up at the start of the risk management process. Secondly it should be enough to identify the critical disruption risks. That is, the disruption risks that are more essential and critical for the ongoing of the company, for example it could be a critical component that is hard to substitute or resource from somewhere else. If we then follow the critical disruption risk backwards we might find new sub-critical disruption risks, and with this process a chain of criticality can be established. What determines if something is critical or not could for example be the delivery time, how fast a new delivery can be received if the first one was unusable. It could be if a component is replaceable or not, or if there are other suppliers on the market that can be used or if there is only one supplier on the market.

Borghesi & Gaudenzi (2013) also gives different analytical tools, including both quantitative or statistical and qualitative tools. For the statistical interference they mention that the likelihood function is key, especially for methods estimating acceptable risk levels from statistics, further they mention two common approaches based on the gravity of a risk, Maximum Foreseeable Loss (MFL) and Probable Maximum Loss (PML). The best known qualitative and semi-qualitative methods for risk

analysis according to Borghesi & Gaudenzi (2013) is, Event Tree Analysis, Fault Tree Analysis, Business Impact Analysis, Business Continuity Planning, Failure Mode Effect Analysis (FMEA) and Dependency Modeling. Dani (2008) also present two tools for risk analysis, where one is the more qualitative FMEA and the other one the more quantitative Data Mining.

According to Borghesi & Gaudenzi (2013) it is of value to understand to which extent the risk debilitates corporate performance, where corporate performance includes both monetary losses and underperformance in key processes. To measure the business performance an effective Performance Measurement System (PMS) can be of good use, especially to organizations that use them for risk management. Although Dossi and Patelli (2010) points out that PMS is highly dominated by financial measurements, although non-financial measurements are taking an emerging role which is consistent with the strategic purpose of PMS, a strategic purpose that also can be found within risk management (Borghesi & Gaudenzi, 2013).

When the risks are analyzed the next step is the risk evaluation where the measured risks according to Borghesi & Gaudenzi (2013) are compared with the risk criteria. In ISO31000:2009 risk evaluation is defined as, "risk evaluation is the process of comparing the risk analysis results with risk criteria in order to determine whether the risk is acceptable or tolerable". Further risk criteria are defined by ISO31000 as, "terms of reference against which the significance of the organization's risk is evaluated. The risk criteria should reflect the organization's objectives and values as well as external and internal context where the external environment and should consider relationships of stakeholders".

The evaluation process allows managers to make a graphical representation of the risks, see figure 2.5, by using a matrix (Borghesi & Gaudenzi, 2013) this is similar to Sodhi & Tang (2012) risk mapping and includes risk rating by estimating the likelihood for the risk occurrence as well as the impact. The assessment can be done by assigning a value between 1-5 for both likelihood and impact and then rating the risks according to this. From these ratings a two-dimensional heat-map can be created where the "red zone" should be risks having both a high likelihood and impact. Sodhi & Tang (2012) calls this the relative risk view, but they also explain the absolute risk view where likelihood is specified as the probability of occurrence over a period of time and impact in terms of monetary losses. From this, the different risks can be classified after priority and required actions.

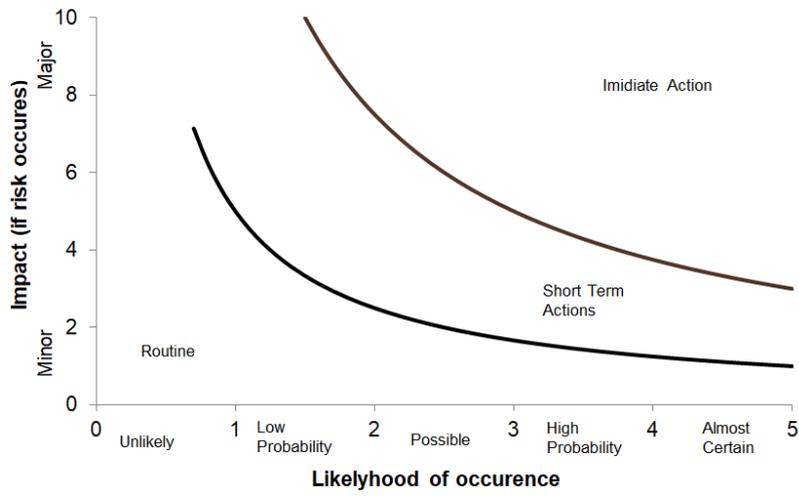


Figure 2.5: Graphical representation of risks, where impact and likelihood are considered (Borghesi & Gaudenzi, 2013)

## **2.3 Risk Treatment**

Supply risk mitigation strategies are mainly there to help organizations in two ways, to reduce the possibility that a risk occurs and secondly to reduce the detrimental consequences of a risk occurring (Jüttner, Peck & Christopher, 2003; Miller, 1992; Chang, Ellinger & Blackhurst, 2015). The strategies are in place to help organizations to solve the underlying supply problem, not covering up the problem by e.g. introducing inventory buffers or using multiple sourcing (Brindley, 2004; Paulsson et al, 2013). However, throughout the literature there has been numerous research of how to mitigate supply risk (Brindley, 2004; Paulsson et al, 2013) and there are a lot of emphasis on that company are trying to bear the consequences of a risk instead of addressing the real problems that makes the risk occur. The analogy here is that hiding something does not make it disappear. Further, following this line of thought, it can be costly for organizations to treat the risk consequences instead or treating the risk cause (Brindley, 2004; Chang, Ellinger & Blackhurst, 2015; Chopra and Sodhi, 2004). For example, increased transactional cost (Zsidisin and Wagner, 2010) when introducing multiple suppliers to cope with supply risk when the risk, in reality, occurs due to e.g. communication problems.

Adding on this the ISO31000:2009 risk mitigation stage is defined as: “Risk treatment is the process of selecting one or more options to modify a risk, and then implementing those options. This can involve, avoiding the risk, removing risk source, changing likelihood or consequences, sharing the risk and/or retaining the risk by informed decisions.” This definition goes in line with emphasis on risk treatment and not risk consequences treatment.

There exist several ways to look at and classify risk mitigation strategies, below we choose to present and reflect on two different ways.

### **2.3.1 Risk Control and Risk Financing**

Antonio & Gaudenzi (2013) emphasizes the ISO31000 definition but they add that risk treatment is a complexed activity aimed at modifying or mitigating risks and the potential economic and financial impact. There exist a lot of different ways of mitigating risks (Paulsson et al, 2013), but going deeper Antonio & Gaudenzi (2013) divide risk treatment into two categories, risk control and risk financing. Were risk control is acting on the two main factors of risk, that is frequency or probability and severity or impact, and thus making losses more predictable. This while risk financing is the mitigation of the economic and financial effects of a risk. In figure 2.6 below the risk treatment depiction by Antonio & Gaudenzi (2013) is showed.

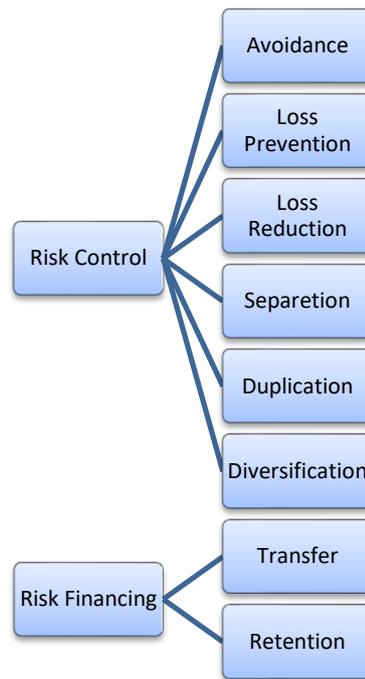


Figure 2.6: Risk treatment options

**Avoidance.** Avoidance is an alternative that represent the decision to not carry out the activity related with the risk, i.e. the firm choose another alternative that is not subjected to the risk in the same way (Antonio & Gaudenzi, 2013), that is simply avoiding taking the risk (Paulsson et al, 2013). This could, for example, be that if a supplier is geographically located at an area with risk for flooding and the organization chooses to buy from another supplier the organization is simply avoiding the risk (Antonio & Gaudenzi, 2013; Paulsson et al, 2013).

**Loss Prevention.** Loss prevention regards the reduction of the frequency of a particular loss; this can be done through quality controls systems, staff training and more (Antonio & Gaudenzi, 2013). Paulsson et al (2013) mentions quality control specifically, where a quality control of the product before it goes in to production can establish if the production fulfils the given technical requirements. Paulsson et al (2013) also mentions education and proper training to prevent risk occurrence as risk treatment options, both of these falls under the loss prevention category. Paulsson et al (2013) also describes increased flexibility in the supply chain as a risk treatment option, which can be achieved by introducing new machinery that lowers the setup time or building modules that can be assembled at a later stage. Backup plans, meaning that the firm has a structured plan that kicks in when a risk actualizes is also specifically mentioned by Paulsson et al (2013). Further, substitute products, meaning having a substitute when the regular product are out of stock or permanently changed (Paulsson et al, 2013) is also according to us a loss prevention technique, but could also be seen as a duplication technique as described below.

**Loss Reduction.** Loss reduction regards the reduction of the severity of a particular loss (Antonio & Gaudenzi, 2013). Severity minimization techniques comes into play when the event of loss is occurring, example, if there is a fire there could be an automatically closing fire door installed or a sprinkler system installed to prevent the fire from spreading (Antonio & Gaudenzi, 2013).

**Separation.** Separation involves the separating and dispersing of a particular asset or activity among different location to make it less subjected to risk (Antonio & Gaudenzi, 2013). The aim is then to prevent concentration of goods, people or business in a single location or market (Antonio & Gaudenzi, 2013).

**Duplication.** Duplication is based on backups, copies or spares of critical assets to guard against risk occurrence (Antonio & Gaudenzi, 2013). An example here could be to have a second source, i.e. use dual sourcing for a component. Paulsson et al (2013) refers to this as buffers which can protect from disruptions in the supply chain by using buffers in form of material or time. Also, over capacity within production, that is having excess capacity to be able to catch up if risk occurs (Paulsson et al, 2013) is here seen as a duplication technique since it can be seen as a buffer.

**Diversification.** Diversification regards the spreading of loss exposure over several projects, products or markets (Antonio & Gaudenzi, 2013). This can be seen in similarity to the differentiation of a market portfolio where you do not want to have all your eggs in the same basket. Having multiple suppliers will lower the possibility that there is shortage of products to the company (Paulsson et al, 2013). In contrary to this Paulsson et al (2013) mentions concentrate as a risk mitigation strategy, meaning, focus on having e.g. one production facility in order to concentrate the risk measures there and protect that facility.

**Transfer.** Transfer regards a handover of the financial consequences of a loss to a third party (Paulsson et al, 2013). There are two different types, namely an insurance transfer and non-insurance transfer (Antonio & Gaudenzi, 2013). Insurance transfer can be described in technical terms as the transfer of a potential financial consequence of a certain specified loss from the insured to the insurer (Antonio & Gaudenzi, 2013), Paulsson et al (2013) calls this insurance. The insurer is typically an insurance company and the risk is typically measurable and definite (Antonio & Gaudenzi, 2013). This while non-insurance transfer is in line with insurance transfer despite that it is not transferred to an insurer (Antonio & Gaudenzi, 2013), Paulsson et al (2013) calls this external responsibilities and points out that this are areas that were originally organizational responsibilities that now are being transferred to a third party that is being economically compensated.

**Retention.** Retention aims at absorbing the loss by generating funds within the organization to pay for the loss. It can be seen as a voluntary assumption of an exposure to loss which then has been identified and analyzed, planned for (Antonio & Gaudenzi, 2013). Risk retention is often chosen if it is impossible to eliminate or transfer the risk or if the transfer cost is higher than the Maximum Probable Loss. Paulsson et al (2013) also classifies this as over capacity within finance.

### **2.3.2 Flexibility and Redundancy**

Compared to the framework developed by Antonio & Gaudenzi (2013) various authors have defined mitigation in two broad terms, flexibility and redundancy strategies. It seems that these two strategies are commonly used throughout the literature and gives a perspicuous understanding of the strategies and they are further explained below.

It is important to understand that there exist no strategies that will solve any given risk. Meaning that as Chopra and Sodhi (2004, p. 55) states “Unfortunately, there is no silver bullet strategy for protecting organizational supply chains. Instead, managers need to know which mitigation strategy works best against a given risk”. Further, Chang, Ellinger & Blackhurst (2015) claims that when addressing risk

organizations needs to be aware that there is probably not one single answer that will solve the situation but rather a combination of strategies that will work best for a given risk.

Chang, Ellinger & Blackhurst (2015) and Zsidisin & Wagner (2010), amongst others, continuous this reasoning by stating that there are two broad categories which mitigation strategies can be divided into, Redundancy and Flexibility.

- *Redundancy*: Focus here is to increase product availability by e.g. increasing strategic inventory, holding safety stock, maintaining multiple suppliers, and adding capacity (Sheffi & Rice, 2005; Zsidisin & Wagner, 2010; Treleven & Schweikhart, 1988)
- *Flexibility*: Emphasis here is for the organization to build capabilities that enables threats and risks to be identified and attended to quickly (Zsidisin and Wagner, 2010). Examples could be, information sharing, better collaboration with partners in the supply chain (Chang, Ellinger & Blackhurst, 2015) or being aware of the financial status of the supplier (Paulsson et al, 2013)

Chang, Ellinger & Blackhurst (2015) applies these two broad strategies to a matrix of probability and severity of risk, see figure 2.7, where they distinguish between mitigation strategies based on the four different quadrants.

- *Low probability and low severity*: When evaluating if appropriate risk mitigation strategies should be implemented organizations needs to weight the cost versus benefits. Meaning that with low probability and low severity often there is no need to have strategies in place since the risk will not affect the organization to that extent it needs to be addressed. This strategy is called *acceptance* and means that the organization accept the possibility that they might be exposed to the risk (Paulsson et al, 2013)
- *High probability and low severity*: Risks that happens more frequently can for example be late deliveries. Since the probability is high and the impact is considered low the redundancy strategy is not the best option since it could cost more than it saves to e.g. increase buffers. Rather, organizations should apply the flexibility strategy where e.g. improved communication can lead to that everyday problems will be solved, and the bigger issues will automatically be attended to (Blackhurst et al, 2011; Richey, Adams & Dalela, 2012).
- *Low probability and high severity*: Examples are terrorist attacks of 9/11 or the earthquake in Japan 2011. Since these events are out of organizational control having flexible communications and a flexible supply chain will not be enough. Therefore, the best mitigate strategy is to have a redundancy strategy, e.g. keeping inventory buffers.
- *High probability and high severity*: Both high probability and high impact. Meaning that these risks should be addressed immediately. The redundancy strategy will keep the organization up and running when the high severity risk occurs, and the flexibility strategy will help to reduce the probability of the risk occurring. Therefore, Chang, Ellinger & Blackhurst (2015) as well as Bode, Wagner, Petersen & Ellram (2011), amongst others, recommends organizations to have a combination of both the strategies to be able to mitigate the high probability and the high severity.

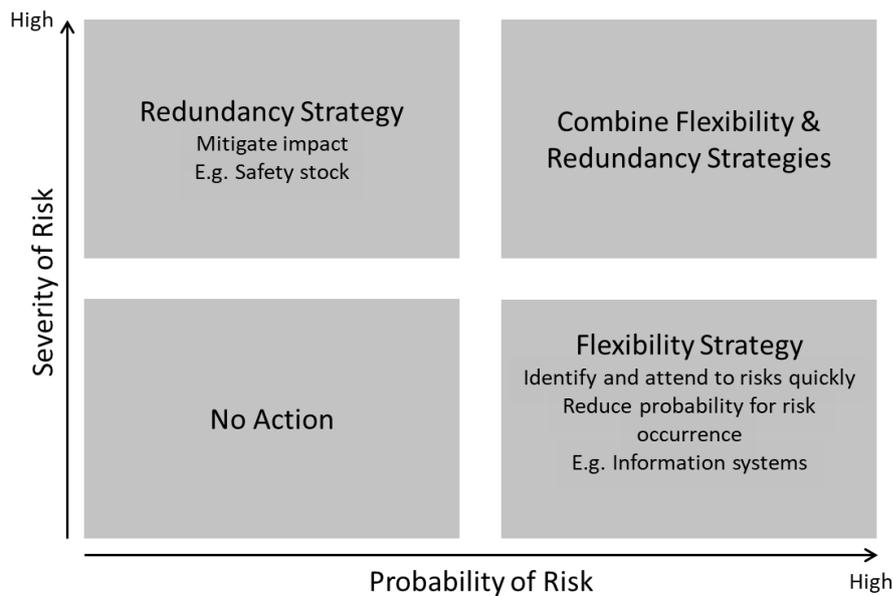


Figure 2.7: Mitigation strategies based on severity and probability of risk (Chang, Ellinger & Blackhurst, 2015)

### 2.3.3 Mitigation strategies related to late deliveries

As previously discussed, there is no quick fix for a specific risk and therefore it is not possible to have explicit mitigation strategies for late deliveries. However, it is possible to narrow down the mitigation strategies so that the focus lies on mitigating late deliveries, e.g. building buffers will not solve the problem. Thus, below follows some mitigation areas that might be of interest when mitigating late deliveries, with emphasis on flexibility strategies.

**Monitoring & quality.** Since late deliveries can occur due to that the supplier is late in e.g. production, one strategy could be to continuously monitor the supplier so that the supplier is in line with their production schedule (Musa, 2012). Musa (2012) pinpoints this by stating that sourcing companies have limited or no control over the external supply base, hence, the need to monitor the supplier.

**Supply chain collaboration.** The purpose with this strategy is to develop collaboration in the supply chain, i.e. developed communication that will, in case of a problem, identify and attend to the problem fast. This mitigation strategy goes hand in hand with the flexibility strategy and with the risk late deliveries, i.e. if goods were to be late it is vital that the information can be spread in the supply chain for appropriate measures to be taken (Zsidisin and Wagner, 2010). One example of this could simply be information sharing, e.g. a supplier and the company shares information that will benefit both and thus the entire supply chain.

**Supplier capacity.** A limited supplier capacity can be problematic if orders from various customers increase and therefore the supplier must prioritize the customers. Hence, the risk of being down-prioritized and thus the risk of receiving products late. The strategy here is to be aware of the supplier capacity and, if possible, be amongst the top priority at the supplier. Examples of this could be working with supplier collaboration or early supplier involvement (ESI) that lets the firm know the supplier's capacity and hopefully be amongst the top prioritized (Zsidisin & Smith, 2005).

**Single or multiple sourcing.** A rather obvious solution can be to switch supplier if one supplier is underperforming and therefore avoid the late deliveries all together. Examples of this could be the

comparison between Ericsson and Nokia who had the same supplier and the supplier had a fire accident and were unable to produce. Nokia had a backup supplier which they quickly turned to and Ericsson, on the other hand, had single sourcing and experienced a loss of USD 400 million (Norrman & Jansson, 2004; Peck et al, 2003). Despite this, it is important to be aware of that introducing multiple suppliers does not come without tradeoffs, e.g. increasing transactional costs and the possibility of the risk visualizes itself in the new supplier again (Peck et al, 2003).

## 2.4 Framework Synthesis

From theory it has been shown that there are several ways to classify risks within the supply chain. These classifications are often related to the entire supply chain. Since the purpose of this study involved mapping the risk environment for the case company related to the procurement part of the supply chain a new framework was needed to be developed which had a procurement focus. The proposed framework, which has not to the authors knowledge been presented in theory before, consists of three dimensions, each describing the risk in a way that will make it more understandable and possible to develop strategies for. The framework will be presented in figure 2.8 and described below. Further explanation of the framework can be found in section 2.2.3.

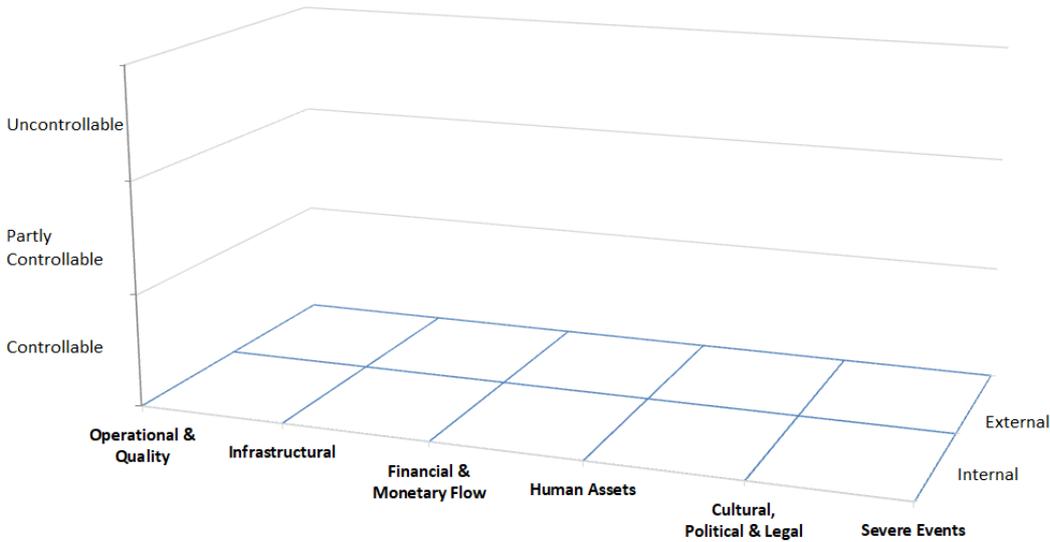


Figure 2.8: Proposed framework for risk classification

The first dimension of the framework explains how controllable the risk is. I.e. if the risk is an uncontrollable event such as an earthquake it will be classed as uncontrollable and actions taken to deal with this directly might be limited since it is not possible to prevent earthquakes. Although indirectly it would be possible to reconstruct the supply chain to not operate in this geographical location. If the risk is controllable it is possible to directly adjust and affect the severity of the risk, example could be how often the quality controls are done to ensure the quality throughout the supply chain.

The second dimension explains if the risk is external or internal to the company. If the risk is internal to the company it occurs inside the organization and can be related to risks within faulty communication at the company. External risks are risks occurring outside of the company but that affects the company from a procurement point of view. This could be market fluctuation that are both external and uncontrollable.

The last dimension describes six different risk categories, these are described in section 2.2.3. These categories explain what kind of risk it is. For example, if a country adjusts the environmental regulations forcing a supplier to shut down this risk can be seen as uncontrollable, external and classified within the category cultural, political & legal. The market fluctuation on the other hand would be classified within financial & monetary flow.

This framework is the theoretical contribution of this thesis as it combines three different dimensions of classifying risks with a focus on procurement.

## CHAPTER 3 METHOD

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*The method chapter describes how this study has been executed. The chapter consist of four parts with emphases on the two major parts, risk analysis and risk treatment. The first part consists of the research methodology. The following two major parts consist of research design, selection phase, data collection and data analysis. The last part consists of reliability and validity.*

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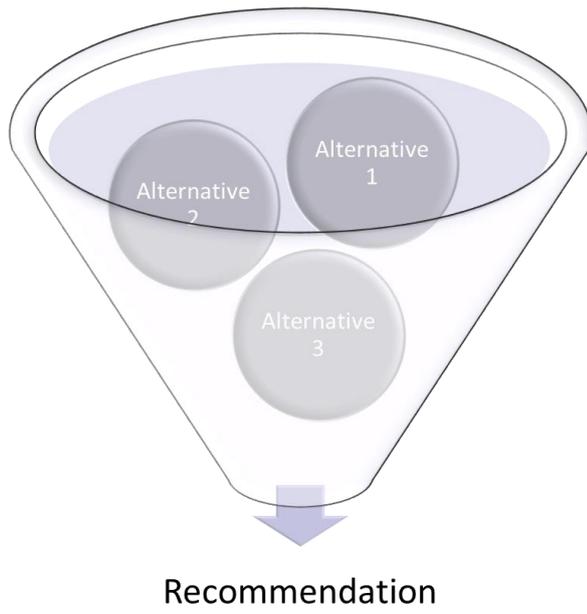
### **3.1 Research Methodology**

The research method can be conducted in multiple ways and combinations, but it should be dependent on the aim and purpose of the research. Other factors that can influence the method choice are constraints in time, money or other resources (Björklund & Paulsson, 2014). Arbnor and Bjerke (1997) states that the chosen methodological view will affect the observations, data and results due to the underlying assumptions done. This leads to the importance of a method being consistent and constructive (Arbnor and Bjerke, 1997).

This study started in collaboration with the company that had earlier communicated an interest for a master thesis within risk management. Due to this, meetings were held between the authors and the company to discuss the, by the company, suggested topic and then alter it to fit the time frame, author objectives as well as company objectives. These meetings ended in a mutual understanding of the contexture of the master thesis. Thus, the master thesis should be divided into two parts where the first one would cover the first steps in a risk management process, namely identification and assessment of risks that the company today is subjected to. In the second step a specific risk should be chosen, and a case study performed for this specific risk regarding the third step in the risk management process, which is risk mitigation.

Parallel to the project a steering committee consisting of the operations director, the business area director and the project owners were created to whom the author should present their findings and emergence of the project.

The practical approach for the both parts of this thesis will follow what can be seen as a funnel. That means, starting broad and then narrow down the perspectives and alternatives as the thesis proceeds. For the first part, risk analysis, this means starting with an assumption that no risks is known and then from that and with help of theory establishing the risk environment, then narrowing this down to find the most important risks for the company and finally selecting one risk to move forth with in the second part, risk treatment. For the second part, risk treatment, this meant starting with the risk chosen from the first part and then from a high level mapping the landscape and in this case process for the risk. Then noting problems and interesting areas to later do further investigation within. This was then followed by choosing the most important areas were causes were discovered to later develop possible solutions. In the end the developed solutions were evaluated and ranked to find the top solutions and finally yield the recommendations for this master thesis. This logic is shown in figure 3.1 below.



*Figure 3.1: Practical logic for the thesis*

### 3.2 Risk Analysis

Due to the strong connection to both the firm and business practice a case study was chosen which would allow a more detailed analysis of the complex and particular nature of the case, which is allowing an idiographic approach (Bryman & Bell, 2015). This study was then divided into two parts, the first part, risk analysis, spanning over the first two steps of the four step risk management process, which is risk identification and risk assessment. See figure 3.2 below for the risk management process and the area that relates to the risk analysis part. Because the nature of the study is to investigate risks that the firm is subject to and then identify ways to handle these there is a need to conduct interviews, brainstorming sessions and workshops to gather and analyze data. This, together with time constraints related to the scope of the study makes a predominantly qualitative approach suitable, this allows a more in-depth analysis since qualitative research is designed to examine the “why” and “how” of questions (Bryman & Bell, 2015; Yin, 2013). Also, as stated by Wu & Blackhurst (2009) interviews are the best option for identifying risks the first time risks are identified and particularly if there is lack of historical data on probability of risk occurrence and impact, which was the case.

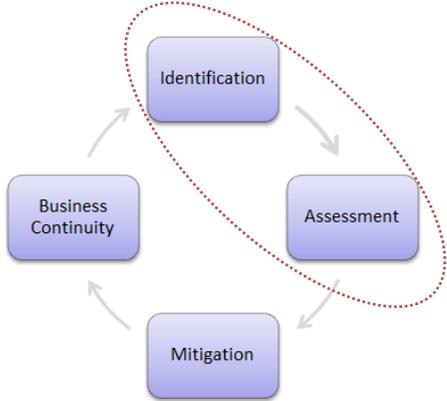


Figure 3.2: Risk management process, the steps identification and assessment is referred to as risk analysis

#### 3.2.1 Research design

- Company & Case Introduction (Understanding and Planning)
- Theoretical Review
- Framework Creation
- Respondent Selection and Creation of the Interview Guide
- Interviews (Data Collection)
- Workshop 1
- Committee Meeting 1

Figure 3.3: Steps taken in chronological order for the risk analysis part

The risk analysis part, as stated above, are following the two first step of the risk management process and is carried out in the form of a case study with a single organization in focus. Figure 3.3 shows the different chronological steps taken for the risk analysis part. This part is also divided into two sub-parts,

one identification part and one assessment part. The fundamental area of the risk analysis lies within theory and even more the first sub-part, risk identification, which hints about a deductive approach (Bryman & Bell, 2015). However, the study is limited to a certain case and is more of a practical and exploratory nature, thus making it an abductive approach, that is, the framework that we derive from theory is not conducted to prove or disprove theory as such, but to assist in understanding practice in a structured way (Bryman & Bell, 2015).

In this first part of the thesis the intention was to mainly gather qualitative data to identify risks that the business area perceives, this is in line with the identification phase of the risk management process. However, the assessment of risks relative each other, which is related to the assessment in the risk management process, was done through a workshop where the attendees were asked to evaluate the risks on different numerical scales, making this data collection quantifiable. Thus, the study should be defined as a mixed study (Bryman & Bell, 2015:644). The qualitative data was gathered through semi structured interviews with the intention to first give a deeper understanding and a holistic perspective of the risk situation perceived within the purchasing part of the supply chain. The quantitative data was gathered during a workshop with the project owners and used to quantify the risks identified.

When mixing qualitative and quantitative methods there is several different ways to choose between. Cresswell & Clark identifies six different designs which are considered being the most frequently used within research (Bryman & Bell, 2015). Without going into detail on all different designs, we instead note that the design we have chosen is known as Exploratory Sequential Design. In this design the qualitative data builds up the foundation on which the quantitative data is gathered. We gathered and analyzed the qualitative data from interviews, after this we created a model for evaluation which was used during the risk evaluation workshop. Figure 3.4 below depicts the Exploratory Sequential Design according to Bryman & Bell (2015).



Figure 3.4: The Exploratory Sequential Design (Bryman & Bell, 2015)

**Criticism against using mixed research design.** Even though the use of mixed research design has become more common one cannot conclude this design to be superior any other design (Bryman & Bell, 2015:659). There are several critical aspects that are necessary to keep in mind when mixed research design is used. For instance, Bryman & Bell (2015:659) mentions that just as when pure qualitative or quantitative approach is used the mixed approach needs to be competently constructed and executed. Also, it must fit well with the problem identified. In addition, the approaches should not be seen as separate components, but rather as complement to one another.

To use a combination of data collection methods can create confusion and thus at the same time increase the requirement of being consequent when gathering data as well as the relevance and connection between data gathered from the different methods. Further, when using a case study, the risk of not being able to generalize increases due to that the information base might be too thin and the accuracy inadequate (Yin, 2013). As authors we have during the development of the thesis tried to reflect upon these disadvantages connected to the study to create an as credible and consistent study as possible.

### 3.2.2 Respondents

**Company.** When we started to discuss which field of supply chain management we were conducting our master thesis in we quickly identified the area supply chain risk management as interesting and upcoming. This is mainly since we both like the idea of risks that could potentially happen or not happen but still if it happens it could have catastrophic consequences for companies. Meaning that the uncertainty of an event gives it a certain excitement. After we decided that it was within risk management we were focused on we screened the market and found a company which had problems related to the procurement risk management which was perfect for us.

**Respondents.** In order to accurately identify risks and then prioritize them accordingly the respondents were different dependent on the purpose. Meaning that to get an overview of the risks, interviews with strategic purchasers from our business area took place whilst when prioritizing the identified risks workshop and meetings with higher level managers were conducted. The reasoning behind this is that the risk that is chosen to be further investigated should be in line with the strategic focus of the company. Based on this reasoning combined with the project work in chronological order the respondents can be separated into three different stages, see table 3.1.

Further, in total ten interviews were conducted to identify the risks and per Bryman & Bell (2015) that is adequate to get a fair and objective overview of a given situation. Moreover, to avoid the possibility of receiving biased information from one department we broadened the interviews to include two more departments, namely supply chain and operational purchasing. The respondents for both the workshops and the committee meetings, see table 3.1, were chosen by the company with a more strategic focus in mind.

Table 3.1: Respondents in the risk analysis part

| Name                   | Purpose  | Respondents   | # of appointments |
|------------------------|--|---|-------------------|
| 1. Interviews          | Identify the most common and most critical risks                         | <ul style="list-style-type: none"> <li>• Strategic purchasing</li> <li>• Operational purchasing</li> <li>• Supply Chain</li> </ul>  | 10                |
| 2. Workshop 1          | Prioritize which risks that should be presented at the committee meeting | <ul style="list-style-type: none"> <li>• Project owners</li> </ul>  | 1                 |
| 3. Committee Meeting 1 | Determining which risk that should be further investigated               | <ul style="list-style-type: none"> <li>• Project owners</li> <li>• Operations director</li> <li>• Business area director</li> </ul> | 1                 |

### 3.2.3 Data Collection

There are several data collection methods, where one method is not superior to any other; rather, dependent on the situation different methods fulfils the purpose better (Björklund & Paulsson, 2004). This paper collects data from both theory and practice in order to have the academic theoretical view and at the same time collect qualitative data from the organization to be able to compare and find resemblances between the two.

### **3.2.3.1 Theoretical**

The purpose of the theoretical data collection was firstly to get a grasp of the area supply risk and how widely the area had been researched. Secondly, to cover the theory behind the first two steps in the risk management process, identification and assessment. Lastly, to create a theoretical framework of supply risk, which we would derive from the supply risk theory. The framework could then later be used to match, identify and categorize identified risks within the organization.

Starting off, the first step was a meeting with Professor Andreas Norrman who is currently working as the director of supply chain management at the faculty of engineering at Lund University. Norrman has written acknowledged academic papers within the field supply chain management and supply risk, hence having a meeting with Norrman was seen as a good initial start to gradually build up the supply risk field knowledge. During the meeting Norrman broadly explained his approach to supply risk and why it is important. Norrman also mentioned the International Supply Chain Risk Management network (ISCRiM) which is a network of researchers and practitioners with the aim of speeding up and improving the research within supply chain risk management (ISCRiM, 2018). When discussing the ISCRiM network Norrman mentioned one author, George A. Zsidisin, who was one of the founders of the network and has written a lot of recognized academic papers and been active in the supply risk field for a long time.

Building on the meeting with Norrman, the second step were a chronological review of Zsidisin's supply risk work. The review was followed by checking interesting linked references, i.e. both backward looking that Zsidisin had used and forward looking that had used Zsidisin's articles as a referencing point. Finally, after this stage an understanding of the field supply risk were achieved. However, to not get biased information from only one origin source an overall literature review was also performed.

The literature review was performed firstly with an initial broad approach to get a holistic view over the field, i.e. avoiding getting to specific into various authors' ideas. The review was partly performed using the database LUB search with key words such as *supply risk*, *supply chain resilience*, *supply risk management*, *supply chain risk*, *supply chain risk management* and *risk management*, this in order to identify where there has been substantial research and where the foundation for the field supply risk lies. Besides using articles, the review was conducted using supply chain risk literature books that were recommended by Norrman and that were in line with the review's purpose. One book that were used a lot was "*How To Assess, Transfer And Communicate Critical Risks*" by Antonio & Gaudenzi (2013) where Antonio & Gaudenzi describes various ways to identify risks within the supply chain for an organization. Another book of interest was "*Säkrare Flöden Genom Effektivare Riskhantering*" by Paulsson et al (2013) where the authors mention how to assess various risks and how to analyze them accordingly.

### **3.2.3.2 Qualitative**

The qualitative data utilized in the first part of this thesis has been collected through ten different semi structured interviews consisting of an interview guide (Bryman & Bell, 2015). The semi structured approach meant more open questions which gave the respondents room to explain their answers, give more detailed answers and the possibility to come up with, for the interview guide, uncovered topics, this help us get out as much as possible from the interviews (Bryman & Bell, 2015). It also assisted the interview with a smoother and more natural flow (Bryman & Bell, 2015). The interview guide itself was

limited to questions intended to help us answer the research questions or gain knowledge that could help us understand the situation that we aimed to investigate (Bryman & Bell, 2015).

The interviews were held at the company's headquarter in Sweden and distributed over one week where scheduling was done after respondent availability. The interview was divided into two parts, the first part consisted of two questions aimed at answering what risks the respondent perceived to be the most common and what risks that the respondent perceived have most impact. Two days before the interview the questions for the first part was sent out to the respondent, this was done to strengthen the credibility of the answers since the respondent had the opportunity to read through the questions in advance (Bryman & Bell, 2015). It also gave the respondent the possibility to prepare for the interview and collect relevant data (Bryman & Bell, 2015). Critique on sending out the questions in advance could be that the answers do not come naturally during the interview, which could reflect reality more than prepared answers since prepared answers can be filtered through company values and culture (Bryman & Bell, 2015). Due to this the second part of the interviews was not sent out in advance and was not communicated in advance either. The reason for this was to get a less filtered answer and the first thing that the respondent came to think about. The second part was also semi structured and followed the risk identification framework derived from theory. This second part was also done as a safety net to make sure that nothing was left out and no relevant risk for the company was missed. When creating the interviews, we as authors had to consider the time frame and the fact that risk analysis part was a pre-study for the risk treatment part which we had distributed more of the time frame to. Due to this we decided to do the interviews as simple and efficient as possible without missing any relevant risk. Thus, we only asked about risks perceived by company employees through single interviews where we focused on the top five risks perceived by the employee. With more time on hand a more thorough questionnaire could have been done, but since the reason for these interviews only was to identify the most important risks we settled for a simpler approach.

Before the interviews all the respondents were asked for approval for recording of the interview, all respondent gave their approval. The purpose of the recordings was to make sure that we did not miss any information given by the respondent (Yin, 2013). Further, permission was granted to use position and other characteristics that could be of interest for the study (Yin, 2013), although the respondent was informed that they would be anonym in the paper. The interviews were held in teams and took around 60 minutes each. During the interviews the authors were assigned different roles where the main interviewer was responsible for conducting the interview and asking questions related to the interview guide whilst the second interviewer was responsible for making sure that the interview guide was followed and taking notes. The second interviewer was also responsible for adding interesting questions along the way and encourages the respondent to elaborate on interesting answers. This approach aimed to strengthen the trustworthiness, make sure that no information got lost as well as provide different perspectives (Eisenhardt, 1989). After an interview a session of 30 to 60 minutes of reflection was taken to go through and discuss the answers given. Later a thorough summary of interviews was done, where the recordings made sure that we did not miss any important piece of information. We chose not to transcribe the interviews since we made the judgement that it would take too long time related to the time frame and because the interviews were of a simple form where the identification of risk areas were in centrum, with some elaboration on, there were no great need for exact quotations.

### **3.2.3.3 Quantitative**

The quantitative data collection was conducted through workshop 1. Data from how respondents answered, i.e. how many that mentioned a certain risk, was although gathered before as a result of the qualitative data analysis, see below. Since both the quantitative data collection and analysis relates to the same point in time and thus was conducted more or less on the same time, these areas will be further described below under the heading Workshop 1.

## **3.2.4 Data Analysis**

### **3.2.4.1 Theoretical Framework**

As mentioned above, the purpose of the supply risk theoretical framework, for this study, is to create a risk classification framework based on past supply risk literature and then match the framework with the identified supply risk at the organization. It was obvious that, depending on which type of industry, type of article and various authors that the supply risk classification were different, e.g. different classification for automotive and aerospace industry. Nevertheless, some resemblance across industries and authors were found, e.g. having one initial broad risk classification that divided the risk into broad categories and then followed by further dividing the risk into smaller and better manageable categories. Based on the risk classification resemblance across industries together with this paper's understanding of the risks within the purchasing and BA a framework consisting of 3 different axes were proposed.

1. *Internal or external risks:* To have an initial classification of internal or external risks will enable the organization to quickly differ between internal risks that can immediately be addressed, and external risks were the organization needs to go beyond the organization's borders.
2. *Degree of Treatability:* Some authors decide to have one dimension of the classification that divides the risks into degrees of treatability. This goes in line with what this paper believes is of importance for the organization, to be able to identify the risks and then see if they are treatable or not will help the organization to choose which risks to focus on.
3. *Operation & Quality; Infrastructural; Financial & Monetary; Human Assets; Cultural, Political & Legal and Severe Events:* This classification is highly dependent on which type of industry and organization and therefore various authors have mentioned different names of the categories. However, interestingly, it was notable that different authors divided the same type of risk into different categories, meaning that the risk are the same but divided differently dependent on which type of classification were in place. The logic here goes that as long as the risk is not ignored or forgotten it does not matter as much in which type of category the risk is placed. Hence, these classifications were developed from literature but with emphasis on the organization and what type of industry it is operating in.

### **3.2.4.2 Qualitative data analysis**

To gain structure the collected data was summarized with the help of the recordings to make sure that nothing got lost. From these summaries we held a first coding of the data to identify patterns within the different risk areas (Bryman & Bell, 2015). Instead of applying a proper thematic approach we applied the theoretical framework for risk identification developed in this master thesis. The identified risk areas were then compared and matched to the frameworks first dimension of risk areas. When all identified risks were placed within one of six risk categories of the framework we started to sub-group the risks into sub-groups called risk. This second level of grouping would for example divide the risk area Operations & Quality into risk Late Deliveries and Faulty Deliveries. Also, a third level of grouping

was done to divide the group risk into a total of 30 risk causes. This third level would for example divide the risk Late Deliveries into the risk causes Production delay, Supplier capacity and Delay due to communication. The risk grouping is shown in table 3.2 below.

Table 3.2: Identified risks with respective risk causes identified within the organization structured into risk areas

| Risk Areas  | Operations & Quality    |                          |                                   |                        |                      |                                 |
|-------------|-------------------------|--------------------------|-----------------------------------|------------------------|----------------------|---------------------------------|
| Risk        | <i>Late Deliveries</i>  |                          |                                   | <i>Faulty Delivery</i> |                      |                                 |
| Risk Causes | <i>Production Delay</i> | <i>Supplier Capacity</i> | <i>Delay Due to Communication</i> | <i>Wrong Quantity</i>  | <i>Wrong Quality</i> | <i>Technical Specifications</i> |

| Risk Area   | Infrastructural                     |                 |                             |                            |                      |                  |  |
|-------------|-------------------------------------|-----------------|-----------------------------|----------------------------|----------------------|------------------|--|
| Risk        | <i>Information Asymmetry</i>        |                 |                             |                            | <i>Physical Flow</i> |                  | <i>Relations</i>                           |
| Risk Causes | <i>Information System Breakdown</i> | <i>Forecast</i> | <i>Faulty Communication</i> | <i>LT for new Products</i> | <i>Traceability</i>  | <i>3PL Delay</i> | <i>Supplier &amp; Personnel Dependency</i> |

| Risk Area   | Financial & Monetary Flow           |                                     |                 |                         |
|-------------|-------------------------------------|-------------------------------------|-----------------|-------------------------|
| Risk        | <i>Cost Drivers</i>                 | <i>Economic Market Fluctuations</i> |                 | <i>Supplier Status</i>  |
| Risk Causes | <i>Understanding Cost Structure</i> | <i>Raw Material</i>                 | <i>Currency</i> | <i>Financial Status</i> |

| Risk Area   | Human Assets           |                           |                     |                          |
|-------------|------------------------|---------------------------|---------------------|--------------------------|
| Risk        | <i>Human Related</i>   |                           |                     | <i>Safety</i>            |
| Risk Causes | <i>Maverick Buying</i> | <i>Lack of Competence</i> | <i>Human Errors</i> | <i>Health and Safety</i> |

| Risk Area   | Cultural, Political & Legal               |                 |                        |                              |                   |
|-------------|---|-----------------|------------------------|------------------------------|-------------------|
| Risk        | <i>Cultural</i>                           |                 | <i>Political</i>       |                              | <i>Legal</i>      |
| Risk Causes | <i>Misinterpretation of Communication</i> | <i>Holidays</i> | <i>Factory Changes</i> | <i>Political Regulations</i> | <i>Corruption</i> |

| Risk Area   | Severe Events                 |                              |                     |                          |
|-------------|-------------------------------|------------------------------|---------------------|--------------------------|
| Risk        | <i>Market Changes</i>         |                              | <i>Disaster</i>     |                          |
| Risk Causes | <i>Major Technical Change</i> | <i>Excluding the Company</i> | <i>Factory Fire</i> | <i>Natural Disasters</i> |

By doing this we enabled a consistency between theory and the developed framework with practice and risks identified at the firm.

This risk identification and grouping together with the theoretical framework were the foundation for Workshop 1 the quantitative data collection and analysis for the risk analysis part.

**Comment.** It should be mentioned that all identified risks fit into the framework without force. Thus, there was no need for an extra category “other”, listing risks that did not fit into the framework, which was a thought we had in the beginning. If this would have been the case another idea was to review the framework to see if it left out any important risk areas. Instead we see this result as rather speaking for than against the framework. Also, it is important to mention that all risks and risk causes identified were risks and risk causes mentioned during interviews, thus the authors did not complement the risk list with any other risks. This is important to notice since it means that the firm can be subjected to risks that they do not perceive today. Also, it means that for other businesses the risks identified could be entirely different.

### ***3.2.4.3 Workshop 1***

Workshop 1 is the first workshop held together with the project owners. This workshop combines the quantitative data collection and analysis of the risk analysis part and is because of that presented here under the same heading. We chose to have a workshop to be able to combine expertise from the company with our own in the format of a discussion where we could explain what was meant and the participants could explain what they meant, thus any question marks could be sorted out (Bryman & Bell, 2015). Another way would have been to let the participants fill out a form separately but then be subjected to the risk of misunderstanding (Bryman & Bell, 2015). Also, at this point when it comes to choosing and ranking the risks we valued a strategic input more since a more strategic position means having a more holistic view of the business. A workshop would also fit well into the timeframe.

The workshop began with a brief power point presentation of the project and how the risk analysis part was conducted. During the presentation the 15 identified risks were presented and explained. A primarily ranking by the author had been done beforehand which was shown during the presentation. The reason for the primarily ranking was to show our perspective and how we, the authors, perceived the situation, it was also done to gain a more objective approach since the managers at the firm which participated in the workshop could have their own agenda and therefore could try to affect the outcome of the ranking.

After the presentation the second part of the workshop began. This part was aimed at discussion and integration with the participants, were a final evaluation and ranking of the risks would be done.

To do the evaluation and ranking, the author had the intention to use the Analytical Hierarchy Process (AHP) developed by Saaty which is a model for structuring and analyzing complex decisions through pairwise comparison (Saaty, 1994) and is, as mentioned by Despontin (1984), more written for ‘leaders’ and decision makers within business than for decision analysts and researchers themselves. The model has proven to be applicable in a wide range of decision situations, not only business and industry decisions, but also decisions with in areas such as healthcare, education, politics, conflict resolution, material handling and purchasing (Zahedi, 1986).

Johnson (1980) criticize the model by pointing out that if the elements of one level do not relate to the element of the level above, i.e. the hierarchy is incomplete, the model may show counterintuitive composite weights. An alternative way of approaching the input data is by consider it as observation with random errors, if this approach is taken these random errors might not be eliminated in the process (Zahedi, 1986). Also, Bartoszynski & Puri (1981) identifies a problem with the capability of the result by viewing it as point estimations of uncertainties. Instead Bartoszynski & Puri (1981) suggest interval estimations, but this would then require knowledge statistical estimation properties. However,

the AHP is widely used and seen as a good way to structure subjective decisions and were therefore seen as suitable for this risk evaluation.

Due to the high amount of risks, 15, the AHP method yield a total of 105 comparisons for each criterion, calculated through the formula  $\sum_{k=1}^{N-1}(N-k)$ , where  $N = 15$ . Using two criteria, impact and probability, this would be 210 comparisons. This amount of comparisons was determined to be too many and thus not feasible to go through all. To deal with this problem an initial ranking of the risks was done. This initial ranking was done under the same two criteria, impact, and probability. These two criteria were chosen due to that the definition of risk is a function of impact and probability (Norrman & Jansson, 2004) as well as the heat-map described by Borghesi & Gaudenzi (2013) that allows a ranking of risks by evaluating the on a discrete scale under the criteria likelihood and impact. For each risk the impact if it occurred and the probability of it occurring was determined on a scale from 1 to 10 respectively. Then this two were multiplied to give the risk its initial ranking. The initial ranking is shown in the result chapter 4.

From this, the top six risks were evaluated through the AHP method, thus only yielding a total of 30 comparisons. The AHP method was created in Excel. The result from the AHP evaluation is shown in the result chapter 4.

#### **3.2.4.4 Committee meeting 1**

It was early established that during the project there should be two committee meetings, one after each part. The intention of these meetings was to create a higher level of reliability and validity by presenting for top management.

For committee meeting 1 the presentation was about the two first steps in the risk management process, risk identification and risk assessment. During the presentation the authors went through how the interviews were conducted, explained what risks that were identified and how these risks were assessed. Then the authors presented the recommendation to proceed with the risk *Late Deliveries* and a possible approach for doing so, i.e. following two articles through the process from purchasing order until measuring point for inbound late deliveries. After the presentation the committee group could ask questions about the thesis approach as well as commenting or approving the recommendations put forth by the authors, i.e. the ranking of risks that were done on workshop 1 and the recommended risk to proceed with.

### 3.3 Risk Treatment

The second part, risk treatment, is spanning over step three in the risk management process, which is risk mitigation. The last step, business continuity management is left outside of the scope of this thesis, see delimitations. See figure 3.5 below for the risk management process and the area that relates to the risk treatment part.

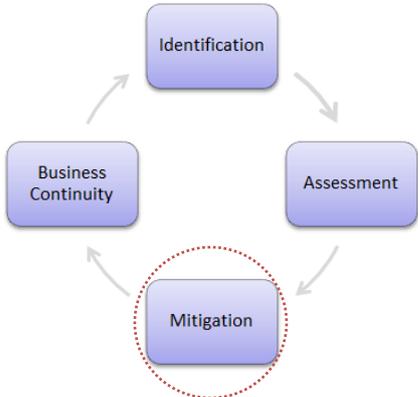


Figure 3.5: Risk management process

#### 3.3.1 Research design

- Deciding Approach (Process View)
- Deciding Articles
- Quantitative Data Collection
- High Level Mapping (SIPOC)
- Detailed Process Mapping
- Check with Project Owners
- Strategic View of the Mapping
- Check with Project Owners
- In Depth Data Collection for Problematic Areas
- Solutions
- Ranking and Evaluating Solutions
- Workshop 2
- Committee Meeting 2

Figure 3.6: Steps taken in chronological order for the risk treatment part

The last two steps of the risk management process are followed in the risk treatment part. Figure 3.6 shows the different chronological steps taken for this part. This step is also following a case study regards the risk mitigation part of the risk management process. The authors chose together with the

project committee at the end of the first part, risk analysis, that the risk to be subject for the second part should be *Late Deliveries* to the company's warehouse from suppliers, i.e. investigating the inbound delivery performance. It was found that theory around the area risk mitigation is more of a general type, i.e. it explains how to classify risks into different categories of mitigation strategies but doesn't give any exact steps on how to mitigate certain risks. For example, theory says that one strategy can be to lower the impact of the risk, but it doesn't in any further extension say how this in particular can be done. Thus, to find more specific ideas of how to mitigate the risk chosen, in this case late deliveries, the authors has tried to find theory around delivery performance and logistics as well as asking employees what mitigation actions they think would lower the risk, this was done on both operational and strategic level. This led to an abductive approach where both theory and practice were investigated (Bryman & Bell, 2015).

The approach for the risk treatment part was to, via process mapping and brainstorming sessions, try and identify underlying causes for the late deliveries investigated. The aim was then to identify actions that can be taken to mitigate the specific risk and risk causes, but not to actually deep dive into this specific actions since that would be projects on its own. Since this step takes on a more high-level approach to the risk situation by covering different action points mainly qualitative data was used, especially in understanding the process. But, also quantitative data, for example in terms of lead time and turnover, was utilized. Thus, this study should as well be defined as a mixed study (Bryman & Bell, 2015:644). More specific the design chosen is called Convergent Parallel Design (Bryman & Bell, 2015:647). In our case the qualitative data is merged with quantitative data to give a more thorough description of the risk situation, both the qualitative and quantitative data where then the fundament on which risk causes were identified and solutions analyzed. Figure 3.7 below depicts the Convergent Parallel Design according to Bryman & Bell (2015).

To make the investigation more comprehensible the case study for the risk treatment part followed the process of two particular traded articles that is sold to customers as a combined product. The first article is a bagasse bowl bought from a supplier in China, thus having a long lead time and is subjected to cultural differences. The second article is its accompanying plastic lid bought from a supplier located in Belgium thus having a closer geographical location and shorter lead time. These two articles were chosen since they together have a substantial impact on profit and at the same time have a history of late deliveries. Also, it was decided that it would be interesting to see differences between sourcing from China or Europe and what requirements this could bring respectively.

The procedure started with mapping the process on a high level by using a SIPOC, see below for further explanation, then mapping the different steps in more detail by "walking the process" and at the same time note different identified problems along the way, i.e. having meetings and brainstorming sessions with people working within the different steps. When the detailed maps were finished a swim lane maps, see below for more detailed description, were created. This was then used in a second round of brainstorming sessions held on both operational and strategic level to identify further problems and solutions to the risk of late deliveries.

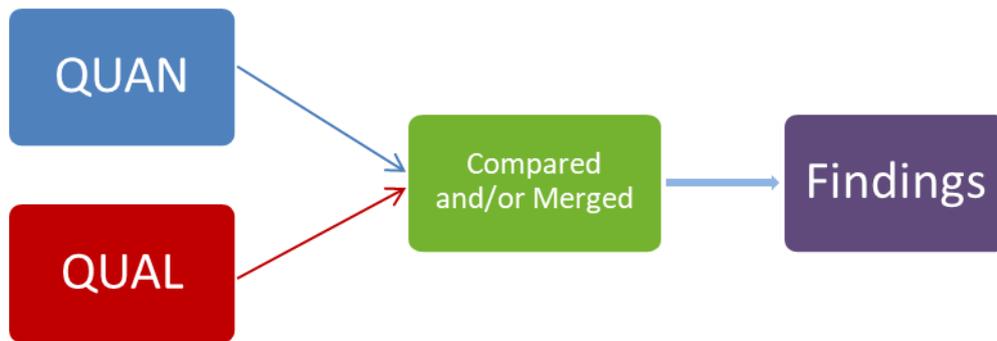


Figure 3.7: Convergent Parallel Design (Bryman & Bell, 2015)

### 3.3.2 Respondents

Based on this chronological order logic, the respondents were divided into 6 different stages, see table 3.3.

Table 3.3: Respondents for the risk treatment part

| Name   | Purpose  | Respondents   | # of appointments |
|--|--|---|-------------------|
| High level mapping (SIPOC)                     | Holistic Overview of the process                                     | <ul style="list-style-type: none"> <li>Project owners</li> </ul>  | 1                 |
| Detailed process mapping                       | In depth knowledge of the process                                    | <ul style="list-style-type: none"> <li>Purchasing</li> <li>Suppliers</li> <li>Transport</li> <li>Warehouse</li> <li>Supply Chain</li> </ul>           | 7                 |
| Strategic view of the mapping                  | Strategic understanding of the process                               | <ul style="list-style-type: none"> <li>Project owners</li> <li>Value chain director</li> <li>Category manager</li> <li>Operations director</li> </ul> | 4                 |
| In depth data collection for problematic areas | Further develop and investigate identified problematic process areas | <ul style="list-style-type: none"> <li>Purchasing</li> <li>Supply Chain</li> <li>Supplier</li> <li>Procurement</li> </ul>                             | 7                 |
| Workshop 2                                     | Discuss identified problems and prioritize related solutions         | <ul style="list-style-type: none"> <li>Project owners</li> </ul>  | 1                 |
| Committee meeting part 2                       | Present and discuss problems with emphasis on feasible solutions     | <ul style="list-style-type: none"> <li>Project owners</li> <li>Operations director</li> <li>Business area director</li> </ul>                         | 1                 |

### 3.3.3 Data Collection

This part also collects data from both theory and practice in order to have the academic theoretical view and at the same time collect qualitative data from the organization to be able to compare and find resemblances between the two.

### **3.3.3.1 Theoretical**

Since part B relies on a process view where the importance is to find the problems and the underlying causes to the process problems and not to identify various theoretical ways to mitigate different supply risk. This also goes in line with what a lot of the theory says regarding risk mitigation, namely that risk mitigation is there to reduce the impact and probability of a risk occurring (Jüttner, Peck & Christopher, 2003; Miller, 1992; Chang, Ellinger & Blackhurst, 2015) and not to cover up the real problems. Hence, it is more efficient to devote the time to identify process problems rather than researching risk mitigation strategies.

However, before deep diving into the process, a smaller literature review on risk mitigation was performed. This was mainly done in order to achieve a broader understanding of which mitigation strategies that the theory suggested and if they were applicable to our case study. The review was performed mainly from LUB search with keywords such as *supply risk mitigation*, *supply chain risk mitigation*, *supply chain mitigation strategies*, *risk management mitigation strategies* and *risk management*. After a broad understanding of theoretical risk mitigation strategies was reached the qualitative data collection part took place.

### **3.3.3.2 Qualitative data collection**

The second part of the thesis was mainly conducted through a qualitative approach. In consultation with the academic supervisor as well as the company it was decided that a process view would be suitable for the risk treatment part where two different articles were followed, see 3.3.1 Research Design for further explanation of the choice for a process-oriented case study for the risk treatment part.

The collection of data for the risk treatment part was mainly done via 18 meetings to which an agenda always was made before. The first eleven meetings can be seen as unstructured interviews where the authors firstly let the respondent describe the area in which the respondent operated and then led into discussion around this area; the authors used an agenda instead of a clear questionnaire (Bryman & Bell, 2015). This approach meant open discussion which gave the respondents room for explanation and the possibility to give detailed answers. Since the authors did not know exactly what to expect on beforehand this format assisted in bringing forth uncovered topics. At the end of the risk treatment part, i.e. from interview twelve and forth the interviews started getting more of a semi-structured character since the authors started to understand the process and knew what they wanted to ask which led to more pinpointed answers but at the same time decreased the possibility that any new areas were brought up (Bryman & Bell, 2015). The interviews were held in teams and took around 45 to 75 minutes each. During the interviews the authors were assigned different roles, one was responsible for taking notes whilst the other was responsible for leading the interview forth. During these interviews the author often used the whiteboard to draw the process discussed; this helped getting a more collaborative meeting and made sure that what the respondent meant was correctly perceived by the authors. After an interview a session of 30 to 60 minutes of reflection were held to go through the interview and summarize and discuss what had been said.

The collection part can be divided into three parts, the first part was the process outlining, that is objectively trying to structure out how the process looks like today and who does what. The second part started when the process was outlined and consisted of meetings and brainstorming sessions on a more strategic level where the process was presented. After the presentation the attendees were

asked to first verify the steps and then explain problematic areas, which were noted. The third step consisted of going deeper into interesting areas to get a more specific understanding of what was going on, information exchange that were done and other details of interest. Between the three steps meetings with the project owners were held to verify the progress of the project.

**Step one.** It was early decided to start at a high level with a SIPOC map and then go into the different areas in more detail by creating detailed maps of each area and identifying problems and then putting these maps together into a swim lane map. The SIPOC is a good way to start out when conducting a process map because it visualizes the input and the output of the process, i.e. stating the beginning and the end of the process. Thus, making sure that the authors and the company had a mutual understanding of the process and what it contained. According to Mishra & Sharma (2014) SIPOC is one of four steps for ensuring that supply chain configuration supports its strategic objectives during the supply chain design phase. The process converts the inputs to outputs which finally will reach the customer of the supply chain, i.e. most not be the customer of the company (Mishra & Sharma, 2014). The swim lane map is a process diagram based on different parallel lanes which are representing different departments involved in the process. Within one of these swim lanes all activities related to that department is placed, the map is also following an overall time axis which makes swim lanes visualizing and effective in showing a process (Petersson et al, 2009).

In this study the SIPOC is created to identify the real problems within the purchasing process and were done together with the project owners. In this process both the supplier and the created purchasing requisition from the internal forecasting department are seen as the suppliers for the process which leads to the inputs in form of the purchasing order from the company and the raw material used at the suppliers. The process in the SIPOC is at very high level without any detailed information see figure 3.8. The outputs are here defined as the two different articles arriving at the customer which in this case is the company warehouse. The warehouse is seen as the customer since it is upon arrival to this warehouse that the inbound delivery performance is measured.

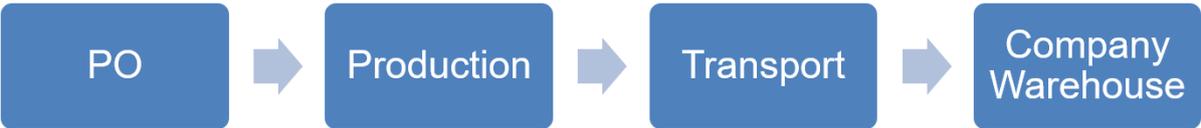


Figure 3.8: High level process map

After the SIPOC was created seven meetings were held to outline the process in more detail where persons within every step of the high-level process were interviewed. Two meetings were held within the operational purchasing department, one meeting at the suppliers respectively, two meetings within logistics and transportation and one meeting within warehousing. From these meetings five different detailed process maps were created, see chapter 4.

**Step two.** This step was held on both a more tactical and strategic level to get an overview and understand how the process connected on a strategic level. At the beginning of these meetings the process as it was at that point were shown and the participants were given the opportunity to come with changes or verify the process. Then the process was further discussed to identify problems and possible improvements ideas. A total of four meetings were held during step two. Parallel to these meetings the swim lane maps were conducted.

**Step three.** During the third step seven meetings were held. The purpose for these meetings were to gain further understanding of areas that seemed more crucial for the process as well as areas where problems had been identified. This involved meetings in Poland which was combined with a visit of the operational purchasing department and the factory and warehouse situated there. Also, a meeting regarding a potential Supplier Relation Management (SRM) system was held since previous steps made it clear that this could be of interest for the company.

### ***3.3.3.3 Quantitative data collection***

The quantitative data collection was conducted through the business intelligence system QlikView and workshop 2. From QlikView data such as lead times, sales, turnover etc. were gathered. From workshop 2 both data collection and analysis were done and are therefore described further below under the heading Workshop 2.

### **3.3.4 Data Analysis**

From the meetings the data collected were summarized which helped the understanding of the process as well as possible problems and solutions. Since the reason was to first map and identify problems in the process and then find solutions there was no need for a proper thematic approach of the coding. This since the process map in itself was the central part and this was created together with the respondents during the interviews. Instead time was set aside after each interview to go through and do a smaller analysis of the collected material. Together with this more qualitative analysis the quantitative data gathered from QlikView were used to get a better understanding of problems and solutions and what could be viable or not.

Overall the data analysis was done parallel with the data collection, that is some analysis in form of identification of problems and ideas to solutions came up along the way of collection. Also, the collection and therefore analysis can be seen in three steps. Were the first step relating to collecting data about all the specific separate process maps and then putting them together into swim lane maps. The second part was to note down all problems in the swim lane map, where they arose and what they affected. The third part was to identify potential solutions and relate them to the problems as well as the swim lane maps.

#### ***3.3.4.1 Workshop 2***

Workshop 2 is the second workshop held together with the project owners. Just as for workshop 1 combined with the quantitative data collection and is therefore presented as a specific event here. The choice of a workshop was to once again be able to combine company expertise with our own in the format of a discussion where nothing was left unanswered and the participant could explain what they meant (Bryman & Bell, 2015). Also, in workshop 2 the strategic view was valued highly.

Workshop 2 was more substantial than workshop 1 and took around 90 minutes. It started with a power point presentation where first case background were presented such as how the operations are performed today and how this can be related to the delivery performance. After that all the problems and solutions were presented and explained, a total of twelve problems and twelve solutions were identified. After the presentation the discussion part of the workshop took place. In this part the participants discussed all the different solutions and ranked their importance after the criteria Impact and Feasibility on a scale on 1 to 10 respectively, this goes in line with the initial risk screening performed in the risk analysis part. Then the scores were multiplied to give the final score and thus the ranking, where a higher score yielded a higher importance. The impact criteria regarded how much the

solution would mitigate late delivery to the warehouse if implemented and the feasibility criteria regarded how feasible this solution was given the status of the company today. These two criteria were chosen due to that the company wanted to decrease the late deliveries, i.e. both have a big impact on late deliveries but also that it would be feasible to implement. Also, here a primary ranking had been done beforehand with the reason to show how we the author perceived the situation and to gain a more objective approach so that no specific solution would be favored by the project owners.

#### ***3.3.4.2 Committee Meeting 2***

The reason for this second meeting were to establish a higher validity of the result and at the same time communicating the result on a strategic level as well as ending the second part and thus the project as a whole. The presentation was about the last step in the risk management process, risk mitigation.

During the presentation the authors started with brief presenting the background. After this all identified problems were presented, both as seen specifically for a supplier and general for the supply chain. Then the ranking of solution was shown were the authors only presented and discussed the top five solutions in more detail. Lastly a summary of the different solutions was made with a time horizon perspective.

### 3.4 Reliability and Validity

**Reliability.** The reliability for a paper aims at describing the probability of the study's replication as well as gives an indicator on how reliable the study is (Bryman & Bell, 2015). Both parts in this study builds on a mixed approach, for risk analysis that is an "Exploratory Sequential Design" and for risk treatment a "Convergent Parallel Design", both described by Bryman & Bell (2015). One deficiency with the qualitative part could be the difficultness to investigate a dynamic and changing environment (Bryman & Bell, 2015). To achieve higher reliability for the qualitative part the process for data selection, interviews, data collection and analysis has been described as in as much detail as possible which facilitates new studies within the field (Yin, 2013). By this thorough description we also aimed to strengthen the study's transparency (Bryman & Bell, 2015). Further on, the reliability also regards the trustworthiness of the measurements taken as well as the presumptions for these measurements (Bryman & Bell, 2015). The study follows the risk management process along with the definition of a risk found in theory which builds on what scholars and researchers have written within the area. Because these basic factors are considered of high reliability the study is considered to have a high stability which according to Bryman & Bell (2015) is a requirement for high reliability.

**Validity.** Validity can be divided into two areas, internal validity, and external validity. The internal validity attends to the question about the relevance of the collected material in relation to the problem as well as how good correspondence the study has with reality (Bryman & Bell, 2015). To strengthen the internal validity several observations, notes and confirmations of the data have been done, also the data has been processed in a correct way (Eisenhardt, 1989). The external validity attends the question of the generalizability of the result. To perform a case study limited to one company has its pros, but it also contributes to a reduced external validity (Bryman & Bell, 2015). To strengthen the external validity the authors have tried to use multiple sources, related and unrelated, were the quality of the material has been seen as high. These sources have been both electrical and printed as well as interviews and quantitative data collected from within the company (Yin, 2013). Instead of putting too much focus on the study's generalizability since the validity in some perspectives can be seen as low, we here emphasize that is an exploratory study to investigate the risk situation for a certain company in a certain business.

## CHAPTER 4 RESULT

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*In this chapter the results of this study are presented. The chapter is divided into two major parts, risk analysis and risk treatment. Part one consists of risk identification, risk areas and risk assessment. While part two consist of background, SIPOC, Process mapping and Swim Lane mapping.*

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### 4.1 Risk Analysis

#### 4.1.1 Risk identification

As mentioned in the method, semi-structured interviews were held at the company. These qualitative interviews were held to assess the risk situation at the company. The identified risks are risks that were mentioned during the interviews, thus it is not certain that this list is exhaustive. However, it is a list of the risks perceived by the company and thus can be seen as the more important risk. The result from the interviews are presented in tables 4.1 to 4.6 below. To enable a fair comparison between the risks internally, tables 4.1 to 4.6 also depicts if specific risks were mentioned during multiple interviews. I.e. if one risk were mentioned multiple times throughout the interviews it will receive a bigger sum compared to a risk that was only mentioned one or two times, compare risk *production delay* and *information system breakdown* for example.

Based on the theoretical framework the identified risks were initially divided into broad categories, e.g. operations & quality or Infrastructural, which this study calls *risk areas*. The risks were then further divided into specific risk groups, e.g. late deliveries, or economic market fluctuations, so called *risk*. Finally, the authors together with the interviewees tried to derive what the risk cause for specific risk occurring could be, so called *risk causes*. Moreover, to further integrate the derived framework the authors decided to declare if the risk were either external (E) or internal (I). If a risk were both external and internal the risk would not receive E nor I, meaning that only risk with only either external or internal would receive E or I. Also, if the risks cause were mentioned by more than 50% of the employees in the given BU the risk cause received a star (\*), i.e. person H, I and J are not considered since they do not belong to the investigated BU. In total ten persons were interviewed, while seven of those were working within the investigated BU, these were person A to G in table 4.1 to 4.6. Person H to J was either outside the purchasing department or the BU.

#### 4.1.2 Risk areas

As mentioned above risk area classification were made which are described below together with presented tables.

##### 4.1.2.1 Operations & quality

Operations and quality covers risks that occur at the supplier and refers to the supplier operation or quality of the products. Risks mentioned within this area were, *late deliveries* and *faulty delivery*.

**Late Deliveries.** Late deliveries refer to purchase orders containing articles that are delivered past the agreed upon delivery window or not delivered at all. Today the company is experiencing an inbound delivery performance at 55%, see graph 4.2. Three specific causes were mentioned and identified during the interviews.

- *Production delay*: delay within the production at the supplier which will affect the supplier's capability in delivering on time.
- *Supplier capacity*: i.e. the supplier having difficulties coping with customer orders from the company and other customers.
- *Delay due to communication*<sup>1</sup>: Poor external communication between the company and the supplier can eventually result in delayed deliveries. Also, the internal communication between e.g. internal departments can lead to delayed deliveries.

**Faulty Deliveries.** This risk category relates to faulty delivery of articles to the company. Three specific causes were discussed during the interviews.

- *Wrong quantity*: goods that arrives to the company that does not match the agreed upon article quantity.
- *Wrong quality*: goods that does not live up to the company quality expectations.
- *Technical specification*: not explicit defined articles specification, e.g. product specification or packaging specification.

Table 4.1: Identified risks for the risk area Operation & Quality

| Risk Areas       | Operations & Quality                 |  |                                   |                                    |                                    |   |
|------------------|--------------------------------------|--|-----------------------------------|------------------------------------|------------------------------------|---|
|                  | <i>Late Deliveries</i>               |  |                                   | <i>Faulty Delivery</i>             |                                    |   |
| Risk Causes      | <i>Production Delay</i> <sup>E</sup> | <i>Supplier Capacity</i> <sup>E*</sup> | <i>Delay Due to Communication</i> | <i>Wrong Quantity</i> <sup>E</sup> | <i>Wrong Quality</i> <sup>E*</sup> | <i>Technical Specifications</i> <sup>I*</sup> |
| Person A         |                                      |  | x                                 |                                    | x                                  | x   |
| Person B         |                                      |  | x                                 |                                    |                                    | x   |
| Person C         | x                                    | x                                      |                                   |                                    | x                                  | x   |
| Person D         |                                      | x                                      |                                   |                                    | x                                  | x   |
| Person E         | x                                    | x                                      | x                                 | x                                  | x                                  |   |
| Person F         | x                                    | x                                      |                                   | x                                  |                                    | x   |
| Person G         |                                      |  |                                   |                                    |                                    |   |
| <b>Sum</b>       | <b>3</b>                             | <b>4</b>                               | <b>3</b>                          | <b>2</b>                           | <b>4</b>                           | <b>5</b>                                      |
| Person H         | x                                    | x                                      |                                   |                                    |                                    |   |
| Person I         |                                      |  | x                                 |                                    |                                    |   |
| Person J         |                                      |  | x                                 |                                    |                                    | x   |
| <b>Total Sum</b> | <b>4</b>                             | <b>5</b>                               | <b>5</b>                          | <b>2</b>                           | <b>4</b>                           | <b>6</b>                                      |

#### 4.1.2.2 Infrastructural

This area covers risks that occurs between the supplier and the company and can be both tangible, i.e. the transit of goods and intangible, i.e. the information flow.

<sup>1</sup> Separated from Production Delay and Cultural – Misinterpretation, due to the significant number of employees pointing this out in the survey and the strong connection to Operations & Quality

**Information Asymmetry.** Relates to asymmetric information exchange that occurs in the internal and external environment for the organization. Four causes were identified for this risk category.

- *Information system breakdown:* can be external breakdowns, such as Vendor Managed Inventory (VMI) system breakdown. Or internal, such as Enterprise Resource Planning (ERP) system breakdown.
- *Forecast:* volatile demand that creates uncertain forecast can create external misunderstanding between the company and the supplier. The forecast can also be managed poorly internally, e.g. lack of expertise.
- *Faulty communication:* faulty information is communicated throughout the supply chain, both externally and internally. This can lead to bad alignment with suppliers and a lack of cross functional focus internally.
- *Lead time for new product:* tends to be delayed which causes faulty information to be spread in the company and to its customers.

**Physical Flow.** This risk area covers risks with the physical flow of the goods, i.e. the physical flow between the supplier and the company. Two potential causes were discussed here.

- *Traceability:* no overview and control of where the articles are during production or transit.
- *3PL delay:* delays that the 3PL provider is responsible for.

**Relations.** Risk category that handles risks with the relations between people or parties.

- *Dependency:* externally this can be related to the company's dependency on a specific supplier. Internally it can be dependency on key personnel within the organization.

Table 4.2: Identified risks for the risk area Infrastructural

| Risk Area        | Infrastructural                     |                 |                             |  |                                 |                              |   |
|------------------|-------------------------------------|-----------------|-----------------------------|--|---------------------------------|------------------------------|---|
| Risk             | <i>Information Asymmetry</i>        |                 |                             |  | <i>Physical Flow</i>            |                              | <i>Relations</i>                            |
| Risk Causes      | <i>Information System Breakdown</i> | <i>Forecast</i> | <i>Faulty Communication</i> | <i>LT for new Products<sup>l</sup></i> | <i>Traceability<sup>E</sup></i> | <i>3PL Delay<sup>E</sup></i> | <i>Supplier &amp; Personnel Dependency*</i> |
| Person A         |                                     |                 |                             | x                                      |                                 |                              |   |
| Person B         |                                     |                 |                             |  | x                               |                              |   |
| Person C         |                                     | x               | x                           | x                                      |                                 | x                            |   |
| Person D         |                                     |                 |                             |  |                                 |                              | x   |
| Person E         |                                     | x               | x                           |  |                                 | x                            | x   |
| Person F         |                                     |                 |                             |  | x                               | x                            | x   |
| Person G         | x                                   |                 | x                           |  |                                 |                              | x   |
| <b>Sum</b>       | <b>1</b>                            | <b>2</b>        | <b>3</b>                    | <b>2</b>                               | <b>2</b>                        | <b>3</b>                     | <b>4</b>                                    |
| Person H         |                                     | x               |                             |  |                                 | x                            | x   |
| Person I         |                                     | x               |                             | x                                      | x                               |                              |   |
| Person J         |                                     |                 | x                           | x                                      | x                               |                              |   |
| <b>Total Sum</b> | <b>1</b>                            | <b>4</b>        | <b>4</b>                    | <b>4</b>                               | <b>4</b>                        | <b>4</b>                     | <b>5</b>                                    |

#### 4.1.2.3 Financial & Monetary Flow

This area covers the risks that are related to the financial status of the supplier, the market and the monetary flow between the companies.

**Cost Drivers.** Area that covers the understanding of the cost structures for the articles that are bought. E.g. understanding the importance of total cost of ownership (TCO).

- *Lack of knowledge:* the insufficient understanding of the total cost picture for a product. This can be caused by incompetency or unclear processes for cost breakdowns.

**Economic Market Fluctuation.** Relates to risk within the macro economical market fluctuations. The company has been working with these fluctuations for a couple of years and feel they have better control of the situation compared to a while back. Two causes were identified here.

- *Raw material:* insufficient insight of the raw material price fluctuations.
- *Currency:* inadequate knowledge of currency fluctuations.

**Supplier Status.** Risk area that covers risks related to the supplier's financial status, e.g. supplier liquidity or risk of going bankrupt.

Table 4.3: Identified risks for the risk area Financial & Monetary Flow

| Risk Area        | Financial & Monetary Flow           |   |                 |                                    |
|------------------|-------------------------------------|---|-----------------|------------------------------------|
| Risk             | <i>Cost Drivers<sup>I</sup></i>     | <i>Economic Market Fluctuations<sup>E</sup></i> |                 | <i>Supplier Status<sup>I</sup></i> |
| Risk Causes      | <i>Understanding Cost Structure</i> | <i>Raw Material*</i>                            | <i>Currency</i> | <i>Financial Status</i>            |
| Person A         | x                                   |   |                 |                                    |
| Person B         | x                                   | x   | x               | x                                  |
| Person C         | x                                   |   |                 |                                    |
| Person D         |                                     | x   | x               |                                    |
| Person E         |                                     | x   |                 | x                                  |
| Person F         |                                     | x   |                 | x                                  |
| Person G         |                                     |   | x               |                                    |
| <b>Sum</b>       | <b>3</b>                            | <b>4</b>  | <b>3</b>        | <b>3</b>                           |
| Person H         |                                     |   |                 |                                    |
| Person I         |                                     |   |                 |                                    |
| Person J         |                                     |   |                 |                                    |
| <b>Total Sum</b> | <b>3</b>                            | <b>4</b>  | <b>3</b>        | <b>3</b>                           |

#### 4.1.2.4 Human Assets

This area regards risks related to the personnel, for example human errors.

**Human Related.** Relates to risks that occur for examples due to human mistakes. Externally this can be faulty communication between companies. Internally this can be lack of competence and the incapacity to share information between employees as well as lack of training. Three causes were discussed.

- *Maverick buying:* material or services that are purchased independently outside of standard procurement procedure.
- *Lack of competence:* e.g. lack of competence at the supplier or lack of in-house competence for some or all departments.
- *Human Errors:* errors that occur due to employees making mistakes.

**Safety.** Risk area that covers the safety of the employees at the supplier. Not specifically investigated since the company does not work close with the supplier’s employees.

Table 4.4: Identified risks for the risk area Human Assets

| Risk Area        | Human Assets                       |                           |                                  |                           |
|------------------|------------------------------------|---------------------------|----------------------------------|---------------------------|
| Risk             | <i>Human Related</i>               |                           |                                  | <i>Safety<sup>E</sup></i> |
| Risk Causes      | <i>Maverick Buying<sup>I</sup></i> | <i>Lack of Competence</i> | <i>Human Errors<sup>I*</sup></i> | <i>Health and Safety</i>  |
| Person A         |                                    | x                         |                                  |                           |
| Person B         |                                    | x                         | x                                |                           |
| Person C         |                                    |                           | x                                |                           |
| Person D         | x                                  |                           | x                                | x                         |
| Person E         |                                    | x                         | x                                |                           |
| Person F         |                                    |                           |                                  |                           |
| Person G         |                                    |                           |                                  |                           |
| <b>Sum</b>       | <i>1</i>                           | <i>3</i>                  | <i>4</i>                         | <i>1</i>                  |
| Person H         |                                    |                           |                                  |                           |
| Person I         |                                    | x                         |                                  |                           |
| Person J         |                                    | x                         |                                  |                           |
| <b>Total Sum</b> | <i>1</i>                           | <i>5</i>                  | <i>4</i>                         | <i>1</i>                  |

#### 4.1.2.5 Cultural, Political & Legal

This area relates to the legal, political and cultural landscape, how it might change and how it might affect the organization.

**Cultural.** This category spans over the cultural risk of doing business with partners outside the domestic market. Two causes were identified.

- *Misinterpretation of communication:* language or hierarchy barriers that might affect the communication between company and the supplier.
- *Holidays:* holidays that is specific for certain countries and might disrupt the ordinary operations, e.g. Chinese New Year.

**Political.** Relates to risk that occurs due to political aspects, such as new laws or regulations. A risk that varies in severity, e.g. a law that forbids something compared to a regulation. Two examples were found.

- *Factory changes:* major changes in supplier factory, e.g. investment in new machines. This can lead to stop in production and thus delayed deliveries.
- *Political regulations:* regulations that affect the supplier, e.g. political regulations that forbid certain types of emissions.

**Legal.** This area covers Illegal procedures such as bribes and corruption.

Table 4.5: Identified risks for the risk area Cultural, Political & Legal

| Risk Area        | Cultural, Political & Legal               |                 |                              |                              |                          |
|------------------|---|-----------------|------------------------------|------------------------------|--------------------------|
| Risk             | <i>Cultural<sup>E</sup></i>               |                 | <i>Political<sup>E</sup></i> |                              | <i>Legal<sup>E</sup></i> |
| Risk Causes      | <i>Misinterpretation of Communication</i> | <i>Holidays</i> | <i>Factory Changes</i>       | <i>Political Regulations</i> | <i>Corruption</i>        |
| Person A         |   |                 |                              |                              |                          |
| Person B         | x   |                 |                              | x                            |                          |
| Person C         |   |                 |                              |                              |                          |
| Person D         |   |                 |                              | x                            |                          |
| Person E         |   |                 |                              |                              |                          |
| Person F         |   |                 |                              | x                            | x                        |
| Person G         |   | x               |                              |                              |                          |
| <b>Sum</b>       | <b>1</b>                                  | <b>1</b>        | <b>0</b>                     | <b>3</b>                     | <b>1</b>                 |
| Person H         |   |                 | x                            |                              |                          |
| Person I         |   | x               |                              |                              |                          |
| Person J         | x   |                 |                              | x                            |                          |
| <b>Total Sum</b> | <b>2</b>                                  | <b>2</b>        | <b>1</b>                     | <b>4</b>                     | <b>1</b>                 |

#### 4.1.2.6 Severe Events

Severe events cover major disasters that are difficult to control, e.g. natural disasters, terrorist attacks and new technology.

**Market Changes.** Risk category that handles major market changes that the company are exposed to. Two causes were identified.

- *Major technical change:* drastic changes that affects the market conditions, e.g. the introduction of smartphones in the mobile industry.
- *Excluding the company:* supplier or customer cuts out the company and does business with each other instead of via the company.

**Disasters.** Relates to external disasters that will affect the company. Two examples were found here.

- *Factory fire:* supplier's factory is caught on fire.
- *Natural disasters:* natural or humanitarian disasters that affects the supplier or the supply chain.

Table 4.6: Identified risks for the risk area Severe Events

| Risk Area        | Severe Events                     |                              |                             |                          |
|------------------|-----------------------------------|------------------------------|-----------------------------|--------------------------|
| Risk             | <i>Market Changes<sup>E</sup></i> |                              | <i>Disaster<sup>E</sup></i> |                          |
| Risk Causes      | <i>Major Technical Change</i>     | <i>Excluding the Company</i> | <i>Factory Fire</i>         | <i>Natural Disasters</i> |
| Person A         |                                   |                              |                             |                          |
| Person B         |                                   |                              |                             |                          |
| Person C         |                                   |                              |                             |                          |
| Person D         | <i>x</i>                          | <i>x</i>                     | <i>x</i>                    |                          |
| Person E         |                                   | <i>x</i>                     |                             | <i>x</i>                 |
| Person F         |                                   | <i>x</i>                     |                             |                          |
| Person G         |                                   |                              |                             | <i>x</i>                 |
| <b>Sum</b>       | <b><i>1</i></b>                   | <b><i>3</i></b>              | <b><i>1</i></b>             | <b><i>2</i></b>          |
| Person H         |                                   |                              |                             |                          |
| Person I         |                                   |                              |                             |                          |
| Person J         |                                   |                              |                             |                          |
| <b>Total Sum</b> | <b><i>1</i></b>                   | <b><i>3</i></b>              | <b><i>1</i></b>             | <b><i>2</i></b>          |

#### 4.1.3 Risk Assessment

Following the risk identification phase was the risk assessment phase, i.e. ranking and evaluating risks.

##### 4.1.3.1 Initial Screening

The assessment part began with an initial screening of the risks to choose 5-6 risks, see the bold marked risks in table 4.7, which would be further evaluated in the AHP. The initial screening was performed

based on two criteria, impact and probability, which were subjectively weighted in a 10-scale ranking system were 10 was considered high impact and high probability.

Table 4.7: Initial screening of identified risks

| Risk                         | Probability | Impact | Point |
|------------------------------|-------------|--------|-------|
| Late Deliveries              | 6           | 5      | 30    |
| Economic Market Fluctuations | 4,5         | 6      | 27    |
| Faulty Delivert              | 5           | 5      | 25    |
| Information Asymmetry        | 5           | 5      | 25    |
| Relations                    | 4           | 5      | 20    |
| Cost Drivers                 | 4           | 5      | 20    |
| Political                    | 2,5         | 7      | 17,5  |
| Human Related                | 3,5         | 4      | 14    |
| Market Changes               | 1,5         | 9      | 13,5  |
| Disasters                    | 1           | 9      | 9     |
| Physical Flow                | 4           | 2      | 8     |
| Supplier Status              | 1           | 8      | 8     |
| Cultural                     | 2           | 4      | 8     |
| Legal                        | 1           | 8      | 8     |
| Safety                       | 1           | 4      | 4     |

#### 4.1.3.2 Analytical Hierarchy Process ranking

This study decided to use the same two criteria, probability and impact, as the initial screening for the AHP method, see figure 4.1. The weights of the criteria as well as the pair-wise comparison between the risks were a subjective weighting performed by the authors together with the project owners. For a comprehensive understanding of how the AHP method works and detailed information of how the weight between the criteria and the pairwise comparison between the risks were performed see method chapter 3 respectively the appendix – Analytical Hierarchy Process.

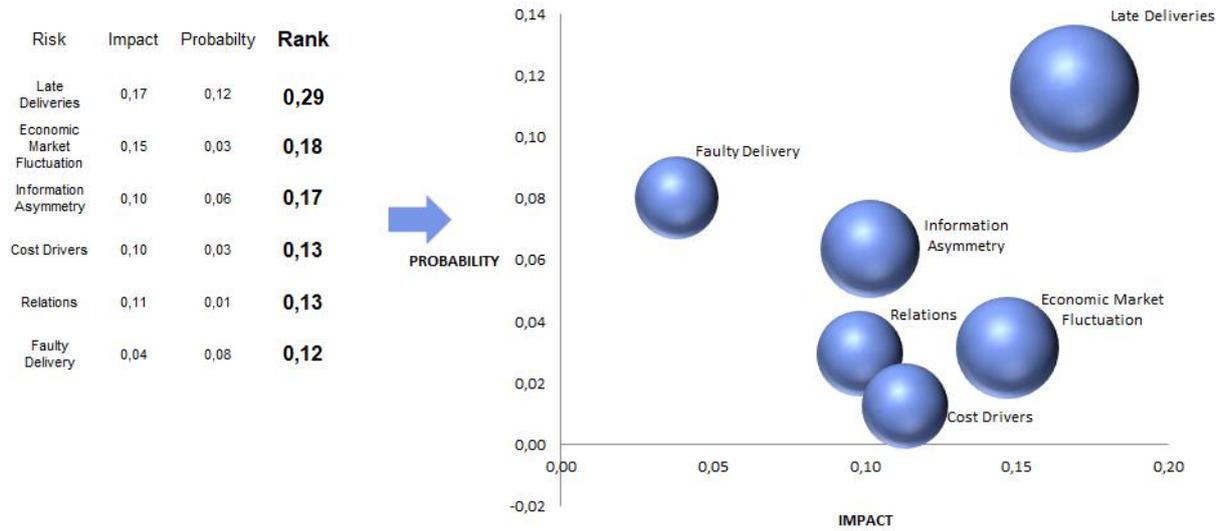


Figure 4.1: AHP analyzes of top 6 risks

**Comment.** The numbers under headlines impact and probability are not specific number nor numbers that should be further investigated. Rather, they are the subjective outcome of the AHP method that builds on weighted criteria times the pairwise comparison risk number.

### 4.2 Risk Treatment

The company is a supplier of tableware concepts as well as packaging and take away solutions. This thesis is done in the trading part of the company, that is the company purchase complete products and sell these to their customers. Historically the company started out in Europe which also were the primarily market and did everything all operations, productions and sourcing within Europe. But, as the turnover and the company grew it started to look outside of Europe to become a global player. This resulted in sourcing from more low-cost countries to achieve a lower price on the articles. This led to that the company today is a global company that are buying from different parts of the world including both Europe and Asia and that exist on more than 40 markets.

The company manages to have a delivery performance to customers on around 90 % for the investigated business area, see figure 4.2, this is measured when the goods leave the company warehouse in Europe. The company is experiencing an inbound delivery performance on approximately 55 %, that is goods delivered within the delivery window, see figure 4.3. Further there was one recent incident regarding an Asian supplier which led to severe supply chain disruptions and the decision to fly products from Asia to Europe was taken. Both figures 4.2 and 4.3 are only for the investigated business area and for the year 2017.

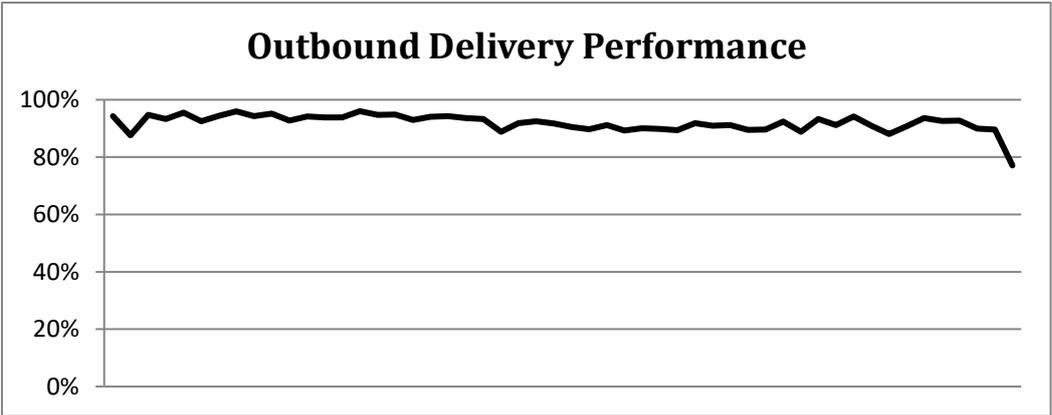


Figure 4.2: Outbound delivery performance for the investigated business area

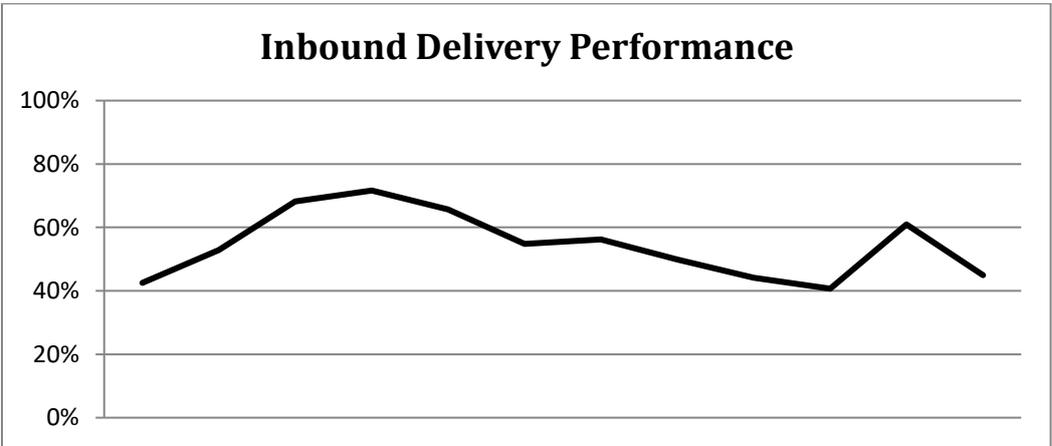


Figure 4.3: Inbound delivery performance for the investigated business area

**The bagasse form.** The bagasse form is a rapidly growing product that drives the sales of the plastic lid because they are sold together. The supplier for the bagasse form is located in China and represents

4,5 % of the investigated business area’s total spend. On the other hand, the case company is approximately 10-15 % of the Chinese supplier’s business. On total the delivery performance for the supplier is 20 % and specifically for the bagasse form it is 42 % on time deliveries. The products are being shipped over sea from China to Europe where the company has their warehouses.

**The plastic lid.** The plastic lid is one of the most profitable products for the investigated business area and is used in combination with several different bowls. The supplier for the plastic lid is located in Belgium and is more of a special case since it once was owned by the company. Due to this shared history the communication and transparency is high with continuously meetings. This has also led to a shared storage at the supplier’s facility that is taken care of by the supplier. The supplier is getting payed due to how full the inventory is i.e. the company pays depending on how many pallet locations that is being used but not how optimized they are used. The Belgium supplier makes up approximately 21 % of the investigated business area’s total spend, while the company makes up 5-10 % of the supplier’s total spend. For this supplier an overall of 87 % of orders are delivered on time, specific data for the plastic lid was not possible to find due to a recent switch of suppliers.

**4.2.1 Suppliers, Inputs, Process, Outputs and Customers (SIPOC)**

From the risk analysis part, the risk *late deliveries* were chosen to take into the risk treatment phase of the study. However, to be able to get an overview and grasp late deliveries better a SIPOC diagram was created, see figure 4.4. The SIPOC diagram was created together with the project owners and describes the suppliers, input, output, customer and a high-level mapping of the procurement process. The supplying companies are in both cases seen as the supplier to the process since they provide input materials that are being used to create the articles. The forecast department that create the forecast within the company is also seen as the supplier to the process since they provide the input that creates the purchasing requisition which the purchasers are placing the orders after. Inputs follow this and are thus the purchase order that is created from the purchasing requisition and the raw material used to create the products. The process is at a very high level and starts with the Purchase Order (PO) moves on to production that follows by transportation and ends at the measuring point for late delivery at the company’s warehouse in Germany. The outputs of the process are thus the articles delivered to the process’ customer which for both articles are the company warehouse in Germany.

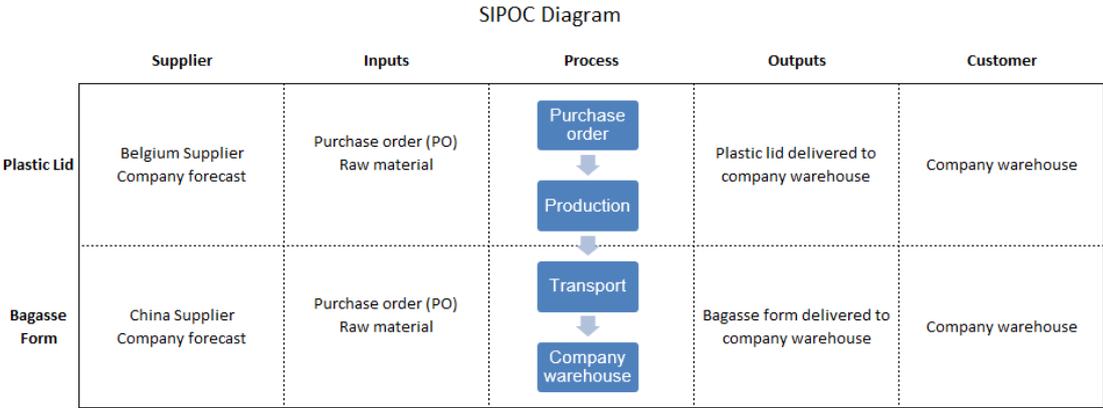


Figure 4.4: SIPOC diagram

After the SIPOC was created the next step was to “walk the process”, i.e. investigate and develop each step in the process in more detail to truly understand the process. Thus, from the high-level process

each process step was individually investigated, and five different process maps were created. These maps are shown and explained below.

**4.2.2 Process mapping**

**4.2.2.1 Purchasing order process**

The purchasing order process (PO Process) as a part of the procurement process is shown below in figure 4.5.

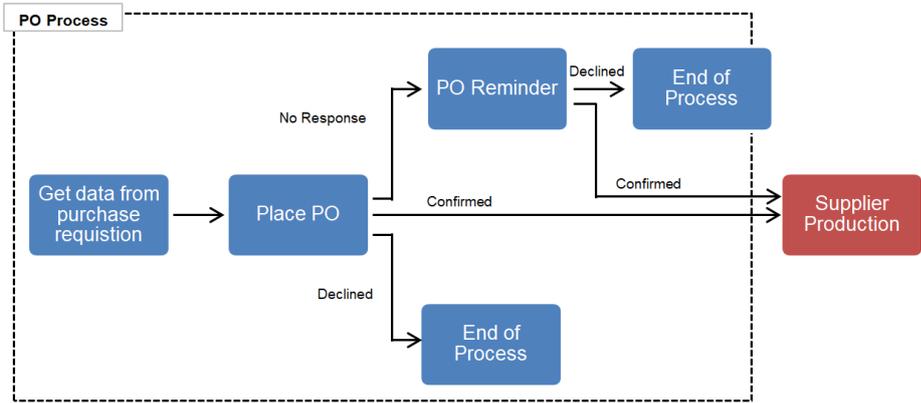


Figure 4.5: The purchasing order process

**Information regarding the PO Process.** The operational purchasers that are responsible for this process are located in company facilities in Poland. There are currently four full time employees and one half time employee working with the PO process and they place around 40 000 orders per year. The operational purchasers are structured after what is called supplier complexity, i.e. they assign a supplier value depending on how complex this supplier is. The complexity and the value relate to the number of articles at the supplier, the amount of purchasing orders placed during a year, the amount of contact with the supplier and how problematic the supplier is. Thus, the different purchasers do not have the same number of suppliers, but they roughly have the same amount of complexity. This means that one operational purchaser can have suppliers in both China, Europe and the rest of the world and be buying from different commodities such as plastic, cardboard, paper, bagasse etc. The sourcing department, situated in Sweden, is structured differently after commodities, i.e. one sourcing manager is only sourcing within one commodity.

The PO process starts with that the operational purchaser gets the purchasing requisition from the ERP system and then places the order following that given information of article and quantity. The supplier has 72 hours to confirm the order, if not confirmed the operational purchaser will resend a reminder to the supplier. When the supplier has confirmed the order, the operational purchaser leaves the order and it goes into the production phase. The operational purchasers have all the daily communications with the suppliers, but focus is on placing orders. All the communication is done via email through the program Outlook.

**Further responsibilities.** The operational purchaser is also responsible for managing and monitoring late deliveries which are done by checking a “late delivery list” that is generated via the ERP system. This list is generated automatically and shows order that has not yet been delivered, i.e. not delivered past the delivery date, or been partly delivered. However, this list is checked manually when the operational purchaser has time to do so and there is no clear guidance of when and how often this

should be done, nor is there any alarm system in place to notice the operational purchaser if something is late. Further, the list that is generated has normally around 200 – 300 delay rows and there is no system in place for prioritization of different orders. From interviews it has been found that an operational purchaser checks “late delivery list” once or twice every other week depending on workload. The process for checking the “late delivery list” is highly manual and starts off with tracking the goods, i.e. checking with transport or the 4PL if they have the goods. If the goods have not left the supplier the operational purchaser has to export the list generated in the ERP system to an excel file, then choose a late order and email the supplier responsible for that delivery asking when the goods will arrive. In best case the supplier can update the delivery information and send it back in an email to the operational purchaser who updates the list in the ERP system manually. In some problematic cases the operational supplier advances to strategic sourcing who then contacts the supplier. An overview of the manual supplier contact process can be seen in figure 4.6 below.



Figure 4.6: Late deliveries supplier contact process

**Product priority.** Another important finding to bring up is that the product priority and classification within the company, i.e. the classification of A, B, C and D products, is not used outside of logistics and warehousing. Thus, it was noted that the operational purchaser, and to some extent the sourcing managers does, not have knowledge about the different classification of products. Also, it was noted that the classification is poorly updated for the investigated since the most profitable product was listed as a B product. The classification is based on historical data of number of order lines, the economical contribution of the product and if the product is newly (1 year) launched.

**Identified problems.** There were three problems identified and noted during the mapping of the purchasing order process which were, *poor communication between the company and Asian suppliers, the company are registering articles under the wrong PO and a lack of article prioritization.* The first one relates to the communications between the company and its suppliers, especially the once in Asia. The communication is mainly done via email and there is no structured way to follow up after an order is placed. Only if the operational purchaser notices that no confirmation is given by the supplier they will contact the supplier again to resend the purchase order or ask why it was not confirmed. The second problem can be seen as information asymmetry and relates to the case that the company is registering articles that arrive to the warehouse in Germany under wrong purchasing orders. Thus, the ERP system will show that articles for a certain PO that have not arrived at the warehouse have arrived, creating confusion and asymmetric internal information. The last identified problem is within article prioritization and relates to that the operational purchaser do not know what articles or orders to prioritize.

**4.2.2.2 Production Belgian supplier**

The process at the Belgium supplier, called production in the high-level process, is shown below in figure 4.7.

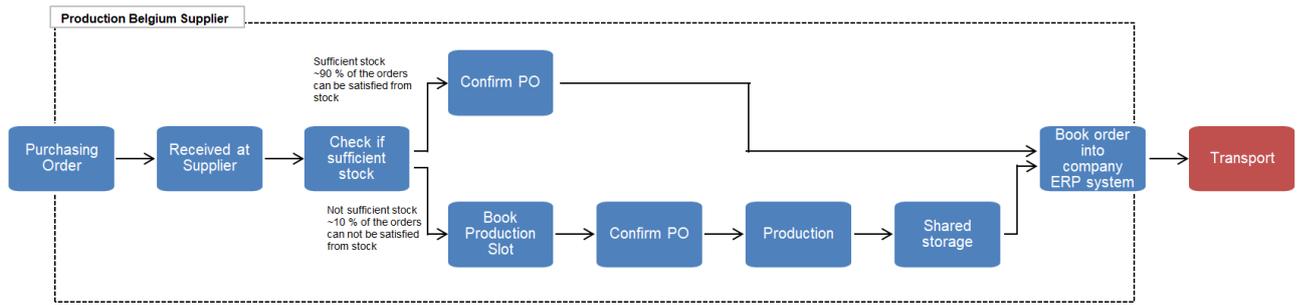


Figure 4.7: Production Belgium supplier

**Information regarding the production process.** The Belgian supplier that produces the plastic lid can satisfy 90% of the purchase orders from stock due to a rolling six month forecast that the supplier receives from the company. The production is automated and consists of two machines, where the first machine produces the plastic film via extrusion and the second machine produces the lids from the plastic film via thermoforming. There is a possibility to store produced plastic film in order to skip the first part of the production. The official lead time from order to delivery is 8-9 weeks. The company and the supplier have a shared storage that the company owns but the supplier is responsible to fill up. The supplier runs three shift and has three off-line extruders and one in-line extruder and a total productivity for the plastic lid on 8 200 pieces per hour. There is no back-up tooling in place to guard against tool breakdown, although there has never been a breakdown historically for these tools.

**Identified problems.** For the Belgian supplier there were three specific problems identified and those were, *no backup specific tooling, no overview and control of the shared storage and long lead time (LT)*. The communication with the Belgian supplier is good; it is one of the bigger suppliers and the company has a shared history with the supplier and continuously meetings are held to develop the cooperation between the companies. The first problem however, relates to that there is no backup for the specific tools used when creating the plastic lid. This will be problematic if the current tool breaks which would lead to stop in production. The second problem regards to the shared storage that is used for the products bought from the supplier. The problem lies in that the company has a bad visibility and overview of the shared storage and that the supplier is the one taking care of it. The third problem relates to the long lead time from the Belgian supplier which is 8-9 weeks even though the production is highly automated and with a high throughput.

#### 4.2.2.3 Production Chinese supplier

The process at the Chinese supplier, called production in the high-level process, is shown below in figure 4.8.

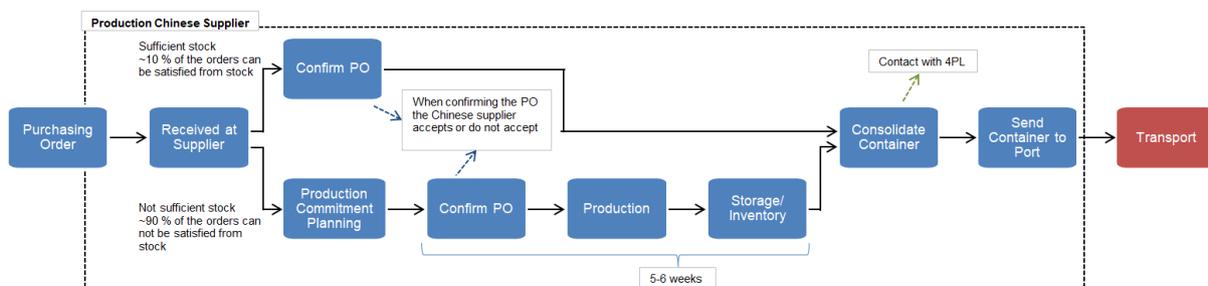


Figure 4.8: Production Chinese supplier

**Information regarding the production process.** The bagasse bowl is produced by the Chinese supplier and the supplier can satisfy 10% of the purchase orders from stock the rest have to go through production which have a lead time of 5-6 weeks. The production is highly manual with a pulp system making the pulp from which the bagasse material is created as bowls. After that the bowls are cut manually, UV treated and stored. From interviews it has been shown that the tooling is sufficient, and that the supplier has sufficient number of machines, today around 100 machines of which several can be used for the bagasse bowl. The biggest bottle neck within the production is the manual labor with a production lead time of around 20 seconds per bowl which equals 180 pieces per hour. This combined with six tools and thus the possibility to run six machines at the same time makes a throughput of around 1 100 pieces per hour.

The supplier receives a forecast once a year which the supplier can produce against and the company is partly responsible to purchase produced articles per the forecast. The production is planned by spreadsheets and the supplier does not have a production planning system. After the production and when the goods are in transit the supplier sends the required documents (pack list, invoice and bill of lading) to the company, this information exchange is done per e-mail. This information exchange is not structured, and it is not clear who has the responsibility of the document exchange. Further, if the documents are received this information exchange is not logged in any system but remain in Outlook as an email. There have been several cases where documents has not been sent without any notification at the company.

**Identified problems.** When mapping the process for the Chinese supplier one specific problem was identified. This problem was *problem within production*. The identified problem relates to e.g. capacity limits in the production or labor issues. It is common that employees go back to their home towns during holidays and then do not come back again thus creating an employee shortage. Since the production is highly manual this can create problems in production and negatively affect the throughput.

**4.2.2.4 Goods in transit**

Since the Belgian supplier and the company have a shared storage where the goods are registered to the company ERP system the transport map only includes the transport from the Chinese supplier production to the company warehouse, see figure 4.9.

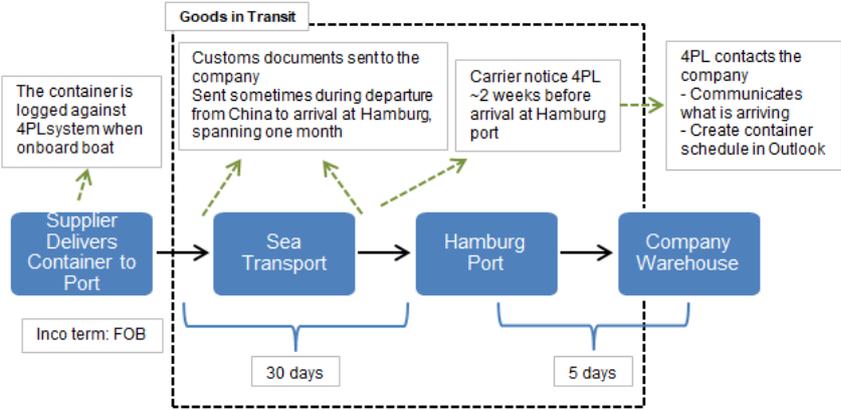


Figure 4.9: Goods in transit process

**Information regarding the transport process.** The company is using a 4PL that handles the transportation from the Chinese supplier to the company’s external warehouse in Germany. The 4PL has a holistic view over the transportation process for the company. The 4PL deals with the contact with the supplier, contact with the carrier over the sea and the contact with the company when the goods are arriving to Europe. The lead time varies depending on the situation in China, but it takes 7-10 days from the time that the container is picked up by the supplier until the container has been shipped. The lead time on sea, that is from the port in China until the warehouse in Germany, is roughly 45 days. From the external warehouse in Europe a 3PL handles the transportation from the external warehouse to company specific warehouses. Also, in this step a document exchange is done when customs documents are sent to the company. This is done sometime during the sea transport and is not structured. Around Two weeks before the carrier arrives in Hamburg the 4PL notice the company and let them know what is arriving so that the company can create a container schedule in Outlook. This documentation is not logged in any system and can because of that not be used to see if orders are on time or not.

**Identified problems.** For the transportation step two problems were noticed and identified, these were *delays due to lack of space in the company’s warehouse* as well as *no overview and control of which documents that have or have not been sent*. The first problem relates to congestion at the company’s warehouse in Germany which can lead to those goods needs to wait at the harbor in Hamburg or temporarily being stored in an external warehouse. The second problem regards to what we in this study calls *uncontrolled information exchange* and relates to that there is no clear control or responsibility over the document exchange taking place when documents are sent to the company.

**4.2.2.5 Company warehouse**

Since the risk this study is investigating are late deliveries and the measuring point for that is the first external warehouse in Germany, it is considered that the process end there. However, to get a better understanding of the process a mapping of the warehouse process was also done, see figure 4.10.

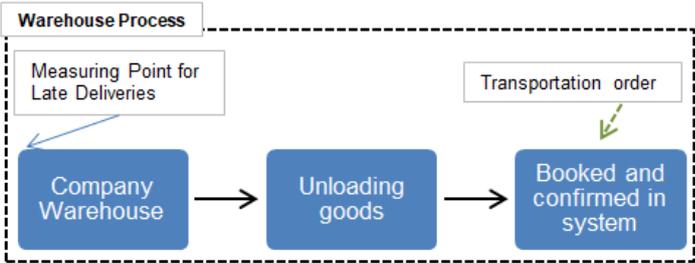


Figure 4.10: Warehouse process

**Information regarding the warehouse process.** First information point for the warehouse is when the 4PL contacts the company that there are arriving containers from the sea. The external warehouse is the measuring point for late deliveries, i.e. are the goods late to the external warehouse then the goods are considered late to the company. It is however important to emphasize that the company does not notice if something is late or not when the goods arrive at the warehouse. When the goods arrive the “late delivery list” in the ERP system is updated, but it is first when someone from the operational purchasing department manually goes through the list that a late delivery is noticed or if someone checks the ERP system for that specific order.

**Identified problems.** Within the warehouse process one problem was identified, this was that *PO's does not match the goods arrived*. That means that when goods arrive the PO that the warehouse personnel receive does not match the goods inside the container. This creates confusion and to deal with this new PO's might be created as a temporarily solution.

**4.3.3 Swim Lane mapping**

From the detailed maps described above this study developed two holistic swim lane maps for the Belgian and Chinese supplier, see figures 4.11 and 4.12 The swim lane map describes and visualizes the connection between various departments in the procurement process.

**The Belgian supplier.** The Belgium supplier has a simpler process due to closer relation with the company and a geographically closer location. The lead time for the plastic lid process is thus also very short, five days, if the article is in stock which is approximately 90 % of the time. The above-mentioned path is shown by the green arrow in the swim lane map. Although, if the article is not in stock then the lead time can be up to 60 days, this is represented with the path of the red arrow. In this specific case the supplier is updating the SAP system when the goods arrive at the shared storage.

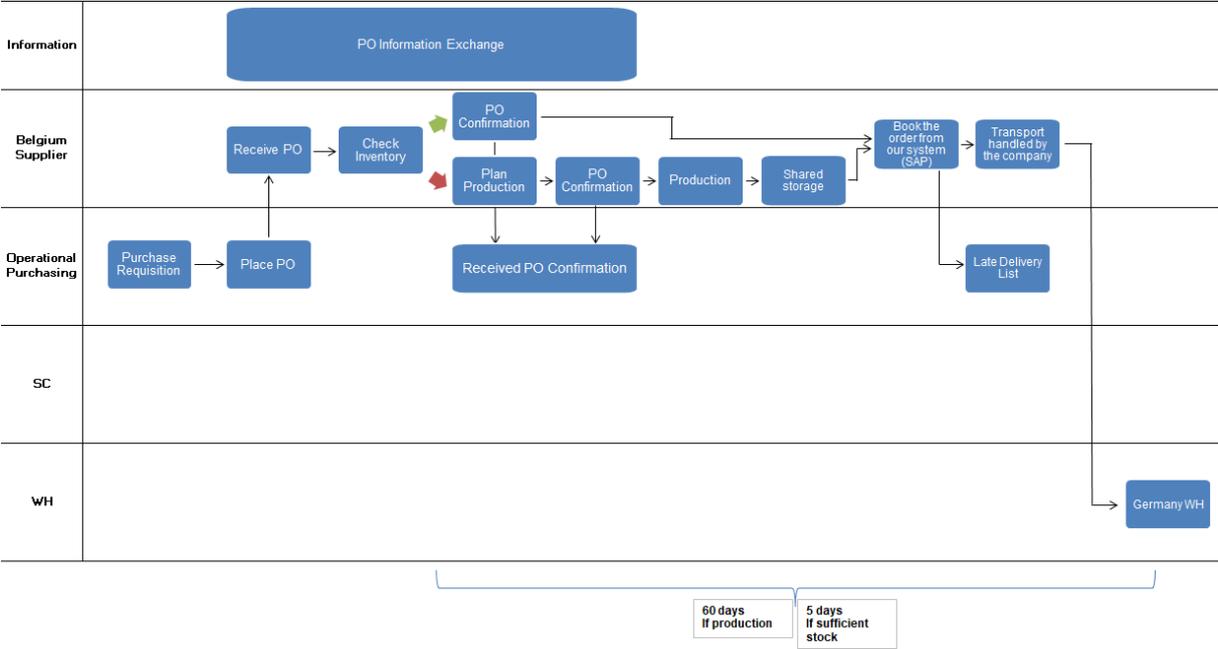


Figure 4.11: Swim lane map for plastic lid produced by the Belgian supplier

**The Chinese supplier.** The process for the bagasse form is more complex and requires more information exchange due to the geographically and cultural distance to the supplier and that there are more actors, such as the 4PL provider, involved in the process. The process has a lead time of 50 days if the article is in stock which is the case for 10 % of the time. The rest of the 90 % of the time the supplier needs to produce the goods against order creating a lead time on around 90 days. The information exchanges happening is not structured. Meaning that no one at the company nor at the supplier keeps track of the information exchange and there is no system to check up if the documents have arrived or not. Also, there is no one at the company that is responsible for the entire process; instead employees are responsible for different functions within the process.

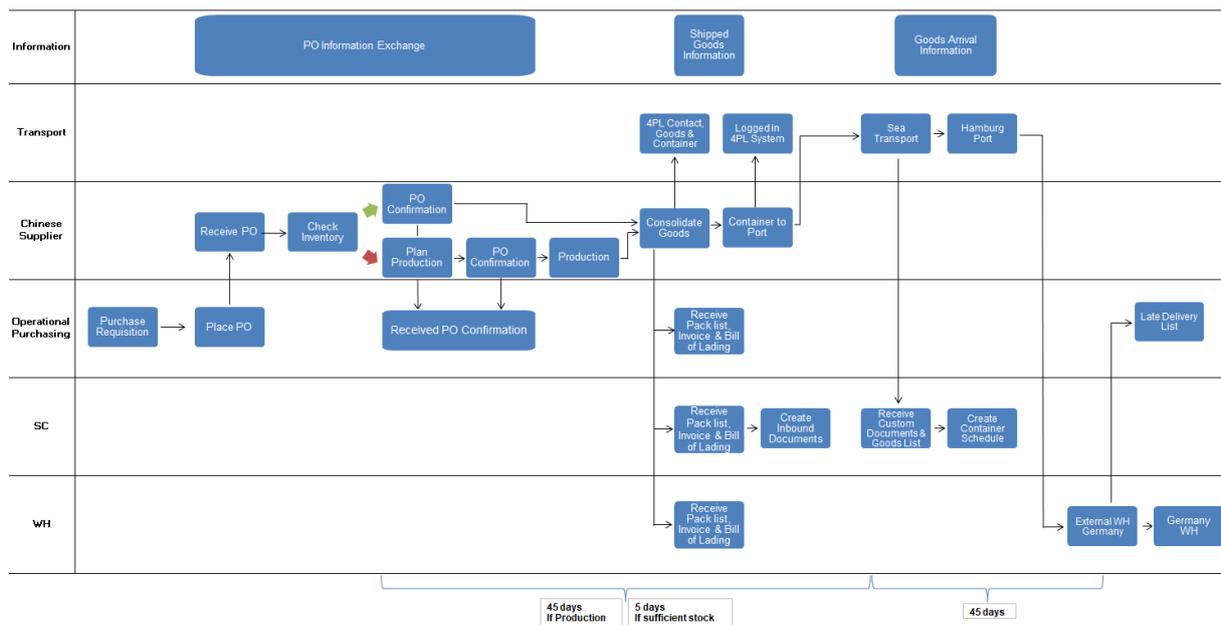


Figure 4.12: Swim lane map for bagasse bowl

**General for the procurement process.** Both processes have common features that can be seen more as how the company are working. Firstly, there is a functional focus, meaning that every function has their own responsibilities and does not understand other functions responsibilities and work. This functional focus will be referred to as silo thinking or silo mentality. There is no process owner and no one that understands the entire process from beginning to end. Further, focus seems to lie on measuring the outbound delivery performance towards customer and not putting too much attention on the inbound delivery performance towards customer. This was for example visualized since the operational purchasers seems to be investigating the outbound delivery performance and not the inbound. The company is at an earlier stage in the purchasing model developed by Weele (2015) and has no proactively risk management in place yet. It was also found that the operational purchasers do not understand the capacity for the suppliers as well as minimal order quantity (MOQ). Common for all purchased articles is that the notice of articles running late can be noticed one to two weeks after that they are late due to the manual check of the “late delivery list” in the ERP system.

**Identified overall problems.** When the swim lane maps for the two articles were compiled and all the information retrieved through the more specific mapping looked through a total of seven general problems relating to both articles were identified. These seven problems are listed below.

- *No cross functional KPIs*
- *Silo thinking throughout the organization*
- *Focus lies to reduce cost but lack of focus on high delivery reliability*
- *No system support for multiple sourcing*
- *Operational purchasers do not know supplier capacity*
- *Late deliveries stay unmanaged to long in the system*
- *Lack of article prioritization throughout the company*

The first problem, *no cross functional KPIs* relates to the perception we got during the interviews that different departments are very strongly focusing on different areas. Some areas have a strong focus

on reducing costs while others focus on outbound delivery performance. These different focuses can lead to misalignment in the company. There are no overall organizational KIPs that all departments are working after; instead different departments are measuring what they find suitable, if measuring anything at all. This can be problematic since different KIPs can counteract each other. This leads us to the second problematic area, *the silo mentality*, which refers to that different departments within the company are like islands governing themselves. This creates sub optimizations within the company which just as the KPIs can counteract each other. Also, the third problem is related to this, but regards the *focus on direct cost savings*, for example this could be focusing blindly on the purchasing price. In this case it seems like the company does not take the late deliveries into account and what cost that these late deliveries might cause. Further, the fourth identified problem is that the current supply chain set up and the IT system does not *support multiple sourcing*. The fifth identified problem goes in line with employee knowledge when it was noticed that the *operational purchasing department does not have knowledge* regarding for example supplier capacity or MOQ. The sixth identified problem relates to the checking of the late delivery list which is being checked once every second week. There is no system in place for checking the late deliveries, so the check is done manually and is done very seldom. The last problem that was identified is the *lack of article prioritization*. There is a classification of articles, but the classification is done within warehousing and is used to optimize the inventory. Thus, the classification is not communicated and used throughout the company properly and an article prioritization is not achieved throughout the company.

## CHAPTER 5 ANALYSIS

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*In this chapter the presented results are being investigated and analyzed. The chapter is divided into two parts, risk analysis and risk treatment. The risk analysis part consists of risk identification and risk assessment. The second part, risk treatment, consists of Background, Identified problems, Identified solutions and Evaluation & ranking of solutions.*

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### 5.1 Risk Analysis

#### 5.1.1 Risk Identification

The interviewed employees described various risks that they were exposed to, e.g. that the end customers complained about lack of product stability, that the company warehouse received damaged goods or that the warehouse received the wrong goods. At a first glance it is easy to believe there are numerous risks, however, when investigation further the employees are describing the same risk but in different descriptions and words. I.e. in this specific case they were describing the risk this study calls *faulty deliveries*, see table 4.1. This goes in line with what Borghesi & Gaudenzi (2013), Musa (2012) as well as Paulsson et al (2013) does when they classify the same risk under different labels. Namely, that the specific risk exists but the label and descriptions of the risk vary and therefore dependent on the risk classification framework the risk will appear under different sections and labels. Furthermore, during the interviews this study found that different employees mentioned the same risk cause that were derived from different risks and thus needed to be identified with the origin risk. For example, different problems with communication were one risk cause that was frequently mentioned, however the origin risk varied. This is visualized from table 3.2 where a distinction had to be made to what kind of communication problems that were derived from which risks. I.e. the risk *late deliveries* have a risk cause called “delay due to communication”, while the risk *cultural* has the risk cause called “misinterpretation of communication” and the risk *information asymmetry* has the risk cause “faulty communications”, see table 3.2. This distinction had to be made to enable a fair comparison between the risk and it is further supported by Sodhi & Tang (2012) whom claims that the risk classification has to be custom made for every industry and organization.

During the interviews different risks and risk causes were mentioned multiple times. This can be an indication that the risk is occurring more often within the organization, but not as a statistical truth. It would be wrong to draw the conclusion that those risks will have a higher probability of occurring since the identification phase is entirely built on subjective opinions and perceptions of the employees and not a correct statistical investigation of historical data. Despite this reasoning, it will, in this paper, been seen as an indication of that the risk is occurring more frequently. The argument behind this is that something that is occurring more often and/or with a high impact might be something that also will be on the respondents’ minds. Adding on this, this study only counted and investigated the risks from the purchase department whilst the other departments were interviewed merely as a mean to get a better objective view of the risks. This will result in that it is the employees within purchasing which input will matter when deciding on the probability of a risk occurring. When considering all the interviewed employees the risks probabilities would have looked differently. However, since this study

were on supply risks related to the business area it was considered appropriate to only count the once within these areas.

Furthermore, dependent on who were interviewed different risks were in focus. The reason for this can be that employees working with certain types of articles or regions have certain opinions on which risks that are important. For example, when viewing tables 4.1 to 4.6 and person G it is visible that the focus there are risks related to information exchange. The explanation behind this is that this specific employee only worked with supplier contacts in Asia and therefore mainly saw risks related to poor communications with the supplier, not risks related to e.g. products quality or traceability. This is a good observation point for the company since it visualizes the silo mentality within the purchasing department, some employees only views risks related to quality while others risk related to information exchange.

### **5.1.2 Risk Assessment**

The initial screening consisted of subjective weighting of probability and impact of the risks and since the weighting were subjective there are possibilities of risks being evaluated on bias grounds. For example, the risk *safety* on the supplier workers might not have the biggest focus from the company employees since they rarely interact with them. Further, it is problematic to put a weighted number on a risk since the company will never know the exact outcome of that specific risk. For example, the risk *market changes* score a 1.5 on probability and a 9 on impact see table 4.7. Evaluating this further it is probably correct to give a low score on probability and a high score on impact. This since major market changes does not happen to often and not in this type of industry but when it happens it can be catastrophic consequences for the company, hence the big impact. However, dependent on the current business structure and flexibility within the organization it can also be an advantage to have a major market change. This since a major market change presents an opportunity for the company to be flexible and change more efficiently compared to their competitors and therefore gain market shares. What is pinpointed here is the problematic nature of stating a number on a risk since the risk will have different severity in its nature and both the probability and the impact are highly dependent on how the company is working with flexibility and proactivity of risks.

Adding on this, when it comes to weighting various risks it becomes a matter of also comparing the risks against one another. Meaning that if one risk gets a weighted score of 9 on impact and another risk get a weighted score of 7 on impact then the latter risk should per definition have a lower impact on the company if occurring. As mentioned, this is highly dependent on the severity of the specific risk and also on how the company is working with risks. Therefore, it becomes even more problematic since one needs to consider both the severity of the risk itself but also in comparison to other risks. Examples could be, *political* and *supplier status* which have a weighted impact score of 7 respectively 8, see table 4.7, meaning that supplier status should have a higher impact on late deliveries. Logically, if the supplier is going bankrupt they cannot deliver anymore and therefore have a major impact on late deliveries. However, political regulations could be e.g. a new law that plastic products in china are forbidden and therefore affecting multiple suppliers for the company. Hence have a bigger impact compared to one supplier going bankrupt. Once again, the problematic area here is to put a definite number on a risk that, in its nature, varies on a lot of different variables, e.g. severity of the risk, comparison to other risks or company being proactive in that risk area.

The same problem phenomenal occurs in the AHP method were there are subjective criteria comparison and subjective risk pair-wise comparison. Namely, impact category was chosen to be weighted 67% while probability 33%, resulting in that impact category got a major influence on the result. This is not negative per say, since the company chose to have a bigger weight on impact, but one should be aware that impact then will have a major influence on the result. Also, compared to the initial screening the pair-wise comparison was performed for both the categories and for all the risks resulting in that all the risks were compared to each other regarding both the categories. Even though it was still a subjective weighting in the pair-wise comparison between the risks this time the risks were thoroughly compared to each other and instead of a definite number the risks received a number that varied dependent on which risk they were compared to. This way the pair-wise comparison will lead to a fairer and not as biased comparison compared to the initial screening.

When performing the pair-wise comparison one need to be aware of these risks are company specific, meaning that even though e.g. *economical market fluctuation* is a macro phenomenal both the probability and the impact will be dependent on how proactive the company are working with those types of risks. For this specific risk the company is aware of fluctuations and working with them accordingly and therefore the risk received a lower weight compared to other risks in the comparison. On the other hand, logically, if the risks were completely missed by the company, as were the case for economical market fluctuations a couple of years ago, the risks itself would receive a higher probability and impact. The consequence for this is that newly identified or unprocessed risks would receive a higher overall ranking compared to an already identified and processed risk would.

Another point of interest is the risk *Information asymmetry* which relates to both internal and external communication between the company and its suppliers. The risk itself is a real risk and will affect many different aspects of the company. However, it is also possible to view the risk as a cause to many of the other risks. For example, the risks *late deliveries* and *faulty deliveries* can both identify one of their causes as information exchange that are poorly performed. Based on this, the risk *information asymmetry* was considered as a cause of many risks and not as a risk that were interesting to further investigate by itself. Subsequently, this resulted in that even though the risk were considered not worth investigating, the risk itself would come up as a cause for the chosen risk and thus would be explored in the chosen risk context instead.

As described all the comparisons were done via a subjective weighting which were necessary simply due to time constraints and that historic data for almost all the risks were non-existing. The exception was for the risk *late deliveries* which were roughly 55% inbound on time and therefore this risk was considered having a high probability. This goes in line with the theory stating that *late deliveries* happen often but with relatively low impact. However, the specific case for this company was that late deliveries did happen often but also the impact was notable. The notable impact actually affects the company which is contradictory to suggested theory, which suggest a relatively low impact. But as for this specific case the relatively low inbound delivery reliability combined with the insufficient goods traceability, which will be seen in risk treatment, resulted in deliveries being one to two months late, hence the notable impact.

## 5.2 Risk Treatment

### 5.2.1 Background to Late Deliveries

Originally, the company only had suppliers in Europe with relatively low lead times and, basically, the same cultures. A while back, with the emerging markets and the possibilities to have suppliers in remote parts of the world with the hope of achieving a bigger profit, a part of the supplier base was moved to Asia. However, there is always a tradeoff; companies need to be aware of system thinking, meaning that varying one aspect will affect other aspects. This is what happened to the company. Basically, the company took the structure and way of conducting business in Europe and applied this to the Asian market as it were. The company expected things to work as they did in Europe, although this was not the case. For example, the lead time from Asian suppliers were much longer compared to equivalent suppliers in Europe. This resulted in that the company needed to be more proactive and have better visibility of the goods if something were to occur. Another example is, the cultural aspects meaning that conducting business with Asian suppliers are different from the equivalent suppliers in Europe. The company needs to be more alert and understand that e.g. a “yes” does not necessarily mean “yes we will produce that PO” but rather “yes we have received the PO”. It is easy to stare blind at the short-term savings and direct purchase price that can be made and forget about the other aspects, such as TCO or delivery performance. The company needs to have a better holistic view over the procurement process and understand that varying one aspect will affect other aspects and the fact that conducting business across the world requires different knowledge and maintenance.

As per today, the company has roughly 90% outbound delivery performance towards the customers while maintaining an inbound delivery performance around 55%. The gap between the outbound and the inbound delivery performance are an indication that the company are probably working with buffers to enable a higher outbound delivery performance. Brindley, (2004) as well as Paulsson et al (2013) states that companies in general tend to introduce buffers to cover up the supply problem and this rather enhances the indication of buffers to explain the gap between outbound and inbound delivery performance. Further, to introduce buffers in the supply chain is classified as a redundancy strategy (Sheffi & Rice, 2005; Zsidisin & Wagner, 2010; Treleven & Schweikhart, 1988) which is contradictory to theory, which suggest a flexibility strategy to work with and mitigate late deliveries (Blackhurst et al, 2011; Richey, Adams & Dalela, 2012). Basically, it is intuitive for companies, when experiencing decreasing outbound delivery performances, to increase the buffers and therefore, on short terms, solve the problem. However, it can be very costly to treat the risk consequence instead of the underlying problem (Brindley, 2004; Chang, Ellinger & Blackhurst, 2015; Chopra and Sodhi, 2004) and this is assumable what the company has been doing in the past.

Another interesting aspect is the silo mentality that seems to exist within the company. Namely, various departments have their own individual KPIs and tend to what is important to them and there is a lack of general overview of the procurement process. For example, the operational purchasers, which are partly responsible for late deliveries, were informed, by their KPI, that the delivery performance was good at roughly 90%. Whilst, the supply chain department were worried about the low inbound performance but that were not a concern from other departments. It seems that all the departments are working properly and handles what they should handle but there is no personnel or department with a more holistic overview over the entire procurement process. Moreover, there were examples when the strategic purchasers simply noticed that the company were out of stock on certain articles and had no explanation of who was responsible and how this could happen. This indicates that

there is no overview over the process but rather various departments working with their tasks and if there is a problem no one is certain who is responsible for the problem and who will resolve and follow up the problem. This is problematic since a late delivery will probably be resolved somehow but the late delivery problem will keep repeating itself since there is no one responsible for follow-up or digging deeper into the problem.

The move and expansion to sourcing from Asia without reconstructing the supply chain, that is still operating in a near shore European supply chain set up, is what we think the cause to the start of late deliveries. This combined with the silo mentality and the strong focus on outbound delivery performance could be a reason to drive up inventory levels to cover for short term loss. This then led to the problems the company is experiencing today, with an uncontrolled supply chain with low inbound delivery reliability and high stock levels to keep up an outbound delivery reliability that is acceptable to customers.

This study is only investigating the procurement process which itself is a part of a bigger process that has its origin in the forecast development and end in delivery to end customer, see figure 5.1. Meaning that, the smaller and the more holistic process are strongly correlated to one another. Resulting in that the company cannot merely work with the procurement process by itself but rather needs to have a more holistic process overview and then further divide that process into smaller processes. For example, the procurement process, and then tie those smaller processes into the more holistic one. In doing this the company can achieve a better cross functional orientation and align the various departments to the same end goal.



Figure 5.1: The purchasing process as part of the more holistic process

### 5.2.2 Identified Problems

When viewing the problems related to the various process maps it was quickly realized that the problems varied a lot and not all problems were connected to the risk *late deliveries* but rather general problems for different departments. Therefore, these problems were not further developed, see table 5.1. It was also established that there would not be a quick fix with one or two mitigation strategies that would, magically, solve the given situation, rather, analyzing the stated problems and connect those problems to the given risk, see table 5.1. This goes in line with that Chopra and Sodhi (2004, p. 55) states “Unfortunately, there is no silver bullet strategy for protecting organizational supply chains. Instead, managers need to know which mitigation strategy works best against a given risk”. As the authors are pinpointing, that understanding the problems which consequences resulted in late deliveries were of grave importance to mitigate the given risk.

Behind this logic were the table 5.1 developed which states the initial identified problems and whether the problem is a general problem or if the problem is only connected to specific departments. The table also depicts if the stated problem is strongly correlated to late deliveries, meaning that a problem that is not connected to late deliveries will not be further investigated. For example, a long lead time from the Belgian supplier is a real problem and one can, probably, draw the conclusion that the company could have a lower lead time if they were higher prioritized at the supplier. But it is not, per

say, the long lead time that make the goods arrive late. If the planning and underlying processes are carried out as planned the lead time does not have a major impact on late deliveries, i.e. late deliveries are not majorly dependent on the lead time. Moreover, the table also depicts whether the problems are department specific or a general problem. These problems will be further developed under each head line, specific problems Belgium supplier, specific problem Chinese supplier and finally, General problems which are found below.

Table 5.1: Identified problems and how they relate to late deliveries

| Problem   | Purchasing | Supply Chain | Warehouse | Belgian Supplier | Chinese Supplier | General Problem | Strongly correlated to late deliveries |
|---|------------|--------------|-----------|------------------|------------------|-----------------|--|
| Communication   | X          | X            |           |                  | X                |                 | X                                      |
| Register articles under wrong PO                      |            |              | X         |                  |                  | X               |  |
| Lack of article prioritization                        | X          | X            |           |                  |                  | X               | X                                      |
| No backup specific tooling                            |            |              |           | X                |                  |                 | X                                      |
| Production problems                                   |            |              |           |                  | X                |                 | X                                      |
| Long lead time  |            |              |           | X                |                  |                 |  |
| Lack of space in company warehouse                    |            |              | X         |                  |                  | X               |  |
| Uncontrolled information exchange                     | X          | X            | X         |                  | X                |                 | X                                      |
| PO's does not match the goods arrived                 | X          |              | X         |                  |                  | X               |  |
| No cross functional KPIs                              |            |              |           |                  |                  | X               |  |
| Silo thinking   |            |              |           |                  |                  | X               |  |
| Focus lies on only reducing costs                     |            |              |           |                  |                  | X               |  |
| No system support for multiple sourcing               |            |              |           |                  |                  | X               |  |
| Purchasing process problems                           | X          |              |           |                  |                  | X               | X                                      |
| Late deliveries stays unmanaged to long in the system | X          |              |           |                  |                  | X               |  |

**Comment.** Table 5.1 states the initial identified problems, that is the problems identified through the mapping process. However, the problems were then further analyzed and broken down to enable a fair comparison and analysis. This will result in some of the problems will e.g. change name, scope or

both. Hence, table 6.2 in the discussion and final conclusion chapter will not completely correspond to table 5.1.

#### ***5.2.2.1 Specific problems Belgian supplier***

As visualized in table 5.1 the only problem that came to light during the mapping were the problems that could occur due to the supplier only having one specific tooling for the plastic lid. The consequence for this could be that if the tool were e.g. dropped and destroyed, the production of the plastic lid would be completely stopped. As mentioned, this has not yet occurred but since the consequences would be so severe for the company the company either should invest in a backup tool or have a backup plan if the tool were to be damaged. It is possible to view this in two steps; first step is being aware of the risk as the company today is and the second step is to have a mitigation plan if the risk were to occur.

Further, this was the only problem that was identified during the mapping phase. However, logically, the supplier will be biased, meaning that they will only point out problems that they view as a problem. Meaning that a problem for one company could be an opportunity for another company. This underlying logic were the case for this supplier since when further investigating the supplier it came to light that the shared storage between the company and the supplier were not, to put it mildly, working in the interest for the company but rather for the supplier. After conducting the mapping, it rose to our attention that the shared storage kind of fall through the cracks, i.e. it was not clear who was responsible for the shared storage. Meaning that there was no overview what kind of articles and how many articles should be there, which safety stock or article prioritization etc. The consequence for this is that there was an incentive for the supplier to fill up the storage with goods that suits them the best, while the company were paying for it. Meaning that the company is paying for pallet location that they are not managing over, obviously this is not considered a problem for the supplier, thus the lack of information regarding this problem.

As for the Belgium supplier, this study found two specific problems that need attending to, *no backup specific tooling* and *no overview and control of the shared storage*, named as *production and storage problems* in figure 5.2 below. These problems are real problems for the company and in the solution section below this study will present what, hopefully, will help solve these problems.

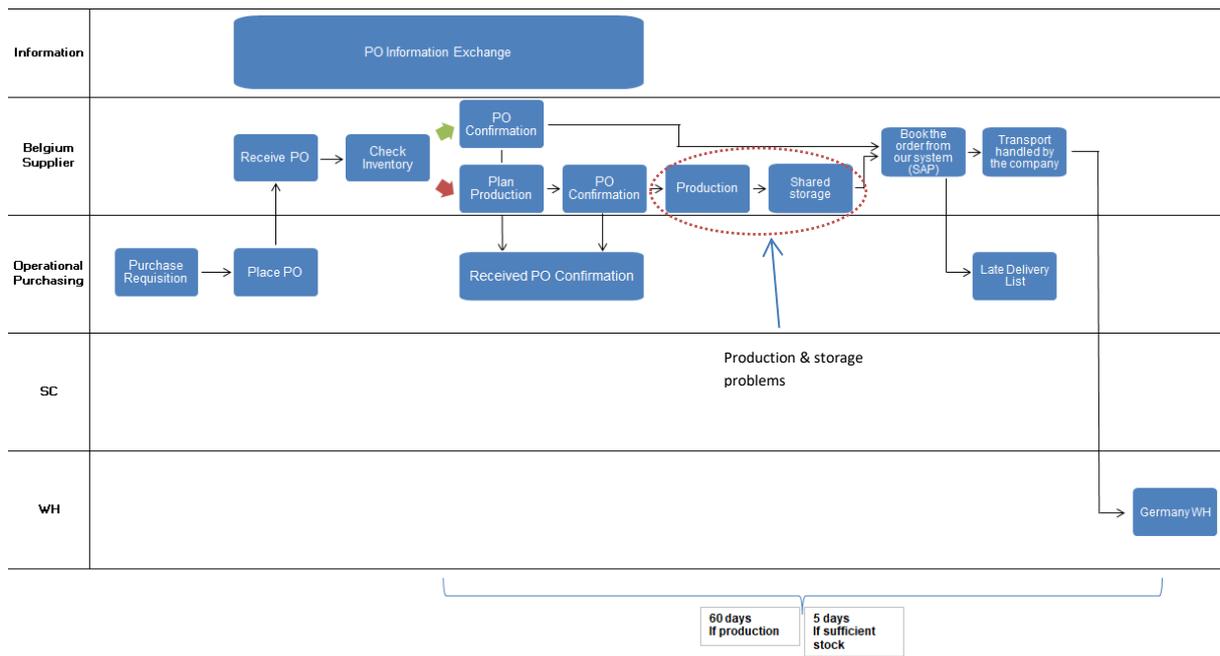


Figure 5.2: Specific problems related to the Belgian supplier

### 5.2.2.2 Specific problems Chinese supplier

Compared to the Belgium supplier, more problems were identified with the Chinese supplier, namely, *Communication with the company, production problems and uncontrolled information exchange*. The communication problem between the company and the supplier are an umbrella term which means that it must be broken down further to enable a fair problem analysis. When breaking the communication problem down one problem became transparent, which was the PO confirmation phase. The operational purchasers were experiencing issues both getting the confirmation but also when receiving the confirmation, it was unclear if the supplier were committed to actually produce per the PO. This study chooses to call this problem *Uncertain PO confirmation*, see figure 5.3.

Moreover, the communication problem or the lack of communication also builds or derives a serious problem that this study calls the *black box*. Basically, from the point when the purchasers receive a PO confirmation until the goods arrive at the company warehouse there is no structured way of communicating, see figure 5.3. The black box consists of more than 90% of the lead time and as the name hints it is a black area for the company where the company are working in the dark. The company have no structured way or clear responsibility deviation for the process, thus creating a bad traceability of goods and information exchange. This, of course, is a problematic area for the company since the traceability and visibility of goods are close to non-existing. There are documents exchanges inside the black box so that the company is, if searched, aware when the goods are leaving the supplier. However, if the documents are not received, there is no system support in place to notice this, i.e. if the documents are not received the company has no clue that the goods are missing. This is viewable as, in the worst case, that the company places a purchasing order then waits 90 days and hopes that the goods will arrive. The analogy here is with murphy's law which states "whatever can go wrong will go wrong", i.e. if the company does not have control and overview of their goods things that can go wrong will go wrong along the process.

The biased supplier information was also identified with the Chinese supplier, specifically *made to order* problem. Even though the company sends out a forecast that they are partly purchase

responsible for the supplier has 90 % made to order while the Belgian supplier were the opposite. As mentioned above, this problem might not be viewed as a problem from the supplier’s point of view, but for the company it is a matter of reducing the lead time by 50 % if the supplier can supply from stock, as per the agreement. This problem is closely entangled with the communication problem since the communication aspect be a cause to the made to order problem. However, the made to order problem can have other various causes, e.g. cultural differences where the supplier does not trust or care about the forecast and it is the PO that is the ultimate proof of purchase. Generally, this made to order problem can also be viewed from a more holistic viewpoint. Specifically, when the macro economic environment is at a boom then companies tend to purchase more goods from the suppliers resulting in that the suppliers could be facing capacity problems, hence the suppliers are forced to prioritize customers. Therefore, suppliers cannot produce towards forecast but rather trying to produce what is the most critical for the most profitable customers. This line of thought could be one of the reasons why the made to order is at 90% and further explain why the company were forced to put some pressure on the supplier to produce their goods a while back. Hence, being higher prioritized at the supplier.

Figure 5.3 below summarizes the problems, in a swim lane, related to the Chinese suppliers.

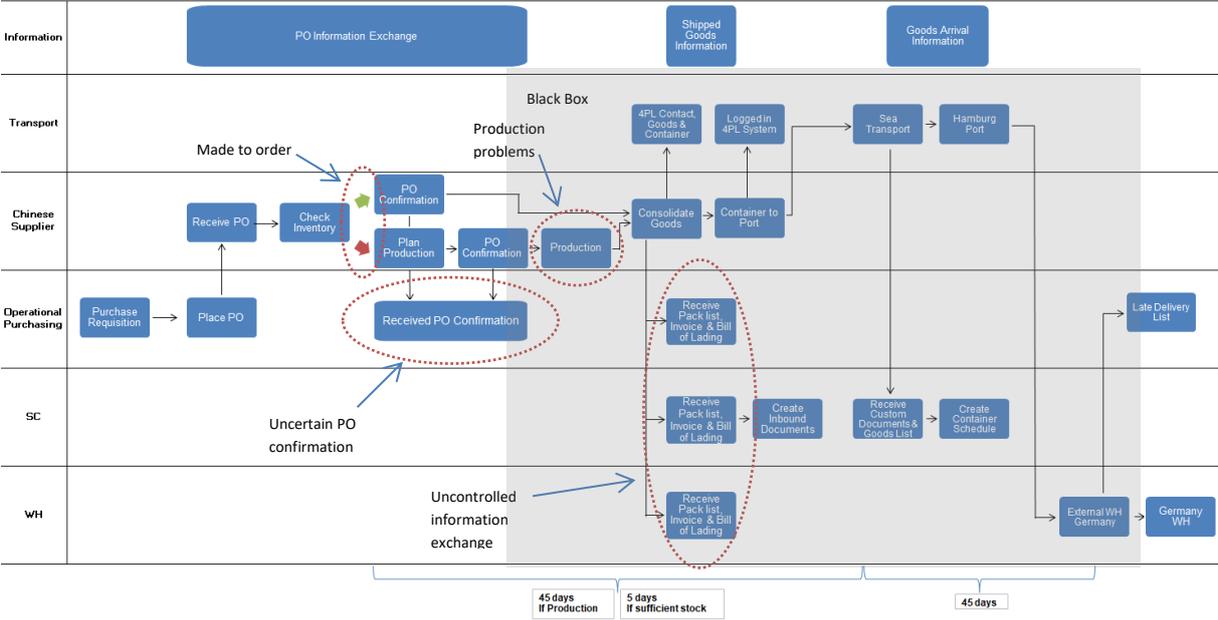


Figure 5.3: Specific problems related to the Chinese supplier

**5.2.2.3 General problems**

The general problems were identified to cover problems common for both the articles and, possibly, throughout the traded goods organization. The problems identified from the mapping were *Lack of article prioritization* and *purchasing process problems*. The first problem, article prioritization, can be seen as a foundation that needs to be in place in order for the company to build develop further. This

relates to that to be able to run you first need to learn how to walk. The analogy here is that the company needs to have certain things in place before they can further build and develop their organization. For example, sourcing more articles then the purchasers need to know which orders should be prioritized in a situation with time constraints. Thus, having a working article prioritization throughout the company. Further, the employees were a bit resistant and confused regarding the article prioritization throughout the company. Also, here it is possible to connect this to the silo-mentality, meaning that the article prioritization does not connect with different departments but rather stays with the department that developed it.

Another identified problematic area was the purchasing department's structure which were based on supplier complexity and BU and therefore not aligned with strategic sourcing. This created department communication problems since the strategic personnel did not know who to turn to, and vice-versa. Logically, if not told otherwise, the operational purchasing department will structure them according to workload, hence the supplier complexity structure. This can probably, once again, be derived to the silo-mentality in the company; if the departments are isolated they will optimize for themselves and not for the good of the company, hence the misalignment. Since the structure and process problem both belong to the operational purchasing department they were matched, and this study calls the problem *purchasing structure and process*, see figure 5.4.

Apparently, the company produced forecast was not being followed by some of the suppliers. There could be a lot of different reasons for this, e.g. weak incentives from the company, lack of forecast trust at the supplier or misunderstanding of what a forecast is. Another explanation for this could simply be that the produced forecast is wrong and therefore not being followed and the suppliers won't produce towards it. Whatever the causes are this study call this problem *forecast problem*, see figure 5.4

Further, late deliveries were noticed when the goods were already late. However, dependent on the workload of the operational purchasers the late delivery list was checked once every week or once every other week. This will result in that goods being late, in the worst-case scenario, would first be noticed as late two weeks past the agreed upon delivery date. Meaning that two weeks after the delivery date has passed the purchasers are starting to investigate what happen to the goods. This is a huge problem since this is one of those problems that lay the foundation that the company operates on. I.e. if goods are delivered late and left unchecked they will, in the ERP system, look like they have been delivered and the ERP system will interpret it as such. This problematic area will have further consequences for the company such as customer order that should have been declined is accepted or POs that should have been placed are not placed. Furthermore, when identifying that the goods are late, it is already too late, the goods are delivered late and the company can only try to locate the goods and bring them to the company. Meaning that the company cannot be active in locating and speeding up the delivery of goods. For example, if the company had a checkpoint e.g. halfway through production and the checkpoint is not being triggered then the company can be proactive and prevent the late delivery at an earlier stage. This means that this problem, which this study calls *late notice of late deliveries*, are in fact two entangled problems, both how often the list is checked and when the actual notice of late deliveries takes place.

The general problems are described in figure 5.4 below. In figure 5.4 the swim lane map for the Chinese supplier is utilized, but all four problems relate to both suppliers.

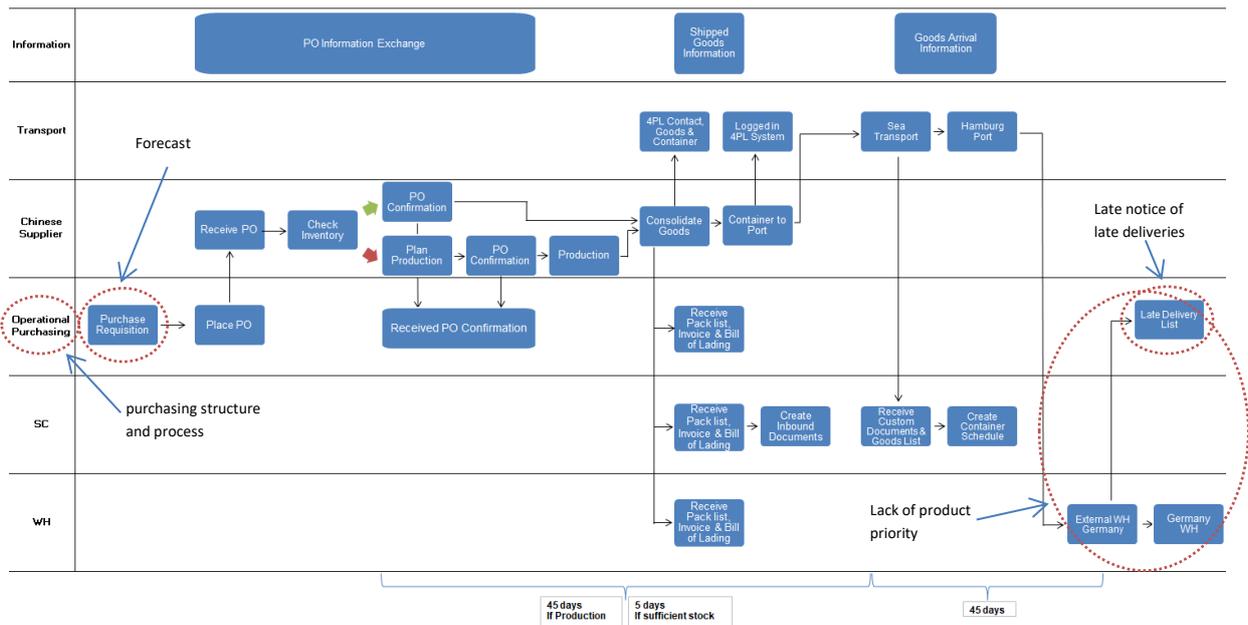


Figure 5.4: General problems related to both suppliers

### 5.2.3 Identified Solutions

As stated there are several different solutions and ways to mitigate late delivery and theory does not give any specific answer as such. The reason for this can be that there are several ways to mitigate late deliveries and that is which solutions to use depends for example on the situation and supply chain setup and maturity for the specific case. Although theory does give areas as for where to focus as well as categories of how to attend different risks. One such area is what Zsidisin & Wagner (2010) calls a flexibility strategy that focus on creating a more agile supply chain, instead of building buffers what is called redundancy strategy. Further, in the framework presented by Antonio & Gaudenzi (2013) different ways to work with the risk is shown. In this analysis the authors focused on solutions related to the flexibility strategy and categories such as Loss Prevention and Duplication. This since it is more related to late deliveries and the focus here is not to cover the problem with excess inventory buffers but to give solutions that increases the delivery performance, thus attacking the problem. The redundancy strategy as well as categorize such as avoidance, loss reduction and risk financing have not been in focus since these strategies does not solve the problem late deliveries as such but rather covers up for the effects of such an event.

Table 5.2 visualizes all the identified solutions and if the solutions are specific for the case suppliers or of a more general, traded goods, nature.

Table 5.2: Identified solutions based on type

| Type    | Solution                    |
|---------|-----------------------------|
| Belgian | Intermediate storage        |
| Belgian | Backup tooling              |
| Belgian | Shared storage              |
| Chinese | Collaboration & information |
| Chinese | New measuring point         |
| Chinese | Warehouse in Asia           |
| General | Department improvement      |
| General | Forecast                    |
| General | SRM system                  |
| General | Last step procedure         |
| General | Multiple Sourcing           |
| General | Article management          |
| General | Safety Stock                |

Based on table 5.2 the identified solutions will be presented in three different categories, namely solutions Belgian supplier, solutions Chinese supplier and general solutions.

### 5.2.3.1 Solutions Belgium supplier

As mentioned above the problems identified at the Belgium supplier is related to production and storage. The question is then how to make sure that the production will not stop. Also, it is a question of how to deal with the shared storage setup that the company has today. A schematic figure over the specific problems and solutions related to the Belgium supplier can be found in figure 5.5.

**Intermediate storage & Backup tooling.** Within production two solutions have been analyzed, both within a redundancy strategy. The first one is to introduce an intermediate storage of plastic film within production. Since the production is done in two steps, first extrusion of the plastic film and then thermoforming, it would make sense to store this film in between so that thermoforming is the only production step left if an order is placed. There are some problems with this solution, firstly it is possible that this is done today to some degree. Secondly, the production planning at the supplier today is to produce for a quarter of a year at once then store this and ship it to the company over time. Thus, it would not necessarily decrease the lead time as such since a quarter of yearly demand is produced at once and kept in storage. Although, it would be possible to produce a lower percentage of yearly demand of the plastic film to use as safety if stock out occurs. This would decrease the lead time for make to order which is the case 10 % of the time. Further, the second solution is to invest in a backup tool to guard against tool break down. Since the plastic lid is of very high importance to the

company and that a stock out of this product would be devastating it would make sense to secure the production with a backup tool.

**Shared storage.** This area is mentioned because it is important to overlook the strategy of having a supplier specific shared storage. This storage is only used for the products bought from the Belgian supplier and thus loses in flexibility and adaptation to the entire supply chain and products within it. The storage seems to be a result of that the company earlier owned this specific supplier. The storage setup seems to be something that just been left after the sale and today is shared at the location of the supplier. Instead of this it might be better to use an external warehouse that is integrated with the entire supply chain and that gives the company total controllability. Also, if kept the incentives regarding the storage should be considered, today the supplier is getting paid to fill up the inventory which could be the reason that the company is experiencing an almost full storage.

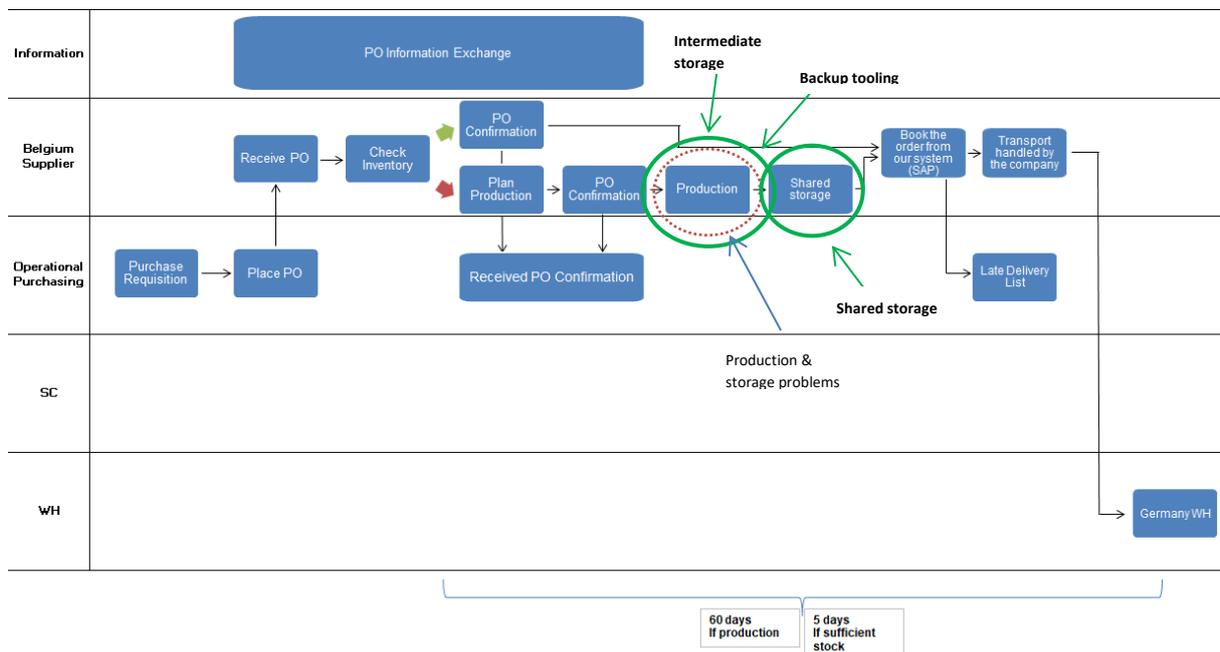


Figure 5.5: Specific solutions and related problems for the Belgium supplier

### 5.2.3.2 Solutions Chinese supplier

The problems identified at the Chinese supplier are mainly related to the deficiency within communication and the traceability of goods and orders. This solution is specific for what was encountered when investigating the case of the Chinese supplier and could therefore not be seen as general since the Belgian supplier has a different supply chain setup. But, it is reasonable to assume that some, if not all, of the solutions presented applies for other suppliers as well. Below a schematic figure over the specific problems and solutions related to the Chinese supplier can be found in figure 5.6.

**Collaboration and information.** The first thing to notice is the lack of communication that is pointed out during the mapping of the Chinese supplier. It is hard to know exactly on what level this communication is done, but there is no structured way of communicating. There is also an uncertainty in the PO confirmation phase, that is, it is unclear what the supplier means with the PO confirmation. Further, the communicated forecast is not meet, which can be the cause of either capacity problems, trust issues or both. A main thing to get a better working purchasing process is to establish a better

communication and information sharing. This would help with understanding the supplier as well as making the supplier understand the company. The sharing of information can be done through several ways, for instance via a Supply Relationship Management (SRM) system which we will be further developed discussed under general solutions. Here we will instead focus on the collaboration part and information sharing via meetings and other form of contact. Collaboration would as stated assist the companies in understanding one another, and it could be a tool for solving the forecast problem or distrust that is seen from the supplier. Collaboration could also result in the company being more prioritized at the supplier which would be advantageous if there is a capacity problem at the supplier. Collaboration would be based on continuously meetings and workshops at both the supplier and the company to establish a collaboration foundation. The solution to collaborate and share information with a specific supplier as described has a lot of advantages but is very costly and takes time. It is important to point out that this is a highly specific solution and is only done for one supplier. Due to this and that it takes a lot of time it is not possible to do it on all suppliers and should only be done if the supplier is one of the more important to the company. Further, this solution will not configure the general supply chain which will be the same.

**New measuring point.** The idea here is to increase the traceability of the goods that is ordered and to create an earlier delivery check, i.e. to measure if the deliveries are in time or not earlier in the process. Today no such check is done; instead the check is done via checking the “late delivery list” after arrival to the warehouse. If a check is made as soon after production as possible it would be possible to notice if something is running late earlier and thus attend to the emerging problem earlier and decreasing the impact of a late delivery. This is in line with what Antonio & Gaudenzi (2013) states about loss prevention and loss reduction. Loss prevention since it would mean that a control system is introduced that controls the delivery performance of the supplier. Over time this early check, can lead to the supplier understanding the importance of the delivery performance and thus lowering the frequency. It would also be in line with loss reduction since it would mean that the company would notice if something is running late before it is actually late, thus making it possible to take actions that reduces the impact of the late delivery. It could be a challenge creating this measuring point since there today is no way this is measured. However, one way to do this without reconstructing too much of the supply chain could be to use the existing information exchange that is done when documents is sent when the goods have left the supplier. If this process is structured and controlled this information exchange could be used as a checkpoint to see if the orders have left the suppliers or not. Another way to do this would be to implement an SRM system where documents can be uploaded and where the supplier can let the company know if the goods are sent according to schedule or not, this solution will be further developed under general solutions.

**Warehouse in Asia.** A warehouse would affect the entire supply chain and can thus be seen as a general solution. But, because it does not apply to the Belgian supplier case it is presented here. Introducing a warehouse can both been seen as a redundancy strategy and a flexibility strategy. It can be seen as a redundancy strategy since it would create a buffer of inventory within the supply chain. Also, as a flexibility strategy since it would increase the company’s control over the supply chain as well as their supply chain resilience. The warehouse would decrease the lead time from Asian suppliers to the company drastically since the company would have control over the goods already in Asia before sent over the sea. This would increase control and traceability of goods within the supply chain network since the goods would be at the company earlier and since an early controlled measuring point for late deliveries would have been created. A warehouse would not only mitigate late delivery,



Potential improvement could be that operational purchasers could be organized in line with sourcing, i.e. after commodities. This could create a matrix organization where teams can be structured after both department and commodity, thus creating cross functionality and potentially a stronger process orientation. With this organizational setup the operational purchasers would be able to gain better knowledge for one commodity and, as the employees within sourcing, become more specialized. The reorganization could mitigate problems such as the uncertain PO confirmation, uncontrolled information exchange and the late notice of late deliveries due to the stronger process orientation. See figure 5.7 for an example of the matrix organization.

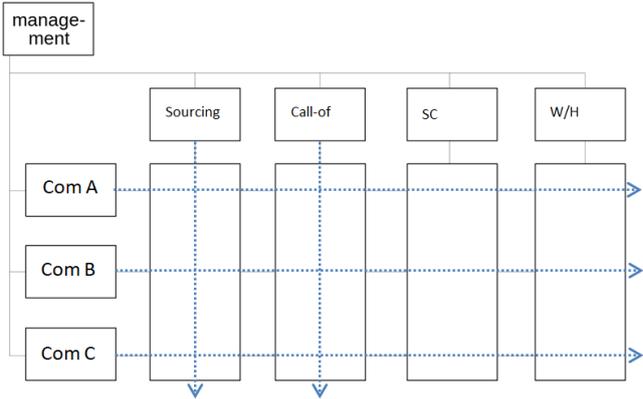


Figure 5.7: Example over a possible matrix organization

Further, to gain a higher presence on the Asian market a call-off team in Asia could be a possibility. This could bridge the culture gap and create stronger relationships to the suppliers leading to higher prioritization and better delivery performance.

**Forecast.** As discussed there is a perceived problem with the Asian supplier when it comes to producing against forecast. What this problem exactly depends on is unwise, but a solution could be to work with incentives for the suppliers to produce against forecast. To find the right incentives it is important to understand the supplier and how it operates which can be done through meetings and workshops. A possible way to create incentives could be to overlook the contracts with the suppliers to see if there are any legal incentives that could be implemented. This could for example be bonuses for following the forecast or penalties if the forecast is not followed. It could also be that the company legally binds itself to purchase the entire or a greater part of the forecasted volume, creating an assurance that the supplier will be able to sell the produced articles. Working with this could help problems such as the forecast not being followed, but also the problem with long lead time due to that 90 % of the purchased goods is produced against order. If the forecast was followed it is logical to assume that the amount produced to stock would increase, thus lowering the lead time from the Chinese supplier.

**SRM system.** A Supplier Relationship Management (SRM) system would in form of a flexibility strategy facilitate and structure a lot of the informational exchange between the company and the suppliers since it would provide a platform where all informational exchange could be taken place. Today the company does not have any platform on which to communicate and interact with their suppliers. All interaction is done manually and via email, which creates a lot of work and information disarrangement since there is not one common platform for all interaction. Orders, delivery schedules and all other information are today sent via email. If a platform would be in place this could first and foremost structure this communication. Further, master data can be updated by the supplier,

document management would be more orderly, order traceability enhanced, and manual labor decreased. Also, steps such as PO confirmation and the placement of PO:s would be done on the platform as well as request for quotations (RFQ) and request for information (RFI). This system would also be integrated with the ERP system making it easier to for example trace late deliveries. It would also be possible to implement this earlier in the procurement process. For example, after production when the supplier sends the documents, this could be used as a measuring point that can alarm and notify the company if documents have not arrived that should have arrived.

**Last step procedure.** This is a highly intuitive solution that regards contacting the supplier and asking if the delivery schedule is held and if the order will arrive as planned. Doing this would create a better visibility inside the black box but considering the amount of orders placed this would not be possible with the workforce within operational purchasing today. It is highly manual and would take a lot of time and is thus costly to execute. Instead it could be seen as a last step that is done for supplier with a record of having a low delivery performance before evaluating alternative suppliers.

**Multiple sourcing.** Multiple sourcing would mean buying from at least two different suppliers. This is seen as a duplication strategy Antonio & Gaudenzi (2013) guarding against the occurrence of the risk with an alternative supplier. The trade-off here is that it is costly to have multiple suppliers active and that it also might decrease quality. This while it will decrease the impact of the risk when it occurs. Another aspect of this however is that this only solves certain selected suppliers or articles, and since it is expensive it would only be possible to do on a few suppliers. Thus, it does not treat the late delivery problem as such but rather decreases the effect of that problem for some selected articles. Considering the costs this should only be done for high valuable goods that is critical to the company, e.g. in the automotive industry it would make sense to dual source different critical engine components to secure the supply. But, since disposable articles are neither expensive nor critical it is questionable if companies should source this type of articles.

**Article management.** Today the company has product segmentation in place, but this is only used within warehousing for safety stock and is poorly communicated to other parts of the company. This is a foundation for the entire company and not just the problems with late deliveries. A product segmentation that is properly executed, communicated and utilized throughout the company would help prioritization when placing orders and tracing orders. It would help knowing if it is worth putting time into working with a certain article and how big the crisis is if a certain product is late. This can also be used to look over the possibility to cut out unnecessarily products that has similar products or that does not contribute to the company's profit. This would help the operational purchasing department better plan their time and prioritize articles.

**Safety stock.** This is also an intuitive solution that follows a redundancy strategy. This regard overlooking and if possible increasing the safety stocks of the articles. It is although important to mention that this does not solve the problem as such, it only treats the outcome and increase holding and inventory costs.

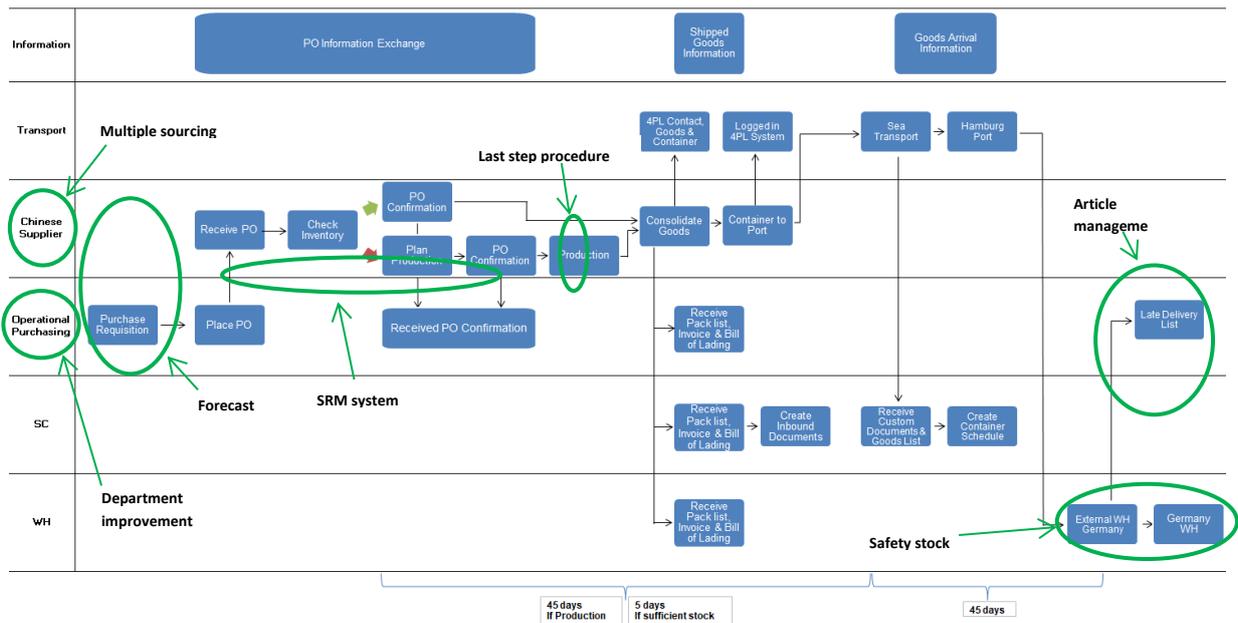


Figure 5.8: General solutions for the supply chain

### 5.2.4 Evaluating & Ranking of Solutions

As mentioned in the methodology chapter there was a second workshop held where the generated solutions and what problem they solved were presented. All the identified solutions in table 5.2 were ranked based on criteria impact and feasibility and given a total ranking, see table 5.3.

Table 5.3: Identified solutions based on type and ranking

| Type    | Solution                    | Impact | Feasibility | Total |
|---------|-----------------------------|--------|-------------|-------|
| General | SRM system                  | 9      | 7           | 63    |
| General | Article management          | 7      | 7           | 49    |
| Chinese | New measuring point         | 8      | 5           | 40    |
| Chinese | Warehouse in Asia           | 10     | 4           | 40    |
| General | Department improvement      | 8      | 5           | 40    |
| General | Last step procedure         | 7      | 5           | 35    |
| Belgian | Shared storage              | 4      | 8           | 32    |
| Belgian | Intermediate storage        | 5      | 6           | 30    |
| Belgian | Backup tooling              | 4      | 7           | 28    |
| Chinese | Collaboration & information | 7      | 4           | 28    |
| General | Forecast                    | 4      | 6           | 24    |
| General | Safety Stock                | 3      | 5           | 15    |
| General | Multiple Sourcing           | 5      | 2           | 10    |

**Comment.** The numbers below impact and feasibility are not definite numbers and should not be treated as such. Example could be the solution *collaboration and information* which is a solution for the Chinese supplier. This solution would probably have a high impact on late deliveries, hence the 7. On the other hand, the low feasibility can be explained that throughout the company it will be hard to implement the solution for all the suppliers, hence the low feasibility.

Moreover, based on the ranking in table 5.3 the top five solutions, see table 5.4, were considered interesting to further investigate and are discussed below. This top five solutions were chosen since they had the highest ranking and it was feasible to investigate further with the given time limit. Further, in the end of this chapter, table 5.4 will state pros and cons with the top five solutions.

Table 5.4: Top 5 identified solutions based on type and ranking

| Type    | Solution               | Impact | Feasibility | Total |
|---------|------------------------|--------|-------------|-------|
| General | SRM system             | 9      | 7           | 63    |
| General | Article management     | 7      | 7           | 49    |
| Chinese | New measuring point    | 8      | 5           | 40    |
| Chinese | Warehouse in Asia      | 10     | 4           | 40    |
| General | Department improvement | 8      | 5           | 40    |

**SRM system.** The SRM system is quite simple to integrate especially as the company can take help of an SRM provider. The integration possibilities with the existing ERP system will make it easy to merge with the current supply chain setup and way the organization works today. The impact of this system is also valued as very high since it would contribute to a better control of the supply chain, traceability of goods, communication with supplier and structure to the day to day work. It would work as a portal were documents are sent and could be used as an earlier measuring point in the process with real time alerts the lets purchaser know if something is off schedule.

**Article management.** The second most important solution is the implementation and development of article management. Since there is already an existing system used in the company’s warehouse related part it is here assumed that it would not be too hard to implement and communicate it to the entire company, thus having a high feasibility. The impact of this system can be both direct and indirect. Direct impact relates to that it will be easier for purchasing to know how important the articles are and on what articles to put energy when tracing late goods our communicating with suppliers. It will also contribute to a better control of articles. Indirect this would create an understanding of what articles that is important, and it would also create an important foundation if the company wants to further expand. For example, if a warehouse in Asia is to be implemented then it is of high importance that the article management is in place and works well; otherwise a new warehouse might create more confusion and complexity if it is filled with wrong or slow-moving articles. This will also make sure that no unnecessary time and energy is spilled on C and D articles. The biggest con worth to mention is that it can take a lot of time to implement a proper article management system.

**New measuring point.** Creating a new measuring point is something that is clearly needed in the current setup, since it is not tenable to only measure if the goods are delivered on time at the company warehouse. It is the visibility that is the most important in this aspect which leads to the possibility to measure and count backwards to see if the goods will arrive on time or not. It would also work as an alert to further investigate if the goods have not arrived at the measuring point in time. This solution is very dependent on how it is implemented, if implemented through an SRM system it would be easier to implement, but if it is not implemented through the SRM system it will be harder to implement and structure. As mentioned the document interchange could be used as a natural measuring point.

**Warehouse in Asia.** The impact of a new warehouse is very hard to estimate, but if implemented properly it is assumed that it would bring both a positive impact and opportunities for the company. Since the Asian supplier base is increasing a warehouse in the region would make it possible to purchase more at one time, creating economies of scale. It would also make it possible to consolidate goods in Asia and send it from there to the end market directly without sending it to Europe first. The flexibility and traceability in the supply chain would also be better since the company would control more of the lead time from supplier to end customer. It would also result in a lower handling cost per pallet since it would be situated in a low-cost country as well as take pressure away from the European warehouses. But, to build and implement a new warehouse into the supply chain comes with a high initial cost and is in need of a more rigid foundation than the company has today. For example, a working SRM system would be critical to have in place before taking this decision.

**Department Improvement.** It is assumed that a rearrangement of the operational purchasing department would serve the company well since it could create a stronger process orientation with teams responsible for commodities. It would also create a stronger connection with sourcing and operational purchasing which could ease the work with tracing goods. We believe that it can be hard to change the setup of the operational purchasing department since there is not a one to one correspondence with sourcing and because there might be resistance to change within the department.

Finally, in table 5.4 below are pros and cons with the above discussed top five solutions stated.

Table 5.4: Pros and cons for the top five solutions

| <b>SRM system</b>             | <b>Article management</b>               | <b>New measuring point</b>            | <b>Warehouse in Asia</b>       | <b>Department improvement</b> |
|-------------------------------|---|---------------------------------------|--------------------------------|-------------------------------|
| Less manual work              | Improved control of articles            | Notice of late deliveries earlier     | Procurement economies of scale | Alignment with sourcing       |
| Integrated with SAP           | Enable product prioritization           | Prevents further problems             | Consolidation of goods         | Process oriented              |
| Better traceability of orders | Profitable products will be prioritized | Possible to integrate with SRM system | Agile supply chain             | Integration & knowledge       |
| Training and license cost     | Sensitive area                          | More workload                         | Initial cost                   | Takes time                    |
| Supplier resistance           | Time consuming                          | Hard to integrate without SRM system  | Need of rigid foundation       | Not 1 to 1 correspondence     |
| Dependency on IT provider     | Implementation necessary                |                                       | One extra shipment             | Resistance to change          |

## CHAPTER 6 DISCUSSION & FINAL CONCLUSION

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*A discussion and the study's conclusion will be presented in this chapter. The chapter is divided in three parts. The first part, risk analysis, will discuss and give conclusion of the risk environment as well as the most critical risk that the company are exposed to. The second part, risk treatment, will discuss and conclude which are the causes for late deliveries as well as present the solutions that this study recommends. The third part, contributions & further research, will present this study's academic and practical contributions as well as the recommended further research areas.*

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### **6.1 Risk Analysis**

The aim of the risk analysis part was firstly to visualize the risk situation that the company are exposed to, this by deriving a theoretical framework that could be used to categorize the company identified risks. However, it is questionable if the, from theory derived, framework was fully used during the risk identification phase. The framework consisted of three axes, see chapter 2, where this study did not use axis number 2 where it is possible to divide the identified risk in terms of controllability. The framework was derived with the first aim to ease the risk identification phase but also to also serve as a framework with which the company could place and map their identified risks. Once the company had placed all the identified risks in the framework and therefore created various groups of risk the next step could be to apply corresponding risk mitigation strategies for different groups. I.e. for one group of risk the strategy could be acceptance while another group of risks could have building buffers as the mitigation strategy. This way, the framework could serve as a referencing point for finding mitigation strategies based on which risks that the company were facing, however, this was not the aim of this study. Therefore, this study chose not to use the entire framework to place the risks but rather using the first aim of the framework, namely to use it as a referencing point in the risk identification phase. Despite having developed a framework which was not entirely used in the study, we believe that the framework can be beneficial both for the company to use in the future and for other companies working with risks and risk management.

Before the framework could be used the procurement risks needed to be identified, this were achieved through interviews. When conducting the interviews, it was identified that the interviewed employees were describing the same risk but with different words and descriptions. For the authors to have a fair comparison between the risks it was not possible to have various labels and descriptions of the same risk. Thus, the need to guide the interviewee towards an agreement that it is the same risk we are discussing. However, there is a possibility that, we as authors, having an impact on employees when further questions were asked to support our hypothesis of which risk the employees were describing. This could, potentially, mean that some risks that the employees were first describing got lost and thus were not included in this study. Building on this, we noticed that the area procurement risks are very much entangled in each other, employees were describing different risks mixed with risk causes that were very similar and almost interchangeable. But for a risk analysis to be conducted there needed to be some sort of structure and categorization of the risks, hence the need to divide the discussed risk with the risk causes. In doing this there is a risk that we as authors became biased and our subjective opinions came into play and affected the structure of the identified risks.

Using the framework as a classification framework while conducting the interviews resulted in a visualization of the risk environment of the company, that also answered the first research question, see below.

*Research question 1: which procurement risks are the company exposed to?*

In total 15 different risks were identified that the company are exposed to, see table 6.1 below.

Table 6.1: Identified risks that the company are exposed to

|             |                 |                              |                       |                |           |
|-------------|-----------------|------------------------------|-----------------------|----------------|-----------|
| <b>Risk</b> | Late deliveries | Faulty delivery              | Information asymmetry | Physical flow  | Relations |
| <b>Risk</b> | Cost drivers    | Economic market fluctuations | Supplier status       | Human related  | Safety    |
| <b>Risk</b> | Cultural        | Political                    | Legal                 | Market changes | Disasters |

The second aim of the risk analysis phase were to rank and give recommendation of which were the most critical risks. Since this ranking were merely based on subjective opinions from the authors and the project owners, one can probably draw the conclusion that somewhere along the way someone’s opinion affected the outcome of the ranking. Despite the authors efforts to make it less subjective, by performing the ranking of the risk by ourselves before presenting it to the company, it is hard to create an objective risk analysis. This since our limited time frame, lack of quantitative data and that it is simply the employees’ opinions that matters. Nevertheless, it would be possible to make the evaluation less subjective by e.g. visiting the suppliers or obtain more quantitative data and thus, making the evaluation more objective. Another interesting aspect is that the more time we, as authors, spent at the company the higher the risk for our opinions being company biased. This is a catch-22 paradox, for us to work with the investigation we need to be at the company and then be exposed to the company opinions and hence the catch-22 paradox. This could, potentially, be a real problem if our opinions got in the way of the investigation. However, in this case, it is considered unlikely since we did not spend enough time at the company that we should have developed these subjective opinions.

Finally, the last aim of the risk analysis was to recommend which were the single most critical risk and therefore should be taking into risk treatment phase. The chosen risk were *late deliveries* and with building on the subjective track, one can also question if the chosen risk really was the most critical risk for the company. In the end it was the higher executives that took the decision which risk should be further investigated. The line of thought here questions that the chosen risk really is the most critical one for the company or that if the chosen risk were in fact the one that were most noticeable at the moment. It might very well be that the most critical risk is a risk that will not be noticed from a year or two from now, while the chosen risk is in the news at the company today. Supporting this is that the company recently had a huge supply problem from Asia which might affect the decision makers into making a short-term decision simply since they were afraid that the supply problem will appear again. The problematic area here is to choose the risk which is most critical for the company on the long run but still have short term benefits. However, we believe that the chosen risk was a good fit for the company when viewing the inbound delivery performance and earlier crisis. Also, the risk was derived

from a more operational perspective and then aligned on a strategic level with the company's goals, hence avoiding choosing a short term beneficial risk.

Another point of interest, which affects the ranking and therefore the recommendations a lot, are the criteria used, impact and probability. Intuitively, the result would probably look different if other criteria were used. Impact and probability were chosen since the theory suggested it and the company agreed with the authors that these criteria would evaluate the risks in a way that suited the company. Despite this it is possible that other criteria would have been better suited for the company and their risk environment. We chose not to further investigate other criteria since both the company and the authors were satisfied with the theory recommended criteria.

Finally, based on the two criteria the most critical risks that the company are subjected to were derived, see below.

*Research question 2: which are the most critical risks that the company are subjected to?*

Figure 6.1 visualizes the most critical risks that the company are exposed to. The risk late deliveries to the company warehouse are the single most critical risk for the company.

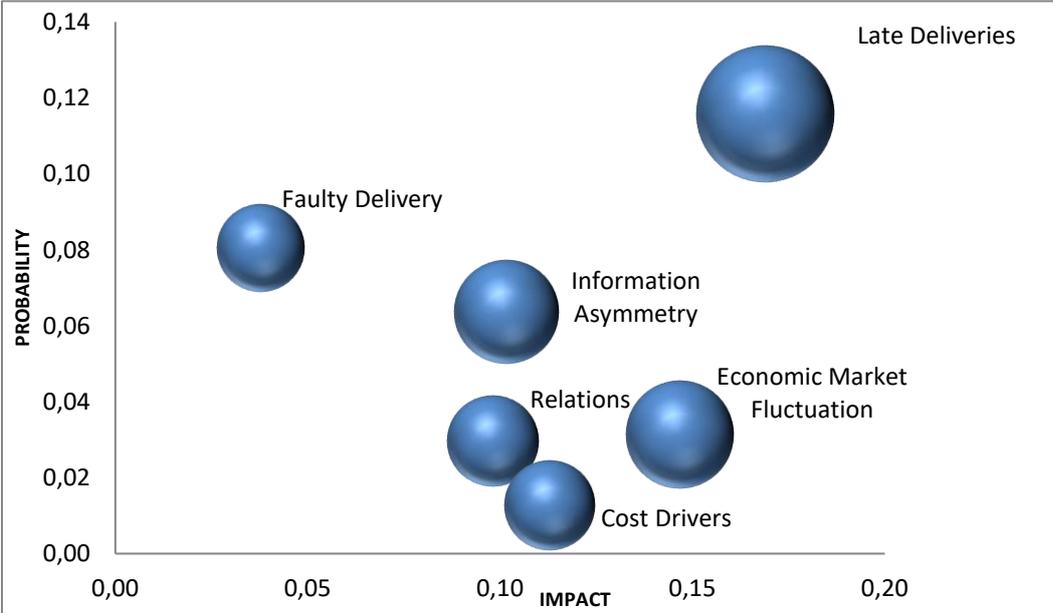


Figure 6.1: The most critical risks for the company

## 6.2 Risk Treatment

The purpose for the risk treatment phase was to firstly understand why the company is experiencing a low inbound delivery performance. This was achieved by deriving underlying causes which were identified through a mapping of the process building up the inbound delivery. When performing the mapping there are of course risks with staying objective. During the mapping it is possible that the fully objective and true situation of how the company actually work was not achieved. A reason for this lies within the qualitative interviews that were held which makes the mapping becoming dependent on knowledge of the employees, how truth full they are when answering and if they perceive the questions as intended or not. It is possible that when we asked a respondent how the process looks, it is possible that this was perceived as “how the process should look” or that the respondent know that the process is not done properly but does not want to shame in that respect and thus tells the process as it should be. An example of this is when we were to find out how often the late delivery list was checked. The first time we asked, in the middle of the meeting, the respondent said that it was check once a day. But, supposing something was not right, we asked the same question again at the end of the interview asking the respondent to give an honest answer. This time the respondent said that the list was check once every week or once every second week, dependent on workload. The reason for this inconsistency in the answer could be outcome of the respondent not trusting us as interviewers enough; that the respondent did not dear to tell the truth because the respondent knew that this list should be checked more often or at least that it would be good to check the list more often, or something else.

Through the process mapping combined with some analysis the causes for the low inbound delivery reliability was identified, see below.

*Research question 3: what are the causes for the low inbound delivery reliability?*

The origin cause to the low inbound delivery reliability lies in that the company took their structure and way of conducting business in Europe and applied this to the Asian market. Hence, applying something that worked in Europe to another market without considering the differences. This was the background problem but today the company are experiencing other problems related to the procurement process, see table 6.2, which result in that goods can be delivered late. In total 9 problems were identified, where 1 was related to the Belgian supplier and 4 was related to the Chinese supplier and 4 was general problems.

Table 6.2: Identified causes for the low inbound delivery performance

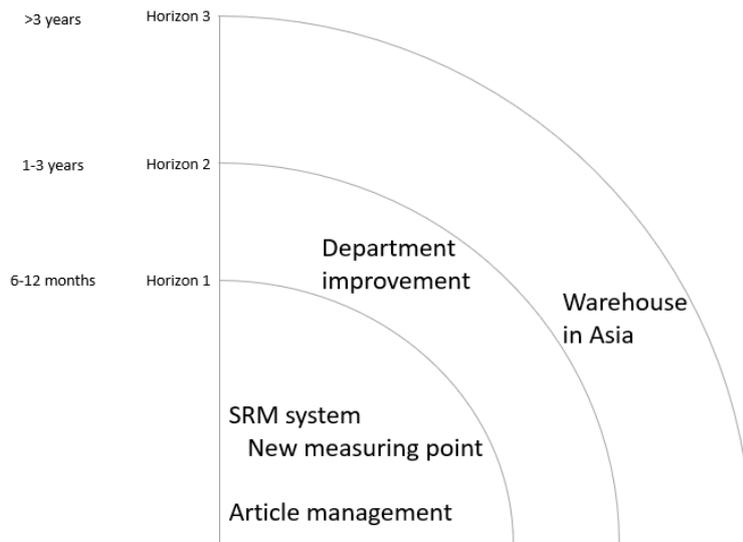
| Problem                           | Belgian supplier | Chinese supplier | General |
|-----------------------------------|------------------|------------------|---------|
| Production & storage              | x                |                  |         |
| Made to order                     |                  | x                |         |
| Uncertain PO confirmation         |                  | x                |         |
| Production                        |                  | x                |         |
| Uncontrolled information exchange |                  | x                |         |
| Purchasing structure & process    |                  |                  | x       |
| Forecast                          |                  |                  | x       |
| Lack of product priority          |                  |                  | x       |
| Late notice of late deliveries    |                  |                  | x       |

Secondly, the aim of the risk treatment phase was to find solutions that will increase the inbound delivery performance. It is important to notice that this thesis takes on a practical case approach meaning that it would not have been possible to motivate all solutions from theory with regards to the timeframe. Because of this there is no theory that specifically confirms that e.g. an *SRM system* or a *Warehouse in Asia* will improve the late deliveries and the situation of the company as such. Instead this recommendation is to be seen as just that, practical recommendations on areas that we as authors believe would be fruitful for the company to look further into. It would then be possible to do individual projects for respective solution and then look deeper into theory to see what scholars have said about these areas related to late deliveries from suppliers. Further it is possible that there are other solutions that we as authors missed in the analysis did not find in theory or that was not mentioned on interviews and meetings. Thus, this report cannot from an academic perspective be seen as fully exhaustive. Instead we believe that as a descriptive research this thesis ambition is to within theory illustrate areas that are connected to risks with late deliveries and within practice for the company assist areas that we strongly believe would be worth investigating further with separate projects.

Finally, this study concludes which solutions that should be implemented to increase the inbound delivery performance, see research question 4 below.

*Research question 4: what should be done to increase the inbound delivery performance?*

For the company to increase the inbound delivery performance, i.e. prevent late deliveries, this study recommends implementing solutions based on three different time horizons, see figure 6.2. Horizon 1 will take place between 6 months to 12 months from now and have solutions *SRM system* with built in *New measuring point* and solution *Article management*. Horizon 2 will take place between one to three years from now and have solution *Department improvement*. While horizon 3 will be more than three years from now and have solution *Warehouse in Asia*.



*Figure 6.2: The recommended solutions with respectively time frame*

### 6.3 Contributions & Further Research

This study contributes to both the theoretical and professional environment while also stating further research areas, see chapters below.

#### 6.3.1 Academic contribution

The focus of this thesis was to determine the most critical risks for the case company and then propose strategies for solving the most critical risk. To do this it was early establish that a model for mapping the risk environment with focus on procurement for the case company was needed. This led us to compile existing theory. It was early discovered that there exist different ways of classifying risks, such as internal and external, macro and micro or in risk areas, but many of these models were one-dimensional, with exception for Lindroth & Norrman (2001) that represent a three-dimensional model. From this theoretical risk identification review we gained the understanding that there are several ways of classifying risks and that these can be combined such that a risk can part of more than one group at the same time. It was also found that the existing frameworks for identifying risks were created for the entire company, i.e. risks relating to both procurement as well as operations and sales. Due to this and with help from earlier research and theory we created our own risk identification model to include different risk dimensions as well as attain a more procurement focus. This three-dimensional risk identification model, seen in chapter 2.4, figure 6.3 below, describes risks as external or internal, how controllable they are and what risk area it relates to. Hence this thesis might become suitable for researchers who are interested in analyzing the risk environment at a company with respect to procurement. For a thorough description of the framework see theory chapter 2.

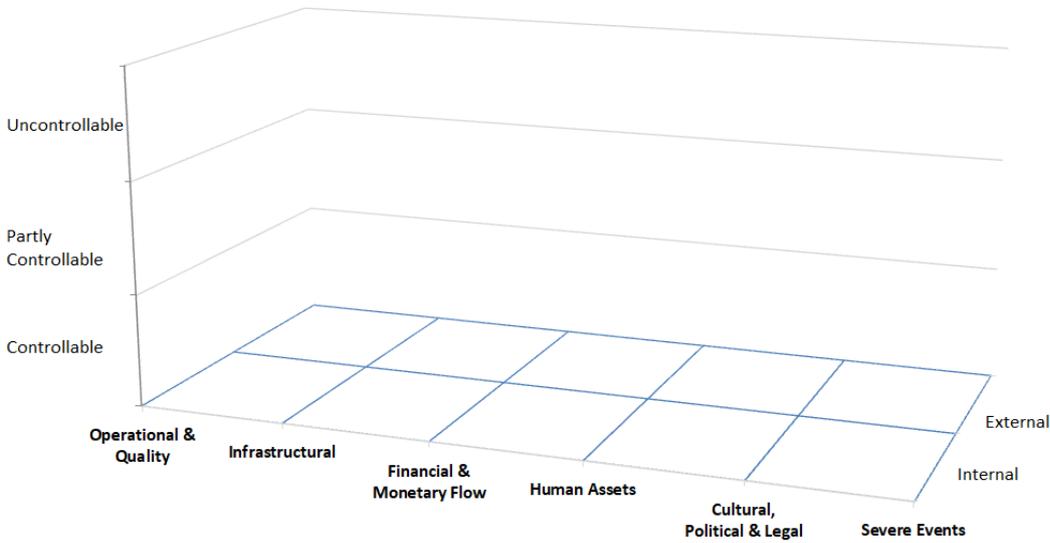


Figure 6.3: Risk classification framework

#### 6.3.2 Practical contribution

Firstly, this thesis describes how to analyze the risk environment for a company. The thesis also proposes a way to assess the different risks when no historical quantitative data is available. Thus, this thesis introduces a way to identify risks and then rank them to identify the most critical risks at a company.

Secondly, this thesis presents a methodology for treating an identified critical risk. Starting off on how to identify problems and causes that might lead to the identified risk. This by early define the risk and

the process that is related to this risk. Then by mapping the steps performed within the process and creating swim lane maps create a visible representation of the process and problems identified. Further, it is shown that a lot of problems and risk causes that arise can be motivated from a lack of process orientation. Also, the thesis proposes a method for identifying solutions and how to evaluate these solutions.

Finally, according to the analysis given in the thesis suggestions regarding improvements have been specified to improve the late delivery situation seen at the case company. The main findings of this thesis suggest that the traceability of goods in transit is of high importance and that this can be achieved by introducing measuring points earlier and throughout in the supply chain. More specifically it suggests that this measuring points can be done by the set-up of a Supplier Relationship Management system or a warehouse geographically closer to the supplier. Furthermore, the thesis emphasizes the importance of making the company work as a whole were information is communicated throughout the company as well as the importance of being process oriented.

### **6.3.3 Further research**

Risk management is gaining interest as an area from both academics and business professionals. But the focus on this research is mainly from a supply chain perspective were everything from suppliers until customer is analyzed. We believe that focusing on different areas within the supply chain to, in more detail, understand how risk management applies to these areas might be a fruitful field for new supply chain risk management research efforts. Further, we believe that this could increase the practical suggestions on how certain risks can be mitigated through the implementation of solutions found within research. This thesis therefore urges the research community to look deeper into how supply chain disruptions might affect different business areas and what concrete actions that can be taken to mitigate certain risks, for example how different mitigation strategies can help in decreasing late deliveries.

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# APPENDIX

## Analytical Hierarchy Process

**Input Data.** Figure 8.1 below shows a snapshot from the excel file describing the input data for the AHP evaluation.

| Input Data                  |    |                                 |             |
|-----------------------------|----|---------------------------------|-------------|
| Category                    |    | Impact                          | Probability |
| Impact                      | => | Probability                     | 2           |
| Late Deliveries             | => | Economic Market Fluctuation     | 3           |
|                             |    | Faulty Delivery Information     | 5           |
|                             |    | Asymmetry Relations             | 1           |
|                             |    | Relations                       | 1           |
|                             |    | Cost Drivers                    | 3           |
| Economic Market Fluctuation | => | Faulty Delivery Information     | 3           |
|                             |    | Asymmetry Relations             | 5           |
|                             |    | Relations                       | 1/3         |
|                             |    | Cost Drivers                    | 3           |
| Faulty Delivery             | => | Information Asymmetry Relations | 1           |
|                             |    | Relations                       | 1/3         |
|                             |    | Cost Drivers                    | 1/3         |
| Information Asymmetry       | => | Relations                       | 3           |
|                             |    | Cost Drivers                    | 1           |
| Relations                   | => | Cost Drivers                    | 1/3         |
| Late Deliveries             | => | Economic Market Fluctuation     | 5           |
|                             |    | Faulty Delivery Information     | 1           |
|                             |    | Asymmetry Relations             | 3           |
|                             |    | Relations                       | 9           |
|                             |    | Cost Drivers                    | 3           |
| Economic Market Fluctuation | => | Faulty Delivery Information     | 1/3         |
|                             |    | Asymmetry Relations             | 1/3         |
|                             |    | Relations                       | 5           |
|                             |    | Cost Drivers                    | 1           |
| Faulty Delivery             | => | Information Asymmetry Relations | 1           |
|                             |    | Relations                       | 5           |
|                             |    | Cost Drivers                    | 3           |
| Information Asymmetry       | => | Relations                       | 3           |
|                             |    | Cost Drivers                    | 3           |
| Relations                   | => | Cost Drivers                    | 1/3         |

Figure 8.1: The input data for the AHP process

**Output Data.** Figure 8.2 below shows a snapshot from the excel file describing the output criteria and the weight of these.

### Output Criteria

|             | Impact | Probability |      |
|-------------|--------|-------------|------|
| Impact      | 1      | 2           |      |
| Probability | 0,5    | 1           |      |
| Sum         | 1,5    | 3           |      |
|             | Impact | Probability | Sum  |
| Impact      | 0,67   | 0,67        | 0,67 |
| Probability | 0,33   | 0,33        | 0,33 |
| Sum         | 1      | 1           | 1    |

Figure 8.2: The output criteria and how these are weighted for the AHP process

**Output Impact.** Figure 8.3 below shows a snapshot from the excel file over the impact output.

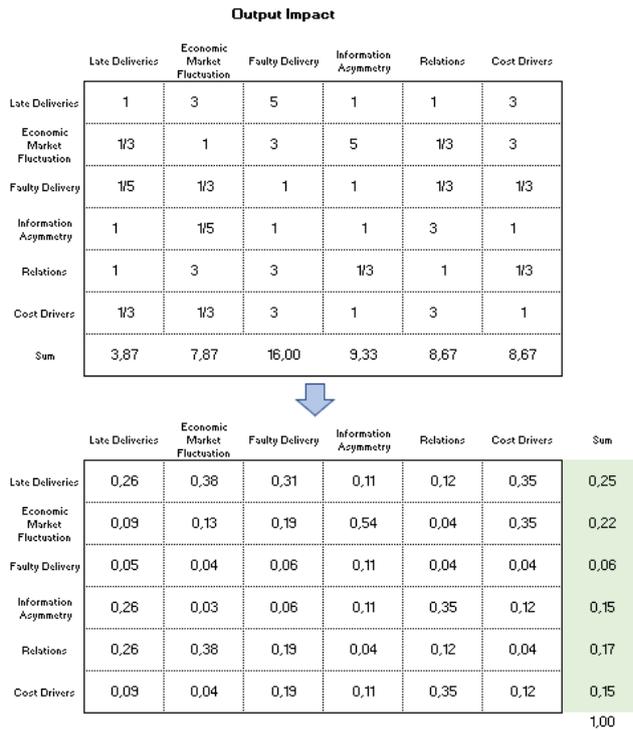


Figure 8.3: The output of impact given from the AHP process

**Output Probability.** Figure 8.4 below shows a snapshot from the excel file over the probability output.

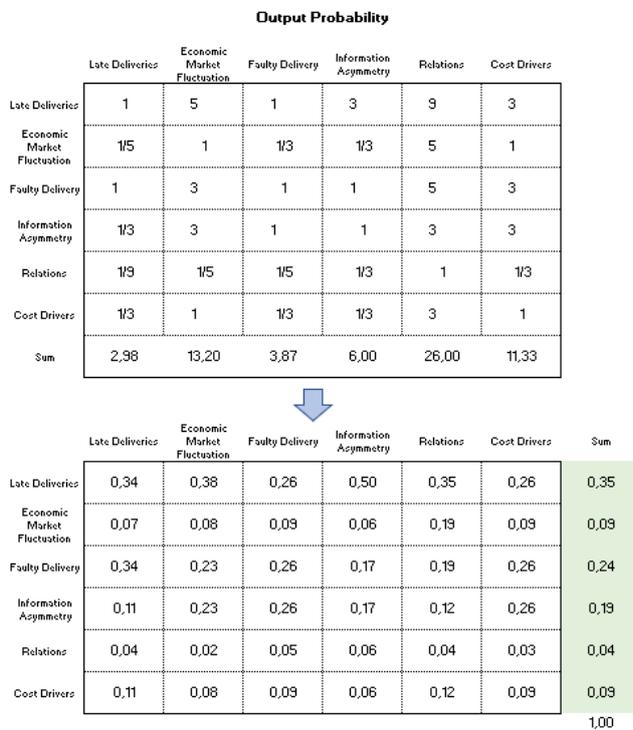


Figure 8.4: The output of probability given from the AHP process