The adoption and impact of theoretical supply risk management strategies in practice: a qualitative approach

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Statement of originality

This document is written by David Bodar, who hereby declares to take full responsibility for its contents. In the creation of this master thesis, no other sources than those mentioned in this document have been used.

Executive summary

Organizations often face a broad range of challenges in successfully managing risks in the upstream supply chain. A comprehensive academic literature base is available on supply chain risk management (SCRM), intended to provide supply chain professionals with strategies and methods on how to best deal with such adverse supply events. The purpose of this study comes forward when considering the pervasiveness of supply risk incidents in practice and the substantial attention supply risk management receives in academic theory. Therefore, the following research question forms the backbone of this study: *what are the most important theoretical supply risk management strategies and how do these theoretical supply risk management strategies impact supply risk in practice?* By answering this question, this study contributes to filling the gap regarding the availability of empirical investigation on this research topic.

To answer this question, this research is conducted along two dimensions. First, relevant academic theory is explored to determine the most important theoretical supply risk management strategies. This exercise results in the development of a conceptual model which is tested via the qualitative examination of supply risk management of fifteen divergent organizations. This case study methodology enables obtaining useful insights into the practical adoption and real-life impact of theoretical supply risk management strategies.

Various interesting insights are obtained. The majority of the studied sub strategies is adopted in private sector organizations. Supply risk management in the public sector appears to be immature. Supply base design is more important for production organizations whereas supplier cooperation strategies see slightly larger adoption rates at goods and services providers. Supply chain visibility scores lower, mainly caused by organizations' reluctance of sharing information. Furthermore, substantial evidence for the enabling role of management support is found as well as poor support for the moderating role of supply chain complexity on the impact of supply risk management strategies.

This study forms a valuable reference work for supply chain managers as the results can be used to benchmark organizations' supply risk management maturity. Furthermore, it enables the comparison of supply risk management practices between organizations differing in terms of industry, size, number of suppliers, level of supply chain integration and managed spend.

Summary of the results in statements

The results are derived from interviews at 15 organizations, both public and private, with revenues ranging from 300 million euro to 22 billion euro and supplier bases ranging from 80 to 30.000 suppliers.

- Not one of the interviewed organization has a formalized supply risk management definition
- Not one of the interviewed organizations employs a supply risk manager
- Not one of the interviewed organizations has a supply risk management department
- All interviewed organizations use at least one supply risk management strategy
- Supply risk management in public sector organizations is immature in comparison with private organizations
- Supply risk management at organizations operating on a national level is less developed than organizations operating on a European or global level
- Production organizations and goods and services providers show similar supply risk management strategy adoption

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1. Introduction

1.1 Background and problem statement

Last year, electric car manufacturer Tesla announced multiple long delays and a fifty percent production target reduction of its new Model 3 car (CIPS, 2017). The main reason for what CEO Elon Musk calls the "production hell", was a major battery assembly supplier who "really dropped the ball". Because of the delivery postponement of several months and reduced production, Tesla currently suffers from high extra costs, reputational damage and decreased investors trust. Another example of the problematic impact supply chain risks can bring forth, is demonstrated by the horsemeat scandal in various major European supermarket chains in 2013 (The Guardian, 2013). A shared key supplier had been structurally processing horsemeat in beef products without reporting. This discovery forced the supermarket chains to recall many of their products and evoked financial damage and severe negative publicity (Madichie & Yamoah, 2017).

The above two examples are just two out of many supply chain risks that have impacted the performance of organizations in recent years. According to Sodhi and Tang (2012), supply chain executives increasingly report concerns regarding supply chain risks for numerous reasons. This shows a parallel with the increasing attention supply chain risk management (SCRM) receives in academic literature (Fan & Stevenson, 2018). According to KPMG International (2014), organizations are becoming more and more prone to quickly changing supply markets and often face multiple challenges in successfully managing supply chain risks. A substantial academic literature base is available on the topic of SCRM, providing various strategies on how to effectively identify, assess, monitor and control supply chain risks. This pervasiveness of SCRM strategies in academic theory raises the question if the adverse events at Tesla and in the European supermarket industry could have been prevented, or at least better managed. This raises questions such as: to what extent are these strategies adopted by practitioners? Also, how do these strategies impact supply chain risks? This study searches answers to these and several more questions by evaluating theoretical supply risk management strategies in practical business contexts.

1.2 Motivation and research questions

One can imagine many more harmful incidents affecting supply chains and many factors influencing successful SCRM (Guertler & Spinler, 2015; Sarker, Engwall, Trucco & Feldmann,

2016). Over the last years, SCRM has become a topic among scholars and practitioners researching supply chain management (e.g. Tang, 2006; Sodhi & Tang, 2012; Ho, Zheng, Yildiz & Talluri, 2015; Fan & Stevenson, 2018). This current research focuses on upstream SCRM, referred to as supply risk management. Ho *et al*. (2015) find that supply risk management theory addresses the most supply chain risk types. In their meta-analysis on SCRM literature, the authors demonstrate the relative importance of supply risk management within this SCRM theory. Both in divergence and quantity, supply risks and the strategies for effective management of supply risks received serious attention by scholars in the recent past (Ho *et al*., 2015). The oversight they provided, serves as a valuable beacon in the vast amount of academic journal papers regarding SCRM and supply risk management. Fan and Stevenson (2018) reviewed as much as 354 SCRM papers addressing many different SCRM strategies, but find the actual impact and motivating factors to be rarely examined. The point of departure for this research is derived from the frequency and impact with which supply risk incidents occur and the above findings of Fan and Stevenson (2018) and Ho *et al*. (2015). This also endorses the relevance of a study on the impact of theoretical supply risk management strategies. This study attempts to add value as the effects of theoretical supply risk management strategies in business contexts are so rarely examined (Ho *et al*., 2015). In existing SCRM literature "good empirical research is in short supply" and therefore accommodates great opportunity to collaborate with industry practitioners in investigating the fertile research area of supply risk management (Sodhi, Son, & Tang, 2012, p. 12). To provide guidance and structure in this research exercise, the following research question is formulated:

What are the most important theoretical supply risk management strategies and how do these theoretical supply risk management strategies impact supply risk in practice?

This research question includes several concepts and assumes relations that require in-depth analysis on an individual level. Therefore separate sub-questions are constructed which are displayed in Table 1. This table also provides the source of data that will be consulted to provide answers, as well as the location of these answers in this research paper. To account for the thorough and complete answer to the research question, individually answering the sub-questions is an essential exercise. RQ1 addresses the exploration of theory on what are considered the most important supply risk management strategies among SCRM scholars. RQ2 evolves from this exploration and assists in finding out how scholars assess the impact of these supply risk

management strategies. This is done by reviewing the effects of the strategies on supply risk as discussed in literature. RQ3 questions whether the theoretical supply risk management strategies are adopted in practice and RQ4 is used to review their impact, in case they are adopted. A distinction between the first (RQ1 and RQ2) and second (RQ3 and RQ4) lies in the source of data where the answer is expected to be found. This distinction must be clear for the remainder of this research to benefit eventual comparison of the answers to the research questions.

Table 6: Research questions

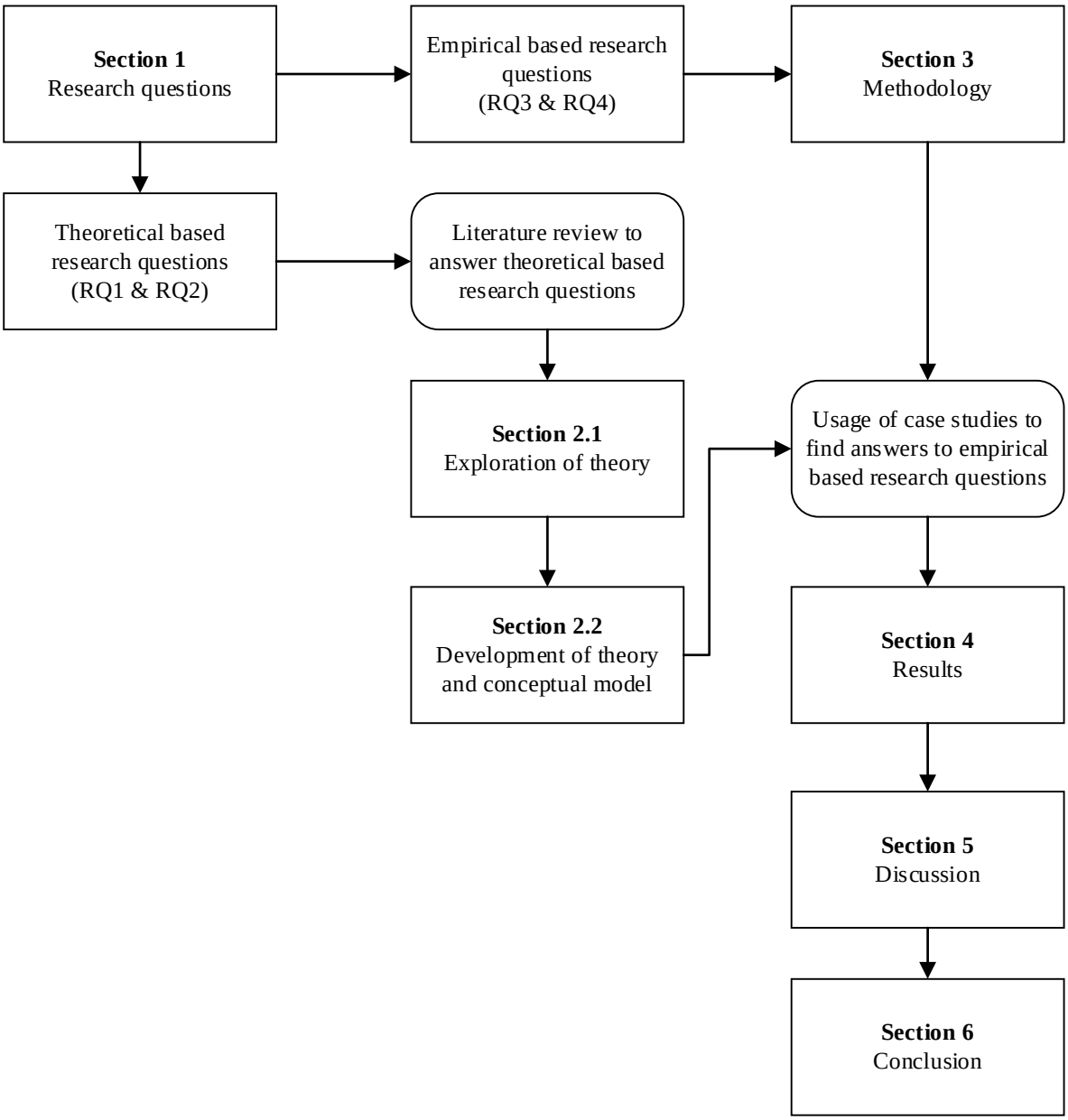
Research question	Source of data	Location of answer
RQ1: What are the most important supply risk management strategies in academic theory?	Literature	Section 2
RQ2: What is the impact of the most important supply risk management strategies in academic theory on supply risk in theory?	Literature	Section 2
RQ3: To what extent are the most important supply risk management strategies in academic theory adopted in practice?	Case studies	Section 4
RQ4: What is the impact of the most important supply risk management strategies in scientific research on supply risk in practice?	Case studies	Section 4

1.3 Research objectives and structure

Three different phases form the backbone of this research. First, SCRM literature is explored to find out which supply risk management strategies are considered effectively impacting supply risk among scholars. These are divided into sub-strategies to provide more in-depth features and possibilities within these generic strategies. The literature study results in a conceptual model, which is adopted to evaluate the impact of major supply risk management strategies on supply risk. It is also intended to link potential moderating and enabling effects to the relations between supply risk management strategies and supply risk as observed in the literature. Second, this conceptual model provides guidance in the collection of empirical data on the presumed relations it describes. Lastly, the gathered results of the data collection are analyzed to assess the strength

and value of the conceptual model. This current section provides oversight of the research structure in Figure 1. Section 2 explores and develops SCRM literature on supply risk and supply risk management strategies and provides the conceptual model. Section 3 discusses the research methodology and evaluates its quality. Section 4 gives an oversight of the research results which are discussed and concluded in Section 5. Section 6 concludes the research and provides limitations and suggestions for further research.

Figure 6: Research structure



2. Exploration and development of theory

The essence of this literature review is finding the answers to the research questions RQ1 and RQ2. Furthermore, it provides structure in the vast array of academic journal papers addressing the topic of supply risk management, corresponding strategies and their presumed effects. Relevant SCRM literature is explored and examined to provide a background of key concepts (Section 2.1) Therefore, several leading studies are reviewed to explore the definition of supply risk (Section 2.1.1) and supply risk management (Section 2.1.2) in academics. Second, major supply risk management strategies are reviewed, assessed and categorized based on three main strategies (Section 2.2.1) regarding supply base design (Section 2.2.2), supplier cooperation (Section 2.2.3) and supply chain visibility (Section 2.2.4). Third, the support of top management for supply risk management practices is discussed (Section 2.3) and the presumed moderating effects of supply chain complexity on the impact of the three general strategies are addressed (Section 2.4). The findings of the literature discussion and assumed impact of the different supply risk management strategies on supply risk evolve in the development of a conceptual model (Section 2.2.7).

2.1 Exploration of theory

2.1.1 Supply risk

This section explores the definitions of supply risk. Furthermore, it reviews the relevant academic literature on the definition of risk in general and supply risk in particular. This exercise supports a broad understanding of several essential elements in this research and provides a background of the academic discussion on supply risk management definitions.

Concept of risk

The concept of risk has been researched in various business settings and has allowed for the investigation of primary corporate functions, such as managerial decision making in risk management (March & Shapira, 1987; Zsidisin, 2003). Risk has been identified by many researchers, who often refer to the definition as proposed by March and Shapira, who state that “in classical decision theory, risk is most commonly conceived as reflecting variation in the distribution of possible outcomes, their likelihoods, and their subjective values." (1987, p. 1404). Manuj and Mentzer (2008) provide a useful consistency between their academic

and empirical exploration of the concept of risk resulting in the division of two crucial components of risk, namely: "(1) potential losses (if the risk is realized, what losses will result and what is the significance of the consequences of the losses; and (2) likelihood of those losses (the probability of the occurrence of an event that leads to realization of the risk)" (p. 196). These findings are in line with the general perception of risk being an "undesirable consequence of uncertainty" and involves "(1) the impact (vulnerability) on the organization if the hazard were to occur and (2) its probability of occurring during the operation" (Van Mieghem, 2010, p. 9). This exploration of risk definitions provides a fruitful starting point for the further investigation of the concept of supply risk.

Supply risk

Several meta-analyses are conducted on SCRM literature, contributing to the lively discussion of how supply chain risk can be defined. Ho *et al*. (2015) reviewed 224 international journal articles on SCRM published between 2003 and 2013, of which 70 articles address supply risk management as an individual research topic. In this literature study no straightforward definition is observed that is shared across the multitude of articles on supply risk (Ho *et al*. 2015). However, many scholars adopt the definition of Zsidisin (2003). He formulated a grounded definition of supply risk motivated by the absence of studies on risk within purchasing and supply management environments. This definition provided a starting point for purchasing professionals and scholars in creating supply risk management strategies to better assess, manage and mitigate supply risk (Jüttner, Peck, & Christopher, 2003; Manuj & Mentzer, 2008;; Wagner & Bode, 2008; Heckmann, Comes, & Nickel, 2015; Ho *et al*. (2015). Zsidisin (2003) defines supply risk as "the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety" (p. 222). Although this definition is often used, it appears not to provide a complete view of supply risk as it only addresses the probability element of risk, and ignores its impact. Ellis *et al*. (2010) attempt to advance the definition of Zsidisin (2003) and define supply risk as: "an individual's perception of the total potential loss associated with the disruption of supply of a particular purchased item from a particular supplier" (p. 36). Here, 'loss' is interpreted as an indicator of the combined likelihood and impact of a supply risk (Ellis *et al*. 2010). Still, this definition leaves room for improvement

as it is limited to the individual's perception, rather than a company-wide perspective on supply risk which is a critical difference in this study. Here, Chen *et al.* (2013) offer a more overarching definition by stating "supply risk is the potential deviations in the inbound supply in terms of time, quality and quantity that may result in incomplete orders" (p. 4). Again a limitation is observed, as supply risk measurement units are restricted to time, quality and quantity. By advancing an earlier definition of Zsidisin, Panelli and Upton (2000), Chen *et al*. (2016) try to address this limitation and define supply risk as: "adverse events in inbound supply that affect the ability of the focal firm to meet customer demands" (p. 1). This broad definition seems the best available fit for the high level approach of this research, as it does not exclude particular elements of risk nor certain units of measurement. However, the discussion on a useful and workable definition of supply risk appears to be lively and does not yet reach a point of saturation.

The exploration of the literature on different risk types and categorizations leads to a broad range of findings. In their literature study, Ho *et al.* (2015) provide a list of supply risks obtained in supply risk management literature (Table 2). This list appears to be useful, but it requires further specification as several risks can be clustered into broader sub categories. Here, the categorization of Van Mieghem (2010) offers a solution. Van Mieghem (2010) categorizes risk types and provides the major supply risks such as sourcing risk, originating from the selection of and interaction with suppliers and information risks, resulting from inaccurate communication and visibility of the supply processes. These risk categories and the corresponding supply risks are displayed in Table 2. Some of the risk factors provided by Ho *et al.* (2015) are not straightforwardly categorizable in one of those three and are therefore displayed in the column 'Other'. An important note to the interpretation of Table 2 is derived from Ho *et al*. (2015). In line with their study, this research recognizes that "some of the displayed risk factors are associated with generic risk types, such as inbound supply risk" (Ho *et al*., 2015, p. 7), while other factors are of more specific types of risk, such as low technical reliability (Tuncel & Alpan, 2010). One should bear in mind the particular aspects and characteristics of the supply industry before incorporating the risk factors into business decisions. Table 2 does not claim to display a full list of supply risks, as this study acknowledges several other studies provide alternative categorizations (e.g. Giunipero & Eltantawy, 2004; Wagner & Bode, 2008). However, for this study, Table 2 provides a useful categorization as it follows a similar division as the observed strategies to address these risks (Autry & Sanders, 2009).

Table 7: Supply risk factors

Risk in sourcing	**Risk at suppliers**	**Risk due to lack of visibility**	**Other**
• Single supply sourcing • Small supply base • Suppliers' dependency • High capacity utilization at supply source • Global outsourcing • Narrow number of intermediate suppliers • Supplier monopoly • Selection of wrong partner	• Contractual agreements • Supplier management • Supplier market strength • Supplier opportunism • Lack of integration with suppliers • Supplier responsiveness • Inability to handle volume demand changes	• Lack of suppliers' visibility • Transit time variability • Supplier fulfilment errors • Inability to meet quality requirements • Failures to make delivery requirements • Supplier bankruptcy	• Low technical reliability • Sudden hikes in costs • Cannot provide competitive pricing • Technologically behind competitors

2.1.2 Supply risk management

The research area of SCRM has proven its fertility and brings forth a substantial cluster of academic journal papers covered in several overarching theory analyses (Sodhi *et al*., 2012; Ho *et al*., 2015, Fan & Stevenson, 2018). On the contrary, supply risk management as a distinguished topic is not always included but still, a substantial amount of research contribute considerable attention to supply risks (e.g. Zsidisin & Ellram, 2003; Zsidisin, Ellram, Carter, & Cavinato, 2004; Zsidisin & Smith, 2005; Wang, Gilland, & Tomlin, 2010; Fang, Zhao, Fransoo, & Van Woensel, 2013; Guertler & Spinler, 2015; Ho *et al*., 2015; Chen, Sohal, & Prajogo, 2016). This section focuses on the available literature on supply risk management in an attempt to provide a viable working definition. It also gives an overview of the discussion of the topic in academics and elaborates on the relation between SCRM and supply risk management.

Definitions and SCRM framework

The different stages of the SCRM framework originate from a lively academic reflecting the comprehensive and complex nature of the SCRM discipline. In their SCRM meta study, Fan and Stevenson (2018) suggest the crucial elements of SCRM are risk identification, risk assessment, risk treatment and risk monitoring, evolving from a lively academic discussion (e.g. Zsidisin *et al*., 2005; Faisal, Banwet & Shankar, 2006; Manuj & Mentzer, 2008; Hachicha and Elmsalmi, 2014).

Based on their comprehensive literature analysis, Fan and Stevenson (2018) provide the folllowing definition of SCRM:

"The identification, assessment, treatment, and monitoring of supply chain risks, with the aid of the internal implementation of tools, techniques and strategies and of external coordination and collaboration with supply chain members to reduce vulnerability and ensure continuity coupled with profitability, leading to competitive advantage." (p. 7)

This definition seem to provide a broad description of what is considered SCRM in recent literature. A broad consenus exists on the first three stages of the SCRM framework: risk identification, risk assessment, risk treatment or mitigation (Ho *et al*., 2015). The fourth stage leaves room for debate (Sodhi *et al*., 2012; Fan & Stevenson, 2018). In this research, it is argued that the research of Sodhi *et al*. (2012) provide the most robust SCRM framework as the fourth stage is not limited to risk monitoring but also covers other resonses to risk incidents. Therefore, it is considered to be more widely applicable. These four stages of SCRM are displaye in Figure 2 and defined as follows:

(1) “Identification of risks and uncertainty is an initial step to manage supply chain risks according to many researchers.
(2) The second SCRM process element is assessment, involving the evaluation of the likelihood and the impact.
(3) The third element of the SCRM process is mitigation, i.e., reducing the likelihood of a particular risk’s occurrence, reducing its potential impact, or both.
(4) The final element of the SCRM process is the response, i.e., responding to an actual risk /event to reduce the potential impact and to hasten recovery" (Sodhi *et al*., 2012, p. 6)

In this study, supply risk management is considered to be a crucial element of SCRM as comes forward in multiple influential SCRM papers (e.g. Jüttner *et al*., 2003; Manuj & Mentzer, 2008; Wagner & Bode, 2008; Heckmann *et al*., 2015; Ho *et al*. 2015). Therefore, the assumption is made that the generic SCRM framework in Figure 2 is useful in the practice of supply risk management as well (Zsidisin *et al*., 2004; Wagner & Bode, 2006; Kern, Moser & Hartmann, 2012). This assumption provides solid support for the further development of SCRM literature in the remainder of this study

Figure 7: SCRM framework

Linking the SCRM framework to supply risk management

The SCRM framework and the interrelations between its elements are studied and validated in supply risk management contexts as well (Zsidisin *et al*., 2004; Wagner & Bode, 2006; Kern *et al*., 2012; Hoffmann, Schiele & Krabbendam, 2013). These findings are expected to provide a useful academic background to compare findings with.

Hoffmann *et al*. (2013) investigate the influence of supply risk monitoring, supply risk mitigation and the maturity of the supply risk management process on supply risk management performance. No support is found for the direct effect of supply risk monitoring on supply risk management performance, but the authors confirm the indirect effect via environmental and behavioral uncertainty (Hoffmann *et al*., 2013). The former regards to "unanticipated changes in circumstances surrounding an exchange which cannot be specified beforehand" (p. 201) and the latter is "the extent to which compliance with agreements of exchange partners cannot be verified ex-post: the buyer has no assurance that the supplier performs as specified" (pp. 201-202). The authors do find evidence for the relevant impact of supply risk mitigation strategies on the strength of supply risk management, both directly and indirectly. Moreover, the maturity of risk management processes is claimed to have a substantial impact on supply risk management performance (Lockamy & McCormack, 2004). The latter is claimed to be the most important effect, because "if companies want to succeed in their supply risk management endeavors, one of the first conditions is a well-developed supply risk management process, reflecting high maturity" (Hoffmann *et al*., 2013, p. 207). Kern *et al*. (2012) agree upon the usefulness SRCM framework in supply risk management and also conduct a study on the subsequent effects of its elements. The authors show superior risk identification is supportive to the consecutive risk assessment phase which successively benefits risk mitigation (Kern *et al*. 2012).. Furthermore, they argue that companies with strong competencies in the above-mentioned steps of supply risk management demonstrate a superior reduction of both likelihood and impact of upstream supply chain risks

(Kern *et al*. 2012). These journal papers provide meaningful additions to the maturity of the research area of supply risk management and its prominent position within the subject of SRCM.

2.2 Development of theory

2.2.1 Strategy categorization

In literature, many different SCRM strategies are proposed and discussed of which supply risk management often takes a significant part (Ho *et al*. 2015). The research area of SCRM is overwhelmingly broad and contains many interesting and useful research opportunities. Research interest and the constraints of time required to narrow down the scope of this study. Therefore, as a logical consequence of this research' scope on supply risk management, all strategies dedicated solely to other types of supply chain risks are left out of scope. What remained, turned out to be still a wide range of supply risk management methods and strategies. A thorough literature study further helped reducing the selection.

Many of the strategies researched, had characteristics in common and were discussed in multiple influential papers. Therefore, implementing a categorization would be a useful method to create more oversight in the extensive collection of strategies. After studying the different strategies, a parallel is found in the research by Autry and Sanders (2009) who investigate different company capabilities impacting the security of supply chains. Supply chain security management shows a harmonious interrelation with the mitigation of supply risks as “they are both involved in the promotion of the overarching concept of business continuity” (Autry & Sanders, 2009, p. 309). Research findings show support for the division of supply risk management strategies into the three main strategies forming the basis of the categorization in this literature review. The authors divide company capabilities into three categories namely: human resources, processes and technology, each consisting of several supply risk management strategies. The categories are defined as follows:

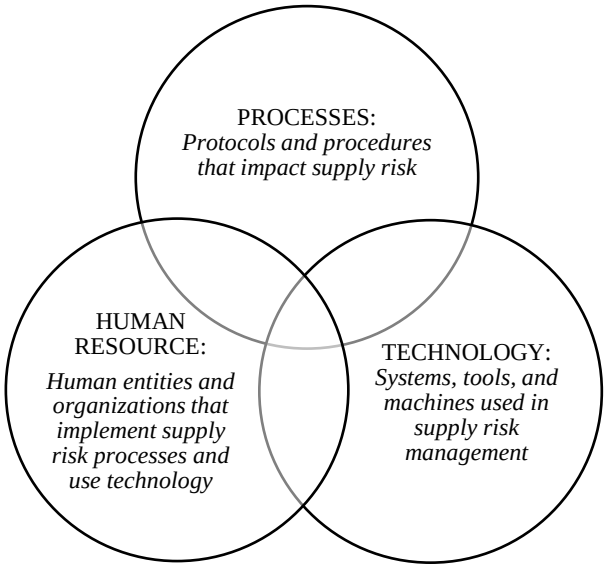
“**Processes** are procedures and protocols as followed by the organization and its supply chain partners. The fundamental aspect of building business continuity into the future rests on well-constructed processes which ensure integrity throughout the supply chain by providing

monitoring, prevention, and responsiveness. It requires policies for everything from supplier quality checks to inventory management to forecasting disruptions.

Human Resources capabilities include organizational leadership, all of the organization's employees, suppliers, as well as government agencies responsible for putting into place programs that require security compliance.

The technology involves the use of systems, tools, and machines that gather, process, and communicate data and information within and between firms. As such, they enable real-time monitoring" (Autry & Sanders, 2009, p. 314).

Figure 8: Foundation for strategy categorization



Each of the main supply risk management strategies distinguished in this study shows considerable overlap with one of the three categories Autry and Sanders (2009) provide. Supply base design [2.2.2] is interpreted as a process capability and supplier cooperation [2.2.3] as a human resources capability (Autry & Sanders, 2009). In their model, supply chain visibility [2.2.4] is interpreted as a process capability, but based on the findings from other literature it could also be interpreted as an (information) technology capability (Tang, 2006; Kurniawan, Zailani, Iranmanesh, & Rajogopal, 2016). Most literature on supply chain visibility shows a strong emphasis on the use of information and technology methods to optimally execute this strategy in supply risk management.

For instance by collecting and sharing supply chain data and using RFID technology to track supply and quality (Tang, 2006; Kurniawan *et al*., 2016; Ho *et al*., 2015). With some minor adaptations, the foundation for the categorization can be displayed as in Figure 3.

Future business continuity requires a comprehensive solution that is interoperable between the organization and other parties in the supply chain. As such, the three types of supply risk management strategies cannot be managed independently (Autry & Sanders, 2009). One could, for instance, imagine supplier cooperation is connected with the use of technology in increasing supply chain visibility or altering the supply base design based on insights from supplier cooperation strategies. The basis for the three types of strategies in Figure 3 therefore show an overlap that represents hybrid supply risk management strategies, which are not pointed out in literature but might result from the empirical research. Based on the shared characteristics and overlap in focus, three categories of supply risk management strategy categories will be discussed in more detail in the following sections. These sections attempt investigate relevant SCRM literature on the most crucial supply risk management strategies and their impact on supply risk.

2.2.2 Supply base design strategies

In 2003, U.S. medical institutions suffered from a 48 million influenza vaccines shortage, due to several reasons of which an insufficient supply base was the most important one (Brooks, 2004). The entire U.S. market was served by just four suppliers. A solution for this problem proposed by the U.S. government involved the signing of risk-sharing contracts with other suppliers. These suppliers were previously reluctant from entering the market, as it was very troubled and risky due to high investment costs. With this new strategy, additional potential suppliers entered the market and helped the U.S. government to increase their supply flexibility and be able to swiftly change between suppliers in case of severe trouble, eventually eliminating the shortage (Brooks, 2004). This example is illustrative for the impact supply base design strategies can have on supply risk, which are discussed in this section.

SRCM meta-studies conclude that several researchers often address multiple methods in studying supply risk management strategies (Tang, 2006; Ho *et* al. 2015; Sodhi & Tang, 2012; Fan & Stevenson, 2018). An interesting discussion can be found in their perceptions of the optimal design of the supply base, a topic that received a lot of attention in academics (Jüttner *et al*., 2003;

Giunipero & Eltantawy, 2004; Kleindorfer & Saad, 2005; Tang, 2006; Craighead, Blackhurst, Rungtusanatham, & Handfield, 2007; Manuj & Mentzer, 2008; Yu, Zeng & Zhao, 2009, Li, Wang & Cheng, 2010; Xanthopoulos, Vlachos & Iakovou, 2012). In their meta-analysis, Ho *et al.* (2015) conclude that in all papers on supply risk mitigation substantial attention is confined to supply base design decision-making. The strategies considered most fruitful in their impact on supply risk, are reviewed in the remainder of this section.

Dual, multiple and backup sourcing

Dual sourcing appears to be a robust strategy to hedge against supply risks such as regarding supplier opportunism, supplier disruptions, quantity and quality of purchased item (Manuj & Mentzer 2008). In all of the investigated cases, it appears to overrule single sourcing (Manuj & Mentzer 2008). However, it should be kept in mind that "dual sourcing requires more investment than single sourcing" and the costs of mitigating risks that might never occur can exceed the costs of dealing with the actual materialized damage from these risks (Manuj & Mentzer, 2008, p. 208). This underscores the idea risk managers should bear in mind the trade-off between the costs of risk mitigation and the costs of the risk itself (Chopra & Sodhi, 2004).

In contrast to the consensus on dual sourcing outperforming single sourcing, some scholars are less confident about the benefits of multi-sourcing over dual sourcing (Fang *et al*., 2013; Ho *et* al., 2015). Although they share agreement on the added value of the addition of third or more suppliers, it is concluded that these bring less marginal benefits than a backup supplier or regular second supplier (Fang *et al*., 2013). However, it should be noted that Fang *et al*. (2013) conducted an simulated study with no real observations which subjects their results to several unlikely assumptions. Tang (2006) does agree that in case of supply disruption, the availability of a backup supplier could be a very fruitful alternative strategy. However, Jüttner *et al*. (2003) stress the benefits of multiple sourcing and argue that multiple sourcing is seen as a traditional method of risk spreading as it increases organizations' flexibility. The authors emphasize the importance of flexibility in risk management because: "especially in global supply chains flexibility is often sacrificed for cost reduction. Consequences can be the inability to react to competitor moves, shifting customer demand or to any other unpredicted event arising from environmental or organizational risk sources" (Jüttner *et al*., 2003, p. 12). This shows there is a discussion on the

extent to which additional suppliers add to the success of supply risk management strategies. Although, upon the impact of any of these strategies on supply risk reduction is unanimously agreed.

Local and global sourcing

Besides the number of different suppliers in the supply base, their geographical whereabouts are considered of critical importance (Craighead et al., 2007). Spreading out multiple supply sources over multiple countries enable organizations to manage various types of supply risks as it increases their supply chain resilience (Trent & Monczka, 2005). Rather than solely a useful strategy to manage risk, sourcing globally also requires additional efforts in supply risk management as it can increase the level of risk itself (Christopher, Mena, Khan & Yurt, 2011). This finding was previously observed by Foerstl, Reuter, Hartmann and Blome (2010), who state "the increasing reliance on a global supply base enhances the need for supply risk management" (p. 119). This leaves room for debate, as a strategy that is proposed to help elimating supply risk, also generates new sources of risk. Here, academic literature does not provide unambiguous conclusions, although the benefits of global sourcing should not be underestimated. Craighead *et al*. (2007) consider global sourcing as one of the best practices in purchasing. Although there is no dispute about the efficiency gains it can bring about, researchers are aware that in many instances it is not possible for buyers to freely shift between different suppliers due to limited availability of supply sources (Kleindorfer & Saad, 2005). This makes one consider a combined sourcing strategy as a useful alternative. Kleindorfer and Saad (2005) underscore the importance of adopting local sourcing strategies as well. Also, Tang (2006) provides arguments in the benefit of sourcing locally: reduced transportation costs, reduced lead times and eventually reduced inventory levels which are major potential sources of supply risk. Furthermore, Tang (2006) provides evidence for a hybrid strategy as "locally optimal decisions can cause operational inefficiency and globally suboptimal decisions for the entire supply chain" (p. 460). It appears to be the case that combining local and global sourcing is best (Autry and Sanders, 2009). They argue that organizations should at least partially develop local supply sources to supplement the supply base and not only rely on global supply sources (Autry and Sanders, 2009). They admit "a local supply source may be more expensive, but it also enables organizations to respond more quickly as market needs change and

can serve as a "backup". By contrast, relying exclusively on an offshore supply base can be risky. This dual sourcing strategy can be very effective" (Autry & Sanders, 2009, p. 317).

Supply base reduction and dropping of risky suppliers

Finding the optimal size of the supply base has been a fertile research topic and is often seen as one of the key objectives in purchasing (Choi & Krause, 2006). Several researchers argue that reducing the supply base can have multiple positive implications (Craighead *et al.*, 2007; Smith, 2009). Downsizing the supply base is seen as an essential instrument to better influence relationships with suppliers and therefore reduce exposure to and impact of supply risks (Smith, 2009). However, a reduction of the supply base cannot be conducted straightforwardly as not simply any supplier can be disqualified. Sarkar and Mohaptra (2006) investigate two dimensions of suppliers: performance and capability. These two indicators can help organizations identify unsatisfactory performing suppliers as well as suppliers lacking capabilities required for succesful business operations. To a large extent, literature agrees upon the impact of supply base reduction on supply risk although critical notes are made (Ogden, 2006; Choi & Krause, 2006). Ogden (2006) adds a critical note by emphasizing supply base size should not be changed too unexpectedly. Reducing a the supply base means a smaller group of suppliers is responsible for the same level of supply. Lasting suppliers are required to increase their production capabilities to maintain the same output levels. Purchasing firms must keep this in mind and where necessary, adjust the pace of reduction to prevent quality issues. Additionally, Choi & Krause (2006) argue that only looking at supply base reduction from a cost perspective, overlooks other effects on the functioning of suppliers and supply risk. These remarks contribute to the critical discussion on requirements for successful supply base reduction.

In some occasions, supply base reduction is found to be strongly connected to the strategy of dropping risky suppliers. Supply base reduction can namely be used both as a strategy to mitigate supply risk, but also be a consequence of dropping risky suppliers. The latter is considered another strategy pursuing the same objective (Jüttner & Ziegenbein, 2009). Evidence is found on the positive impact of excluding unreliable suppliers from the supply base on supply risk, indicating these two strategies can also be adopted simultaneously (Jüttner *et al.*, 2003). This not only impacts supply risk, it also helps preventing risk as with the elimination of questionable

suppliers, risk is avoided. Furthermore, the adoption of these strategies helps the buying firm leveraging purchases at key suppliers that are considered reliable and convenient (Zsidisin *et al*., 2004). Allocating the same supply over less suppliers, indicates a higher buying power which forces suppliers to perform better. In this way, supply base reduction benefits in more than one way.

The findings in this section provide us with **Hypothesis 1**: *supply base design strategies have a negative impact on supply risk.*

2.2.3 Supplier cooperation strategies

The second general supply risk management strategy is supplier cooperation. It several sub-strategies to optimally coordinate and cooperate with a broad variety of suppliers to negatively impact supply risk. Following the logic of Autry and Sanders (2009) and Figure 1 in the previous section, "well thought out processes and sophisticated technology are only tools and procedures but are not enough" to achieve business continuity without adverse events in the supply of goods (p. 325). These insufficient resources requests the major organizational players; top management, employees and suppliers, to cooperate in the pursuit of minimizing supply risk. This provides an interesting research direction to further examine. Here, Fan and Stevenson (2018) provide a useful interpretation of the previous finding as “better relationship building and improving collaboration [with suppliers] may provide more competent supply chain risk management” (p. 222). Furthermore, the authors state “empirical evidence is, however, needed to reassess the general premise that more collaboration is better for the buyer as there is no added benefit from investing resources in managing risk in some situations […] and then to examine how to effectively bring traditional supplier and customer relationship management practices into SCRM” (Fan & Stevenson, p. 222). Several researchers provide arguments for the added value of bringing such partnerships into practice. For instance Li, Rao, Ragu-Nathan, & Ragu-Nathan (2005) indicate cooperation with suppliers increases the buying firms' involvement in supplier activities leading to opportunities to improve both parties' operations. Similar conclusions are observed by Chen *et al*. (2013) who find that "suppliers' capability and performance is improved, operations of the two

companies are better coordinated, the continuity of supply is ensured, and supply risk is reduced" (p. 7). These insights lead to the further investigation of several relevant sub strategies in the field of supplier cooperation, which will be discussed in the following sections.

Upstream integration with suppliers' operations

Upstream integration with suppliers' operation is often discussed and promoted as a prosperous strategy to improve cooperation (e.g. Giunipero & Eltantawy, 2004; Ritchie & Brindley, 2007; Manuj & Mentzer, 2008; Braunscheidel & Suresh, 2009). Especially, several major supply side risks motivate upstream supply chain integration. These are capacity constraints, suppliers' asset specificity and the leverage relation between buyer and supplier (Manuj & Mentzer, 2008). Upstream integration to impact such risks can materialize in various ways, such as jointly investing in risk management. Braunscheidel and Suresh (2009), argue that cooperatively investing in risk management practices can reduce the likelihood of exposure to supplier opportunism, as valuable supplier inside information can emerge from such cooperation. Such information, however, needs to be shared in order to prove its value. Here, Giunipero and Eltantawy (2004) place the critical remark that by sharing information, the risk arises that suppliers will use this information solely for their well-being. Considering this risk, risk management investments in upstream integration can be a more profitable strategy rather than one-sided information sharing (Giunipero & Eltantawy, 2004). This finding indicates that solely information sharing is not enough to achieve a fruitful upstream integration which can impact supply risks. This is conveniently summarized by Cousins and Menguc (2006) who argue "that the use of socialization and integration will reduce the perceived risk between the buyer and the supplier as it increases the information flow and transaction-specific investment of both parties. Therefore, reducing the likelihood of opportunistic behavior" (p. 605). Importantly, it needs to be mentioned that upstream integration "may increase control and reduce risks in a supply chain, but it changes variable costs into fixed costs" (Manuj & Mentzer, 2008, p. 209). By upstream integration, organizations do make concessions on their flexibility which can influence their overall SCRM.

Supplier screening, monitoring and (self-)assessment

Knowledge of your supply chain partner's activities can be very a relevant resource leading to greater insight into the impact and likelihood of supply risk (Kraljic, 1983). It helps establishing a risk profile, based on which critical decisions can be made. Several researchers provide methods to contribute to the understanding of supply chain partners criticalities and potential non-compliancy, such as supplier screening, monitoring and (self-) assessment (e.g. Tang, 2006; Autry & Sanders, 2009; Foerstl *et al.*, 2010; Chen *et al*., 2013). It appears to be evident that these checks are conducted before suppliers enter the supply base to reduce risk exposure (Tang, 2006). This finding is advanced by Autry and Sanders (2009). These authors furthermore propose the practice of supplier self-assessment: "it is important to screen and regularly monitor current and potential suppliers for the risks they may pose to security. Self-assessment by suppliers can be used as part of the screening process, and it can be an internally developed risk-scoring approach […….] Using this approach, companies can identify high versus low-risk suppliers and consider this in the request for quote (RFQ) process. The continuous monitoring of current and potential suppliers can be stored in a database of suppliers and the assessment results of risks monitored over time" (Autry and Sanders, 2009, p. 327). Zsidisin *et al*. (2004) place this practice in perspective as they indicate the frequency and intensity of risk assessment activities should depend on the relationship and (expected) level of cooperation between the buying and supplying organization. Existing literature on this topic seems to lack insights in distinguishing between different suppliers. One can imagine assessing suppliers of for instance key raw materials is more evident than a supplier of less urgent items. Despite limited availability of detailed distinction, the general consensus on the added value of such activities provides an interesting avenue for further empirical examination.

Supplier relationship management

Co-operative risk management initiatives are more rewarding than independent risk avoiding procedures such as insurances and posing requirements on supplier service levels (Kleindorfer & Saad, 2005). This finding is shared by Faisal, Banwet and Shankar (2006), who underscore the importance of building collaborative relationships with suppliers in supply risk management. However, these researchers do not distinguish between different types of suppliers which, as stated before, is crucial. Here, two journal articles of Tang (1999; 2006) provide valuable additions. The

first paper identifies different types of supplier relationships for different types of market conditions, which help in identifiying the most favorable supply risk management strategy (Tang, 1999). Advancing his earlier research with more detailed suggestions, Tang (2006) proposes "four types of supplier relationships: vendor, preferred supplier, exclusive supplier and partner. These four types differ from each other in terms of types of contracts, length of contracts, type of information exchange, pricing scheme, delivery schedule, etcetera" (p. 455). These findings provide input for further consecutive research on supplier relationship management. Ritchie and Brindley (2007) contribute to the level of knowledge on this topic by identifying several suggestions that can be used to improve supplier relationship management: "relationship development, agreed performance standards, regular joint reviews, joint training and development programs, joint pro-active assessment and planning exercises, developing risk management awareness and skills, joint strategies, inter-partnership structures and relationship marketing initiatives" (p. 310).

The above discussed literature does provide useful insight but only limitedly reflect on the conditions that determine the impact of supplier relationship management. Ritchie and Brindley (2007) indicate such initiatives may not directly help mitigating the source of supply risks better but enable organizations to increase awareness and responsiveness in case of adverse supply events, helping to reduce the exposure to systematic risks. The length of the developed relationship impacts the success of the execution of supply risk management, according to Zsidisin *et al.* (2004). Kraljic (1983) adds to this that also market conditions influence the success via impacting the buyer's bargaining power and the strategic importance of the purchased item.

Early supplier involvement

Between supplier screening, monitoring and (self-) assessment and actually building relationships with suppliers, come incentives early involve them in operations and decision making. After the moment suppliers are selected, it is vital to the buying organization to involve them early in its supply risk management processes (Zsidisin & Smith, 2005). This smoothens communication, and allows for a transparent cooperation from the beginning. Then, according to Ritchie and Brindley (2007), regular meetings with suppliers are crucial to create a thorough understanding of their operations, supply risk plans and identify potential vulnerabilities or risk creating events. The earlier these activities start, the better the cooperative risk mitigation. These findings also support

the development of joint mitigation plans for all potential risks identified (Autry & Sanders, 2009). Besides underscoring the importance of early supplier involvement, literature also provides evidence for its impact as supply risk management strategy. Giunipero and Eltantawy (2004) find support for relationships between strong risk management, early supplier involvement, supplier management and collective evaluation of risk mitigation practices. These authors argue that in scenarios of novel buyer-supplier relations, supply executives from the start of the relation should "share and assess supplier risk management plans, implement automatic integration with supplier operations, and increase and strengthen the flow of communication with the supplier" which adds to the benefits of addressing and mitigation of supply risk (Giunipero & Eltantawy, 2004, p. 710). These findings provide relevant insights in the impact of early supplier involvement on supply risks.

Strengthen supplier communication

The last major supplier cooperation strategy that emerges from this literature investigation involves strengthened supplier communication. Communication with suppliers is key in the development of relationships and enables better risk management via a better understanding of supply chain partners requirements and needs (Khan *et al.*, 2009). This can help in the prevention of various supply risks, which can originate from inadequate communication. The importance of improving communication with suppliers is further supplemented by Giunipero and Eltantawy (2004), who see it as a critical strategy in risk mitigation and the development of competitive advantage. Bad communication can lead to adverse supplier behavior. Christopher and Lee (2004) explain how this can occur. A low level of visibility can reduce the confidence of a purchasing firm in the security of his supply as he might become insecure on timely delivery and the status of his order (Christopher & Lee, 2004). The authors argue that improving communication with suppliers can lead to greater confidence in their operation as visibility increases via interrupting the so-called risk spiral. This effect is further investigated by Tang and Tomlin (2009) , who explain: "each supply chain partner either "inflates" their order or "disguises" their on-hand inventory because of for instance the lack of confidence in the replenishment lead time, demand forecasts. The confidence level deteriorates further as every partner starts gaming the system, and hence, the "risk spiral" continues" (p. 162). This effect underscores the importance of strengthened

supplier communication in supply risk management. Also, the link with increased supply chain visibility shows interesting correspondences with the following section (2.2.4).

The findings in this section provide us with **Hypothesis 2**: *supplier cooperation strategies have a negative impact on supply risk.*

2.2.4 Supply chain visibility strategies

As indicated in previous sections, enhancing supply chain visibility is often part of supply risk management strategies. This section addresses it as a separate strategy, as literature shows it entails a broad range of sub strategies. Here, the research by Francis (2008) is useful as it provides an oversight of various definitions of supply chain visibility proposed for many different business contexts. The author captures the most critical elements in the following definition: “supply chain visibility is the identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times for these events” (Francis, 2008, p. 182). This definition provides guidance in the overview of supply chain visibility strategies in the remainder of this section.

Supply chain visibility strategies can be beneficial “as supply chain visibility improves, each supply chain partner can generate more accurate forecasts of future demands and better coordination” (Tang, 2006, p. 482). Furthermore, Tang (2006) finds this can be achieved via information sharing strategies, allowing for collaborative forecasting, increasing insight into suppliers inventory levels, production planning and replenishment plans. This is supplemented by Chen *et al*. (2013) who state: "without visibility of upstream flows, managers are uncertain about the order cycle time, demand forecasts, suppliers' capability to deliver, etc. Hence, they rely on double guessing which leads to an overreaction that further masks the visibility and increases risks […] Along with the operational or/and strategic information available across the supply chain, better visibility is achieved and risk is reduced" (p. 13). This is agreed upon by Autry and Sanders (2009) stating that “visibility of the supply network can help a company anticipate a disruption and mitigate their effects when they do occur” (p. 316). The above statement provides a preview of the discussion in the following subsections. These explore SCRM literature on strategies to

better manage supply risk via increased supply chain visibility and provide oversight of the ones considered to have the most impact.

Sharing information with suppliers

Asymmetries in accessible information can be a major issue in an effective cooperation between buyers and suppliers (Zsidisin & Ellram, 2003; Wiengarten, Humphreys, Gimenez & McIvor, 2016). Accessible information includes inventory levels, demand forecasts or production planning (Tang, 2006; Wiengarten *et al*., 2016). Advancing the above idea, Zsidisin and Ellram (2003) link limited supply chain visibility to classic economic theory by arguing: "increased 'transparency' of information between organizations leads to sharing of knowledge, increased collaborative abilities, and improved risk management for both supplying and purchasing firms." (p. 23). These authors find that reducing the likelihood of supply risk occurrence can result in improved supplier performance as moral hazard and adverse selection are minimized. "Moral hazard in a supply management context, refers to the risk purchasing firms encounter from suppliers that do not put forth the agreed upon effort to meet customer demand. Adverse selection, on the other hand, involves the misrepresentation of a supplier's ability to meet customers' requirements. […] Reducing the likelihood of supply risk occurrence can result in improved supplier performance" (Zsidisin & Ellram, 2003, p. 24). This argumentation provides some valuable insights in how well-performed sharing information can help increasing supply chain visibility and eventually impact supply risk. Faisal *et al*. (2006) even take this a level higher by indicating that sharing of information is a critical enabling factor for successful SCRM, as it facilitates strong supply chain risk mitigation.

In addition to the perks of sharing information distinguished by Zsidisin and Ellram (2003), Kurniawan *et al*. (2016) find it also helps improving supply chain responsiveness. In this way, supply and demand fluctuations can be better foreseen and help avoiding risks in an early stage. Francis (2008), supports these findings by indicating that sharing information with upstream supply chain partners can be interpreted as a key strategy in improving supply chain visibility (Francis, 2008).

Traceability and RFID technology

An alternative to improving communication or purposely sharing critical company information with suppliers, the technology exists to provide real-time insight in demand, supply, inventory levels and capacity levels at critical nodes in the supply chain (Autry & Sanders, 2009). For instance: "systems can be put in place that automatically track breaking news and monitor media websites for information regarding problems at high-risk locations" (p. 316). Via this, a flow of information can be generated assisting in the flexibility and accuracy of responses to supply chain disruptions. Sheffi (2005) provides the example of Cisco's eHub. Here, the connection of multiple tiers of the supply network allows supply chain partners to have thorough visibility into the supply chain. This includes "potential disruptions, capacity problems, and potential delays or shortages" (Autry & Sanders, 2009, p. 317). Choi (2011) provides evidence for these findings by indicating supply risk levels reduce as a result of supply chain partners cooperating in implementing RFID technology. This research area does lead to believe it can bring forth promising applications in the field of supply risk management and is therefore included in this research, despite it appears to be not very mature yet.

This sections' findings lead to the establishment of **Hypothesis 3**: *supply chain visibility strategies have a negative impact on supply risk.*

2.2.5 The enabling role of management support

It can be challenging to justify the money and time spend on risk assessment, contingency plans and risk management if a risk never materializes. Therefore, board-level awareness and appreciation of supply risk management are evident for successful risk mitigation plans (Zsidisin, 2000). Jüttner (2005) adds to this that board-level involvement in supply chain management is often limited to cutting costs, regardless of the potential adverse impact on supply chain resilience. The researcher emphasizes the lack of board-level appreciation for the topic resulting in serious incidents due to supply risks. A proposed solution is that the board has to accept responsibility for SCRM and take care of organizing the implementation (Jüttner, 2005).

The above findings are supported by Giunipero and Eltantawy (2004), who underscore the importance of top management support in successful supply and risk management. The costs of undesirable events need to be assessed in comparison to the realized benefits from adopted strategies to decrease both the likelihood and adverse impact of supply risks. To do so, Giunipero and Eltantawy (2004) provide several managerial approaches to supply risk management. As opposed to merely attempting to grab for greater risk control, supply managers are advised to focus more on the solid management of risks. Although the former often seems a tempting strategy, the latter is claimed to be more fruitful. Likewise, it is argued that risk management policies require a coherent mandate from top management. Supply professionals often invest a substantial share of their time planning and assessing supply risk. Therefore they need to rationalize the costs they make in each procurement decision by identifying its potentially hazardous characteristics (Giunipero & Eltantawy, 2004). Hiring and developing high-quality procurement professionals is vital as well as allowing them to go after endeavors that are potentially risky. Nonetheless, a prerequisite for the latter is the presence of an appropriate risk management plan (Giunipero & Eltantawy, 2004). Pfohl, Köhler and Thomas (2010) advance these findings and add that all actors of the supply chain and at all levels, inside or outside the organization, are aware and involved in risk management plans and activities.

Considering much different supply (chain) risks, Chopra and Sodhi (2004) propose a management approach consisting of two practices. "First, they [the managers] must create a shared, organization-wide understanding of supply-chain risk. Then they must determine how to adapt general risk-mitigation approaches to the circumstances of their particular company" (2004, p. 59). The authors argue this can be achieved through the concepts of ‘stress testing’ and subsequently through ‘tailoring’ of risk management approaches.

‘Stress testing’ enables managers to have a clear idea of the costs and impact of potential risks and prepares them for unforeseen events and greatly lowers risks. The first step includes the identification of key suppliers and other key sources of potential risk. Secondly, questions are raised such as “What might happen if a particular supplier could not deliver for a month?” or “What if a supplier raised prices by 20% at the termination of a contract?” in order to assess possible adverse supply chain impacts and the company’s level of preparedness (Chopra & Sodhi,

2004, p. 59). Stress testing helps management identify risk-mitigation priorities for the near, medium and long-term.

'Tailoring' risk management approaches are based on the trade-off between the implications of risk itself and the costs of mitigating the risk. Managers need to keep a vigilant eye on this optimal balance which is influenced by three critical interactional effects. The first one addresses the increasing costs of risk reduction. This involves that using inventory to cover risks is much more expensive when risk levels are high than when they are low. The second shows that pooling risk reduces the total of reserve required for a particular level of risk coverage. The third illustrates how pooling benefits grow the level of risk coverage: inventory pooling benefits are considerable only at high levels of inventory or forecast risks. The three effects should be balanced by managers to tailor their responses to risk and increase their grip on costs. By using this approach, the management responsible for risk management shows willingness and a pro-active attitude which are expected to result in a better understanding and mitigation of supply risks (Chopra & Sodhi, 2004).

In literature, supply risk management is sometimes discussed and expressed in different orientations. Autry and Bobbitt (2008) refer to the promotion of supply risk management as supply chain security orientation (SCSO). They suggest various drivers and conditions causing an organization to become supply chain security oriented. Most of their findings are advanced by Autry and Sanders (2009) who state that: "top management support and employee factors are the primary conditions that affect the pervasiveness and/or acceptance of SCSO within firms. However, top management's awareness of security and risk management implications for breaches of security is not sufficient" (p. 310). Therefore, it is argued that top management must be the driving force in the implementation of supply risk management initiatives and show commitment to the process. The absence of top management engagement in both these initiatives is assumed to lead to other employees neither understanding nor appreciating the importance of supply risk management (Autry & Sanders, 2009). Additionally, "the authors suggested that when employees are motivated and empowered to cooperate with security/risk management initiatives, when they possess positive attitudes about security/risk management, and/or possess integrity and loyalty to the firm while dealing with sensitive information, they can better facilitate SCSO" (p. 310). The interviewed supply chain managers by Autry and Bobbitt (2008) are aware that top management

is responsible for the crucial role of educating and conveying the importance of supply security and risk management. Autry and Sanders (2009) underscore that these initiatives are the primary factors required for successful risk management next to CEO's taking direct oversight of these processes or installing a senior vice president to become expert in these practices.

Potential hazards of supply risks do not simply originate from within the boundaries of a single organization. Berg, Knudsen and Norrman (2008) therefore argue that for successful supply risk management, obviously organisational borders have to be crossed. Clear and decisive risk-leadership becomes more desirable as supply risk management operates in an inter-organizational set-up. “Taken all together, risk leadership, risk policies and strategies are closely linked to what level of risk the organizations are willing to take, thus making it very difficult to manage the supply chain risk exposure as one entity.” (Berg *et al*., 2008, p. 303). Prerequisite to make this work is the creation of a mutual comprehension of potential risks and risk management among all actors, which is considered the responsibility of top management (Pfohl *et al*., 2010).

The enabling effect of management support on successful supply risk management is widely discussed and emphasized in the academic literature in this section. Therefore, testing its enabling influence on the three primary supply risk management strategies will be part of this research. The findings of this literature study result in **Hypothesis 4**: *management support for supply risk management in organizations enables the impact of supply risk management strategies on supply risk.*

2.2.6 The moderating role of supply chain complexity

“With more vulnerable supply chains on one hand and more dynamics and complexity in a globalized world on the other hand, disruptions hit supply chains more often and with much worse impact on the continuity of production” (Kern, Moser, Hartmann & Moder, 2012, p. 61). This observation contributes to what is stated by Manuj and Mentzer (2008). They find several trends contributing to increased supply chain complexity. These are: growth in outsourcing and off-shoring, increasingly demanding customers, geographical dispersion of supply chains, access to markets in emerging economies and unanticipated events such as terrorist attacks and natural disasters. They define supply chain complexity as “aggregate measure of the structure, type, and

volume of interdependent activities, transactions, and processes in the supply chain. It also includes the information, constraints, and uncertainties under which these activities, transactions and processes take place" (Manuj & Mentzer, 2008, p. 213). The authors argue that better management of supply chain complexity can lead to better supply chain performance and SCRM. Their qualitative research finds evidence for the moderating effect of supply chain complexity on the relationship between supply risk management strategies and the goals it is intended to serve, namely negatively impacting supply risk. Manuj and Mentzer (2008) also find several complexity reduction measures that positively influence risk management outcomes. Other scholars provide the finding that organizations are more enabled to manage supply risks in less complex supply chains (Wilding, 1998) and that this has a positive impact on supply chain performance (Vachon & Klassen, 2002). Kern *et al*. (2012) find that complexity of global supply chain operations adds to the requirement of thorough and strong SCRM strategies. This is intended to go along with improved "knowledge about a company's most critical components, processes and suppliers worldwide in order to focus the existing resources on the most fragile areas of the supply chain" (Kern *et al*., 2012, p. 64). Choi and Krause (2006) add to this that a reduced supply chain complexity increases the ease and success of supply risk management operations via for instance increased supplier responsiveness. Also Craighead *et al*. (2007) confirm the moderating role of supply chain complexity as it is positively related to supply risk and negatively related to the ease of coordinating supply risk management. The findings in this section provide us with **Hypothesis 5**: *the impact of supply risk management strategies on supply risk is moderated by supply chain complexity*.

2.2.7 Results from literature and conceptual model

The results of the literature exploration and development in Sections 2.2.1 – 2.2.6, can be summarized into a shortlist. This list is shown in Table 3 and provides an oversight of the supply risk management strategies that are considered the most important in theory and that are found to have a negative impact on supply risk. This list provides the underlying backbone connecting the exploration and development of theory, as it results from the exploration, and will be used in the development of new insights in the following sections. It follows the structure of the found supply risk management strategies in literature.

Table 8: List of theoretical strategies

Supply base design strategies	**Authors**
Local sourcing only	Tang (2006); Kleindorfer and Saad (2005)
Combine global and local sourcing	Monczka (2005); Craighead *et al*. (2007); Autry and Sanders (2009); Trent and Foerstl *et al*. (2010)
Dual sourcing	Manuj and Mentzer (2008); Autry and Sanders (2009); Fang *et al*. (2013)
Multiple sourcing	Jüttner *et al*. (2003); Manuj and Mentzer (2008); Fang *et al*. (2013); Ho *et al*. (2015)
Backup suppliers (only as back-up)	Tang (2006); Fang *et al*. (2013)
Supply base reduction	Choi and Krause (2006); Ogden (2006); Smith (2009)
Dropping of risky suppliers	Jüttner *et al*. (2003); Zsidisin *et al*. (2004); Jüttner and Ziegenbein (2009)

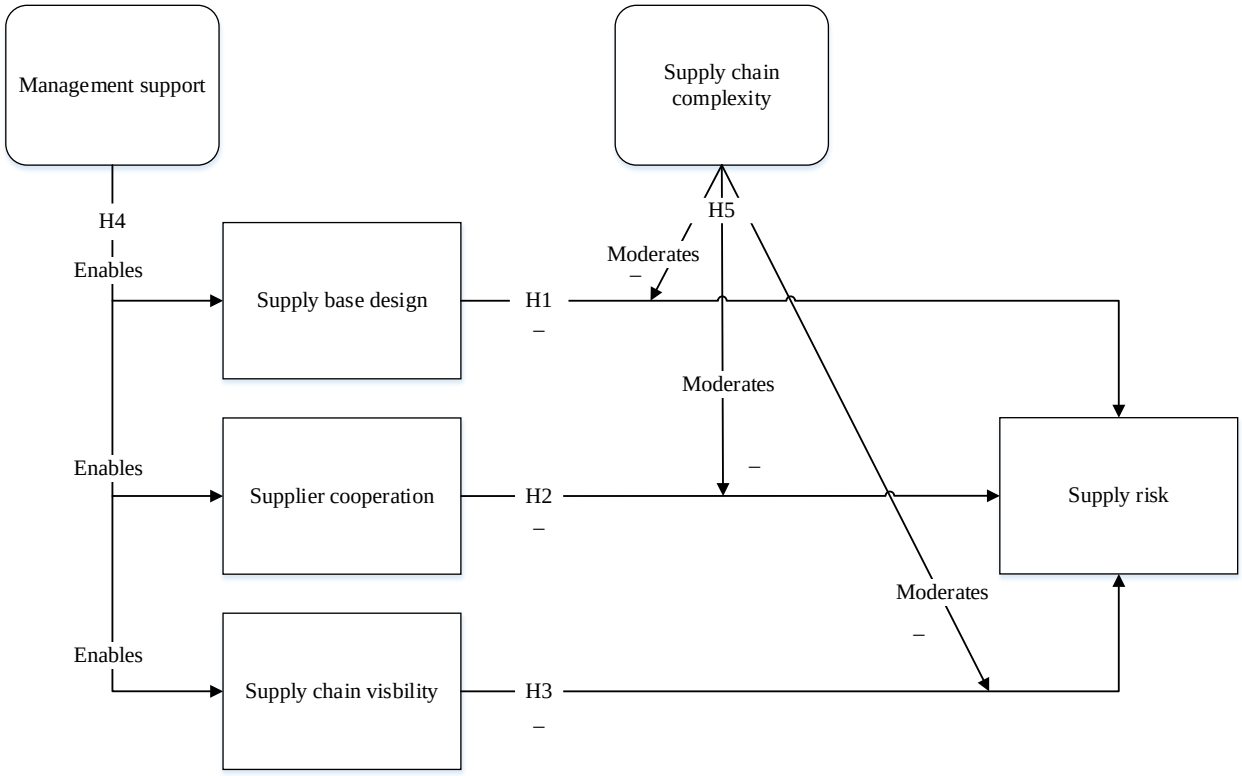
Supplier cooperation strategies	**Authors**
Upstream integration with suppliers' operations	Giunipero and Eltantawy (2004); Li *et al*. (2005); Cousins and Menguc (2006); Ritchie and Brindley (2007); Manuj and Mentzer (2008); Braunscheidel and Suresh (2009); Chen *et al.* (2013)
Supplier relationship management	Tang (1999); Zsidisin *et al*. (2004); Kleindorfer and Saad (2005); Tang (2006); Faisal *et al*. (2006); Ritchie and Brindley (2007); Fan and Stevenson (2018)
Early supplier involvement	Giunipero and Eltantawy (2004); Zsidisin and Smith (2005); Ritchie and Brindley (2007); Autry and Sanders (2009)
Supplier screening, monitoring and (self-)assessment	Kraljic (1983); Tang (2006); Autry and Sanders (2009); Foerstl *et al*. (2010); Chen *et al*. (2013)
Strengthen the flow of communication with suppliers	Christopher and Lee (2004); Giunipero and Eltantawy (2004); Khan *et al.* (2009); Tang and Tomlin (2009)

Supply chain visibility strategies	**Authors**
Increase traceability in the supply chain	Sheffi (2005); Autry and Sanders (2009); Chen *et al.* (2013)
Share information with different parties in the supply chain	Zsidisin and Ellram (2003); Giunipero and Eltantawy (2004); Cousins and Menguc (2006); Tang (2006); Faisal *et al.* (2006); Francis (2008); Wiengarten *et al*. (2016); Riley *et al.* (2016); Kurniawan *et al*. (2016)
Share inventory levels with strategic suppliers	Tang (2006); Autry and Sanders (2009) Kurniawan *et al*. (2016)
RFID technology	Sheffi (2005); Autry and Sanders (2009); Choi (2011)

Apart from these strategies, the literature study in the previous sections brought forth relevant insights in the enabling effect of management support on the impact of supply risk management strategies. Also, the moderating effect of supply chain complexity is discussed and seems relevant

for further empirical exploration. The general strategies, supply chain complexity and management support for supply risk management all form constructs and are proposed as independent variables introduced in the conceptual model in Figure 4. The conceptual model displays the presumed relations between the constructs and their impact on supply risk. As can be seen, the three independent variables, supplier cooperation, supply base design and supply chain visibility are expected to negatively impact supply risk. The effects of these three are expected to be enabled by management support for supply risk management. Supply chain complexity is expected to moderate the negative impact of these three independent variables. For all three strategies, supply chain complexity is expected to negatively influence their impact. In other words, supply chain complexity is expected to weaken the impact of supply risk management strategies

Figure 9: Conceptual model



3. Research methodology

3.1 Research design

As is demonstrated in Section 1 and 2, existing research on supply risk management has not satisfactorily proven its practical relevance yet. In recent years, several meta-analyses have been executed to summarize and assess the wide range of supply risk management methods and strategies in the literature (Ho *et al*., 2015; Sodhi *et al*., 2012; Tang, 2006; Fan & Stevenson, 2018). These researchers share the conclusion that the majority of supply risk management literature is of a conceptual nature and emphasize the importance of empirical research and the additional value to this field of science. Therefore, a qualitative research approach is followed to deliver valuable empirical research. Qualitative research is demonstrated to be a rewarding research method while investigating business practices and is defined as "research that involves analyzing and interpreting text and interviews in order to discover meaningful patterns descriptive of a particular phenomenon" (Auerbach & Silverstein, 2003, p. 3). The qualitative approach is expected to reflect its value in the research field of supply risk management, as it evolved from organizations' experiences in real life situations. It accentuates the viewpoints of the subjects under study, whereas quantitative methods are merely driven by the perspectives of the researcher (Bryman, 2017). The viewpoints of the subjects in this study provide critical elements to learn more about the impact of supply risk management strategies.

For the evaluation of the impact of supply risk management strategies in various corporate contexts, a qualitative case study approach is the most useful method of inquiry. According to Yin (2009), case studies and interviews are evident methods of analysis when the phenomenon under investigation are not distinguishable from their contexts, i.e. organizations representatives that will be interviewed are expected to be part of the organizations supply risk management strategy. Furthermore, case studies offer opportunities to study phenomena in their natural settings, enabling the exploration of underlying meanings and complex links (Miles & Huberman, 1994; Yin, 1994; Oke & Gopalakrishnan, 2009). Also, this research method seems "appropriate where existing knowledge is limited because it generates in-depth contextual information which may result in a superior level of understanding" (Oke & Gopalakrishnan, 2009, p. 170). In this research, limited knowledge refers to the limited knowledge of the practical impact of supply risk management strategies, a key driver for this study as empirical research on this topic is scarce. These findings

provide support for the qualitative investigation of theoretical supply risk management strategies as a higher level of understanding of their practical applicability advances the current state of SCRM knowledge.

Regarding the case study approach, semi-structured interviews are used to obtain primary data. Within the constraints of time availability and travel distance, an attempt is made to schedule interviews as personal conversations as much as possible. According to Louise Barriball and While, personal interviews are a useful means for data collection as they eliminate the potential of the low response rate of surveys and allow the opportunity to "evaluate the validity of the respondent's answers by observing non-verbal indicators" (p. 328). Furthermore, the semi-structured nature of interviews meets two important considerations: "first, they are well suited for the exploration of the perceptions and opinions of respondents regarding complex and sometimes sensitive issues and enable probing for more information and clarification of answers. Second, the varied professional, educational and personal histories of the sample group precluded the use of a standardized interview schedule" (Louise Barriball & While, 1994, p. 330). The latter consideration requires the interviewer to sometimes diverge from the interview protocol "in order to pursue an idea or response in more detail" (Gill, Stewart, Treasure & Chadwick, 2008, p. 291).

3.2 Sampling approach

The selection of case studies is intended to maximize the benefits and exploitation of data obtained from a relatively small sample (Flick, 2009). To do so, a sampling framework was designed and implemented in consideration with the procurement and supply chain advisory practice of KPMG. This provided the researcher with valuable guidance, professional assistance and insights in the relevant corporate contexts, as well as an indication of potential case study subjects' accessibility and fit for the research. Following this multilevel case selection process, this resulted in a preliminary list of 52 senior management level supply chain, sourcing and procurement professionals representing a total of 51 organizations. A further reduction was required, based on an estimate of the organizations' relevance for supply risk management practices and an indication of their exposure to supply risk. In total, 42 representatives were invited directly to participate in the study via the partner and director of KPMG's procurement and supply chain practice. The invitations contained only a brief and general oversight of the study and a request for participation.

Any elaborations on the contents and specific aim of the research were left out, to eliminate the chance of potential interviewee prepossession as much as possible. Out of the original list, 22 representatives agreed upon participation. However, sixteen interviews are scheduled as the other six could not be planned within the available time frame. These interviews are conducted with sixteen different participants, i.e. each interview was held in a one on one conversation setting to benefit the openness and unbiasedness of interviewee answers. Two participants represented the same organization, but different departments (FINGR). As it concerns the same organization, these two interviews allow for more in-depth insights and comparison of answers, but are considered as one case.

An overview of the selected case studies is provided in Table 3 and consists of a brief description of the participating organizations, their industry type, interviewee position, geographical footprint and size expressed in annual revenue and number of employees. Eight organizations are production companies, five are goods and services providers, and two are public sector organizations. For confidentiality considerations, code names are assigned to each case as opposed to expressing the full organizations names. The final sample shows a high variance in geographical footprint, with the majority of organizations operating on a global level. Furthermore, all participants work in an executive, director or other senior management function and are therefore expected to provide a sufficient level of in-depth insight into strategic decision making in a supply chain context. Thirteen organizations are of a private nature, and two are operative in the public sector.

3.3 Data gathering

To provide in-depth insights and answers to the research questions, semi-structured interviews are used as the primary source of data collection. In April and May 2018, a total of sixteen interviews are conducted at various locations in the Netherlands, mainly (head) offices of the organization the interviewee was representing. These sixteen interviews are used in fifteen case studies, as two interviews concerned representatives from the same organization (FINGR). Fourteen interviews were held face-to-face, two by phone. Up front, permission was asked to take recordings of the conversations as to benefit the accuracy of answers in the analysis, under the condition of confidentiality. Fifteen representatives agreed with this. In one case, recordings were not allowed.

Here, the interviewee was prepared to lower the pace of conversation and used several whiteboards to support the ease of understanding of his reasoning and answering. Notes were taken as accurately as possible. Based on the comprehensiveness of the interviewee's explanation and the level of detail in the notes, this did not harm the quality of the interview output. However, it excluded the possibility to use exemplary quotes in the analysis. This interview lasted for approximately ninety minutes. The lengths of the recordings range between 38 and 83 minutes and in all cases this was sufficient to cover the interview questions. The variance in time per interview is clarified by the representatives' personal interest in the topics covered, the provision and discussion of background material and examples and therefore anecdotal and exemplary style of answering.

Each interview, the interviewer started with a short introduction of the research to provide similar each conversation the same point of departure. Next, interviewees were asked to provide background information on both their activities and responsibilities within the organization as well as their experiences with the topic of supply risk management. The interviews are preceded and supplemented via the inquire of secondary data. Several web searches are conducted to provide a background and context of the organization under investigation. Where necessary, this background information is complemented during the interviews. Furthermore, LinkedIn profiles lead to a basic understanding of the interviewees' background and experience with the topic. In some cases, annual reports and organization-specific web pages provided valuable secondary data indicating points of interest within the investigated supply risk management practices, as well as relevant news articles.

During the semi-structured interviews, the interview protocol (Appendix I) provided guidance to the conversations. This protocol is established in consideration with KPMG Advisory and is verified on usefulness during several practice interviews. This exercise helped to improve and finalize the final version, which is used during the conversations. The interview protocol follows the structure of the literature exploration and development. It starts with an exploration of the concepts of supply risk and supply risk management and continues with questions on the adoption and impact of the three general supply risk management strategies, the enabling effect of management support and the moderating effect of supply chain complexity. This broad structure is maintained in all conversations. One of the strengths of semi-structured interviews is that it

allows for deviation in-between initial the key questions, which often lead to the insightful results and examples (Gill *et al*., 2008). To create a comprehensive understanding of the discussion topics, detailed probing proved its relevance as an instrument for data collection. Explicit and incisive follow-up questions often resulted in exemplary quotes and insightful details, unique to the participants' individual experiences and context, a method derived from Ritchie, Lewis, Nicholls and Ormston, 2013.

As can be observed in the interview protocol, the exploratory questions on the supply risk management practices were followed up by questions on the adoption and impact of theoretical supply risk management strategies. A list of supply risk management strategies is introduced to the interview participants to support critical thinking and increase the accuracy of answers. This list is shown in Table 3 and provides a concise oversight of the different sub-strategies that are obtained in the literature in Section 2.2. The list that is actually used during the interviews is included in Appendix II. This list facilitates the acquisition of detailed information and enables reaching the appropriate level of depth on critical research topics (Ritchie *et al*., 2013). By critically discussing this list in each interview, an overview of the presence of individual strategies at organizational level could be constructed. This oversight formed the backbone of the data analysis discussed in the following section.

3.4 Data analysis

Before the case analysis phase can be successfully initiated, the set of raw data needs to be critically reviewed, transcribed and translated. The data collection phase resulted in a substantial amount of raw primary data. As a consequence, the data reduction phase is evidently important. It helps distinguishing relevant from irrelevant interview parts such as dialogues deviating too much from topics within the scope of the research. This exercise was performed in parallel with the transcription and translation of the audio recordings from Dutch into English, as in all but one case Dutch was the language of conversation. Reviewing and assessing these transcripts resulted in the tabular individual case overviews (Appendix III). These overviews consist of two parts. The first part gives an overview of exemplary quotes describing the current state of the organizations supply risk management, or “as-is” situation. Here, the relevant interview output gives an oversight of different supply risks playing a role and what the current supply risk management practice looks

like at each individual organization. This information is intended to provide a context and background for the second part. Here, exemplary quotes relating to the constructs of the conceptual model are displayed. Adopting this method assisted in creating a database of textual data exemplary for the relevant topics of this study. This second part is established to supports the answering of RQ3 and RQ4

In the analysis phase, the case study output overviews (Appendix III) provide “iterative tabulation of evidence for each construct” and helps “shaping construct definition, validity and measurability” (Eisenhardt, 1989, p. 533). Next, case study output on the several constructs is used in a cross-case analysis, allowing for comparison between the different output. This supports the pursuit of finding logical patterns and interconnections in the research output via within-case and cross-case analysis (Miles & Huberman, 1994). Comparisons are made based on case study output such as exemplary quotes, as well as on detailed organization information that was collected before, during and after the interviews. Examples of this data are organization size in terms of revenue and number of employees, the size of the supplier base, the annual budget spend by the purchasing department, a categorization based on industry, ownership type etcetera. As MUNIC regards a local government, revenue is not applicable. Here, the annual budget is included. Furthermore, the case studies’ individual output was checked and reviewed for internal consistency. In some cases this brought ambiguities to the light after which the interview participant was consulted for clarification.

By introducing and discussing the list of strategies (Table 3) on a structural basis during every interview, a rich and detailed dataset is obtained. Moreover, this dataset, apart from some minor corrections, provided ready to use input on the adoption of strategies and their considered impact. This data is assembled into an oversight of strategies adopted per organization and distinguishes four different labels per strategy (Table 7). These are 'Yes' (refers to adoption), No (refers to non-adoption), Planned/in progress (refers to strategies that are currently on the agenda or are in development), and Not mentioned (refers to a missing data point). In few but in some cases, the interview participant was not able to answer whether a strategy was adopted or not. Here, the assumption is made that the strategy was not adopted. Considering the interviewees' high-level positions, the assumption is made that unawareness of strategies presence can be interpreted as absence of these strategies. In some instances, strategies are found to be on the agenda or in

development. Table 7 displays the distinction, but in the remainder of this research, these strategies are considered as adopted. The development of such strategies indicates that organizations recognize their potential impact and enable them to provide potentially relevant insights. The semi-structured nature of the interviews enabled the interviewer to ask critical questions regarding these in progress strategies. This allowed for a critical assessment about the maturity of the development progress and expectations of the impact of the supply risk management strategies on the agenda or in development. The oversight in Table 7 is supplemented with calculations that provide insight in the adoption of each individual strategy per organization, the total number of strategies adopted per organization, the number of organizations that uses each specific strategy and so on. Section 4 discusses these insights in detail.

3.5 Evaluation of quality

According to Yin (1994), "four tests (…) have been commonly used to establish the quality of any empirical (…) research. Because case studies are one form of such empirical research, the four tests also are relevant to case study research" (p. 32). The definitions of these measures are derived from Yin (1994):

- "Construct validity: establishing correct operational measures for the concepts being studied
- Internal validity: establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships
- External validity: establishing the domain to which a study's findings can be generalized
- Reliability: demonstrating that the operations of a study, such as the data collection procedures can be repeated, with the same results" (p. 33).

To account for construct validity, prior to the interviews various alternative sources of data were consulted and compared for analysis. This consultation provided the researcher with a broader understanding of the organizations' attitudes towards the practice of supply risk management and strategies implemented in this field. In some cases, annual reports provided insights on companies' risk appetite, including supply and supply chain risk. In other cases, recent news articles from business media described that organizations under investigation recently suffered from

disturbances and tumult in the industry and supply chain. These a priori insights allowed for more detailed questioning and probing, advancing the quality of the final interview data. Also, the interview participants hold positions as Chief Procurement Officer or an equivalent role, supply chain or sourcing director or other senior management function within these fields of expertise. All interviewees proved to have the ability to relate to the abstraction level of the research topics and had access to crucial information on a strategic professional level.

When investigating causal case studies, internal validity often is a difficult quality requirement to address. According to Eisenhardt (1989), “it is important to discover the underlying theoretical reasons for why the relationship exists. This helps to establish the internal validity of the findings” (p. 542). Therefore, this research accounts for internal validity as the conceptual model is based on an extensive literature review and was developed before the establishment of the interview protocol and therefore before the collection of data. This tactic enabled the researcher to minimize observational error, as measurement criteria (e.g. the list of strategies) was developed prior to the interviews.

External validity is increased via compiling a sample of multiple cases of distinctive organizations with various scales of operation and supplier bases, and who are active in different markets. These key figures and information are displayed in Section 4 – Table 4. The variation and comprehensiveness of the case study sample ease the process of generalization of research findings. The heterogeneity of the sample suggests support for external validity or ‘generalizability’, "as theories must be shown to account for phenomena not only in the setting in which they are studied but also in other settings" (Gibbert, Ruigrok & Wicki, 2008, p. 4). According to Ogden (2006), following a replication logic helps to enhance external validity. In this research, this approach follows the same structure in background investigation per case study and follows the interview protocol. Furthermore, a high response rate is obtained while providing only very limited information about the contents of the research (22 responses out of 42 invites). This high response rate reflects interviewees genuine interest in participating in the research, contributing to the belief of interviewee unbiasedness and advancing the quality of this study. During the sample selection, this background investigation is conducted on participants' and their organizations' via online news articles, LinkedIn profiles, annual reports and conversations with

supply chain and sourcing experts from KPMG Advisory. No indications for interviewee biasedness was found, contributing to the reliability of the case study sample.

The use of an interview protocol (Appendix I) is considered a critical tactic in qualitative research, as it enables and increases its repeatability and therefore reliability (Jacob & Furgerson, 2012). This protocol was reviewed and revised twice by procurement and supply chain experts of KPMG Advisory. One of them is a partner holding a PhD in purchasing, and the others are a senior consultant and consultant with broad knowledge and experience in these areas of expertise. This tactic helped to add quality to the interview questions and as a result, benefitted a smooth and accurate data gathering process. According to Ogden (2006), "another important item in the pursuit of research reliability is the case study database. Independent of the need for a central repository, the main point here is that every case study project should strive to develop a formal, retrievable database so that in principle, other investigators can review the evidence directly and will not be limited to the written reports. In this manner, the database will increase markedly the reliability of the entire case study" (p. 32). Yin (1994) describes such databases can consist of several components obtained during the case study. For this research, the case study database consists of an oversight of a company background, news articles, e-mail correspondence with participants, interview notes, interview recordings, several documents obtained during and after the interviews, annual reports (where applicable), other results obtained during the case study process and the case study overviews (Appendix III).

4. Results

To provide a broad context for the results discussed in this section, a comprehensive oversight is established. Table 4 displays this oversight of key figures and information for each case study. This information contributes to a better understanding of the results via a broader perspective of the case study's backgrounds. Investigating supply risk management practices in general led to various interesting findings. Not one of the interviewed organizations appeared to have any formalized definition of supply risk and supply risk management. Neither did any of them have a formalized supply risk management department nor supply risk manager positions (Appendix III). These findings may raise questions on the maturity level of supply risk management in practice. Most of the organizations perceive supply risk management as a part of the business that operates at an intersection of their risk management, procurement, supply chain, financial and sometimes other departments. The way in which supply risk management materializes, very much depends on the type of organization. For instance, as CONST argues *"I would recognize supply risk management as a process, but it is not defined as such. It is part of our overall risk management processes*". DIARY states: "*People here are busy with supply risk management, but not always under this name*". These answers fairly represent the perception of the majority of organizations in the sample.

This section exposes the relevant results on the adoption and impact of the various theoretical supply risk management strategies at the inquired organizations. Table 5 gives insight in the adoption of the three general strategies on a high aggregation level. It states the number of organizations that adopt at least a particular number of sub-strategies. Table 6 displays the number and share of organizations adopting each individual sub-strategy. Table 7 displays the adoption of each strategy on organizational level. A distinction is made for different types of organizations as explained in Section 3.2 The contents of these tables will be discussed in detail and provide the backbone of this section.

Table 9: Overview of cases[1] [2]

Category	Case	Industry	Description	Position	Geographical dispersion	Size of supplier base	Managed spend (annual)	Revenue (annual)	FTEs
Production organizations	**AEROS**	Aerospace	Multinational automotive and aerospace components organization – Department responsible for distribution, maintenance repairs and other services	Director Global Procurement	Global	*1.000*	Not shared	11.5 billion EUR	58.000
	ANIML	Animal nutrition	Multinational organization active in animal and aqua nutrition	Group Procurement Director (CPO)	Global	2.500 raw materials, 30.000 indirect	4.8 billion EUR	6.5 billion EUR	11.000
	BREWR	FMCG	Large internationally operating FMCG company active in beer and other beverages – Regional department for a local brewery	Manager Contract Management & Procurement	*Europe*	*2000*	*1 billion EUR*	22 billion EUR	76.000
	DIARY	FMCG	Multinational organization operative in dairy products, ingredients	Director Business Procurement Ingredients	Global	11.000 direct, 20.000 indirect	*1 billion EUR*	12.1 billion EUR	22.000
	FINGR	Chemicals and nutrition	Large multinational organization active in the health, nutrition and chemicals – Food specialties department	Global Purchasing Director, Head of External Manufacturing	Global	*400*	Not shared	8 billion EUR	21.000, 1500 in department
	FRAGR	Fragrances, flavors and cosmetic actives	Large multinational organization production company active in flavors, fragrances for all kinds of products	Global Procurement Director Indirect Materials & Services	Global	*8.000 (indirect procurement)*	*600 million EUR (indirect procurement)*	3 billion EUR	7.000
	OFFIC	Office furniture	Organization active in trade and production of office furniture	Procurement Director	National	1200	120 million EUR	300 million EUR	1.800
	YACHT	Luxury yachts	Manufacturer of exclusive luxury yachts	Head Procurement & Contract Management	Global	1.500	Not shared	Not shared	450
Goods and services providers	**CABLE**	Telecommunications and television	Large international organization active in TV and broadband, providing both goods and services in this market	Director of Procurement Center of Excellence	Global	10.000 - 15.000	6.8 billion EUR	17 billion EUR	47.000
	CONST	Construction	Construction concern active in development and building for living, working, transport and recreation - International department	Global Procurement & Logistics Manager	Global	Unknown	*200-250 million EUR*	7 billion EUR	20.000
	FACIL	Facility services	Internationally operating family business active in facility and employee services and healthcare	Director Procurement	National	60-80	200 million EUR	1 billion EUR	25.000
	REALS	Real estate	Large multinational real estate organizations active in development and services. - Division specialized in global workspace facilities and services	Regional Sourcing Director BeNeFraLux	*Europe*	*15.000 (in the Netherlands)*	*400 million EUR*	11 billion EUR	75.000
	TRAVL	Travel and transport association	Association arranging road assistance, insurances and various travel products	Procurement & Supply Chain Director	National	3.000	700 million EUR	1 billion EUR	3500
Public organizations	**MUNIC**	Municipality	Local government of a large municipality in the Netherlands	Concern Manager Procurement	National	13.000	2.1 billion EUR	5.6 billion EUR (budget)	13.500
	TRNSP	Transportation	Large national public transportation organization in the Netherlands	Manager Procurement Support & Intelligence	National	5.500	1.3 billion EUR	5 billion EUR	34.000

[1] Figures in italics display information of the interviewed department only
[2] All figures that were not available in Euro are converted making use of the exchange rate of 8 June 2018

Table 10: Strategy adoption (aggregated)

General strategy	Sub-strategies adopted	Production organizations	Goods and services providers	Public organizations	Overall
Supply base design	1 or more	100%	100%	50%	93%
	2 or more	88%	100%	0%	80%
	3 or more	88%	80%	0%	73%
	4 or more	75%	80%	0%	67%
	5 or more	50%	20%	0%	33%
	6 or more	0%	20%	0%	7%
	7	0%	0%	0%	0%
Supplier cooperation	1 or more	88%	100%	50%	87%
	2 or more	88%	100%	0%	80%
	3 or more	75%	80%	0%	67%
	4 or more	50%	20%	0%	33%
	5	38%	0%	0%	20%
Supply chain visibility	1 or more	75%	80%	0%	67%
	2 or more	63%	60%	0%	53%
	3 or more	38%	0%	0%	20%
	4	13%	0%	0%	7%

Table 6: Strategy adoption (detailed)

		Production organizations (8)		Goods and services providers (5)		Public sector (2)		Overall (15)	
General strategy	Sub-strategy	Number of organizations	Share	Number of organizations	Share	Number of organizations	Share	Number of organizations	Share
Supply base design strategies	Local sourcing only	1	13%	1	20%	0	0%	2	13%
	Combine global and local sourcing	5	63%	3	60%	0	0%	8	53%
	Dual sourcing	6	75%	3	60%	0	0%	9	60%
	Multiple sourcing	7	88%	4	80%	0	0%	11	73%
	Backup suppliers (only back-up)	4	50%	2	40%	0	0%	6	40%
	Supply base reduction	5	63%	3	60%	0	0%	8	53%
	Dropping of risky suppliers	4	50%	4	80%	1	50%	9	60%
Supplier cooperation strategies	Upstream integration with suppliers operations	5	63%	2	40%	0	0%	7	47%
	Supplier screening, monitoring and (self-) assessment	7	88%	5	100%	1	50%	13	87%
	Supplier relationship management	6	75%	4	80%	0	0%	10	67%
	Early supplier involvement	5	63%	3	60%	0	0%	8	53%
	Strengthen the flow of communication with suppliers	4	50%	1	20%	0	0%	5	33%
Supply chain visibility strategies	Share information with different parties in the supply chain	5	63%	2	40%	0	0%	7	47%
	Share inventory levels with strategic suppliers	4	50%	2	40%	0	0%	6	40%
	Increase traceability in the supply chain	5	63%	3	60%	0	0%	8	53%
	RFID technology	1	13%	0	0%	0	0%	1	7%

Table 7: Strategy adoption per organization

		Production organizations								Goods and services providers					Public organizations			
General strategy	**Sub-strategy / Case code**	**AEROS**	**ANIML**	**BREWR**	**DIARY**	**FINGR**	**FRAGR**	**OFFIC**	**YACHT**	**CONST**	**CABLE**	**FACIL**	**TRAVL**	**REALS**	**MUNIC**	**TRNSP**	**Adopted + Planned/in progress***	**Not Adopted***
Supply base design	Local sourcing only	0	0	X	0	0	0	0	0	0	0	X	0	0	0	0	13%	87%
	Combine global and local sourcing	X	X	0	X	X	X	0	0	X	X	0	0	X	0	0	53%	47%
	Dual sourcing	X	X	X	X	X	X	0	0	0	X	0	X	X	0	0	60%	40%
	Multiple sourcing	X	X	X	X	X	X	0	X	X	X	0	X	X	0	0	73%	27%
	Backup suppliers (only back-up)	X	0	0	X	0	X	0	X	0	X	X	0	NM	0	0	40%	53%
	Supply base reduction	0	X	X	0	X	X	X	0	P/IP	X	X	0	NM	0	0	53%	40%
	Dropping of risky suppliers	X	X	X	0	NM	NM	0	X	X	X	X	0	X	X	0	60%	27%
Supplier cooperation strategies	Upstream integration with suppliers' operations	X	X	X	P/IP	X	0	0	0	0	X	X	0	0	0	0	47%	53%
	Supplier screening, monitoring and (self-) assessment	X	X	X	X	X	X	0	X	X	X	X	X	X	0	X	87%	13%
	Supplier relationship management	NM[3]	X	X	X	X	X	0	X	X	X	0	P/IP	P/IP	0	0	67%	27%
	Early supplier involvement	NM	X	P/IP	X	X	X	0	0	0	X	X	0	X	0	0	53%	40%
	Strengthen the flow of communication with suppliers	0	X	X	0	X	0	0	X	X	0	0	0	0	0	0	33%	67%
Supply chain visibility	Share information with different parties in the supply chain	0	X	P/IP	0	X	X	0	X	X	X	0	0	0	0	0	47%	53%
	Share inventory levels with strategic suppliers	X	X	X	0	0	X	0	NM	0	0	X	X	0	0	0	40%	53%
	Increase traceability in the supply chain	X	X	P/IP	0	0	X	0	X	X	X	X	0	0	0	0	53%	47%
	RFID technology	NM	0	P/IP	0	0	0	0	0	0	0	0	0	0	0	0	7%	87%

X = adopted
0 = not adopted
NM = not mentioned
P/IP: planned/in progress
*In case two percentages do not add up to 100%, this is explained by the strategies that are not mentioned during the interviews (NM)

4.1 Adoption and impact of supply base design strategies

4.1.1 Adoption of supply base design strategies

Regarding the adoption of supply base design strategies, Table 5 and Table 6 show several interesting insights. All of the production organizations adopt at least one supply base design sub-strategy in their supply risk management practice. All of the goods and services providers at least two. Still half of the production organizations adopt at least five strategies, indicating their popularity in this category. This finding is in slight contrast with goods and services providers, as there only 20 percent adopts five or more strategies. Public organizations are found to adopt by far the least supply base design strategies.

Only one organization limits its sourcing options to local suppliers (BREWR). Contrarily, combining local and global sourcing is a somewhat popular strategy, adopted by the majority of private organizations. CONST phrases the benefits of this hybrid strategy as: "*global sourcing is something we are very active in and within CONST will only grow. Local sourcing we also do a lot, as we often operate in countries far away. Local sourcing can be very beneficial there. You need to keep the local suppliers as a friend is my experience. Combining local and global sourcing is best"*. TRNSP explains the absence of a geographical sourcing strategy in the public sector "*as we are subject to European tender law, we cannot discriminate suppliers based on geographical location."*

Dual sourcing and multiple sourcing are also adding substantially to the high adoption rates in the private sector (Table 6). Several explanations are observed. For instance, FINGR sees "*strong benefits of dual (or multi) sourcing over single sourcing in terms of potential risk reduction as some of our required materials are unique, and the number of suppliers is very limited.*" ANIML adopts multiple sourcing as "*from a risk management perspective, it is most convenient to have a commoditized product, and you have multiple sourcing. If we have multiple options, it is per definition the case we spread production.*" In some cases, multiple sourcing is explicitly preferred over dual sourcing. At BREWR: "*dual sourcing can be fine, but we strive to have more suppliers per supply item.*". In the case of FACIL, dual sourcing is a conscious choice: "*for strategic products and services we work with dual sourcing in supply. This is not because of the limited availability but because of our own wishes.*"

The establishment of backup suppliers can be interpreted as both complementary as well as a substitute for dual or multiple sourcing. Several organizations indicate this is an active strategy they adopt (YACHT, FRAGR, AEROS, CABLE, DIARY, FACIL). Others see this

not working well (ANIML, BREWR). They argue suppliers one wants to be able to rely on, need to be incorporated in the business. ANIML: "*in my experience, backup suppliers do not work. You cannot only call them in case something happens while never doing business. You have to buy something every now and then to maintain the relationship. You cannot expect that someone you never do business with helps you immediately when you have a problem. They have their customer preferences*."

Supply base reduction seems an attractive supply risk management strategy (Table 6). At AEROS, however, supply base reduction is not possible as the organization depends on suppliers providing essential but very specific products that cannot be sourced alternatively. Contrarily, FINGR "*is eager about building strong relations with our suppliers, but is also well aware this is not possible with a supply base of four hundred. Therefore we combine this* (supplier) *cooperation strategy with supply base reduction*." The statement by FINGR is exemplary for the most organizations adopting supply base reduction; it is a challenge to keep control and anticipate risk when having a very long tail of low spend but very diversified suppliers. Also at ANIML in the tail end "*there's a low share of our spend, but a lot of diversity and a lot of suppliers causing a lack of control. That is a big challenge. I have no clear view on these suppliers. It can be a very small company only making a single product for us but potentially works in a way that can bring us a huge exposure. Therefore, for these categories supply base reduction is important.*"

The last supply risk management strategy in this category is the dropping of risky suppliers. It often relates to the strategy of supplier screening, monitoring and (self-) assessment as the dropping of risky suppliers can be one of its consequences. BREWR describes this as: "*for supplier and quality risks we have a worldwide audit program defined globally, implemented locally stating the requirements for suppliers. We run the audit, if something is not aligned with the requirements, they get a grace period of three months to solve the issue. If not, they are disqualified and we stop buying at them. This is a standard procedure*". The impact of this strategy is questioned, as generally suppliers cannot be easily dropped without harming the own business continuity. Rather than dropping suppliers, some organizations are found to adopt strategies to help develop such insufficiently operating or risky suppliers (ANIML, DIARY, BREWR).

4.1.2 Impact of supply base design strategies

Where the previous section elaborated on the extent of adoption of supply base design strategies, this section addresses their impact. A notable finding from this exercise is that all sources providing support for the positive impact of supply base design strategies on supply risk reduction, are production organizations. Among goods and services providers, no evidence is found that leads to more insight on the impact of supply base design strategies on supply risk. More organizations provide evidence on the adoption rather than on the impact of supply base design strategies.

For BREWR, the impact of supply base design on supply risk materializes via creating and maintaining multiple sourcing possibilities. As the "*capacity risk at our suppliers is a daily practice*" especially with BREWRs high quality requirements. BREW explains its management of capacity and other single source risks as follows: *"for instance in de carton market, there are maybe twenty major players. But the ones meeting our requirements, are only three. One of them is very flexible, but its quality is okay. The other has very high quality but is not flexible at all. The third one is small and has a bit of both. That one is nice to have in case something happens to one of the two large firms."* Furthermore, BREW has a supplier development practice, similar to ANIML and DIARY which enables them to impact supply risk via supporting and (re)designing operations of their risky supply base. For instance via the creation of extra production lines or facilities (DIARY). ANIML explains: *"problems occurred at a very strategic supplier and we sent our own improvement team to help improving. We had two parties in China, and we sent our Supplier Development team, and we also have a quality manager in China directly reporting to the quality manager in the Netherlands. They cooperated to implement the improvement plan together with the supplier."* In essence, also YACHT is active in maintaining and developing its supply base design from a risk perspective as *"if a supplier constantly does not meet our agreements, he goes out. If he has financial problems, we ask him "how much do we owe you, if we pay you this, are you able to repair your damage?", if so, there's a chance we are willing to help. But if he does not perform, he goes out. But in this way we've helped suppliers and prevented risks in the past."*

Supply base reduction and alternative sourcing is another recurring strategy beneficially impacting supply risk. Here, OFFIC notices that *"I think we can easily reduce our supply base from 1200 to 3-400 and start outsourcing a lot more. One specific screw is purchased at one supplier, we need parties that take care of this. The whole long tail of suppliers disturbs our*

processes, outsourcing this creates more focus and reduces risk". In this line of thought, ANIML sees slimming down its supply base also as negatively impacting its supply risk, mainly at indirect goods: "*here's a low share of our spend, but a lot of diversity and a lot of suppliers causing a lack of control. That's a big challenge. I have no sight on these suppliers. It can be a very small company only making a single product for us but potentially works in a way that can bring us huge exposure."*

4.2 Adoption and impact of supplier cooperation strategies

4.2.1 Adoption of supplier cooperation strategies

Table 5 provides several interesting insights on the adoption of supplier cooperation strategies. All goods and services providers adopt at least two supplier cooperation strategies (Table 5) compared to 88 percent of the production organizations. The latter category, however, adopts most strategies, as still half of them adopt at least four strategies, compared to one-fifth of the goods and services providers. 38 percent of the production organizations adopt all the investigated strategies. As with supply base design, again the public sector scores very low these strategies. Only one strategy is adopted by one organization. The remainder of this section elaborates on the individual strategies and provides more details to these findings.

Some difference is found in the degree of upstream integration with suppliers operations between production organizations and goods and services providers. For instance CABLE "*does invest in some suppliers, actually, it's an active integration as we acquire some suppliers. What we do a lot is developing products together; bespoke products to our organization. Also, business process outsourcing could be seen as upstream integration.*" At several production organizations, upstream integration is on the management's agenda and is currently under development. BREWR expects to benefit from a new initiative: "*we definitely integrate and collaborate upstream with suppliers. Past two, three years we ran a program called 'Supplier Collaboration'. Together with our top-15 critical suppliers, we identify the effects of BREWRs demand on their supply chains and how we can better align operations. This also includes risk mitigation.*"

Prerequisite for this collaboration or integration often is a structured and adequate supplier screening, monitoring and/or (self-) assessment. This is found to be an active supply risk management strategy in all organizations except OFFIC and MUNIC. OFFIC relates the

absence of a structured assessment program to the fact that "*procurement and supply risk management in our organization and industry are very immature*". The depth of supplier analysis adopting this strategy comprises various methods and processes. In all cases, it entails at least a financial check and the signing of a supplier code of conduct. FINGR sees the benefits: "*assessment of the financial situation of suppliers works well in preventing for potential supply risk*". Some organizations do these assessments themselves, others work with external auditors. For instance, FACIL explains: "*suppliers are sometimes checked via independent external bureaus on financial health. Compliance with local and international law and regulations is tested via tender rating, in conversations and in formal annual accordance*." CONST underscores the importance of doing these checks upfront: "*as we work on very specific projects with specific products we have to assess our suppliers before we start working with them. We cannot easily switch our supply to another supplier in case something goes wrong or he goes bankrupt. Therefore the assessment in advance is a very important strategy*."

Besides screenings and assessments prior to cooperation with suppliers, monitoring during the contract period is also found an active and effective strategy. Some do this with a set frequency, others conduct random checks. DIARY conducts both: "*upfront an external party conducts a screening, and suppliers sign our code of conduct etcetera. During agreements, random checks are executed.*" Some organizations (DIARY, BREWR, CABLE, REALS) also assess potential supplier dependency, in order to prevent suppliers from becoming too much dependent on them. REALS describes this as follows: "*we assess our share in the supplier's revenue to make sure we are not too large because then a supplier becomes too dependent and if our work with them is over they might get into trouble. Our client can become too powerful compared to their suppliers.*"

A clear connection between supplier screening, monitoring and assessment and supplier relationship management as supply risk management strategies is observed. Sufficient screening is often seen as prerequisite for a beneficial relationship with suppliers. This holds for most organizations. CONST: "*whether this* (supplier) *assessment is done by CONST or a local audit company, depends on the importance of the delivery. Most of the times we send our own people anyway. Plus, if you're working with firms in the far east, you face cultural differences and the importance of building relationships. If you go their yourselves, you show your face and automatically work on your relations. This can ease things out in the consecutive phases a lot*". Another relation is found between supplier relationship management and the strategy of early supplier involvement. YACHT: "*I'd rather know something is going to be late*

in an early stage than a supplier not telling us this. This has to do with your relationship management, how you treat your suppliers. They have to be comfortable to report issues in an early stage, as this benefits everybody." For REALS, early supplier involvement is not even a choice, it is integral part of their business. REALS: "*Early supplier involvement is something we always do. They have to be aboard and checked before we bring out a quote to our clients…….REALS' employees cannot interact with suppliers that are not in the* (supplier) *system.*"

4.2.2 Impact of supplier cooperation strategies

This section discusses the various ways in which organizations see supplier cooperation strategies impacting supply risk. Supplier cooperation strategies are supported to negatively impact supply risk via several routes on which this section elaborates.

In the highly critical aircraft industry, AEROS successfully manages to cover its financial supply risk by signing back-to-back cooperative contracts and other deals with original equipment manufacturers (OEMs) who often have a strong monopoly position (AEROS). Via this form AEROS hedges against unexpected supply price increases by OEMs, which sometimes occur. FACIL sees the impact of strong contract management and supplier relationship management on supply risk. FACIL: "*since we have decent contract management, we see a lot of benefits and build relationships with suppliers. In the past, after the payment of an invoice we were handed over to God's mercy.*"

CONST and FRAGR show strong support for the impact of supplier communication and cooperation via supplier relationship management. CONST operates much in Asian markets where communication with suppliers is vital: *"knowing each other and knowing what you can expect from each other, trying to decrease the language and cultural barriers and explaining things, eliminates a very large source of risk* (...) *I have an experience where something went wrong in the production process with severe implications due to bad communication. At that point, there was only one thing I could do: grab a flight and go there immediately. Making sure people started talking to each other again, having dinner together and aligning opinions. Making sure people trust each other. This ensures you the highest possibility your product is good and delivered on time. I experienced this a lot and it helped* ." FRAGR deals with the risk of "*single sourcing of very specific raw materials of which the harvest can fail*". Here, "*relationship management is one of the most important factors. As a*

harvest in a certain market is failing, we make sure we still get the best a supplier can produce as we make sure we are preferred. We achieve this via a strong relationship" (FRAGR).

Regarding supplier screening, monitoring and (self-) assessment, here FINGR sees perks. After suppliers conduct a self-assessment and sign the supplier code of conduct, they are audited "*to verify the received results about their sustainability level, treatment of people and environmental footprint"*. It is stated that this helps them mitigating two risks: "*on the one hand, FINGR as a company does not want to work with parties that do not meet sustainability requirements for ethical purposes. This can lead to for instance reputational damage. On the other hand, considering, for instance, the Blue Sky program in China, these suppliers have a serious risk of their operations being shut down by the government because they do not meet sustainability requirements. This can cause scarcity and unavailability of products. Which with this strategy we prevent ourselves for.*"

4.3 Adoption and impact of supply chain visibility strategies

4.3.1 Adoption of supply chain visibility strategies

The third and last general strategy that is investigated, addresses five strategies to manage supply risks via increased supply chain visibility. Table 5 shows that supply chain visibility strategies are less adopted than supply base design and supplier cooperation. 75 percent of production organizations adopt at least one sub-strategy against 80 percent of goods and services providers. This number drops substantially when the number of adopted strategies increase. Especially at the goods and services providers. There, no organizations are present that adopt more than two supply chain visibility strategies.

The first sub-strategy in this field of interest is sharing information with different parties in the supply chain. At AEROS, this is considered crucial. Information on products' progress and whereabouts is shared across their supply chain in order to create visibility in the availability of components. This is an active strategy as aircrafts cannot wait long to be repaired, and giving insight in lead times allow AEROS to anticipate potential risks and timely search for alternatives. This visibility is very important as in the case of an air crash, the source of the problem can be traced back more easily. Also for CONST such findings are noticed. "*Supply chain visibility is very important for us, for our major materials. If we buy a steel construction, we know from day to day what its status is because we control it, send someone*

and know the details. We know when it leaves, we have a quality inspector there who will be present at the loading and unloading, we monitor this very strictly. Because of planning, but also because of damage and quality."

Apart from the strategy of sharing information with suppliers which is rather generic, sharing specific inventory levels appeared to be an important strategy in some cases as well. However, according to BREWR its benefits are sometimes hard to pursue, in case the supplier is a powerful player in the market: "*one of my contract management strategies involves making sure to know your suppliers. This gives us the power and visibility to perform optimally in all circumstances. This also means knowing the supply chain, knowing where stocks are kept etcetera. The bottleneck for this, however, is trust in information sharing. If a supplier is larger than us, we cannot enforce anything*". For FRAGRs, inventory sharing is currently in development: "*currently we are busy with our suppliers to allow them insight in our consignment stocks. In that way, they have insight in our needs and inventories and then they are responsible for this stock being in the right place at the right time.*" ANIML takes it even a level higher, by allowing some suppliers to manage their inventory: "*we do vendor management inventory. In some cases, we have inventory that is managed and replenished by the supplier. With a number of strategic suppliers we have fully integrated the ordering and invoicing processes.*"

A majority of the non-public sector organizations adopts strategies to increase traceability in the supply chain, but at only two of them this involves (pilots with) RFID technology (BREWR, FACIL). Especially RFID appears to be not a very popular strategy, but its expectations are quite high as BREWR phrases it: "*We started asking suppliers to share stock levels, levels of products in the supply chain. This is all done very straightforward and can be done much more advanced with blockchain and RFID etcetera. We currently run trials with this, but it is not yet an active strategy*". Or as YACHT stated: "*I'm a great fan of RFID, but it can be complicated as components with RFID cannot be processed in a yacht.*" Apart from RFID, several other strategies to increase traceability and visibility in the supply chain are adopted to impact supply risk. At AEROS, supply chain visibility and traceability are very important risk mitigation strategies. Every adjustment, repair or other adaption to an aircraft or component is documented in every detail. Every product is completely traceable along the supply chain to ensure that in case of an air crash, the source of the problem can be traced down to manufacturer, service provider or any other possible stakeholder. DIARY sees the impact and importance of traceability rising: "*we are an organization we call 'from grass to glass',*

we have the full supply chain in-house. We very clearly know our supply chain. Of course we do buy raw materials from other supply chains, but many of that are also under our management. This means the necessity and urgency for this topic (supply chain visibility) has not been high, but now is picking up because of consumers becoming more and more demanding regarding product origin and visibility." Although at DIARY, increased visibility appears to be consumer driven, at FRAGR it is part of the industry standard to ensure sustainable supply of product: "*Traceability in the supply chain for us is evident. This has to do with the country of origin, especially in the flavors industry. This supply chain must be visible*".

4.3.2 Impact of supply chain visibility strategies

Investigating the impact of supply chain visibility as a strategy, as it is less adopted, also less support is obtained for its impact on supply risk. However, some interesting insights are found which are discussed in the following paragraphs.

Contrarily to the substantial number of organizations stating they share information with their suppliers to increase supply chain visibility, not many can provide support on the impact on supply risk. OFFIC is one of the few that explains why they do not see the benefits of sharing information with suppliers to increase supply chain visibility. OFFIC indicates in their industry organizations are averse to sharing such information due to previous bad experiences with suppliers. OFFIC: *"relatively few information is shared with suppliers. We have a handful of strategic suppliers with whom we share more and more information. But there's a lot of suspicion in our industry. Everybody has set up everybody at least once in the past."* Furthermore, also on the sharing of inventory levels, not much evidence is found.

Other strategies to increase supply chain visibility show stronger support. An interesting finding is that several organizations indicate to pursue better visibility in the supply chain for corporate social responsibility and sustainability (CSR) purposes (FINGR, FACIL, YACHT). Here, for instance FACIL sees the benefits of increasing visibility on the origin of one of their products, in case conducted via a physical check. FACIL: "*for the case of clothing, which is very important for us, we even sent a colleague to India to personally check the working conditions together with our CSR manager. This helped a lot."* Also YACHT does such checks. YACHT: "regarding critical materials from a CSR perspective, we sometimes visit production sites in critical countries to asses if everything is compliant with our and

standards and legislation. Some of our customers are very concerned on this topic, and will not allow any issues in this matter. Going there ourselves and seeing it with our own eyes then is the only option, and it works".

To increase traceability and visibility in their supply chain, ANIML has "*implemented a system linked to our ERP system to visualize the supply chain from our suppliers to us and from us to our customers on a minute level. We suffered from strikes in China. My first question was, how many containers do we have there, and are we exposed? Do we have to account for delays to our factories? That question I was able to answer within a minute. We can plot this, and see where our containers are. That we have very clearly visible.*" This example demonstrates the impact their system to increase supply chain visibility has on quickly acting in the case of adverse supply events.

4.4 Management support as enabler

In essence, the adoption of supply risk management strategies always seems a consequence of at least some form of management support for supply risk management. Without support from top management, actions to improve or concretize supply risk management initiatives cannot materialize, for instance as financial resources have to be made available. A vast majority of the organizations in the sample provide support for the enabling role of management support which is discussed in detail in the remainder of this section.

A common finding from the cross-case analysis was the absence of any formalized definitions of supply risk and supply risk management. However, this did not seem to be an indicator of the absence of supply risk management. Moreover, supply risk management is often considered to be a vital part of operations that it is intertwined with all kinds of departments and organizational activities. For instance at BREWR is stated: "*I don't think supply risk management as a separate topic is explicitly mentioned on the board's agenda, but the operations of the breweries are always the focal issue. In this, supply risk management gets a lot of attention, driven by the different parts of our procurement organization and therefore is also driven by the board.*" Regarding this mix of departments, REALS states: "*there's a risk measurement committee that consists of procurement, the business, legal, finance and what's needed depending on the risk. They review the high-risk suppliers and decide on the actions that need to be taken depending on where the risk lies. It's an operational group in charge of*

what is the nature of the risk, what are potentially the consequences and what actions do we need to do with this specific supplier?"

The extent to which top-level management is aware of supply risk (management) varies substantially between the organizations under study and depends on several factors. An effective supply risk management practice turned out to be inherent to management support for supply risk management. Organizations with a self-declared lack of structural approaches and future vision in supply risk management are OFFIC and TRAVL. For instance, OFFIC states that its procurement practice "*does not receive the attention it should receive within this organization*" and "*is very immature*". This could be seen as an explanation for the fact only two of the 17 strategies are present.

Several organizations indicate management support is enabling their supply risk management impact. For instance at REALS: "*Clients choose for our business because they know we can deliver a guarantee on security at suppliers, due to our* (supplier) *system. It is enclosed in our company statement that in this way we pursue the protection of our brand. This is also because we're a technical firm and cannot permit ourselves any mistakes. Our accident rate is very low, all these things result from decent risk management. This includes not working with suppliers who mess around.*". Here, it concerns technical goods and service provider that is required to eliminate all potential chance of accidents and malfunctioning. A similar result is found at AEROS, which operates in the highly regulated aerospace industry, as aircrafts and components are subject to very high safety standard assessments, rules, audits and checks. AEROS has a comprehensive risk department and an airworthiness team, but (supply) risk management is always to some extent present in every team, decision and part of the organization. Furthermore, some organizations indicate that supply risk management or at least some elements are present in their enterprise risk management strategy (ANIML, CABLE, CONST).

Some organizations' management receives updates on supply risks, such as CONST and FRAGR: "*Management is continuously updated on the progress of projects and corresponding risk analyses. Supply risk analysis is a very important part of our project reports and these report are frequently sent to the highest level in our organization*". At FRAGR it depends on the procurement categories as "*top management is informed swiftly about certain supply risks, especially in the case of their critical raw materials. For direct procurement, management support seems to have a stronger enabling effect than for indirect procurement*

as the interviewee states: "in indirect procurement, we are lagging behind a couple of years." At REALS, the management is not per definition informed on supply risk management, but it does receive its support as "*the preferred supplier events are procurement driven but heavily supported by the top management of our organization because it works.*"

In his executive position as a CFO, the respondent at ANIML can assess both the enabling effect of management support for supply risk management as well as supply risk management itself. He has the experience of implementing risk management initiatives and could see how the organization responded. ANIML: "*one of the things we do, is indicating risks at a category level, what are the possibilities and impossibilities per spend category. First people thought this was very bureaucratic, as they thought they knew how things work, in their heads, so I do not have to write it down. Until the moment you do write it down, they see how things can do differently than expected. That is, when discussing risk management, per definition is an integral component of our sourcing plan*." and "*we are currently implementing a project called Master Data Management with which we structure data for all items and suppliers for worldwide access. In the beginning, people find this a very unattractive design, but if you do not have this in place, you can forget about the rest. This is our first priority.*". In other words, from his management position, he can see the direct consequences of (supply) risk management initiatives in terms of how the organization deals with it.

4.5 Supply chain complexity as moderator

For the moderating effect of supply chain complexity, little evidence is found. Most of the organizations indicate supply chain complexity does not affect the impact of adopted supply risk management strategies. The motivations that lay behind these findings vary substantially and is further discussed in this section.

The majority of organizations does not see the complexity of their supply chain changing. DIARY: "*I think new technology solves current complexity, but new technology also brings new complexity. This makes me believe that as a result, it remains the same.*". A similar result is found at FRAGR, with the note that this regards indirect procurement, but a similar absence of this effect is expected for direct procurement: "*for indirect procurement, I don't see the complexity changing a lot, apart from consolidation in the logistical sector. I would say it's pretty stable.*" Moreover, FINGR also provides evidence for the above statement: "*the complexity has not per se changed, but our knowledge and insights into all possibilities and*

different tollers has increased. That is the question. Because we know work in a newly established tolling department, it received a lot more attention, and we are more aware of what is possible and happening." Lastly, CONST states market conditions can become more complex but this does not have to affect the impact of risk management: "*requirements of our clients become harder, competition is increasing, but I do not see the complexity increasing risk or making risk management harder to execute.*"

An interesting result emerges from the comparison between FINGR and FRAGR, who are operating in similar industries. Here, FINGR indicates supply chain complexity affects the impact of supply chain visibility: "*a high supply chain complexity influences the effect of supply chain visibility. In a complex supply base consisting of a lot of low spends, high importance suppliers, leverage on these suppliers is low. This impacts the level of visibility these suppliers allow you to have. The longer the tail end with bottleneck suppliers, the higher the complexity of the supply chain and therefore the more risks.*" On the contrary, FRAGR states supply chain complexity impacts their supply base and sourcing possibilities: "*the complexity of regional regulations and quality standards enforce us to adapt parts of our product portfolio sourcing to a regional or local level, whereas for the bulk goods we see that large figures enable us to purchase on a global scale.*"

REALS also indicates supply chain complexity influences the impact of supply base design strategies. A key difference is that not increased, but decreased complexity influences the impact of sourcing strategies: "*lately we see a lot of consolidation in the market. Normally we spread our risk by sourcing from multiple suppliers, but when firms are acquiring each other this gets harder.*" TRAVL sees complexity in connection with supply chain transparency as "*complexity decreases as transparency increases, this makes it easier to manage risks. However, data usage and data risks can complicate matters.*" Apart from these indications of complexity in the market and supplier base, YACHT also sees its products and materials becoming more complex: "*because the boats are becoming more complex, and materials become more innovative, the risks are increasing considerably. It's becoming very complicated and this affects your operations.*"

5. Discussion

This research starts off with the main question '*what are the most important theoretical supply risk management strategies and how do these theoretical supply risk management strategies impact supply risk in practice?*'. This section discusses how the outcomes of this qualitative research enable the assessment of theoretical supply risk management strategies' adoption and impact in practice. The structure of this section is similar to the development of literature (Section 2.2) and the research results (Section 4). Section 2.2 addresses the most important supply risk management strategies and their impact on supply risk in theory by providing answers to RQ1 and RQ2. Table 3 provides the list of strategies that form the summarized answer on RQ1 ('*What are the most important supply risk management strategies in academic theory*'. This list provides structure in the answer on RQ2 ('*What is the impact of the most important supply risk management strategies in academic theory on supply risk in theory?')* which is provided throughout the course of Section 2.2.

In Section 4, new insights emerge in search for an answer to RQ3 **(**'*To what extent are the most important supply risk management strategies in academic theory adopted in practice?')* and RQ4 ("*What is the impact of the most important supply risk management strategies in scientific research on supply risk in practice?*'). Again, the list of strategies (Table 3) forms the backbone in the pursuit of gathering targeted and detailed case study input. The remainder of this section discusses the results from literature and practice in the search for additions, confirmations and contradictions to SCRM theory. This discussion follows the structure of the conceptual model and critically reviews the impact of the individual constructs as well as their interrelations. This section is concluded by reflecting on the hypotheses and providing the revised conceptual model based on the obtained findings.

5.1 Supply base design strategies

Starting with supply base design strategies, many more organizations were able to provide evidence on the adoption rather than the impact of supply base designs strategies (Table 5). Only production organizations were able to provide more insight on both adoption and impact. This category also shows higher adoption rates than goods and services providers. This could be explained by the indicated low maturity level of supply risk management at several of the investigated organizations. This low maturity decreases their ability to reflect on the impact of

specific strategies, as they might be recently adopted or still in development (Pfohl, Köhler, & Thomas, 2010).

Some sub-strategies appeared to be more popular in terms of adoption rates than others. The hybrid local and global sourcing strategy as for instance discussed in Autry and Sanders (2009), is often observed. These authors stress the benefits of a combined sourcing strategy, which is substantially reflected in the empirical findings (Table 6). Also, strong support on dual and multiple sourcing is observed, showing an expected correspondence with academic literature (e.g. Manuj and Mentzer, 2008; Fang *et al*., 2013; Ho *et al*., 2015). These findings reflect a trend of globalization in many organizational processes and business in general (Manning, Larsen, & Kannothra, 2018).

The strategies of backup suppliers, supply base reduction and dropping of risky suppliers, are found to be correlated. This relation is already announced in literature as reducing the supplier base can be both the consequence as well as a motivation for dropping of risky suppliers (Zsidisin *et al*., 2004). Investigating this in practice leads to new insights as various organizations rather help to develop risky or bottleneck suppliers instead of dropping them (ANIML, DIARY, BREWR). This seems to only hold for production organizations, as they often deal with strict requirements for their raw materials. Critical raw materials are often very scarcely available which increases the dependency on specific suppliers (Caniels & Gelderman, 2005). Also, with the current know-how and resources of these large organizations, it is often easier and more convenient to develop quality problems at suppliers rather than dropping them. In this trend of prevailing supplier development, another novel insight is observed. Whereas literature (e.g. Tang 2006; Fang *et al*., 2013) provides clear reasoning for the benefits of backup suppliers, in practice organizations do not see this a useful strategy straightforwardly (ANIML, BREWR). These organizations argue that maintaining suppliers solely as a back-up does not work. If suppliers are only considered as backup possibility, organizations do not build a relationship with them and cannot rely on their help and flexibility when required (ANIML). Therefore, BREWR keeps its suppliers nearby by always allocating them a small part of the total supply. Here, a the link between supply base design and supplier cooperation is exposed as these sourcing strategies enhance relationships with suppliers (Wagner, 2011). More awareness of such relationships between strategies could benefit organizations in advancing their supply risk management. In this mater, ANIML, DIARY and BREWR prove to be valuable examples.

Another contribution to the literature, is that supply base design strategies are rarely adopted in the public sector. Therefore, public sector organizations are in most cases deliberately left out of scope in the discussion of strategy adoption and impact. These findings affect the value of the results as public and private sourcing often differ too much to draw unambiguous conclusions (Stentoft Arlbjørn & Vagn Freytag, 2012). TRANSP indicated tender legislation restricts their liberty of having sourcing preferences based on geographic location. This seems a rather doubtful result, as the European Union guarantees free movement of goods and services in its member countries. The relative unimportance of supply risk management in the public organizations could be an alternative explanation, reducing the interviewee's ability to provide an alternative explanation

5.2 Supplier cooperation strategies

The adoption and impact of supplier cooperation strategies provide several interesting insights. For both production organizations and goods and services providers, rather high strategy adoption rates are found, with a slightly higher outcome for goods and services providers (Table 5). The difference is explained by the low maturity of supply risk management at one of the production organizations and therefore does not provide evidence for firm conclusions (OFFIC). In general, evidence shows that strong cooperation with suppliers is considered very important, often crucial for successful supply risk management and business in general which helps explaining the high adoption rates. This result significantly adds to the limited existing literature on the benefits of supplier cooperation in supply risk management (Terpend & Krause, 2015). A recurrent finding is the poor strategy adoption rate at public organizations: only one supplier cooperation strategy is adopted at one organization. This result appears to be novel, as the studied literature does not explicitly differentiate between public and private organizations in the adoption and impact of supply risk management strategies. However, as stated before, the small number of public organizations in the sample requires precaution in making inferences.

The high adoption rates and impact of supplier screening, monitoring and (self-) assessment methods, leave less space for debate. Both literature (Tang, 2006; Autry & Sanders, 2009; Chen *et al*., 2013) as well as a convincing majority of the organizations (Table 6), adopt such strategies. Here, the deviant case occurs of a public sector organization adopting this strategy as well (TRNSP). This can be explained by the fact that TRNSP is responsible for a

significant share of public transportation in the Netherlands, submitting them to strict safety requirements and regulations. This supports the idea that organizations working with critical products and materials more often adopt supply risk management strategies (Zsidisin *et al*., 2004).

In addition to the previous strategy, supplier relationship management is a very useful strategy in both theory and practice. Faisal *et al*. (2006) and Ritchie and Brindley (2007) stress the importance of maintaining strong relationships with suppliers for successful SCRM. The majority of both production organizations, as well as goods and services providers, support this finding. Furthermore, Tang's (1999) four supplier relationship types based on Kraljic (1983), shows overlap with findings in practice. BREWR, FINGR and ANIML are examples of organizations adopting supplier relationship management that clearly adjust the amount of effort invested in supplier relations based on their strategic importance. Regarding supplier relationship management, the remark must be made that it a broadly defined strategy, allowing for the inclusion of a wide array of methods and practices. This could be an alternative explanation for the relatively high strategy adoption rates (Table 6).

The importance literature attributes to the impact of strong supplier communication (Giunipero & Eltantawy, 2004; Khan *et al*., 2009) is limitedly supported by empirical results. Half of the production organizations and only one of the goods and services providers indicate the adoption of this strategy. This overall result seems rather remarkable. One would expect the global scale of operations of most organizations to increase the importance of good communication. These findings indicate that here, organizations can improve and reap the benefits following the example of CONST and YACHT. CONST and YACHT put great emphasis on the importance of strengthened supplier communication and see its impact.

5.3 Supply chain visibility

Compared to supply base design strategies and supplier cooperation strategies, supply chain visibility strategies show lower, but still rather high, adoption rates. Logically, also less evidence for their impact is observed (Table 5, Table 6). The limited discussion on supply chain visibility strategies corresponds between literature and practice. Not much research has been conducted on these topics yet. A critical discussion on several novel results is outlined in the remainder of this section.

Several figures in Table 6 raise interest. Supply chain visibility strategies show the lowest adoption rates. Especially the zero percent for the public sector organizations requires further explanation. These findings fit into the broader perception that "public procurement professionals have narrow perspectives on supply chain management compared to their private sector counterparts; and public sector professionals have different perceptions regarding the importance of topics, tools and techniques to support their performance on the job" (Larson, 2009, p. 222). These are interesting attributions to the current state of SCRM literature, as not many empirical studies on supply risk management strategies are conducted that account for public sector organizations.

Production organizations and goods and services providers show some more compelling results. Literature studies lead to believe such strategies are useful in supply risk management (Zsidisin & Ellram, 2003, Faisal *et al.* 2006; Wiengarten *et al.* 2016). Some empirical findings underscore the shared argument of the scholars in this field of research. For instance at AEROS, information sharing and transparency across the supply chain is as product quality and lead times are highly critical in the aircraft business. ANIML even has full transparency and automated ordering and invoicing with some strategic suppliers who are authorized to manage and replenish parts of ANIMLs inventory. Also, other production organizations share inventory information with suppliers (BREWR, FRAGR). This trend is explained by the fact vendor managed inventory or sharing inventory levels has perks for organizations working with perishable goods (ANIML, BREWR, FRAGR) as is explained by Yu, Wang and Liang (2012). Organizations working with non-perishable products have less

Literature findings on supply chain traceability are scarce compared to the evidence that is found in practice. Looking at the arguments for more traceability leads to some interesting novelties fitting global trends of consumer awareness and increasing sustainability requirements (Winter & Knemeyer, 2013). These trends are reflected in several organizations' supply risk management (DIARY, BREWR, FACIL, FINGR, TRAVL). Enhanced supply chain visibility helps them in the elimination to of unreliable product sources and bring undesirable practices light. Here RFID technology can play an important role. According to Choi (2011), RFID technology could be a beneficial tool in the reduction of supply risk. In practice, organizations indicate they are not yet ready to implement RFID technology to better manage supply risk (YACHT). There are some organizations running trials with RFID or similar technology who expect it to become more impactful in the future (BREWR, FACIL). A justification for the low support could be the high costs of implementation of such technology

(Sarac, Absi & Dauzère-Pérès, 2010). Here, growing demand for sustainable supply chain operations could fasten these developments (Winter & Knemeyer, 2013). These findings help explain the discrepancy between adoption and impact of supply chain visibility strategies. From a sustainability perspective, it makes sense to indicate supply chain visibility is receiving attention in the organization (Closs, Speier & Meacham, 2011). However, the ability to reflect on the impact of supply chain visibility strategies is less present, suggesting that a sustainable image is prevailed over actual sustainable business.

5.4 Management support as enabler

In Section 2.2.6, a broad literature study stresses the consensus the enabling role of management support for supply risk management (e.g. Zsidisin, 2000; Jüttner, 2005; Autry & Bobbitt, 2008; Autry & Sanders, 2009; Pfohl *et al.* 2010). The empirical results in Section 4.4 gives reason to believe this holds true in practice as well Despite the absence of formalized definitions of supply risk and supply risk management within the questioned organizations, the majority of organizations provide evidence for its enabling role. It can, however, be questioned whether this is a very revealing result. One could speculate to what extent the organizations' representatives, if they are not part of top management themselves, are outspoken about this support if it was absent. The enabling effect of management support is rather straightforwardly defendable as many arguments can be raised to support this finding. Making resources available, placing supply risk management strategy on the agenda, reporting about supply risks at board level; several indicators for management support are imaginable. However, OFFIC supports the opposite by clearly indicating management lacks support for supply risk management. Similar results hold for TRAVL. In other cases, for instance, FACIL, the researcher had to be more pervasive to obtain candid results.

In essence, the adoption of supply risk management strategies always seems a consequence of at least some form of management support for supply risk management. Without support from top management, actions to improve or concretize supply risk management initiatives cannot materialize, as for instance financial resources have to be made available. This makes the enabling effect both convenient to defend as well as difficult to prove. All in all, the pervasiveness in literature, as well as the unity in empirical results regarding management support for supply risk management, lead to confidence in this conclusion.

5.5 Supply chain complexity as moderator

The expected moderating effect of supply chain complexity on the impact of the three general supply risk management strategies is not convincing. In literature, general agreement exists on the increasing supply chain complexity and its repercussions on the success and impact of supply risk management strategies (Choi & Krause,2006; Craighead *et al.*, 2007; Manuj & Mentzer, 2008). However, when investigating this in practice, contrasting perceptions are observed. Some organizations do not see supply chain complexity changing and therefore are not in the ability to reflect on its potential moderating role (e.g. DIARY, FRAGR). Others experience increased supply chain complexity but do not see it affecting the impact of supply risk management (CONST). One of the few organizations that do see a relation between supply chain complexity and the impact of supply chain visibility, is FINGR. This has to do with FINGRs interpretation of supply chain complexity: a supply base with many low spends, high importance suppliers. Here, low leverage on these suppliers causes low visibility. A solution to this problem could be reducing the supply base and therefore reducing supply chain complexity.

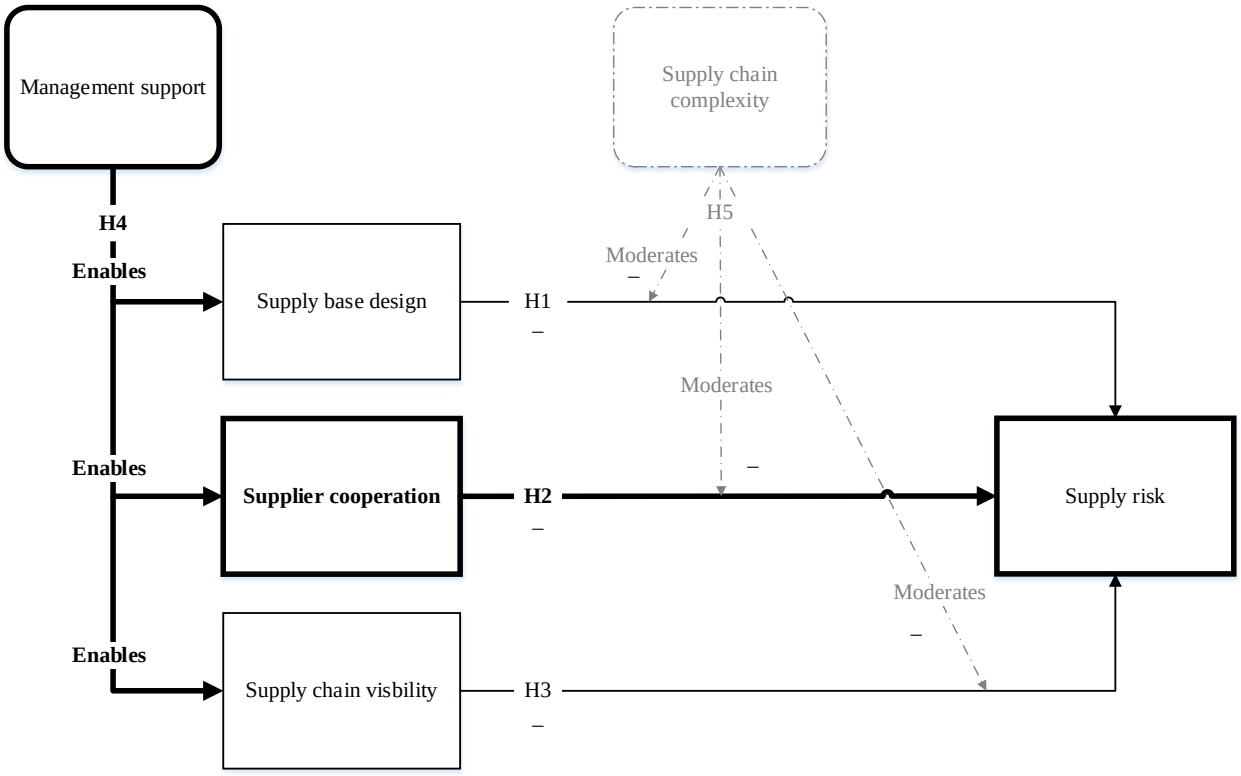
5.6 Hypotheses support and revised conceptual model

The exploration and development of theory, as well as the empirical case study research, provide several interesting observations. First, many of the sub-strategies are found to be interconnected and sometimes reflect an orderliness, which was anticipated in the literature development (Autry & Sanders, 2009). Therefore it is rather hard to interpret and implement these sub-strategies as independent methods of risk management. Furthermore, the strategies described and presented to organizations' representatives during interviews, reflect a broad perspective on supply risk management. This high-level perception makes it challenging to provide clear and one-sided strategy definitions, impeding the search for valuable answers. On the other hand, this approach leaves room for interviewees' interpretation which often lead to valuable and unconventional answers. Based on the discussion in Section 5.1-5.5, Table 8 and Figure 5 are composed. Table 8 provides a brief oversight of the hypotheses and whether these are accepted or rejected. The revised conceptual model is displayed in Figure 5. Here the different lines reflect the extent of support for the presumed relation; thick lines for strong support, thin line for moderate support and dashed line for no support.

Table 8: Support for hypotheses

Hypothesis 1	*Supply base design strategies have a negative impact on supply risk*	Supported
Hypothesis 2	*Supplier cooperation strategies have a negative impact on supply risk*	Supported
Hypothesis 3	*Supply chain visibility strategies have a negative impact on supply risk*	Supported
Hypothesis 4	*Management support for supply risk management in organizations enables the impact of supply risk management strategies on supply risk*	Supported
Hypothesis 5	*The impact of supply risk management strategies on supply risk is moderated by supply chain complexity*	Not supported

Figure 10: Revised conceptual model[4]



Legend

Thick line: strong support
Thin line: moderate support
Dashed line: no support

6. Conclusion

6.1 Main findings and research implications

The incentive for this study was initiated by the questionable adequacy and insufficient accomplishments of current state supply risk management. In supply chain risk management (SCRM) literature, "good empirical research is in short supply" (Sodhi *et al.*, 2012). The added value of this research is derived from the synthesis of academic insights and practical experiences. In many organizational settings, a multitude of risks can and do evoke severe damage to upstream supply chain operations if well thought out supply risk management strategies are absent. This study adds to the current state of SCRM knowledge along two dimensions of supply risk management research: the adoption and impact of theoretical supply risk management strategies in practice. Furthermore, this research conducts a novel approach by including public sector organizations as well as service providers. These are rarely considered in existing supply risk management literature, which is mostly limited to production organizations. It needs to be emphasized that all results are derived from a broadly differentiated range of organizations and therefore better lend themselves for high level insights and research implications rather than very detailed conclusions.

In this study, the exploration of theory results in a broad perspective on supply risk and the importance of supply risk management in the field of SCRM. The development of theory enables the identification of the most crucial supply risk management strategies and their impact on supply risk. Furthermore, recent studies suggest that management support is expected to play an enabling role for supply risk management strategies and supply chain complexity is expected to moderate their impact. From this literature exploration and development exercise, the conceptual model emerges, providing the foundation for the empirical analysis. Here, the strength of the conceptual model is evaluated in practice and several patterns and contradictions in the adoption and impact of the theoretical supply risk management strategies are revealed.

The adoption of supply risk management strategies is found to be high in the private sector. Here, many strategies are adopted or currently being developed, underscoring the importance of SCRM. In contrast, the public sector has a very low maturity in the adoption of supply risk management strategies. Due to the high-level approach of this study, interesting insights on the impact of supply risk management impact are obtained. Supply base design strategies are more pervasive and impactful in production organizations whereas supplier cooperation strategies see slightly larger adoption rates at goods and services providers.

However, a major finding is that these two strategies are often related. Several organizations indicate they rather cooperate with and develop their suppliers than using them solely as back-up or drop them in case they become risky. These two supply base design strategies show a strong link with supplier cooperation strategies, as supplier screening, monitoring and (self-) assessment and supplier relationship management are the underlying prerequisites. Compared to the other two general strategies, supply chain visibility scores lower. This is mainly caused by organizations' reluctance of sharing information with supply chain partners, motivated by competition. A summary of the adoption rates per strategy is included in Table 9. Furthermore, substantial evidence on the importance of management support in enabling supply risk management is found compared to limited support for the moderating role of supply chain complexity.

Table 9: Summary of strategy adoption

General strategy	Sub strategy	Adopted or in development (% of organizations)
Supply base design	Local sourcing only	13%
	Combine global and local sourcing	53%
	Dual sourcing	60%
	Multiple sourcing	73%
	Back-up suppliers (only back-up)	40%
	Supply base reduction	53%
	Dropping of risky suppliers	60%
Supplier cooperation strategies	Upstream integration with suppliers' operations	47%
	Supplier screening, monitoring and (self-) assessment	87%
	Supplier relationship management	67%
	Early supplier involvement	53%
	Strengthen the flow of communication with suppliers	33%
Supply chain visibility	Share information with different parties in the supply chain	47%
	Share inventory levels with strategic suppliers	40%
	Increase traceability in the supply chain	53%
	RFID technology	7%

6.2 Reflection, limitations and suggestions for further research

This research started by wondering how it can be explained that adverse supply chain events occur often, despite the comprehensiveness and maturity of the SCRM discussion in academic literature. Looking back, it is concluded that this cannot be explained by the fact that

supply risk management strategies are not adopted in practice. Contrarily, the high strategy adoption rates reflect the opposite. A possible explanation could be the general absence of a structured approach to supply risk management and a lack of formal attention for supply risk management. No strategy is found that is never adopted. Also, all organizations adopt at least one but often substantially more strategies. However, not one organization works with a formalized definition of supply risk management, nor did any of the organizations employ a supply risk manager or supply risk department. Supply risk management appears to be a rather unstructured practice. Organizations tend to rely on the instincts of their purchasing and supply chain employees and only in rare cases quantify or formalize supply risks. This lack of formal recognition for supply risk management could be a possible explanation for the frequency and severity with which supply risk incidents manifest. This leaves several valuable opportunities for further research, which will be discussed in the following section.

For academics, this study provides several valuable points of departure in the broad and fertile research area of SCRM. The empirical additions make several parts of this study relevant for further exploration. The high-level approach subject the researcher to some restrictions in drawing resolute conclusions on a detailed and individual sector level. Therefore, it is suggested to expand this research on a lower industry aggregation level. For instance, production organizations could be further subdivided into fast moving consumer goods or industrial goods. Several organizations indicated a changing consumer demand and sustainability requirements force them to have clear visibility of their complete supply chain operations. This emphasizes the importance of further investigation of supply chain visibility strategies, as many technological developments such as RFID technology can offer valuable solutions. Here, academics could add value via independent research of the adoption and usefulness of such technology applications.

The qualitative case study methodology generates insights that are hybrid in almost in any case and tailored to the individual organization. This approach limits the possibilities of generalizability and reproducibility, as the primary data source, interview conversations, can never be replicated in exactly the same manner. A quantitative study on a similar research problem could emerge in several interesting additional insights, as it allows for a more extensive study involving a larger number of organizations, easing comparison across data and over time (Earl, 2013).

The chosen approach has several other limitations which create opportunities for future research. The three general strategies investigated emerged from a broad variety of academic journal papers. In the attempt to specify which sub-strategies are included and which not, assumptions had to be made. The sub-strategies addressed are considered the most important, but cannot be all-encompassing. To a large extent, supply risk management strategies comprise bespoke and adapted solutions, as different organizational contexts require this. Therefore, a suggestion for future research is to investigate the adoption and impact of alternative supply risk management strategies too. One could think of supplier development programs, which was mentioned by several organizations. This will help filling the gap in literature and increases the practical applicability of theory in this important research area. Furthermore, the research area of SCRM provides many opportunities to illuminate other sources of supply chain risk, such as demand risk and operational risk (Manuj & Mentzer, 2008). Advanced research on these topics contributes empirical insights to SCRM literature and provides practitioners' with improved knowledge and insights in the fertile research area of SCRM.

7. References

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Appendix I – Interview protocol

Administrative details

NAME: ……..
POSITION: ……
DATE:……
Agree with recordings…..YES/NO

Organizational details
Checklist for web inquiry:

- Ownership type (public/private)
- Type of industry
- Number of FTE's
- Annual revenue

Checklist for interviewees:

- Length of supply risk management practice
- Number of suppliers
- Geographical dispersion of organization (national, European, intercontinental)
- Annual spend managed by procurement and/supply department

Introduction to the research

[Introduce research and goals of the interview]
[State importance of "no"/"I do not know" as a valid answer possibility]

1. Introduction – [context]
[1] Could you please describe your position and responsibilities within the organization?

2. Supply risk (management) and strategies used

Definitions
[2.1] How would you define supply risk (management)?
probe Do you have formal documented definitions?
probe Can I see them after the interview?

[2.2] What types of supply risk are relevant for your organization?
probe Can you list them?
probe Can you prioritize them?

[2.3] Do you measure these risks?
probe Do you have KPI's to measure these? # incidents, # delays, # almost incidents etc.
probe Are you content with this way of measuring?
probe Do you have experience with other indicators?

probe Do you have data available on this? Monthly reports etcetera?

3. Practical strategies

[3.1] How would you consider the presence of thorough supply risk management strategies in your organization?

probe Which strategies do you use?
probe Do you have your strategies written in formal documentation?
probe Can I see them?
probe How often is this evaluated or reviewed?
probe Have you ever changed your supply risk management strategy?
probe To what extent is your organization aware of these strategies?
probe How many FTE's are working on supply risk management?
probe How successful do you consider these strategies?
probe Can you give an example of when your organization suffered from supply risk?
probe (How) did your supply risk strategy help?
probe Have you seen supply risk decreasing as a result?

[3.2] Have you heard of these supply risk management strategies?

- **Supplier cooperation strategies**
- **Supply base design strategies**
- **Supply chain visibility**

[Show list with supply risk management strategies and sub strategies]

4. Academic strategies

Supplier cooperation strategies

[4.1] Do you implement **supplier cooperation strategies** to mitigate supply risk?
[Use list to show strategies from literature]

Supply base design strategies

[4.2] Do you use **supply base design strategies** to mitigate supply risk?
[Use list to show strategies from literature]

Supply chain visibility

[4.3] Do you use **supply chain visibility** strategies to mitigate supply risk?
[Use list to show strategies from literature]

CONDITIONAL IF ANSWER TO [4.1] IS POSITIVE

[4.1.1] Which supplier cooperation strategies do you use?
[Use list to mark strategies from literature]

[4.1.2] How would you describe the impact of supplier cooperation strategies on supply risk?
probe Positive/negative? Why?
probe Strong/weak? Why?
probe Could you give an example?

CONDITIONAL IF ANSWER TO [4.2] IS POSITIVE

[4.2.1] Which supply base design strategies do you use?
[Use list to mark strategies from literature]

[4.2.2] How would you describe the impact of supply base design strategies on supply risk?
probe Positive/negative? Why?
probe Strong/weak? Why?
probe Could you give an example?

CONDITIONAL IF ANSWER TO [4.3] IS POSITIVE

[4.3.1] Which supply chain visibility strategies do you use?
[Use list to mark strategies from literature]

[4.3.2] How would you describe the impact of supply chain visibility strategies on supply risk?
probe Positive/negative? Why?
probe Strong/weak? Why?
probe Could you give an example?

5. Enabling and moderating effects

[5.1] To what extent is board level support of supply risk management successfully enabling risk mitigation in your organization?

[5.2] Is supply risk management part of the enterprise risk management strategy of the board of directors?
probe If yes, how would you describe the attention it receives?
probe If yes, how do you report about supply risk management?
probe If yes, who receives this report?

[5.5] Has the complexity of your supply chain increased in recent years?
probe Can you provide an explanation for this?
probe Did this bring you problems due to increased supply risks?

CONDITIONAL IF ANSWER(S) ON [4.1], [4,2] and/or [4.3] IS POSITIVE

[5.3] How would you describe the effect of supply chain complexity on the impact of…..
[5.3.1] …supplier cooperation on supply risks?
[5.3.2] …supply base design on supply risks?
[5.3.3] …supply chain visibility on supply risks?

6. Risks in law and regulations

[6.1] Do you test whether suppliers comply with local and international laws and regulation related to supply risks?
probe If yes, how?

[6.2] Do you test whether suppliers comply with agreed contract terms and conditions?
probe If yes, how?
probe By supplier audits, a contract management team, a digital system, an external bureau etc.?

7. Conclusive questions

[7.1] What are future developments in this field you consider promising or interesting?
[7.2] Are there any other relevant issues we have not been able to address yet?

THANK YOU

Appendix II – List of strategies

Supply base design strategies	**Adopted**	**Note**
Local sourcing only		
Combine global and local sourcing		
Dual sourcing		
Multiple sourcing		
Back-up suppliers (only as back-up)		
Supply base reduction		
Dropping of risky suppliers		

Supplier cooperation strategies	**Adopted**	**Note**
Upstream integration with suppliers' operations		
Supplier relationship management		
Early supplier involvement		
Supplier screening, monitoring and (self-)assessment		
Strengthen the flow of communication with suppliers		

Supply chain visibility strategies	**Adopted**	**Note**
Increase traceability in the supply chain		
Share information with different parties in the supply chain		
Share inventory levels with strategic suppliers		
RFID technology		

Appendix III - Case study output

Case overview of AEROS

AEROS – "as is"	*This tabular overview of the AEROS case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• For AERO, the major supply risk lies in the quality of purchased components. These need to meet very strict airworthiness requirements that ensure an aircrafts' (component) suitability for safe flight.
Organization's supply risks	• Airworthiness risk (quality) – the risk a component is not declared airworthy and therefore cannot be used in an aircraft, which can therefore not be repaired (on time) and cannot be used in airline operations. This is the most important risk, but it is regulated by the European Aviation Safety Agency (EASA) • Obsolescence risk – if an aircraft type is out of production (OPA) but is still used by airline operators, in some cases that a required spare component is not (easily) available anymore. Then sourcing alternatives have to be found, or the component needs to be produced in-house which often happens by hand. This has its repercussions on lead times which can become very long. • Financial risk - as for most components there is only one possible producer, Original Equipment Manufacturers (OEM's) are often monopolists. This can cause unexpected and unavoidable supply price increases of sometimes up to 120%. This decreases AEROSs ability to maintain price stability to their customers
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• AEROS operates in the highly regulated aerospace industry, as aircrafts and components are subject to very thorough assessments, rules, audits and checks and safety requirements are extremely high. It works with 1000+ suppliers. There is a risk department and an airworthiness team, but (supply) risk management is basically present in team, decision and the DNA of the organization. • AEROs supply base consists of two types of suppliers. 98% of their supply originates from so called 'approved suppliers' that produce components that are meeting all requirements of the EASA. The EASA gives out forms and certificates that allow organizations to design and/or maintain and/or produce airworthy aircraft components. AEROS possesses all three and is also allowed to give out certificates to external suppliers. By this policy, the EASA covers all risk management regarding product quality and to a high extent determines the supply base, as many components are only produced by very few manufacturers as a result of the strict policy. • Alternatively, the other 2% of supply is purchased at sub-contractors who work under certification. These firms receive permission to produce a certain component by order of AEROS and based on their component design. These firms are intensively audited on many different factors, such as the translation of the design drawings into working plans. Nothing is produces that does not meet the 'Conformity to Design' approval. • The auditing of the latter category consists of a risk log that holds all potential supply risks, a categorization (generic risk or priority risk), a QIS (quality information sheer) and a risk matrix displaying the likelihood and potential impact per risk per supplier. • To optimally deal with the risk of long lead times, AEROS's inventory team is continuously weighing the risks between the costs of inventory and costs of not being able to supply. This is a risk management strategy to optimally balance the risk of obsolescence/unavailability and unnecessary high inventory costs.

AEROS - testing the conceptual model		*This tabular overview of the AEROS case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• Based on the ubiquity of supply risk management in AEROS, the tentative conclusion is drawn that management support for the supply risk management practice is vital as risk management and supply risk management have roots in every decision that is made in the organization.
Theoretical supply risk management strategies	General	-
	Supply base design	• Dual or back-up sourcing serves as a strong strategy to address the obsolescence risk/risk of long lead times • Alternatively, if a supplier is unable to produce the required components he can give out a manufacturing license agreement that enables AEROS to produce in-house, based on the suppliers' design drawings. • Single sourcing is undesired, but is due to force majeure often the only possibility as OEMs are often monopolists • New sourcing possibilities cost a lot of money as they are subject to all requirements before they receive certification to design/maintain/produce. • Combining local and global sourcing is an active strategy • Supply base reduction is not a possibility as most suppliers provide essential but very specific products
	Supplier cooperation	• AEROS successfully mitigates the financial risk of sudden increases in costs of supply by closing deals and signing back-to-back contracts with OEMs • AEROS also integrates operations and collaborates with suppliers' operations as sometimes they produce components based on AEROS's design drawings or vice versa.
	Supply chain visibility	• Supply chain visibility and traceability are very important risk mitigation strategies for AEROS. Every adjustment, repair or other adaption to an aircraft or component is documented in every detail. Every product is completely traceable along the supply chain to ensure that in case of an air crash, the source of the problem can be traced down to manufacturer, service provider or any other possible stakeholder.

		• Information is shared across the supply chain in order to create visibility in the availability of components. This is an active strategy as aircrafts cannot wait long to be repaired, and insights in lead times allow AEROS to anticipate potential risks and timely search for alternatives.
Supply chain complexity as moderator		• AEROS does not consider the complexity of the supply chain to be increasing and therefore impacting the effect of their supply risk management strategies. An aircraft is designed to be used the next 20, 30 or 40 years so it is known what components are required and there's also minor change in who is allowed to provide these components

Case overview of ANIML

ANIML – "as is"	*This tabular overview of the ANIML case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• -
Organization's supply risks	• "It starts with consciousness of continuity of suppliers and what risk you are exposed to there and ranges to all operationally related supply chain risks, you know, we can buy something in China but if you are facing lead times of six to eight weeks, different ports, different transport modalities, various risks connected to that." • An example is given for the vitamin industry. Last year a production facility of one of ANIML's vitamin suppliers caught fire. This was a best in class organization, with very strong safety and risk regulations. Where ANIML sometimes can be concerned of for instance Chinese vitamin suppliers, one would never expect this to happen at this best in class firm. Luckily ANIML was not sourcing a lot from this facility, but this example shows you cannot control every risk and ANIML always takes the possibility to improvise into account." • "The allocation was pure luck on our side. I like this as a test case, as I question myself and my people "would we do something different knowing this right now?", probably not. Some things you cannot control." • "The problem with risks, is that the diversity is huge. We have the oversight, but its rather complex and comprehensive matter."
Organization's definition of supply risk management	• -
Organization's supply risk management practice	• "One of the things, I actively started with when I started at this company, is that it per definition, looking at the procurement practice, is defining procurement strategies and procurement sourcing plans as in a lot of places, you won't find them, or not thoughtfully enough. I started a training program to learn and assess the minimal requirements. We implemented professional category management." • "One of the things we do, is indicating risks at a category level, what are the possibilities and impossibilities per spend category. First people thought this was very bureaucratic, as they thought they knew how things work, in their heads, so I don't have to write it down. Till the moment you do write it down, they see how things can do differently than expected. That is, when discussing risk management, per definition is an integral component of our sourcing plan. Of your total strategy and consequently of your plan." • "In some innovative categories, risk management plans are even the start of the strategy. Why? In a number of those categories we were growing very fast. We're talking growth numbers of 20-25% per year" • "We are currently implementing a project called Master Data Management with which we structure data for all items and suppliers for worldwide access. In the beginning, people find this a very unattractive design, but if you do not have this in place, you can forget about the rest. This is our first priority. The second priority is better organize and formalize our reporting and risk measurement. At some of our major operating companies, for example in the Netherlands, we already do this, and report on late deliveries, incomplete deliveries, the number of claims, the number of quality checks thus far I cannot consolidate this worldwide." • "The fact that this has not yet received very much attention, at least the operational part, indicates we're not facing mega problems on a daily or weekly basis. Only the risk exists we leave a lot of optimization opportunities unattended. Maybe you keep your stock level too high, safety stock too high etcetera." • "I'm also member of the risk management advisory board of ANIML. We assess what risks do we see in general as an organization, in all possible areas. From IT to financial risks to supplier risks, business continuity management. A number of those risks we assess a lot higher then purely the risks at supplier side. We have to make this tradeoff, of where you want to invest your time in. What role do risk play in terms of money?" • "The classic Kraljix matrix is part of our procurement strategy. I like it because of its simplicity. You look at impact on operating results, what are the risks. Then you conclude that if a product has a relatively low impact but a high risk profile, you take different measures than when a risk is low and has also a low impact. This differentiation, is the most important. We do not have one approach for all product categories." • "We have a business support framework for all risks. Twice a year with an internal and external audit we have to demonstrate we do this. Bureaucracy wise there is pressure to make sure all oversights are good." • "With eye on the future, part of our risk management strategy is anticipating the unavailability of certain products." • "For strategic suppliers we conduct audits ourselves" • "Problems occurred at a very strategic supplier and we send our own improvement team to help improving. We had two parties in China, and we send our Supplier Development team, and we also have a quality manager in China directly reporting to the quality manager in the Netherlands. They cooperated to implement the improvement plan together with the supplier.". They cooperate to implement the improvement plan together with the supplier. How do you prevent competitors also benefit from this? You can't, but we can negotiate a head start, let's say only we benefit from this the coming year as we invest the time and money. This we do. It's too simple to just kick someone out."

ANIML - testing the conceptual model		*This tabular overview of the ANIML case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• "Supplier relationship management and risk management are part of our enterprise risk management." • "Procurement is one of our key control elements, also supplier risks."
Theoretical supply risk management strategies	General	• "The choice and/or presence of supply risk management strategies is very much dependent on the product category which makes it hard to provide generic answers."
	Supply base design	• "From a supplier audit result points of improvement emerge. If we consider these serious enough, we follow up ourselves, if otherwise the supplier receives an improvement report and depending on the type of risk a period X to follow up. We cannot often say, oh, your score is too low, you're out. This is often also not in our interest. We give an analysis period for improvement, if nothing improves we have to make a decision. Then a supplier can be noted on the blacklist." • "We combine local and global sourcing. We look at what is the category, what is the structure of the supplier market, and we can say global sourcing only but if you take for instance minerals and trace, that's per definition often, because its lower costs products, local or regional markets. We can say global sourcing only, but these markets are very local. What we can do, is learn how do we do this by purchasing a product somewhere in the region. What is the cost base? How can you optimize the supply chain? So in this case we still have global category manager, but eventually we purchase everything regionally. It's local sourcing, but from a global view. It's globally coordinated" • "For other product categories, for instance vitamins, you have four or five suppliers, or producers, with whom you make deals on a global scale, then it really is global sourcing. Risk management is part of that, but it starts with your commercial strategy." • "Per definition it's always combined. That's where the issue starts. That you have local execution, can be one of the conclusions." • "People asking single sourcing, good or bad? If we don't have to, we avoid it. But if we work with an innovation and we commit ourselves to invest heavily, then you initially per definition have to deal with a single sourcing situation. This is not bad, as you purposely choose for it and both parties invest. But then you have to have an idea of what the situation looks like in five, ten years. This means you have a different type of commitment and a different consideration of risks then in a multiple sourcing situation." • "From a risk management perspective, it's most convenient to have a commoditized product and you have multiple sourcing. If we have multiple options, it's per definition the case we spread production." • "Single sourcing is only if there are no alternatives." • "In my experience, back-up suppliers do not work. You cannot only call them in case something happens while never doing business. You have to buy something every now and then to maintain the relation. You cannot expect that someone you do never business with helps you immediately when you have a problem. They have their customer preferences." • "The supply base reduction discussion for us is mainly alive at indirect goods. Here we have 30.000 suppliers. Here's a low share of our spend, but a lot of diversity and a lot of suppliers causing a lack of control. That's a big challenge. I have no sight on these suppliers. It can be a very small company only making a single product for us but potentially works in a way that can bring us a huge exposure. Therefore for these categories supply base reduction is important."
	Supplier cooperation	• "From a supplier audit result points of improvement. If we consider these serious enough, we follow up ourselves, if otherwise the supplier receives an improvement report and depending on the type of risk a period X to follow up. We cannot often say, oh, your score is too low, you're out. This is often also not in our interest. We give an analysis period for improvement, if nothing improves we have to make a decision. Then a supplier can be noted on the blacklist." • "As sales forecast is never 100% accurate, it's always good to build a relation with a good local trader per region for spot buying. One, because of delivery reliability and two, to keep a feeling for a local market and the local price fluctuations." • "In my experience, back-up suppliers do not work. You cannot only call them in case something happens while never doing business. You have to buy something every now and then to maintain the relation. You cannot expect that someone you do never business with helps you immediately when you have a problem. They have their customer preferences." • "We do vendor management inventory. In some cases we have inventory that is managed and replenished by the supplier. With a number of strategic suppliers we have fully integrated the ordering and invoicing processes." • "Regarding supplier relationship management, this depends on the categorization. For our strategic suppliers we have quarterly reviews" • "For me, supplier relationship management is also differentiating between parties. You cannot treat every party the same way." • "Western companies are more formalized. But especially with Asian companies, we invest relatively much time in relationships and for instance dining. One, it's fun, and nice food, second, it's a means to get very much information on what's happening in the market, what are they doing, what are their investment plans, how do they see certain developments. Eventually you get so much information there, that's also supplier relationship management. You won't get this information in any other way."
	Supply chain visibility	• "The supply base reduction discussion for us is mainly alive at indirect goods. Here we have 30.000 suppliers. Here's a low share of our spend, but a lot of diversity and a lot of suppliers causing a lack

		of control. That's a big challenge. I have no sight on these suppliers. It can be a very small company only making a single product for us but potentially works in a way that can bring us a huge exposure. Therefore for these categories supply base reduction is important." • "Here data management is a the first step, to create insight in what we are doing there, make sure the categorization is in order." • "Track and traceability we do insufficient, it's not as developed as in other industries" • "What we do as procurement strategy is mapping the entire supply chain, mostly from a cost perspective. Who are the suppliers of our suppliers' suppliers and are there correlations or dependencies and do we understand those? We do this, but this is not translated to our daily supply chain via tracking and tracing. In our industry it's not very critical" • "The first control we want to have well in order. If there's a quality issue or whatever other issue, we need to be able to tell which batch or supplier it was, and trace the issue back. This we are able to. As long as you can do that, I think it's okay." • "Inventory levels we share with strategic suppliers, not with everybody." • "We do have implemented a system linked to our ERP system to visualize the supply chain from our suppliers to us and from us to our customers on a minute level. We suffered from strikes in China. My first question was, how many containers do we have there, and are we exposed? Do we have to account for delays to our factories? That question I was able to answer within a minute. We can plot this, and see where our containers are. That we have very clearly visible." • "Share and assess supplier risk management plans is a standard agenda point when we start a cooperation. We always discuss and share this."
Supply chain complexity as moderator		• "Awareness has increased because of the exposure and international operations, risk awareness and risk management has increased. I also think this is a broader societal trend. Our tendency to control has ever increased. Also via the technological possibilities. This also holds for businesses. The will to control, plan and manage."

Case overview of BREWR

BREWR– "as is"	*This tabular overview of the BREWR case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• IT security risks. "Recently a major container company and terminal operator suffered from a security breach causing our flow of goods to be shut down " • "Capacity risk at our suppliers is a daily practice " • Commodity risk (unavailability)
Organization's definition of supply risk management	• Not present. "We implement the term contingency analysis that covers what-if scenarios"
Organization's supply risk management practice	• "The supply department of BREWR has an company-wide contingency model, a list with somewhat 100 eventualities that could impact our production continuity. This is reviewed and checked annually. Supply risk management does not have an separate department but I expect my team to do this." • "My team cooperates with i.a. the quality, planning and logistics department and the Global Procurement Team to assess the supply network, identification of risks and what actions we implement in case of adverse events" • "A good supply risk management practice is inventory management. We always make sure to have a 4 to 6 weeks supply in stock to keep going in case of adverse supply events" • "Risk assessments and risk analysis only at first tier level is not sufficient anymore. Because the commodity market is picking up and the economy is growing, our suppliers sometimes cannot get their raw materials. That's why we are more and more interfering with the second tier. In this way, we eliminate risk" • "Next to that, for our primary materials we have a commodity team hedging the risks of unavailability via long term contracts which is also a way of risk management" • "Our demand market becomes more and more erratic, our supply market becomes more and more unstable making us question ourselves: how often should we review our risk situation?" • "We do have kind of a dashboard that keeps record of disruptions, quality and etcetera in the operational performance. We do not have a dashboard for the major structural risks as mentioned before. Those are reviewed twice a year" • "We have to be honest that price is most important in supplier selection, but after that security of supply always is the second most important" • "For supplier and quality risks we have a worldwide audit program defined globally, implemented locally stating the requirements for suppliers. We run the audit, if something is not aligned with the requirements, they get a grace period of three months to solve the issue. If not, they're disqualified and we buying at them. This is a standard procedure" • "Sometimes in the case of a specific product, we only have two suppliers. They tend to get too comfortable in their position and then we start discussing with Global Procurement the possibility of introducing a third supplier ourselves. How can we help a small firm to become larger by supporting them to meet our product standards, giving them more volume etcetera. This is a supplier development strategy we use to make some suppliers feel less comfortable, negotiate better prices and of course increase security of supply." • "Currently our risk management is organized locally but our operations are regional, as we share a lot of suppliers in the region (Western Europe). We can decide to hold certain level of for instance safety stocks of glass. But then a brewery in another European country can come to us in case they're out of glass. This hits our EBIT. Organizing the risk management on a regional scale could prevent this."

BREWR - testing the conceptual model		*This tabular overview of the BREWR case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• "Trust with suppliers and a decent IT landscape are enablers for the success of our contingency model" • "I don't think supply risk management as a separate topic is explicitly mentioned on the boards agenda , but the operations of the breweries are always the focal issue. In this supply risk management gets a lot of attention, driven by the different parts of our procurement organization and therefore is also driven by the board." • "As our breweries are operating quite independently, a more centralized management could be beneficial but I think BREWR is a very decentralized organization that does not want to lose its flexibility. On a global scale this will never work, but on a regional scale it would."
"Theoretical supply risk management strategies	General	• "We have many different supply risk management strategies, they can vary with the category of the product." • "In a separate silo, these strategies don't work sufficiently. Therefore you should be doing it in combination" • "Supply base design is a precondition for supplier cooperation. We fix the supply base for a certain period and consecutively we start working on supplier cooperation. It's more an orderliness than a prioritization." • "Supplier cooperation is an ongoing process and supply base design should be reassessed periodically." • "For me, supply chain visibility and supplier cooperation cannot be separated."
	Supply base design	• "We attempt to have our suppliers as near as possible. This gives us a competitive advantage towards other production facilities at BREWR. With this strategy, we can keep costs low and it benefits sustainability and flexibility. I you look at our supplier dispersion across the world, it is very locally oriented. 80-90% comes from Western Europe." • "Our supply base is too large to be subjected to a decent consultation structure, good improvement structure, strategic partnerships, proper risk analysis. It is impossible to execute all these plans properly with 2000 different suppliers." • "We have to reduce the supply base to focus on a small number of large, stable and professional parties with whom we can have such conversations and run analysis with. A target for the procurement team is identifying these crucial strategic suppliers" • "Our target is to reduce the number of suppliers from 2000 to 1500." • "For all our primary purchased products we have a second and third supplier in. The primary supplier supplies the largest flow of goods but the artwork and tooling are brought under at other parties. For instance for the production of drinking cans you need special tooling, this is sourced from another company than the one supplying the materials. In case something happens, they can act swiftly. Also for these raw material of primary products, we have at least two but preferably three suppliers. These second and third suppliers are not only for back-up requests; we keep them aboard and nearby because we let them supply a smaller part of the total supply. In this way, we always can rely on them in case something happens at the primary supplier." • "Single sourcing is definitely something we try to avoid and this is certainly not part of our strategy. It brings only risks rather. For not business critical activities, such as facilities, its fine but still not an active strategy." • "Dual sourcing can be fine but we strive to have more suppliers per supply item." • "For instance in de carton market, there are may be twenty major players. But the ones meeting our requirements, are only three. One of them is very flexible, but its quality is okay. The other has very high quality but is not flexible at all. The third one is small and has a bit of both. That one is nice to have in case something happens to one of the two large firms."
	Supplier cooperation	• "We require suppliers in advance to meet our requirements in order to work with us. These cover international standards for IT risk management. Recently these IT checks and assessments have become very important for us due to the increase in problems and risk" • "We definitely integrate and collaborate upstream with suppliers. Past two, three years we ran a program called 'Supplier Collaboration'. Together with our top-15 critical suppliers, identify the effects of BREWRs demand on their supply chains and how we can better align operations. This also includes risk mitigation." • "One of the reasons we started this program is that we came to the conclusion that we will not deviate from these fifteen critical suppliers. They are very large players, and we need them to run our business. Then it's best to build a long term relationship, make sure to understand the shared supply chain and actively focus on this. Old school procurement, negotiating and changing suppliers every now and then at a certain point doesn't work anymore. You're out of options. With technological developments you end up with one, maybe two parties being able to deliver your demand. Especially with our high requirements" • "We are considering early supplier involvement as a strategy as to my opinion this receives more attention as it can bring forth valuable information about suppliers' capabilities we are not even aware of." • " BREWR used to be an organization that used to dictate how things should be going. Luckily this attitude is changing, as for instance a carton supplier knows way better than us what is possible with his product."
	Supply chain visibility	• "We started asking suppliers to share stock levels, levels of products in the supply chain. This is all done very straightforward and can be done much more advanced with block chain and RFID etcetera. We currently run trials with this, but it is not yet an active strategy" • "We also ran a pilot in block chain applications with a supplier to identify and show how sustainably sourced our products are." • "One of my contract management strategies involves making sure to know your suppliers. This gives us the power and visibility to perform optimally in all circumstances. This also means knowing the supply

		chain, knowing where stocks are kept etcetera. The bottleneck for this, however, is trust in information sharing. If a supplier is larger than us, we cannot enforce anything" • "Our IT landscape is not very mature yet. This makes supply chain visibility hard to establish."
Supply chain complexity as moderator		• "Everything is becoming more complex and volatile, making your risk management more and more important. However you're risk management is good, you think through your strategy very well and you know which suppliers you need, it should make things easier in the end. We are somewhere in the journey to establish this and I would state for most categories we are doing quite well. But we do see our supply network becoming more and more complex, driven by shortage in the market, sometimes created by suppliers on purpose to drive up prices. Then we have to find other suppliers which makes the network more complex and diverse." • "The more specific your product requirements, the more difficult your supply risk management. BREWR is quite good in making this difficult in that sense"

Case overview of CABLE

Cable – "as is"	*This tabular overview of the CABLE case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• "We've identified a series of risk that we want to verify our suppliers against to, basically […]. We're looking at financial risk, operations risk and also corporate social responsibility risk, those are the three main areas we're focusing on. Each of those has several components" • "The financial risk is related to the health of our suppliers" • "Corporate social responsibility risk is a set of risks related to environment, labour, ethics, corruption, and conflict minerals. For this we use EcoVadis. It provides services to the industry. It evaluates all of our suppliers against a series of about 100 elements of supplier risk. You can evaluated geographical areas, if there's any corruption risk highlighted etcetera". • "Operational risk, this would be related to our dependency on the supplier, the suppliers dependence to us, the suppliers location, IT security and data privacy" • "Financial risk is an important element for us, so this one is quite closely monitored."
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• "The financial risk is related to the health of our suppliers and usually evaluated by our treasury team who have their own methodology for assessing our suppliers" • "Corporate social responsibility risk is a set of risks related to environment, labour, ethics, corruption, and minerals. For this we use EcoVadis. It provides services to the industry. It evaluates all of our suppliers against a series of about 100 elements of supplier risk. You can evaluated geographical areas, if there's any corruption risk highlighted etcetera". • "For each of those risk, we evaluate on a scale the impact it has on our business. This gives us a heath map. It's quite a traditional methodology. We didn't reinvent the wheel on that" • "We have 10-15.000 suppliers but we do not run a risk assessment on all of them. It has no need to run a risk assessment on your tail suppliers. There we do some basic checks on risk mitigation. Ensuring that they comply to our code of business conduct." • "We have specific requirements for suppliers when they onboard which is required for the entire footprint of suppliers" • "Maybe if you have a full team available for supply risk management you can assess the full supply base but you have to evaluate what is the cost and benefit of doing that. Are your risk located in all your suppliers? No. We need to target and concentrate our efforts on our strategic and critical suppliers. This assessment is run on approximately 400 suppliers" • "In our risk analysis we identify the risks, CABLEs share in the suppliers revenue, showing how dependent they are on us. Alternative sources of supply, switch time, switch costs, criticality of the suppliers product/service, as in how critical is the supplier to us in delivering to our customers and suppliers country of operation. Oracle for instance will not have a direct impact on our customer base. And then we evaluate the impact. How much impact would a supplier problem have on the customer base? How many customers would go out of operations if that supplier seized to provide? And also how many of our markets does that impact." • "We also give the risk a score as to give it a weight in our overall risk evaluation. Risk assessment for us looks like a rating" • "High risk suppliers are monitored on a quarterly basis and those risk are re-evaluated quarterly." • "Then there's a risk measurement committee that consists of procurement, the business, legal, finance and what's needed depending on the risk. They review the high risk suppliers and decide on the actions that need to be taken depending on where the risk lies. It's an operational group in charge of what is the nature of the risk, what are potentially the consequences and what actions do we need to do with this specific supplier?" • "The key project of my team is to really embed and expand the risk assessment, beyond the existing supplier base." • "There's nothing worse than having risk resources as an organization and doing nothing with it."

CABLE - testing the conceptual model		*This tabular overview of the CABLE case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• "The awareness [of supply risk management] is increasing. And also depending on the events that happen in the world you see the awareness popping up. There's also more demand for it. My team often receives requests from different team members to assess suppliers in certain areas. It is part of the annual objectives as well, to make sure that we assess risks" • "There is some elements of vendor risk management in the enterprise risk strategy. We also have SOX, Sarbanes and Oxley, a special law requiring organization to report about certain financial risks which has some elements related to vendor risk management as well."
Theoretical supply risk management strategies	General	• "We have five major supply markets for which different strategies apply. The answer [on the effect of the strategies on supply risk] would be different for each of them." • "Also, the approach is really different on services and on goods."
	Supply base design	• "Both global, local and combined global and local sourcing are strategies we use but it very much depend on which market we're in." • "Dual sourcing for sure and multiple sourcing is also a strategy we apply in certain categories." • "We also apply back-up suppliers." • "We currently have a big program going on to reduce our supply base" • "Dropping risky suppliers is basically a consequence of our risk assessment. First there's a round of remediation plans and corrective actions. If, as a result of these corrective actions, they show no improvement then yes, we eventually may have to take the decision together with the business [to drop the supplier or not] as procurement on itself cannot decide. We buy on behalf of the business and decide collectively with the risk oversight board consisting of procurement, business, legal, finance and if needed other stakeholders. It is quite a difficult decision to make eventually. You need to have another supplier in place so I would not rank this as the number one solution."
	Supplier cooperation	• "We evaluate our supplier base regularly" • "CABLE does invest in some suppliers, actually it's an active integration as we acquire some suppliers." • "What we do a lot is we develop products together. Bespoke products to our organization. Also business process outsourcing could be seen as upstream integration." • "Supplier relationship management by all means"
	Supply chain visibility	• "We have a whole set of processes around increasing visibility in the supply chain." • "We need to share demand forecasts etcetera as we have lead times of up to two years." • "I don't think we are quite mature in the area of sharing and assessing supply risk management plans." • "I don't know if RFID technology is used."
Supply chain complexity as moderator		• "Clearly the more you have a global organization, the more complex it is. Imagine you have an organization operating in one country and supply is only coming from one country, from a risk perspective the oversight is much easier. I'm not saying the risks are less, but the oversight is easier. A global organization with over 10.000 suppliers and 40+ countries of operation complexity is for sure increasing. For sure you've read in the press recently our divestment activities we have also, that also generates a certain set of risks related to supply chain. For sure it's not simplifying, the complexity is increasing for sure."

Case overview of CONST

CONST – "as is"	*This tabular overview of the CONST case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• Building materials, spare parts, consumables, services (sub contracts) • "Supply risks for us are plenty. It's part of our business as we work with very tight time schedules. We often order goods that are not yet fully completed and they have to be shipped from all over the world. We wait till the final moment to purchase as the goods are sometimes not completely engineered yet. (CONST in most cases purchases one of a kind products that have to be specially developed, such as steel constructions and pipelines) This generates risks that are major part of our business and need to be managed." • "Risk of miscommunication and culture differences with our global suppliers" • Risk of insufficient quality of purchased goods • "Risk at transfer of documentation such as bills of lading. This is interpreted very differently by for instance the Chinese compared to us." • "Risk of shipment. You need to find a ship that can transfer the load, it need to be fast enough to meet our time schedule, that doesn't go to different ports, that does not delay etcetera. Then you have the risk of loading and unloading and transportation to the construction site. It's quite a wide array of potential risks we cope with and have to manage."
Organization's definition of supply risk management	• "I would recognize supply risk management as a process but it is not defined as such. It is part of our overall risk management processes. Supply risk management for us is very time oriented as we work with tight project planning schedules."
Organization's supply risk management practice	• "We conduct an assessment at every organization we work with" • "Regarding quality, we always send a quality inspector to the location of production. He checks their organization, how the processes are set up, how their technical documentation is organized,. We also attempt to execute a financial scan, if possible to see what we can expect. Also we check and verify references where possible." • "Whether this assessment is done by CONST or a local audit company, depends on the importance of the delivery. Most of the times we send our own people anyway." • "Plus, if you're working with firms in the far east, you face cultural differences and the importance of building relationships. If you go their yourselves, you show your face and automatically work on your relations. This can ease things out in de consecutive phases a lot"

	• "Supply risk management is part of my responsibilities, I try to assess the potential hazards and hire experts where needed and coordinate and consult the different departments that can help in managing the specific risk." • "In the tender phase, we already conduct risk analyses. We try to prevent for all risks beforehand and if we see a risk that we cannot prevent for, we make provisions. Risks are measured in matrices that display the likelihood and the potential impact of the risk. During the process this is continued to be monitored and controlled" • "We work with a very detailed procurement planning per project consisting of when should what be purchases, the engineering planning, transportation time, lead times etcetera. This planning helps identifying potential sources of supply risk in an early stage as this procurement planning is aligned with the overall project planning. This is reviewed every month, next to the overall risk assessment"

CONST - testing the conceptual model		*This tabular overview of the CONST case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• "Management is continuously updated on the progress of projects and corresponding risk analyses" • "Supply risk analysis is a very important part of our project reports and these report are frequently send to the highest level in our organization"
Theoretical supply risk management strategies	General	• "CONST procurement consists of very little repetitive elements, as products are uniquely designed and needed on a lot of different places in the world. It's different every time." • "Regarding global procurement in in particular Asian markets, which for us is quite a lot, communication with suppliers is key. You're dealing with different cultures, which you have to bring together. Knowing each other and knowing what you can expect from each other, trying to decrease the language and cultural barriers and explaining things, eliminates a very large source of risks. It's simple: communicate! This makes a lot more possible. Communication about emerging problems, potential delays etcetera. Without communication, things go wrong." • "It doesn't matter where you purchase your goods, it can be China, the Netherlands or Timbuktu, as long as you are open and clear about what you're doing"
	Supply base design	• "For instance for steel constructions in the far east, I try to limit my supply base to one or two suppliers. I don't feel the necessity of approaching a lot of suppliers as it is the strength of the cooperation that makes it successful or not." • "Global sourcing is something we are very active in and within CONST will only grow." • "Local sourcing we also do a lot, as we often work in countries far away. Local sourcing can be very beneficial there. You need to keep the local suppliers as a friend is my experience" • "Combining local and global sourcing is best." • "Depending on the product type, it's multi sourcing or single sourcing" • "Single sourcing is not very useful for us,. As we work in all parts of the world at the same time we cannot source a specific type of product at one supplier. That's also the reason why local sourcing can be beneficial, as we source some products per project locally and therefore use multiple sourcing. It depends on the region and the availability where we purchase it." • "We are aware of multiple supplier options as they often have limited capacity and limited possibilities. As we do not buy products from the shelves, and everything is custom made, we sometimes have to switch between suppliers. Therefore multiple sourcing in general this works good for us but only before we start a project. Once it's started, not anymore." • "We try to keep our supply base small, but this is a hard exercise because of the nature of our business. I know that within CONST it is a active strategy, but I also know in practice it is actually not possible."
	Supplier cooperation	• "In my view the construction sector is quite immature when it comes to early supplier involvement. Speaking on behalf of CONST, we lately worked on a complex project where we involved the supplier from the early start as a strategy to mitigate risks. I can see that it works and creates opportunities for us and our supplier. We build in strategic conditions and cooperative KPI's to all benefit. I know the construction sector in general is more reluctant in such form of supplier cooperation. We see the benefits such as excluding risks." • "This for us is still in development stage, the entire organization needs to be able and supportive and this is often not yet the case." • "For instance for steel constructions in the far east, I try to limit my supply base to one or two suppliers. I don't feel the necessity of approaching a lot of suppliers as it is the strength of the cooperation that makes it successful or not." • "As we work on very specific projects with specific products we have to assess our suppliers before we start working with them. We cannot easily switch our supply to another supplier in case something goes wrong or he goes bankrupt. Therefore the assessment in advance is a very important strategy." • "I had an experience where something went wrong in the production process with severe implications due to bad communication. At that point, there was only one thing I could do: grab a flight and go there immediately. Making sure people started talking to each other again, having dinner together and aligning opinions. Making sure people trust each other. This ensures you the highest possibility your product is good and delivered on time. I experienced this a lot and it helped "
	Supply chain visibility	• "Supply chain visibility is very important for us, for our major materials. If we buy a steel construction we know from day to day what its status is because we control it, send someone and know the details. We know when it leaves, we have a quality inspector there who will be present at the loading and unloading, we monitor this very strictly. Because of planning, but also because of damage and quality." • "This is not done with special technology, but we have our people in place. Via e-mail and reports we keep each other up to date. We have a procurement system showing the status of deliveries and also all reports are documented here." • "If a supplier is working on a critical component of a project, and I am not aware of his operations, I would be fooling myself. I have to make sure my people are present there, continuously monitoring. We're talking about risk of millions of euros, so you demand control there "

Supply chain complexity as moderator	• "The world is getting smaller. What I see is the benefits of cutting out trading houses as middle men. When we buy our goods directly at the source, we have more control and can ensure it follows our rules and procedures. We now communicate more with our suppliers, have more influence on the final product and save costs on brokering. The extra attention we have to give it know would otherwise be lost in extra costs for the i.a. broker." • "The complexity remains the same, but we are doing more ourselves and our tools become better. We now have an ERP system to follow and record the business" • "Requirements of our clients become harder, competition is increasing. But I do not see the complexity increasing risk or making risk management harder to execute."

Case overview of DIARY

DIARY – "as is"	*This tabular overview of the DIARY case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• "I'm responsible for the ingredients business group. There we have do deal a lot with this matter (supply risk) as we have to make sure we get the right raw materials, right packaging, in which we face disruptions in our logistical processes. Disruption in your logistical process means, put it simple, no delivery to your customer." • "It's not the only risk. We deliver various products. One of those are ingredients for infant nutrition. This is very much subject to regulations. You need a lot of certifications for this, and what makes it very complex, is that changes are not easily accepted which makes your risk profile a lot higher. If there's something with a high risk profile, it's infant nutrition, so we very closely monitor this. The quality requirements are very strict which makes it very specific and hard." • "Looking at our portfolio, 75 to 80 percent has similar specifications, single sourcing without many alternatives."
Organization's definition of supply risk management	• "People are busy with supply risk management, but not always under this name."
Organization's supply risk management practice	• "It's not the only risk. We deliver various products. One of those are ingredients for infant nutrition. This is very much subject to regulations. You need a lot of certifications for this, and what makes it very complex, is that changes are not easily accepted which makes your risk profile a lot higher. If there's something with a high risk profile, it's infant nutrition, so we very closely monitor this. The quality requirements are very strict which makes it very specific and hard." • "Looking at our portfolio, 75 to 80 percent has similar specifications, single sourcing without many alternatives. Disruption in this is large." • "We have a program called the Supplier Contingency Program. I'm currently busy developing a new version of this." • "There where we have high risks, we have taken good measures. Think of consignment stock, extra inventory, things like that. But I want to take it to the next level as I believe supplier contingency is part of your entire supplier relationship management rather than an individual thing." • "I don't think that if you have single source supply, developing a second supplier is the only solution." • "Regarding important final products, I think you should not always develop a second supplier, as with this you have the chance of throwing away your margins in the sales market." • "We have a supplier program in place to help developing suppliers enhancing their products and production." • "For me, supplier relationship management is part of supply risk management. Here we look along two axes, on the one hand what volumes can a supplier produce and on the other hand what innovations can he bring, and do we see this add the value we need and does it concern a relationship that should be managed by risk management."

DIARY - testing the conceptual model		*This tabular overview of the DIARY case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• DIARY has a quite mature supply risk management practice, although it is currently in a transition phase to a different approach. From a management perspective, the importance of supply risk management is acknowledged, demonstrated by various initiatives.
Theoretical supply risk management strategies	General	• "These strategies differ very much for direct and indirect procurement, this is managed differently, also from a risk analysis perspective. For instance for direct you have an supply agreement that ends at a certain point in time. When looking at indirect procurement, and in your Kraljic's matrix you're in the upper right corner, the moment you sign the agreement, you have a very large supply risk, as you work with one supplier for one service with whom you have to deal an X number of years, with no possibility to switch. You buy a machine, and that can only be serviced by that supplier. The supply risk aspect is completely different compared to purchasing raw materials. There in your contract you can say, I have three alternatives. If you buy a machine with a specific service, forget it, then you have a lock-in."
	Supply base design	• "We have both global and local sourcing, its simple, last year we initiated global categories" • "Global gives you leverage, from a pricing perspective, we have a relation with a supplier in oil and vitamins, who's very large in Europe but rather small in the U.S. We don't have leverage in the U.S. but via our global contracting we do have it, providing us better service and attention as compared to the situation with only a local contract." • "In case of a risk, this is better managed as from your framework agreement, you're top priority compared to being somewhere low on the list. Absolutely." • "Local sourcing we do as we often have a global framework agreement with local tandems attached for local situations that can be different." • "Single sourcing now is seen as a necessary evil, but I try to teach my people that it can also be an opportunity. Purchasing a good single sources but selling it also single sourced (business to business) this can also be a tactic to protect your margins. The moment you start developing your supplier base and more of the product becomes available on the market, it can mean it becomes available for your competitors as well, which can lower your own margins eventually. This is a mindset I try to move people into. I don't see it as a necessary evil." • In case of single sourcing, DIARY always checks and ranks suppliers on production lines and if they have one or more production locations. It's not a strict prerequisite. "If we need that supplier and he has only one production line, we are unlucky. But what we then do is try to help and develop this supplier creating either another production line or an extra location." • "We have suppliers labeled as alternative supplier who are not yet screened, but we know they can be a back-up supplier. If we need them, we immediately conduct the screenings." • "Supply base reduction is not a goal on itself, it should not matter how many suppliers you have as long as they add value." • "Upfront an external party conducts a screening, and supplier sign our code of conduct etcetera. During agreements, random checks are executed."
	Supplier cooperation	• "I don't think that if you have single source supply, developing a second supplier is the only solution." • "We have quite a unique position, with clients who are also our competitors. Then you can look at programs and supplier development initiatives to see how you can develop your supplier." • "Here at DIARY we say, you should check whether a relationship adds value. If a relationship adds value, its good, if not, you should consider saying goodbye to each other." • "For me, supplier relationship management is part of supply risk management." • "The suppliers we conduct supplier relationship management on can also be small suppliers of whom we expect innovations. It is not restricted to volume, but to potential added value." • "Currently upstream integration with suppliers is in progress, we do this with suppliers that can add value through innovations"
	Supply chain visibility	• "We are an organization we call *from grass to glass*, we have the full supply chain in-house. We very clearly know our supply chain. Of course we do buy raw materials from other supply chains, but many of that are also under our management. This means the necessity and urgency for this topic (supply chain visibility) has not been high, but now is picking up because of consumers becoming more and more demanding regarding product origin and visibility." • "Only where necessary for certain innovations and developments"
Supply chain complexity as moderator		• "Yes and no, I think our supply chain has been complex ever since." • "I think new technology solves current complexity, but new technology also brings new complexity. This makes me believe that as a result it remains the same."

Case overview of FACIL

FACIL – "as is"	*This tabular overview of the FACIL case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• Liability in the supply chain • "Sustainability of suppliers, corporate social responsible procurement" • Quality and on time delivery of ICT tools and systems

Organization's definition of supply risk management	• "We try to guarantee at the source, regarding client contracts we try to place the risk as much as possible at our suppliers."
Organization's supply risk management practice	• Suppliers in ICT are checked via external audits. • "Suppliers in facility goods and services are contacted on a monthly basis or by an independent scan, scenario analysis, back-up possibilities and pace of availability and employability" • Suppliers are sometimes checked via independent external bureau on financial health. Compliance with local and international law and regulations is tested via tender rating, in conversations and in formal annual accordance. • "Lately we hired a risk and compliance employee who looks at the agreements we sign with our suppliers, these are very actual themes." • "Supplier risks need to be covered up front." • "We have KPIs to measure how fast we can be back in operation again if something happens in our supplied systems, where is the data, how fast is it available, how are the contingency possibilities of the supplier etcetera? This we test via scenario analysis. This is mainly relevant for IT suppliers." • "With our other suppliers, for instance for office suppliers, we have arrangements and a monthly reporting. But this is less sensitive than our core business of services"

FACIL - testing the conceptual model		*This tabular overview of the FACIL case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• The interviewee reports on a quarterly basis to the CFO who reports to the Executive Board about supply risk management. This indicates the importance • "Compared to five years ago, when I started in the procurement division a lot has been improved. We started a contract- and supplier management practice whereas before it all depended on just sending invoices." • "In 2012 we centralized FACILs procurement and IT operations which has benefited us a lot. FACIL is a holding company consisting of 170 organizations, so centralizing these processes helped us a lot compared to the individual practices before."
Theoretical supply risk management strategies	General	• The majority of our spend is in facilities procurement which does not harm the continuity of our core business.
	Supply base design	• "For our strategic suppliers we have back-up suppliers, but we do not have many strategic suppliers. For the other suppliers we don't, they are easily exchangeable. For instance for the workwear of our employees and our IT suppliers." • "For strategic products and services we work with dual sourcing in supply. This is not because of the limited availability but because of our own wishes."
	Supplier cooperation	• "I think that if you work on a long term relationship, you should be discussing other matters than solely contractual agreements. But in this cooperation, the risks should be covered up front which is done by our legal department. You have to make good agreements with your partners, but everything you obtain after the partnership is started is pure profit for both parties." • "Such strategic partnerships are not per se a risk management strategy, but they do have a negative impact on supply risk which is nice."
	Supply chain visibility	• "It all starts with trust, and for this you have to be able to open the door for each other and give insight in your operations." • "From a CSR perspective we would like to have more insight in the supply chain. For instance for the clothing, I need to know where and how this is produced. In this market I need visibility in the supply chain, but for many of our other products this is not relevant at all." • "But for the case of clothing, which is very important for us we even sent a colleague to India to personally check the working conditions together with our CSR manager. This helped a lot."
Supply chain complexity as moderator		• "As an organization we have grown a lot in the professionalization of procurement and contract management in the last six years. Before we didn't have a lot of contracts with suppliers and now we have secured that quite well and I see we are very alert on potential risks in that matter. We cover the risk well." • "Since we have decent contract management, we see a lot of benefits and build relationships with suppliers. In the past, after the payment of an invoice we were handed over to god's mercy."

Case overview of FRAGR

FRAGR – "as is"	*This tabular overview of the FRAGR case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• Single sourcing. "For indirect procurement, we purchase quite specific machines. At some of those in my portfolio we have a single source. For instance our sampling machines comes from only one supplier. If occasionally a delivery is delayed or postponed, it's not a big deal. But if it stops working, we have a problem. As making samples is a very specific and costly operation, we cannot easily shift production to another location. Also, by standardization of our work, these machines have to produce exactly the same output in all our locations across the world. We cannot permit any differences in output so we need to work with the same machines" • "Also single sourcing of very specific raw materials of which the harvest can fail" • "I'm a great fan of dual and/or multiple sourcing, but the market must be suitable for it" • "For instance, the quality of sugar is standardized across the world. Then you shouldn't work with single sourcing. You should have at least two, three suppliers, depending on the potential risk. Even if it's one of these firms has a fire, they can be out of production for several months. Then you need to have your alternatives in place."
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• "What's unique about our supply chain, as we are a medium to large organization, is that as we use very specific products that are highly concentrated, resulting in our supply base being very scattered and consisting of many different small farmers and suppliers. We have a very long tail with a lot of small materials requiring a lot of personal attention. Therefore relationship management is very important for the continuity of our supply chain." • "Especially in indirect procurement, we are not yet very mature. It's my responsibility to get it on the right level" • "We lack a decent documented approach in indirect procurement. I recognize the value of decent risk management plans." • "It's always a bit of a fight between finance and procurement, regarding safety stock, working capital. For which materials is it useful to create more stock? Do we allocate the extra stock in the supply chain? We have several methodologies." • "Due to our forced single sourcing in some product categories, we have to be alert on suppliers financial health and run assessments on this. On an annual basis we check the balance sheet, PNL based on the annual reports " • "For our category managers, risk management is a very important task of their daily activities. Assessing suppliers, benchmarking them, checking their track records, financial health. This is important before you offer a concept to the executive committee asking for their approval. We're talking contracts of 30-33 million. These are organization changing decisions. That's why you exactly need to know what your supplier is doing and is able to do." • "We start with a financial analysis, then we visit the companies to benchmark them, investigating the operational processes, eventually we rank our suppliers to come to a decision." • "If we select a new major supplier and we do not immediately capture this in contracts, we don't have control." • "In contracts, we agree that we have the right to execute audits" • "Currently we are busy setting up a supplier risk management program. Do we already work with supplier risk management? Yes we do. Is it fully implemented in the organization? No. Every category manager is doing this in his own way. We now have somebody who is going to develop a more structured program. Segmenting suppliers, how do we treat them, degree of risk. We are looking if we can develop and/or implement a tool for this."

FRAGR - testing the conceptual model		*This tabular overview of the FRAGR case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• Top management at FRAGR is informed swiftly about certain supply risks, especially in the case of their critical raw materials. For direct procurement, management support seems to have a stronger enabling effect than for indirect procurement as the interviewee stated "in indirect procurement, we're lagging behind a couple of years."
Theoretical supply risk management strategies	General	• "FRAGRs supply risk management are different for each procurement strategy, which is divided in raw materials for flavors, raw materials for fragrances and indirect procurement. As for indirect procurement, in general, it's is quite easy to find alternatives." • In direct procurement (raw materials), FRAGR works with many specialized products and materials, making the procurement and sourcing operation a lot more complex. The indirect procurement department is more busy with reducing costs, and reporting to the CFO, the direct procurement operation is more cooperating with the business units and interested in the product costs.
	Supply base design	• "The complexity of regional regulations and quality standards enforce us to adapt parts of our product portfolio sourcing to a regional or local level, whereas for the bulk goods we see that large figures enable us to purchase on a global scale. If you try to sell your product aligned with German hygiene and quality standards in Egypt, you won't sell a thing, it's way too expensive." • "For fragrances, apart for the very special products such as vanilla, most raw materials are sourced in bulk quantities and on a global scale. For the flavor department, more or less half of the products is

		sourced on a global scale and the other half on a regional or local scale. For indirect procurement, we have a large spend global. But this does not always work. Therefore, we implement a combination of global and regional/local sourcing from a cost, reaction time, supply chain risk and working capital perspective." • "Single sourcing only if there's no other supplier or if we standardize our operation on one type of machine because of patents" • "Our purchasing volumes are not shockingly large, so it doesn't work to source at let's say five different suppliers. If I allocate it at two, it's important we still stay in good relation with all five. Would it be necessary to change suppliers for whatever reason, we need the relationship to be on a good level. For instance if we need to purchase quickly, or we have a new customer with specific requirements."
	Supplier cooperation	• "Relationship management is one of the most important factors. As a harvest in a certain market is failing, we sure we still get the best a supplier can produce as we make sure we are preferred. We achieve this via a strong relationship. With specific types of raw materials we sometimes also see single sourcing, as for some goods we only buy a couple of grams." • "Our purchasing volumes are not shockingly large, so it doesn't work to source at let's say five different suppliers. If I allocate it at two, it's important we still stay in good relation with all five. Would it be necessary to change suppliers for whatever reason, we need the relationship to be on a good level. For instance if we need to purchase quickly, or we have a new customer with specific requirements." • "Currently we are busy setting up a supplier risk management program. Do we already work with supplier risk management? Yes we do. Is it fully implemented in the organization? No. Every category manager is doing this in his own way. We now have somebody who is going to develop a more structured program. Segmenting suppliers, how do we treat them, degree of risk." • "Our industry is quite small, at conferences we always meet the same parties. So you automatically develop relationships with parties and this enables early supplier involvement. In this way we also have relationships with suppliers we may not directly need, but we might need if the economy starts booming. Therefore we always keep talking with them." • "Early relationship development and personal relations in our industry are very important. RfP's are only to create a base, after that we always keep talking. This is mainly interesting for our smaller suppliers, of which we have a lot. It holds to a lesser extent for for instance the large multinational chemical suppliers." • "In the fragrance industry, everybody knows each other. In the flavor industry, the majority does." • "Our industry cannot be seen from a commodity perspective, and does not allow for standardization. It is not a market of large numbers. One of our category managers twice a year travels the world to visit small farmer's, making such specific products we buy in kilograms on an annual basis"
	Supply chain visibility	• "Such strategies are used for our raw materials division." • "Traceability in the supply chain for us is evident. This has to do with the country of origin, especially in the flavors industry. This supply chain must be visible" • "Currently we are busy with our suppliers to allow them insight in our consignment stocks. In that way they have insight in our needs and inventories and then they are responsible for this stock being in the right place at the right time." • "In sharing private information with suppliers, we are very reluctant" • "For our worldwide air and ocean transportation, we work with one logistics supplier. Here we are very transparent and open, to make sure everything is delivered on time and suppliers can proactively react to the actions we take. As logistics directly concerns our product, here transparency is very important. For the rest, the commodities its less relevant. If you receive them tomorrow its fine, if you receive them the day after tomorrow it's also fine."
Supply chain complexity as moderator		• "The complexity of regional regulations and quality standards enforce us to adapt parts of our product portfolio sourcing to a regional or local level, whereas for the bulk goods we see that large figures enable us to purchase on a global scale. If you try to sell your product aligned with German hygiene and quality standards in Egypt, you won't sell a thing, it's way too expensive." • "For indirect procurement, I don't see the complexity changing a lot, apart from consolidation in the logistical sector. I would say it's pretty stable." • "For the raw materials I would not exactly know this. But I don't think in our industry this is very much the case."

Case overview of FINGR

FINGR (1) – "as is"	*This tabular overview of the FINGR case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• "The risks that you do not get your product delivered on time when you need it." • "Especially from a purchasing perspective, supply risks are strongly inbound related, ensuring your deliveries are received on time and complete. Everything that can adversely impact this, are the risks that you should try to mitigate. You should keep stocks as low as possible which means you have to organize your supply chain as efficiently as possible."
Organization's supply risks	• "There is an incredible amount of risks we experienced or potentially experienced. These range from: bad weather and therefore the unavailability of trucks. In the past we had a factory in China where it was snowing so heavily that when we needed a continuous flow of products, we had to divert to local suppliers due to the weather conditions there. Another one is related to strikes, this causes problems in for instance France due to closed highways. It can also be a production problem at a supplier or a force majeure. It can be incredibly many different risks." • "The biggest risks at this moment are all related to the environment and this impacts the entire market."
Organization's definition of supply risk management	• Not present

Organization's supply risk management practice	• Risks are not precisely measured or quantified but Kraljic's matrix is used to motivate decisions which are mostly judgement call • FINGR implements risk assessment and mitigation plans. These are build up from their production facilities and involve supplier and product evaluations to identify potential hazards. This is documented and executed by the three purchasing teams of which this is an essential part of their job. With this, risk profiles are created and mitigating actions are decided based upon those. • In the search for potential suppliers, FINGR first ask them to fill out the supplier code of conduct. Next, they are asked to do a supplier self-assessment. Afterwards, FINGR has the possibility to do an audit to verify the received results about their sustainability level, treatment of people and environmental footprint. • "This helps mitigating two risks. On the one hand, FINGR as a company does not want to work with parties that do not meet sustainability requirements for ethical purposes. This can lead to for instance reputational damage.. On the other hand, considering for instance the Blue Sky program in China, these suppliers have a serious risk of their operations being shut down by the government because they do not meet sustainability requirements. This can cause scarcity and unavailability of products which with this strategy we prevent ourselves for." • "Sustainability is a very important topic within supply risk management for us" • "A very upcoming initiative is the CO2 reduction strategy. FINGR is also committing to this. This means not only reducing our CO2 footprint, but also the ones of our suppliers. We hope this works all the way up in the supply chain, via suppliers discussing this with their suppliers etcetera. This is an active strategy we implement. And for this we need to increase supply chain visibility"

FINGR (1) - testing the conceptual model		*This tabular overview of the FINGR case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• -
Theoretical supply risk management strategies	General	• FINGR considers the three strategies below not separate from each other, but rather different phases in one overarching supply risk strategy • "This is not a ranking but a chronological order in forming a strategy. First you need to know what your suppliers are doing and what they are able to (supply chain visibility) and supplier sustainability management is part of that. Based on that information the supply base can be designed. Eventually this supply base has to be managed and aligned with service level requirements. This enables us to reduce costs and risks in our supply chain." • Visibility of the supply chain still contains a risk, of which a part can be mitigated by supply base design. Then comes further risk mitigation by structurally managing and cooperating with the supply base. The remainder has to be mitigated internally. For instance, if a required material is very scarce or vulnerable finding an alternative material can help reducing risk. • "The choice for specific material is not part of our supply base design, as the consideration is made in our internal organization. We have to check whether this material is scarce or not, is subjective to regulatory issues and so on. Once we know this, we start looking for suppliers. However, we can ask our current suppliers to start working with alternative materials. This is then part of the supplier cooperation strategy"
	Supply base design	• "Searching for possibilities to consolidate production of various products at our existing suppliers and therefore reducing the supply base is a very active strategy at FINGR. But its global sourcing per definition. You still need to have your alternatives" • FINGR is well-aware that a good relation is necessary especially with bottleneck and strategic suppliers. The challenge in this is a combination of high risk and low spend, which causes the FINGR to have a low leverage. • FINGR sees a strong benefits of dual (or multi) sourcing over single sourcing in terms of potential risk reduction as some of their required materials are very unique and the number of suppliers is very limited. However, this needs to be aligned with their strategy of creating more leverage at bottleneck suppliers in order to increase influence in supplier operations.
	Supplier cooperation	• This very strongly coincides with supplier relationship management. "If you have a good and strategic relation with a supplier, you can get a lot more done than if you minimize this relation to a transaction solely". • "FINGR is eager on building strong relations with our suppliers, but is also well aware this is not possible with a supply base of 400. Therefore we combine this cooperation strategy with supply base reduction." • "We are implementing supply base reduction to build a better base. We cannot build 400 relations with a team of 15 people" • FINGR is well-aware that a good relation is necessary especially with bottleneck and strategic suppliers. The challenge in this is a combination of high risk and low spend, which causes the FINGR to have a low leverage. • "Single sourcing preferably not, but for small bottleneck suppliers you won't find two, three or four suppliers for products where you have already very little spend."
	Supply chain visibility	• "A very upcoming initiative is the CO2 reduction strategy. FINGR is also committing to this. This means not only reducing our CO2 footprint, but also the ones of our suppliers. We hope this works all the way up in the supply chain, via suppliers discussing this with their suppliers etcetera. This is an active strategy we implement. And for this we need to increase supply chain visibility." • FINGR's CEO is a great supporter of a high CO2 per ton emission price. The organization organizes its operations and costs based on a fictive CO2 emission price that is almost ten times higher than the current level. This helps to build in flexibility, anticipate higher CO2 emission fines in the future and causes incentive to lower CO2 emissions before the government takes measures. The risk of production shutdown or high fines due to environmental violations are anticipated.
Supply chain complexity as moderator		• "The complexity of our business and supply chain lies in the large amount of small but important suppliers and spend at those suppliers." • "If you have a small spend on relatively unique materials with high quality requirements, your alternatives are very limited. On top of that, your attraction to the corresponding suppliers is also small"

	• "Supply chain complexity has a very large impact on all three strategies" • FINGR sees supply chain complexity also increasing due to for instance stricter regulations and increased food safety requirements. • For FINGR, a high supply chain complexity influences the effect of supply chain visibility. In a complex supply base consisting of a lot of low spend, high importance suppliers, leverage on these suppliers is low. This impacts the level of visibility these suppliers allow you to have. • "The lower your spending power, the harder it is to get insight in supply chain documentation, audits etcetera." • "The longer the tail end with bottleneck suppliers, the higher the complexity of the supply chain and therefore the more risks."

FINGR (2) – "as is"	*This tabular overview of the FINGR case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• The two major supply risks for FINGR are not being able to meet capacity targets ("If your production facility produces two percent less than expected, your sales decrease by two percent") and the market that behaves differently than expected • FINGR faces supply risks at external manufacturers, but the major current supply risks originate from internal operations
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• Basically, the practice of tolling can be seen a supply risk management strategy. External manufacturing (tolling) works in three situations. First, FINGR works with external manufacturers in the case of insufficient in house production capacity. Second, when production capacity is sufficient but technological know-how is not. Third, when it concerns a new, potentially interesting, product of which the market value is yet to be determined. In the last case, tolling is used to prevent for potential risks caused by high initial investments in new production facilities when the market for the product is not yet proven to be valuable. • "We do have a general evaluation process of what we consider a risk, but that is really at a high level. The development of this is currently in progress." • "We aim to better foresee the risks in our entire supply organization network, mainly the internal network" • "Knowing what the internal supply risks are, is the biggest step we have to take" • FINGR is currently working on their supply risk management practice by mapping risks and their potential hazard to product quality, safety, health, environment and continuous improvement. This is done with several KPI's. Also the management team should be doing well. Based on the findings a heath matrix is built. • "We do not use complex theories. We identify the factors of potentially causing risk. Then, we evaluate every toller on those factors. So it is not very complex. Every toller has a dedicated tolling manager from FINGR who works together with a quality manager and others to assess the toller. This process is mainly based on feeling, as it's not rocket science." • "We assess this by estimating the turnover of the toller, or estimating their capacity and our share in that. These are methods to get a feeling of your importance. If you use one percent, you are not important. If you use twenty percent, you are. Another example is looking at the person you are dealing with. Do you speak with the local sales person or are you at the table with the CEO? This gives you an idea of your importance"

FINGR (2) - testing the conceptual model		*This tabular overview of the FINGR (2) case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• "It is important that the management team is doing well" • "The establishment of the external manufacturing department can be seen as strategy to mitigate risk. Before, FINGR worked with external manufacturing but not with a centralized vision, structured plans and professionals dedicated only to these tasks. It was merely an ad hoc approach"
Theoretical supply risk management strategies	General	• -
	Supply base design	• "I understand the importance of strategically building a supply network. Where are my suppliers located in the world? What kind of partnership do I want? Completely integrated or not? Do I want back-ups or not? This is more a general strategy, I understand that. But even if you do so, you still have risks in your network." • Supply base design is seen as a general strategy to start with in the beginning. "This works in the beginning, but after that it helps less. Once you have a certain supply network, will not quickly change it. Especially in the case of tollers, are this is a lot of work due to all the technology that has to be implemented. You won't do this three times" • "We used to have tollers where we had risks, before this department was established. The organization was not aware of the risks, only after they saw the problems increasing but then we had no back-up. Nowadays, I make sure we have a back-up for the tollers whose performance I consider a risk. Having back-up cost money. You cannot always go to dual supply" • FINGR sometimes reduces the number of suppliers as it can become too large. It works now with around 30 tollers. The quantities and spend vary more, sometimes 50 percent up or down. The spends depend on the balance between market demand and the internal capacity. The number of tollers

		decreases when FINGR consolidates a traditionally spread base of tollers. A reason for increase is when internal capacity is insufficient. In total, the number of tollers does not vary much • Supply base design is seen as a general strategy to start with in the beginning. "This works in the beginning, but after that it helps less. Once you have a certain supply network, will not quickly change it. Especially in the case of tollers, are this is a lot of work due to all the technology that has to be implemented. You won't do this three times"
	Supplier cooperation	• "I would add supply performance measurement and improvement as a strategy, as the solution not always lies in finding alternative suppliers. Sometimes there are none, or you cannot do so. Then it is better to improve the performance together. This could be part of supplier cooperation strategies." • "Assessment of the financial situation of suppliers works well in preventing for potential supply risk"
	Supply chain visibility	• "The second, integration with key suppliers will increase. Rather than being two separate organizations, which needs to remain this way, a lot of transactions can be automated and integrated. In my view, that hardly happens." • "Integrating activities, not taking over suppliers. Sometimes you can be happy you did not acquire a supplier, as the market goes in another direction than expected. On the contrary, sometimes my needs are not large enough to run a factory. However, a supplier with different customers can do this."
Supply chain complexity as moderator		• "The complexity has not per se changed, but our knowledge and insights in all possibilities and different tollers has increased. That is the question. Because we now work in a new established tolling department, it received a lot more attention and we are more aware of what is possible and happening." • "These people where already there, but we did not know"

Case overview of MUNIC

MUNIC – "as is"	*This tabular overview of the MUCIC case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• "We don't have many issues in receiving what we required, there we have very good advisors working, who think properly about the risks we need to consider."
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• MUNIC does not have a structured supply risk management practice. It depends very much per category and project how (supply) risks are managed as many situations and projects are one of a kind. There are five domains connected to five lead buying practices: social, physical, business management, ICT and facilities. Therefore risk management is organized decentralized. • The procurement department of MUNIC is responsible for policy and control, and their work has much to do with lawfulness in the allocation of resources. • "Our project teams do consider risk, especially upfront. In the public sector we have the possibility to put down the risk to the market." • "In the process of tendering, you try to identify all possible risks upfront and then ask the market: how will you make sure we do not have this risk?, How do make sure you delivery on time? But then you're talking about the complete project result." • Risk management is mostly included in the preparations of tenders. "We have to put the market to its power to benefit from it, but this requires a lot of thinking from our advisors up front (before a tender is sent out)." • "Take for instance the healthcare, you have the risk a supplier does not deliver the required services on time. These risks are as much as possible eliminated up front. If something goes wrong, you can use your lessons learned in the new contract." • "It involves a lot of thinking ahead, with that we can prevent a lot of risks." • "The public sector requires you to think ahead at least a year before you sent out a tender." • "As the city council changes every four years, and public procurement at MUNIC is an important practice that requires continuity, risk management is organized decentralized via the specific project teams"

MUNIC - testing the conceptual model		*This tabular overview of the MUNIC case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• Not present
Theoretical supply risk management strategies	General	• Not present
	Supply base design	• "Tender law is basically the way to prevent supplier dependency and sourcing. If there's only one supplier, you don't have to send out a tender, because your market mechanism has failed. I can imagine some very specific products, for instance regarding safety, national security matters. • If in Europe more cars are used in terrorist attacks, MUNIC can always make a quick call to order concrete blocks to close squares and open spaces. Such things can always be done. • Also, as a public organization, MUNIC has the responsibility to benefit the local economy. They have no incentive to give one supplier a mega order and finding after three years the possible alternatives are bankrupt. They have a responsibility of behaving socially and socially allocating

		resources. This to a large extent determines their sourcing strategies. It involves a lot of long term thinking
	Supplier cooperation	• Not present
	Supply chain visibility	• Not present
Supply chain complexity as moderator		• Not present

Case overview of OFFIC

OFFIC – "as is"	*This tabular overview of the OFFIC case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• Availability of products • Reliability of deliveries • Quality problems • Single sourcing. "Is one of our largest risks, as we have only a handful of suppliers that can supply what we need. This has to do with technical requirements and order size. In terms of Kraljic, they are all the way up and right" • "Our suppliers also deliver to automotive and kitchen companies that are a lot bigger than us. As we and they are in a cyclically sensitive business, and the economy is picking up, it can happen we are last in line when we need something from our suppliers. The automotive and kitchen industry purchases a multiple of what we do."
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• "OFFICs procurement practices is very immature." • "Last year we started with some checks and balances." • "Availability of products comes first, then price and then quality." • "Our suppliers also deliver to automotive and kitchen companies that are a lot bigger than us. As we and they are in a cyclically sensitive business, and the economy is picking up, it can happen we are last in line when we need something from our suppliers. The automotive and kitchen industry purchases a multiple of what we do." • "Then it comes down to the relationship, which is in general quite good, also because we are a relatively old company." • "We do a credit check at our suppliers, that is the only thing we do in structured way. A financial analysis. Furthermore we have a subjective analysis, as I call it, that is, by the way, good. The men who are doing this work long for the company, as much as twenty or thirty years. Based on experience and knowledge they can assess whether a supplier has its things in order. But this is not documented in a structured way. It's hard to implement this. You cannot teach an old dog new tricks."

OFFIC - Testing the Conceptual model		*This tabular overview of the OFFIC case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• Not present, absence of supply risk management practice
Theoretical supply risk management strategies	General	• "Procurement in our organization and industry is very immature"
	Supply base design	• "In an ideal situation we would see dual sourcing. But this is hard, all products we sell are uniquely designed and not modular. As our products are designed right now it doesn't lend itself for dual sourcing." • "Sometimes we have a product that can only be produced at one or two suppliers. Then it turns out these suppliers are our direct competitors. Then it depends on your own philosophy whether you want to do business with them or not. I'm convinced we don't make the difference at the production side, I think we should make the difference at the front side, our sales, our reliability etcetera. But apparently people in this organization do not want to buy at our direct competitors. Then you have even less choice." • "I think we can easily reduce our supply base from 1200 to 3-400 and start outsourcing a lot more. One specific screw is purchased at one supplier, we need parties that take care of this. The whole long tail of suppliers disturb our processes, outsourcing this creates more focus and reduces risk."
	Supplier cooperation	• "Then it comes down to the relationship, which is in general quite good, also because we are a relatively old company." • "We do a credit check at our suppliers, that is the only thing we do in structured way." • OFFIC has experienced buyers who can be seen as actors in supplier relationship management, they know their supplier very well and can rely on them if something goes wrong. This helps in risk reduction but is organically grown, not an active strategy.
	Supply chain visibility	• "Relatively few information is shared with suppliers. We have a handful strategic suppliers with whom we share more and more information. But there's a lot of suspicion in our industry. Everybody has set up everybody at least once in the past." • "I'm a fan of sharing information and start developments together with our strategic suppliers. All the rest, we don't have to share with, they're replaceable in my view."
Supply chain complexity as moderator		• "I don't think complexity is changing and influencing our risk. We have quite a traditional industry and the customers' needs are not much changing in that." • "Law and regulations are requiring more. The European Union is demanding more from us regarding sustainability for instance."

Case overview of REALS

REALS – "as is"	*This tabular overview of the REALS case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• "Brand protection, anything that can happen at our suppliers that could potentially put us in bad publicity." • "Risk of suppliers becoming too dependent on our organization and bringing themselves in financial danger." • "The most risks we have in supply are in the area of HSE (health, safety and environment) as in the basis with purchases services we do not have the problem of unavailability." • "Our largest risk is that suppliers are not aboard on time. " (Registered and checked in the supplier portal, which enables the possibility to send out purchase orders). "Sometimes we have to register a couple of hundred suppliers I a few hours which not always goes well. Especially if the screening shows adverse outcomes."
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• REALS has a sophisticated supplier portal system in which all suppliers and their required data have to be documented. For clients with higher supplier requirements this can be adjusted in the system. In this way risks at suppliers are flagged before cooperation starts, as suppliers have to be documented into and checked and verified by the system before for instance invoices can be paid. • "REALS employees cannot interact with suppliers that are not in the system. This practice includes a check on bank accounts, certificates, chamber of commerce registration et cetera. This is double checked by our central supplier assessment team in Poland. If one of the items is a potential problem, this is flagged and the original local requester has to give an approval on this deviation or make sure his requested supplier meets all requirements. The system also automatically request suppliers to update insurances and other relevant documents as it keeps track of termination dates." • "We test and document many parts of a supplier" • "We assess our share in the suppliers revenue to make sure we are not too large, because then a supplier becomes too dependent and if our work with them is over they might get into trouble. Our client can become too powerful compared to their suppliers. " • Example: "We advised a large client that had a strong preference for a medium sized facilities supplier to consider a larger supplier because of potential dependency issues. If this is a large client it can matter a lot, even more when REALS is involved too." • "We also asses our suppliers HSE (health, safety and environment) on a point scale, on financial health." • "We invest quite a lot in supply risk management up front, rather than facing the risk working with bad parties and having to repair the damage afterwards." • "We can only work and send out purchase orders to suppliers entered in the local database, which is part of the national database which is part of the global database. In this way we ensure we know the parties we work with"

REALS - testing the conceptual model		*This tabular overview of the CABLE case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• "Clients chose for our business because they know we can deliver a guarantee on security at suppliers, due to our (advanced supplier) system. It is enclosed in our company statement that in this way we pursue the protection of our brand. This is also because we're a technical firm and cannot permit ourselves any mistakes. Our accident rate is very low, all these things result from decent risk management. This includes not working with suppliers who mess around." • "The preferred supplier events are procurement driven by heavily supported by the top management of our organization because it works."
Theoretical supply risk management strategies	General	• -
	Supply base design	• Multiple and dual sourcing are used by REALS but not specifically as a strategy to mitigate risk
	Supplier cooperation	• "We only work with suppliers who are capable of working with us in terms of capacity and profitability. If they do not make any profit from our orders, we do not work with them as it becomes a risk too much. Running projects while making losses, doesn't work. Especially not in our service sector" • "Early supplier involvement is something we always do. They have to be aboard and checked before we bring out a quote to our clients" • "Currently we are starting up our supplier relationship management program on a local scale. We are organizing events where all our preferred suppliers are invited as well. This is quite unique in this form. We also have breakfast meetings every three months. During these meetings we discuss what we are doing, what are our plans and innovations etcetera"
	Supply chain visibility	• "Such strategies are not very relevant for REALS"
Supply chain complexity as moderator		• "Lately we see a lot of consolidation in the market. Normally we spread our risk by sourcing from multiple suppliers, but when firms are acquiring each other this gets harder."

Case overview of TRAVL

TRAVEL – "as is"	*This tabular overview of the TRAVL case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• "The core risk we face at TRAVL concerns our association's image. This might result from other risks in the supply chain." • Example: Supplier of our travel services in potentially risky countries such as South Africa. If something happens to TRAVL's customers due to inadequacy or irresponsible behavior of such suppliers, they can face big problems and negative media attention and lose members. This is a risk that cannot be caught in a contract, even if you put all the risks at the supplier/agent, TRAVL still gets the negative publicity. • Supplier bankruptcy • Risk of not being able to provide back-up supply
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• "We are an organization with quite some attention for procurement, purchase procurement and risks but it's not the most important " • "As to this point, the attention supply risk management receives within TRAVL is insufficient but due to some incidents that took place last year now its suddenly on a sort of agenda but people have no idea of how to solve this, and if people will actually do this." • "No categorization of suppliers is present. We are busy categorizing suppliers and supply risk. The management of different suppliers can vary from only analyzing the contract, but at some suppliers we will execute assessments more frequently and thoroughly. Currently, I'm developing this framework." • "Designing a nice framework is one thing, but motivating and convincing colleagues to use it for supply risk management is another."

TRAVL - testing the conceptual model		*This tabular overview of the TRAVL case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• "We are an organization with quite some attention for procurement, purchase benefits and risks but it's not the most important." • "Audit and risk have attention for this, and have appointed and communicated supply risk with our board of commissioners to make them aware of the risks."
Theoretical supply risk management strategies	General	• -
	Supply base design	• "We need to purchase some services globally as we for instance offer our travel and medical services globally. If something happens to a customer in the United States we cannot ask him to come to the Netherlands for treatment. Is this a sourcing strategy? You could argue it is." • "Multiple suppliers is always preferred, as long it is justifiable in a cost management perspective. We always have to make the tradeoff between costs and the level of risk that is reduced by making those costs."

	Supplier cooperation	• "The supplier screening upfront we do quite well, but I think more attention during the duration of a cooperation is a point of improvement."
	Supply chain visibility	• "In some products, such as cars, there are components used you can be certain of this is made from materials of which cannot be guaranteed they are completely sustainable. You cannot influence this as you as purchasing partner does not have the buying power to change the car suppliers behavior. This needs media attention and starts growing in people's minds first." • "Visibility in supply chain is only useful in our retail domain."
Supply chain complexity as moderator		• "Complexity decreases as transparency increases, this makes it easier to manage risks. However, data usage and data risks can complicate matters."

Case overview of TRNSP

TRNSP – "as is"	*This tabular overview of the TRNSP case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present, but it is recognized as a specific point of interest as TRNSP is obliged to work with tenders and follow tender legislation
Organization's supply risks	• Continuity of suppliers (operations) • "We are subjected to strict safety requirements, which bring risk"
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• "We are subject to the European tender law. When we send out a tender we check what can be possible alternatives, how easily can a supplier be replaced. A tool helps us finding out. We have a check list consisting of criteria, also switch time etcetera. If these criteria show a high risk, we know we have to put extra financial requirements in the tender. If the risk is medium, you can consider it and if risk is low, then you don't add these extra criteria. These assessments we execute ourselves via a sort of decision tree." • "We also check and assess for other risk, which are of course different per product you purchase. If a product or supplier is strategic and very important, we can use a risk manager to make a risk analysis. The risk department is centrally organized at TRNSP and can always provide assistance when needed." • "In writing our tender plan, we always have a lot of attention for risks to take into consideration. Our tender board oversees the correctness and transparency of these tenders, procedures and documentation before a tender is sent to the market. For internal control and making sure we follow the law" • "But we have a high level risk matrix for strategic risks to see what risks are relevant in the sourcing process and which ones in the contract management. This shows us which risks have a high impact, for these we have KPI's"

TRNSP - testing the conceptual model		*This tabular overview of the TRNSP case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• "We do not have a reporting scheme to report supply risks to the board"
Theoretical supply risk management strategies	General	• -
	Supply base design	• "As we are subject to European tender law, we cannot discriminate suppliers based on geographical location. Unless the execution of our service leaves no choice." • "Within our organization the number of suppliers we request to send us an proposal, depends on the amount spend. Below 50.000 euro, only one request for proposal is required, between 50.000 and 100.000 three to five and above 100.000 euro five or more." • "When a tender process is started, we can start different types of procedures. First you can do a selection of suppliers, and consequently a proposal phase, but you can also do both. But in the selection phase, you check references and communicated requirements a supplier has to meet in order to participate in the proposal phase."
	Supplier cooperation	• "We also check and assess for other risk, which are of course different per product you purchase. If a product or supplier is strategic and very important, we can use a risk manager to make a risk analysis. The risk department is centrally organized at TRANSP and can always provide assistance when needed." • "It not often happens we include a multiple sourcing request in a tender plan. This depends on the size of the assignment. But this is all set from a risk assessment perspective." • "TRNSP is limited in building relations with suppliers and appoint preferred suppliers because tender law requires fair chances for every supplier interested in the tender. There are some exceptions in legislation that allow you to stay at a certain supplier, for instance because of intellectual property." • "You take a risk if you do not exactly follow the law, you can stay with a specific supplier but you have to be able to fully explain why." • "In the case of specific service or product, you can decide to work with long term contracts, in this way you can start building a cooperation"
	Supply chain visibility	• "These strategies differ per type of purchase category. For instance for maintenance our materials, we require our suppliers to make sure our inventory is always in order and sufficient."
Supply chain complexity as moderator		• Not present

Case overview of YACHT

YACHT – "as is"	*This tabular overview of the YACHT case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Organization's definition of supply risk	• Not present
Organization's supply risks	• Late delivery. YACHT works with very specific and bespoke materials, often requiring handwork. "Building a yacht takes 2-3 years, and many components have a lead time of several months up to a year." • Risk of delay in planning, as a result of the above or other incidents in the production or supply process. "If a major component is one day delayed, this means 30 people cannot do their work. That's the risk." • "Even a delayed bucket of paint can delay our production" • "As we work with very much different large and small components, we have the risk of not knowing what is where in our storage. We're talking 12.000 orders, 4.000 trucks full of components." • Supplier bankruptcy • Risk of working with innovative technology and products from immature organizations
Organization's definition of supply risk management	• Not present
Organization's supply risk management practice	• There's a difference between the procurement function for daily business which is most of the time the same and purchasing for projects. In the latter there's a difference between technical buyers and buyers for finalizing the building of the yachts. • Regarding the risk of late delivery: "We have a team of five, six people continuously trying to solve the puzzle of our project planning. This is called the building coordination. Their findings are shared with procurement, the wharf and based on that, we start working. They are continuously assessing how long certain work will take, and if the planning needs to be revised if some things are delayed" • "We do not accept delay. When something is about to delay the production of a yacht, we immediately get everybody together and make sure we have a very, very good communication. We also have project meetings on a regular basis." • "Our advanced and decent planning is helping us a lot in preventing risks in delay, ten years ago, we were working with a long list of what needed to be done. This is way better. We made huge steps in this." • "Some risks you cannot cover up front. For these you have to assess to what extent you accept these, and if they materialize, you grab them individually and try to solve them the best you can. You can make every mistake only one time, because if you've made a mistake, the next time it goes well." • Regarding critical materials a CSR perspective, YACHTs sometimes visits production sites in countries to asses if everything is according to their and general standards. Some of their customers are very concerned on this topic, and will not allow any issues in this matter • "We do not have KPI's to measure risks."

YACHT - testing the conceptual model		*This tabular overview of the YACHT case provides all relevant primary data gathered in interview(s) and is enriched with secondary data obtained from annual reports, websites and other relevant available documentation. It provides a summary of the case and follows the structure and uses the constructs of the interview protocol.*
Management support as enabler		• -
Theoretical supply risk management strategies	General	• -
	Supply base design	• "We source as many as possible locally. Our yachts have a quality label as they're Dutch. This is what our customers expect." • "We use a single sourcing strategy, knowing there are alternatives. There are multiple parties able to do the job, but from a family business and quality perspective we have a base of suppliers we always work with. These suppliers know what we need and what our quality requirements are. In the case you do this job with another supplier, they won't understand it for the first five years which means we have to invest a lot to achieve the similar results. Is this called single sourcing? I have no idea, but this is how we work with a number of our major components." • "For our standard products we need in high volumes, we use back-up suppliers. For our critical components this is often not possible. We cannot replace an engine room for another, yachts are designed based on this." • "If a supplier constantly does not meet our agreements, he goes out. If he has financial problems, we ask him "how much do we owe you, if we pay you this, are you able to repair your damage?", if so, there's a chance we are willing to help. But if he does not perform, he goes out." • "We can also threat with making claims if he does not do what we agreed upon."
	Supplier cooperation	• "I'd rather know something is going to be late in an early stage than a supplier not telling us this. This has to do with your relationship management, how you treat your suppliers. They have to be comfortable to report issues in an early stage, as this benefits everybody." • "All our suppliers have to sign our purchasing terms, stating for instance within which frames deliveries need to be done. When this is signed, we know what we can mean for each other and start working. If a supplier cannot agree, we start the dialogue to eventually find agreement. By investing in this upfront, we can eliminate risk of delays as the agreements are clear." • "We are very kind, unless you fail, as an agreement, is an agreement." • "We execute an assessment upfront with new and unknown suppliers, after we start working together, this is built on trust and experience." • "The checks we do perform, deliver us not many answers. The majority of suppliers going bankrupt last year, had passed the checks. It really is a snapshot." • "Sometimes we work with very innovative your start-ups. We check their track record at the chamber of commerce. If we see they have a very low revenue, what's worth your risk analysis? Maybe they will grow exponentially the next couple of years. You don't know. What's your risk then? That you cannot implement new innovations. We work with innovative systems as we want to be an innovative yacht builder, this involves risks you sign for if you start working with these companies." • Regarding critical materials a CSR perspective, YACHTs sometimes visits production sites in countries to asses if everything is according to their and general standards. Some of their customers are very concerned on this topic, and will not allow any issues in this matter. "We went for instance to Vietnam to check their production processes and their financial administration to assess the supplier."
	Supply chain visibility	• "We are open to our suppliers. We also need to know how they take measures to for instance data security. We cannot permit any data breaches at suppliers. We need to know what they are doing and this can only be achieved via open communication and sharing information. But this needs to protected very well. Everything is in the cloud these days, everything is open. This complicates things." • "I'm a great fan of RFID, but it can be complicated as components with RFID cannot be processed in a yacht." • "Not being able to find something is a risk, as if something is not present or cannot be found, twenty people cannot do their job. I'm a great fan, but we cannot use RFID. We use barcodes and scanners instead." • "Regarding critical materials from a CSR perspective, we sometimes visit production sites in critical countries to asses if everything is compliant with our and standards and legislation. Some of our customers are very concerned on this topic, and will not allow any issues in this matter. Going there ourselves and seeing it with our own eyes then is the only option, and it works"
Supply chain complexity as moderator		• "Because the boats are becoming more complex, and materials become more innovative, the risks are increasing considerable. It's becoming very complicated and this affects your operations."