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Factors Influencing Supply Chain Risk Management Among Norwegian Industrial Firms

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Preface

This master thesis marks the end of a two-year Master of science in Logistics program at Molde University College. The master thesis was written in the period between December 2017, and May 2018.

For the successful completion of this master thesis, I would like to acknowledge the contributions to those who took part of it.

First and foremost, the I would like to thank Berit Irene Helgheim for her assistance in finding a topic to write the master thesis about when I was at a loss before Christmas. Special thanks and appreciation to my master thesis supervisor Professor Arnt Buvik. He was of constant help and support whenever I needed, provided suggestions as to how to proceed and valuable insights in the findings of this study.

I would also like to thank Mwesiumo Deodat Edward for the help and effort he did to this work when he ran the dataset and checked its internal validity using AMOS24, which significantly increased the analysis of this study.

Finally, I would like to thank the respondents for taking time out of their busy schedules to answer the survey distributed during this study to collect the data analyzed. Without their contribution this study could not have been done.

Abstract

Purpose: *The aim of this study was to examine how various factors influence the level of supply chain risk management (SCRM) among firms operating within the Norwegian industry.*

Design/methodology/approach: *This study is based on basic theory of supply chain management and risk management, in addition to lean and agile strategies. Furthermore, this study employed a quantitative research method with a descriptive research design. A questionnaire was developed and distributed to 1351 firms, across eleven industry segments, with a response rate of 11.2%. A hierarchical regression model was used to test the hypothesized relationships because the study includes an interaction effect.*

Findings: *Risk perception, disruptive risk, and agility is positively associated with SCRM. Whereas regional production (decentralized production), is negatively associated with SCRM. Finally, an interaction effect between supply risk perception and supplier performance with respect to SCRM was found to be empirically significant. Thus, supplier performance reduces the effect of supply risk perception with respect to SCRM.*

Theoretical Implications: *This study contribute to existing supply chain risk management literature by empirically proving relationships between factors influencing SCRM. Furthermore, the setting of this study is within the Norwegian industry, an area in which there exist little previous research.*

Managerial Implications: *This study have identified factors, which significantly influence supply chain risk management. While there are several important factors, the most important factor is supplier performance, which was found to reduce the effect of supply risk perception impose on SCRM. Therefore, mangers should engage high performing suppliers, or help develop suppliers with low performance.*

Keywords: *Supply chain risk management, supplier performance, risk perception, agility, disruptive risk, regional production, vulnerability, flexibility, responsiveness, efficiency.*

Contents

1.0 Introduction

1.1 Background of the study

Current business trends to increase competitiveness and efficiency, such as lean manufacturing, increased variety of products, reduced buffers (inventory), demand for shorter lead times, JIT, globalization, outsourcing, reduced supplier base (single sourcing), are resulting in increased complexity and vulnerability of supply chains (Thun and Hoenig 2011); (Norrman and Jansson 2004); (Zsidisin and Ellram 2003); (Harland, Brenchley and Walker 2003); (Jüttner 2005). Thus, the strive for efficiency increases the complexity of the supply chains, making them more exposed and vulnerable to risks and disruptions. Recent events, such as the "The Albuquerque Accident" costing Ericsson about $200 million (Norrman and Jansson 2004), have demonstrated that a disruption affecting a link in a supply chain can affect companies' ability to continue their operations (Jüttner, Peck and Christopher 2003); (Jüttner 2005). Events such as this have increased risk awareness, and resulted in a broader focus on this area, both from an academic and a practitioner point of view. However, the concepts of supply chain vulnerability and its respective risk management is still a developing area (Jüttner, Peck and Christopher 2003); (Jüttner 2005). Furthermore, although the attention to these phenomena have increased, little research has been done to explore the current situation within the Norwegian industry. Through their Master thesis work, (Sørland and Wembstad 2016), compared inbound and outbound risk management among Norwegian manufacturing firms. They found that the companies focused more or their inbound supply risk than on their outbound delivery risks. However, they did not specify which supply risks the firms focused on, or how these risks influenced the amount of risk management the firms implemented. Therefore, the researcher is interested in examining some supply risk factors and whether they significantly influence the level of supply chain risk management among firms operating within the Norwegian industry.

1.2 Research Problem

The purpose of this study is to investigate which supply related risks firms operating in the Norwegian industry focus on and how these risks influence the level of risk management the firms engages in with respect to their most important supplier. The literature includes many approaches, first of all with respect to the theoretical point of view. As this is an early investigation into the area, this study will apply basic supply chain management and risk management theory. Second, there are many various definitions of risks and techniques to mitigate them. This study follows the work of (Thun and Hoenig 2011); (Chopra and Sodhi 2014). (Thun and Hoenig 2011) investigated various risks and risk management in the German automotive industry by analyzing the risk's likelihood of occurrence and their impact on the firm (probability x impact). (Chopra and Sodhi 2014) define two risks, recurrent and disruptive, and present two strategies avoid supply chain breakdowns, regionalization and segmentation. Recurrent risks can be mitigated through improved efficiency, whereas disruptive risk must be mitigated through increased resilience despite additional costs and efficiency loss (Chopra and Sodhi 2014). There are two widely used supply chain strategies, lean and agile. Lean focus on improving efficiency (Lee 2004); (Abdulmalek and Rajgopal 2007); (Melton 2005). Thus, making it an appropriate strategy to deal with recurrent risks. Whereas agile focus on flexibility and being able to adapt quickly to sudden changes in the market (Christopher 2000); (Christopher and Towill 2000); (Qrunfleh and Tarafdar 2013). Making it an applicable strategy to mitigate disruptive risks. Finally, supply risks are dependent on the supplier, thus this study also investigates how supplier performance affect the perceived risks and level of risk management implemented by the focal firms in the context of supply chain risk management.

1.3 Objective of the study

The objective of this study is to investigate how supply risk exposure, supplier performance and risk management techniques influence the level of supply chain risk management among Norwegian industry firms.

1. Examine factors which influence supply chain risk management (SCRM) among Norwegian industry firms.

1.4 Significance of the study

This study seeks to contribute to the research in supply chain risk management (SCRM), which according to (Jüttner, Peck and Christopher 2003) and (Jüttner 2005) is still a developing area. Very little research has been done previously within the Norwegian industry with respect to this topic. SCRM is an important approach to competitiveness, as increased integration and interdependency between firms has led to the competition moving from firm vs firm, to supply network vs supply network. Furthermore, as argued by (Jüttner, Peck and Christopher 2003) and (Jüttner 2005) risk management must be a joint effort within the supply chain.

1.5 Scope of the study

As this study seeks to investigate various factors influence SCRM among firms operating within the Norwegian industry, the scope of the study is limited to firms operating in the Norwegian industry. Thus, this study allows multinational firms to be a part of the analysis, but they must be located in Norway, and it is only the Norwegian location, which is subject to the analysis. To identify firms operating within Norway, the researcher used a database managed by Proff Forvalt. This database consists of firms operating within various segments in the Norwegian industry, provides contact and financial information, and allows the user to limit the search to specific segments or criteria. The researcher limited the study to eleven segments, Oil and Gas, Fishing, Textile and Clothing, Paper and paper products, Rubber and plastic, Electronics, Machinery and equipment, Metal goods, Chemicals and Furniture.

1.6 Organization of the study

This paper consists of seven additional chapters. Chapter 2 constitutes the theoretical framework and literature review used in this study. Chapter 3 presents the research model and its variables, additionally it presents and the research hypotheses to be tested by the analysis. Chapter 4 discuss the research methodological approach and questionnaire development and administration. Chapter 5 discuss the measurement model, defines and operationalize the variables used. Chapter 6 consist of preliminary data screening, reliability and validity assessment. Chapter 7 tests the hypotheses and presents the findings of the analysis. Finally, chapter 8 includes the discussion and conclusion of the findings of this study, and outline its implications, limitations and further research.

1.7 Chapter summary

This chapter introduced the background and purpose for this study along with its research problem and area of the study. Further, it presented some of the topics, which will be discussed during the study, and outlined the general structure of study.

2.0 Chapter 2 – Theoretical Framework and Literature Review

This chapter presents the theories and literature review, which constitutes the framework for this study. The purpose of the framework is to link this study to previous research and theories which support any decisions, discussion and findings made throughout this research. The chapter is divided into subsections, each describing a theory. The theories presented in this chapter are Supply Chain and Supply Chain Management which has to do with managing the flows of resources and information in an efficient manner. Additionally, two strategies, lean and agile, are discussed. Risk and Risk Management, which defines risk and vulnerability of entities and how an organization can manage these to avoid or exploit threats and opportunities. Finally, the theories are combined to discuss how Risk Management can be applied in the context of Supply Chain Management.

2.1 Supply Chain

The concept of supply chain got a lot of attention during the 1970s and 1980s as a strategy to increase competitive advantage through increased effectivity and efficiency in material flows through firms and their trade partners (La Londe and Masters 1994). (Peck 2006) argue, "in their totality, supply chains links organisations, industries and economies". There exist many definitions of what a supply chain is, often adapted to the context it is used in e.g. manufacturing, retail, service, marketing, strategy etc. While some are more thorough than others, there seems to be a consensus of the concept within the literature as the values of the concept remains the same.
(La Londe and Masters 1994), argue that there are no firms which produce the final product on its own, that it uses inputs from other firms, such as raw material and components. Thus, a firm purchase inputs from another firm, processes it and sells it to another firm, ultimately reaching the end customer. This holds especially true in recent times with many firms focusing only on their core competence and outsourcing the remaining production. (La Londe and Masters 1994), therefor provides a simple definition: *"The set of firms which pass these materials forward"*. A more thorough definition is provided by (Christopher 2011):

"The management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole."

In their work, (Mentzer et al. 2001), performed an extensive literature review in an attempt to understand the current concept of supply chain and create a clear definition, the authors created this definition of supply chain:

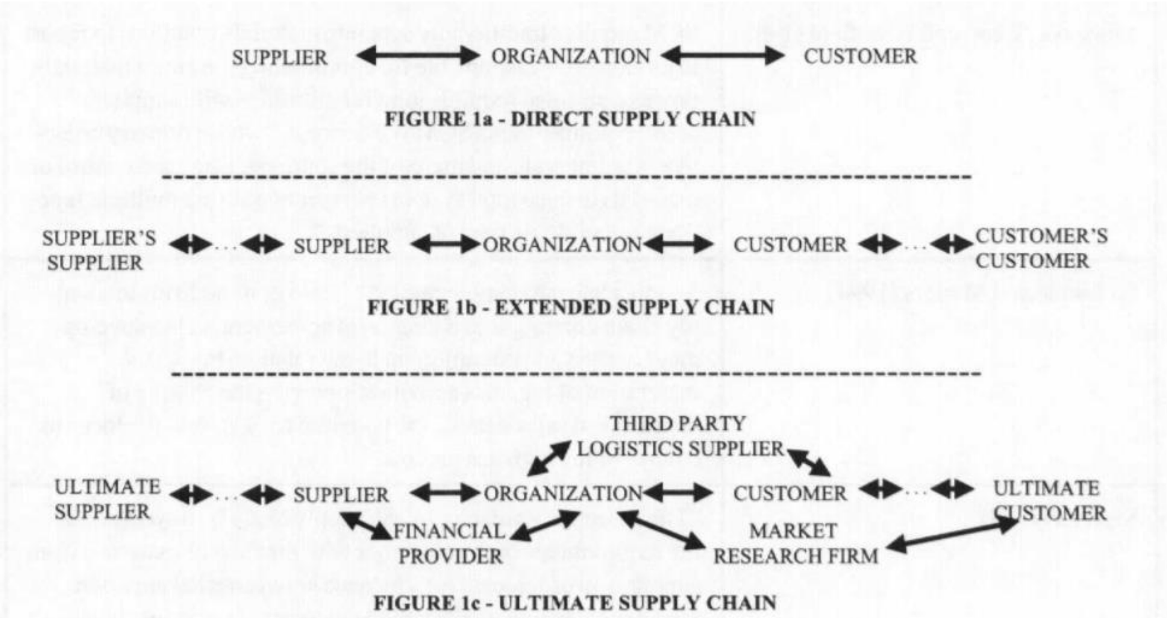
"a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer".

In the author's opinion the definition provided by (Christopher 2011) is a little vague, as much can be included when "managing relationships", and while (Mentzer et al. 2001) provides a definition with a narrower scope, they fail to include the aspect of improved customer value and cost efficiency, which is the very purpose of a supply chain. Thus, for the purpose of this paper, a combination of the two definitions will be used:

"a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from source to sink, to deliver superior customer value at less cost to the supply chain as a whole."

As such, supply chain, is understood as individuals or organizations linked together in a network collaborating on upstream and downstream activities (flow of goods, services, finances and information) to achieve higher customer value and improved performances at lower cost. (Mentzer et al. 2001) further argues that there exist three different scopes of a supply chain, based on its complexity i.e. direct supply chain, extended supply chain and ultimate supply chain, shown in Figure 3.1.

Figure 3.2.1 Types of supply chains based on complexity. *Adapted from (Mentzer et al. 2001)*



A direct supply chain consists of an organization (focal firm) and its tier 1 (direct) supplier(s) and customer(s), the organization purchase inputs from its supplier(s) and sells its output to its customer(s). The extended supply chain goes one step further and includes tier 2, the supplier's supplier(s) and the customer's customer(s). The ultimate supply chain includes all organizations or individuals which are involved in the upstream (supply) or downstream (demand) activities of the focal firm. E.g. from raw material to consumer or end user, described by (Mentzer et al. 2001) as the ultimate supplier or customer.

Figure 3.2.2 Supply Network. *Adapted from (Harrison and Hoek 2008)*

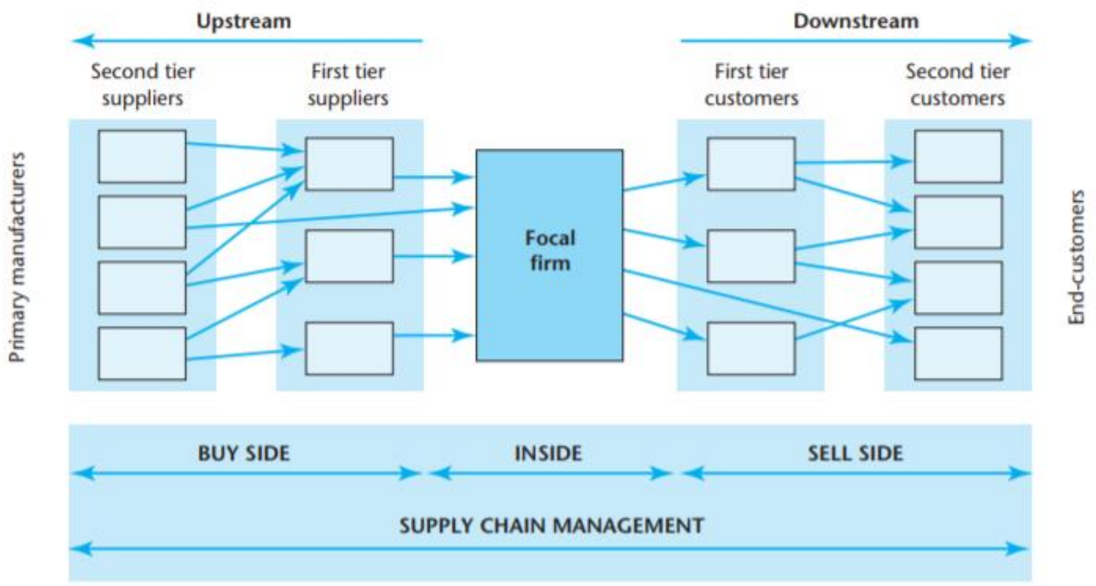


Figure 3.2 displays a typical supply chain and its interaction between the organizations involved. On the buy side (supply side / inbound logistics) the focal firm purchase inputs from its suppliers which in turn purchase inputs from their supplier, which are referred to as upstream activities. On the sell side (demand side / outbound logistics) the focal firm sell its output to its customers whom in turn sell their output to their customers or consumes it, which are referred to as downstream activities. However, many argue that this illustration is too simple, as the concept on supply chain continues to grow. Supply chains are increasingly believed to go beyond the traditional delivery of the final product, as after sales services, return logistics and other functions are implemented. Furthermore, each product has its own supply chain, and components from one supplier can be used in several of an organization's products, adding to the complexity, thus it's not uncommon that hundreds or even thousands of organizations are involved in a final product's supply chain. Cross-linkages and two-way exchanges between supply chain members may also occur, and some products/services aren't tangible such as television and telecom. As a result of these elements, many are arguing that the process of moving material should be viewed as a supply network rather than a supply chain (Waters 2007); (Harrison and Hoek 2008); (Christopher 2011).

Figure 3.2.3 Supply Network and Figure 3.3b) Supply Network in Context. *Source: (Harrison and Hoek 2008)*

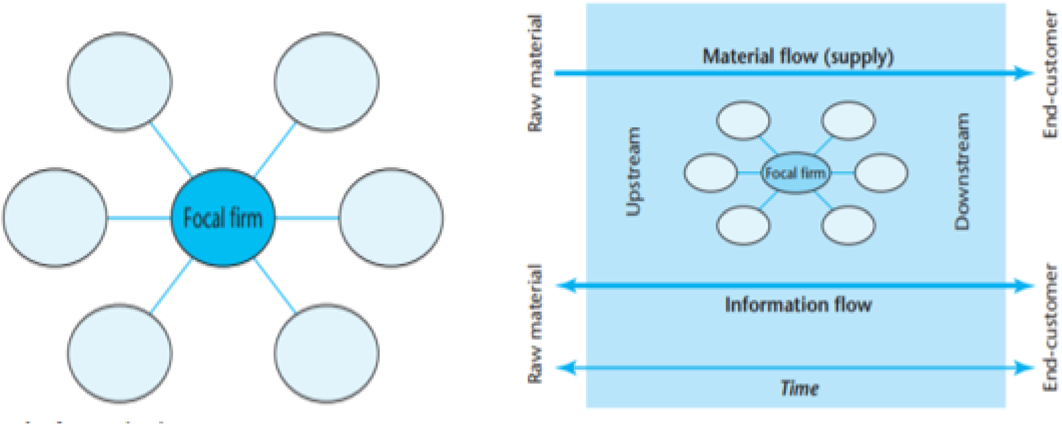


Figure 3.3 shows a network of organizations which the focal firm has interaction with in order to deliver its products/services. Figure 3.4 shows this in the context of a process where the interactions between the network members doesn't necessarily happen sequentially, but over the course of time material (deliverables e.g. people, components, products, services, information, finances etc.) are moved through the network to the final customer or end user. In this study, the term supply chain is used, as this still is the most widely used term in the literature.

2.2 Supply Chain Management

Supply chain management has to do with the management of the relationships between an organization and its suppliers and customers which comprises its supply chain. (Mentzer et al. 2001) argues that this is a source of confusion with no clear definition. The authors therefore examined the existing literature in an effort to understand the concept as perceived the literature and propose a definition of the concept. Based on the literature the authors propose that supply chain management concept can be classified by three categories: a management philosophy, implementation of a management philosophy and a set of management processes. Where the management philosophy is viewed as a set of beliefs that the firms which operates within the supply chain can directly and indirectly impact the performances of the other members and the supply chain as a whole. Thus, the degree of a firm's productivity, its integration and cooperation with the other members affect the performance of individual firms within the supply chain and the performance of the supply chain as a whole. Implementation of management philosophy is viewed as the activates which are conducted in order to implement the philosophy. Based on their extensive literature review, (Mentzer et al. 2001), lists seven activities believed to be necessary to successfully implement a supply chain management philosophy, see table 3.1. Finally, the set of management processes is viewed as the effort firms take to manage their relationships with upstream and downstream members of the supply chain. Based on these categories of supply chain management (Mentzer et al. 2001) define supply chain management as;

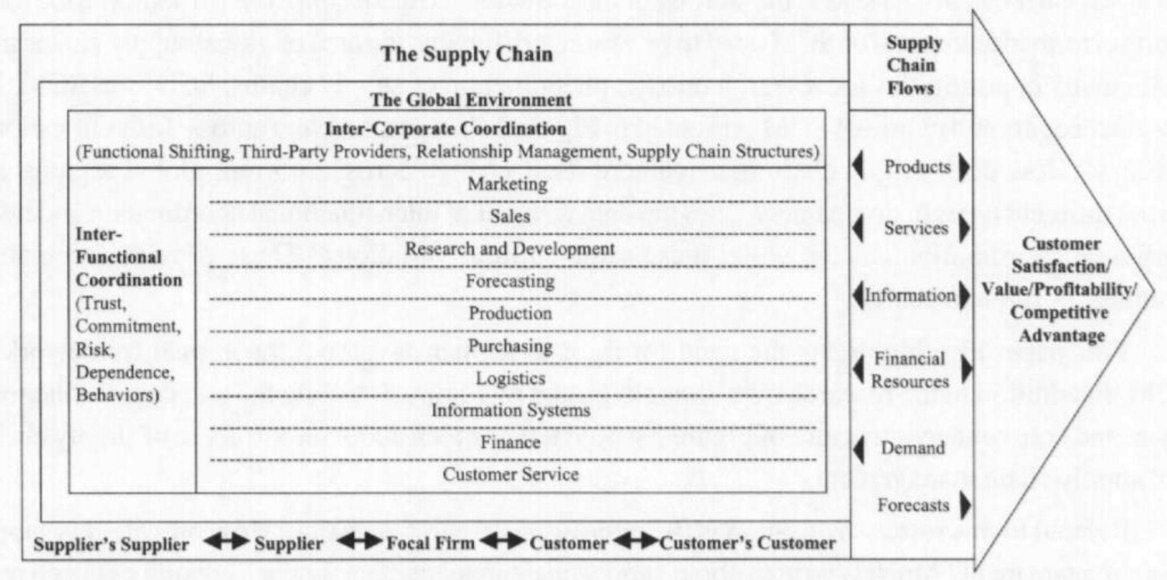
"the systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chains, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole"

Table 3.2.1 Supply Chain Activities. *Adapted from (Mentzer et al. 2001)*

1. Integrated Behavior
2. Mutually Sharing Information
3. Mutually Sharing Risks and Rewards
4. Cooperation
5. The Same Goal and the Same Focus on Serving Customers
6. Integration of Processes
7. Partners to Build and Maintain Long-Term Relationships

Further, the authors, developed a conceptual model, see figure 3.5, and argue that supply chain management drives customer value and satisfaction, which increase the competitive advantage of the supply chain as a whole and by extension its individual members, ultimately improving profitability. To do so, however, requires what the authors refer to as inter-functional coordination, comprised of but not limited to trust, commitment, risk and reward sharing, dependency and behavioral aspects which is necessary for the relationships to work long-term. Further, traditional business functions must be coordinated, for instance, real time point of sale data may improve forecasting, resulting in more efficient production and inventory management, but only if it's made available and shared with the supply chain members. Thus, through inter-functional coordination and intercorporate coordination the supply chain flows can be efficiently managed improving customer value and satisfaction, which in turn affect the supply chain's competitive advantage and profitability (Mentzer et al. 2001).

Figure 3.2.4 A Model of Supply Chain Management. *Adapted from (Mentzer et al. 2001).*



In their paper, based on the findings of "Supply Chain Management 2012 and Beyond", a comprehensive research initiative, (Melnyk et al. 2010) argues that to achieve competitive advantage, a supply chain must be designed and managed to deliver specific outcomes, and that these outcomes should reflect the customers preferences. Six potential outputs are identified; costs, responsiveness, security, sustainability, resilience and innovation. The authors further argue that these outputs are not mutually exclusive and can and should be mixed in order to achieve sustainable competitive advantage. However, while some outputs complement each other, such as responsiveness and innovation, others are contradictive, such as cost and innovation. Appendix 1. offer greater detail on the six outcomes and their potential traits. (Melnyk et al. 2010) further argue that once the desired outcomes are selected, those outcomes affect the characteristics and traits of the supply chain. While they must be present within the supply chain, they need not be implemented in each and every link, in fact, harnessing them in the right places may be the most effective solution, tough challenging. Thus, it is important a firm's supply chain strategy reflects their desired output. While there are many strategies, two have gotten much attention across various industries, i.e. Lean and Agile.

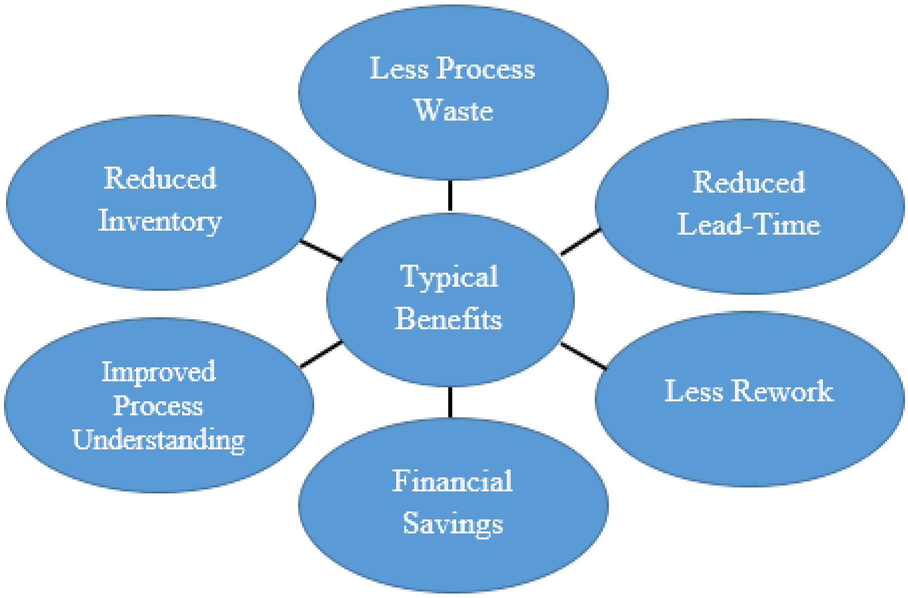
2.3 Supply Chain Strategies

This section presents two major and widely adapted supply chain strategies, lean and agile.

2.3.1 Lean

Lean originate from the Toyota Production System. At its core, Lean, focus on continuously increasing customer value through eliminating non-value adding activities, i.e. activities that do not increase customer value. Wasteful activities are eliminated from an organization's processes, streamlining value-adding activities. (Christopher 2000) argue that lean is about doing more, with less. Thus, increasing customer value and by extension competitiveness and profitability. Some tools include just-in-time (JIT), SMED (single minute exchange of dies) and Kanban's (Abdulmalek and Rajgopal 2007); (Melton 2005). (Abdulmalek and Rajgopal 2007) defines JIT as; *"a system where a customer initiates demand, and the demand is then transmitted backward from the final assembly all the way to raw material, thus "pulling" all requirements just when they are required"*. Kanban is a visual signaling system (often a pre-filled internal order of parts) which pulls products through the processes according to customer demand. Whereas SMED is a changeover reduction technique (Abdulmalek and Rajgopal 2007); (Melton 2005). Figure 3.5 below, present some typical benefits a firm may achieve through implementing Lean, as discussed by (Melton 2005). As will be discussed in the next sections of this chapter, (Chopra and Sodhi 2014), argue that efficiency in operations mitigates the effects of recurrent risks, making Lean a powerful strategy when focusing on these kinds of risks. According to (Lee 2004) a lean supply chain can provide an organization with higher profits, internal manufacturing efficiency and flexibility, however it lacks in external flexibility, i.e. meeting changing customer requirements. Furthermore, while Lean increases the efficiency and competitiveness of firms, and have proven imperative in many industries, it does so at the expense of increased vulnerability (Thun and Hoenig 2011); (Norrman and Jansson 2004). The purpose of Lean is to remove wastefulness, thus, the leaner a supply chain becomes, less redundancy exists within it, and the supply chains ability to sustain disruptions is reduced. For example, as mentioned above Lean involves JIT, which is an approach to reduce the need for inventory, as the required inputs are delivered just when they are needed. While reducing inventory cost and this approach reduces the frims ability to maintain its productivity if supply is disrupted. As pointed out by (Hauser 2003) just in time, may become just-to-late.

Figure 3.2.5 The Benefits of Lean. *Adapted from (Melton 2005).*



2.3.2 Agile

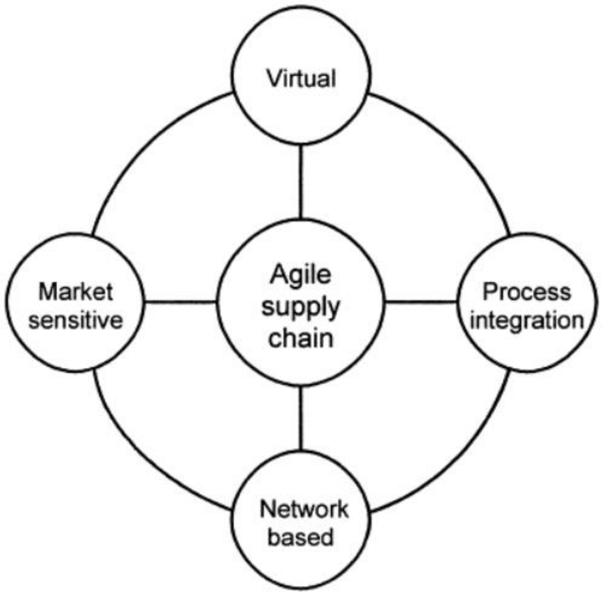
(Lee 2004) argue that agility is critical characteristics of firms today because sudden shocks, i.e. disruptions, have become more frequent during the recent years. (Lee 2004) further argues that agile supply chains recover faster from disruptions, and refers to two examples, how Nokia solved the supply crisis during the "Albuquerque Accident" which will be discussed in more detail in the next section, and how Dell solved their supply crisis after an earthquake hit Taiwan and disrupted supplies of computer components. Dell responded to the supply crisis by changing the prices of computer configurations, to redirect their customers towards products that did not contain the disrupted components. Both Nokia and Dell increased their respective market share on the expense of their competitors following the disruptions.

(Christopher 2000) as describes agility as;

> *"Agility is a business-wide capability that embraces organizational structures, information systems, logistics processes, and, in particular, mindsets. A key characteristic of an agile organization is flexibility."*

He also defines agility as *"the ability of an organization to respond rapidly to changes in demand, both in terms of volume and variety"*, and argues that is necessary in markets with volatile and unpredictable demand, to ensure that the firm can adapt quickly to changes in customer preferences. Essential to an agile strategy is market sensitivity, integration with other supply chain members to facilitate better information sharing and process integration (e.g. customer demand and market trends, for instance through EDI-systems), postponement (delaying customization of a product to the point of customer order penetration), as illustrated in figure 3.6 below.

Figure 3.2.6 The Agile Supply Chain. *Source: (Christopher 2000)*



(Christopher 2000) and (Christopher and Towill 2000) further argues that the aim of an agile supply chain is to keep an inventory of generic, half fabricated items, and postpone further customization to the demand is certain, thus reducing risks associated with for instance inventory, forecast errors and deviations between supply and demand. Furthermore, agile supply chains seek to use high quality market information, i.e. real time data, and integration with suppliers and customers to move the decoupling point (customer order penetration point) as far upstream in the supply chain as possible, while keeping inventories as far downstream as possible to meet demand quickly.
Further (Christopher 2000) argue that lead-time on incoming items are often the critical factor, to how agile and flexible an organization can be. Therefore, agile organizations often rely on maintaining strong supplier relationships with a limited number of high performing suppliers (Christopher 2000); (Lee 2004).
(Qrunfleh and Tarafdar 2013) found that agile supply chain strategy contributed significantly to the responsiveness of the firm and argue that the greater the extent of agile supply chain strategy the firm implement, the greater its responsiveness became. The authors also found that postponement, facilitated responsiveness, through greater flexibility.

2.4 Risk

Risk is an ambiguous term with many different definitions; this is because risk is an abstract concept, which can vary depending on the context it is applied to. Further, those exposed to it may also perceive risk differently. The concept of risk is often associated with something negative, for example the probability of loss, and the magnitude of that loss. However, there is a discussion regarding whether risks may also be a source of opportunity (Hillson 2003). He further, provides this definition of risk as an opportunity *"an uncertainty that could have a positive effect leading to benefits or rewards "*, and argue that firm should minimize the likelihood of negative risks, and maximize the likelihood of opportunities. However, for the purpose of this paper, risk is associated with the negative impacts of uncertain and unwanted events, and how various risk management techniques are applied in the supply chain context to mitigate the negative impacts of these events. Therefore, in this paper, the researcher view risk as defined by (Mitchell 1995) *"the probability of loss and the significance of that loss to the organization or individual"*. Furthermore, (Norrman and Jansson 2004) who define risk as "*the chance, in quantitative terms, of a defined hazard occurring",* argues that risk is measurable, expressed as *"Risk = probability x consequence".* This definition of risk will also be applied during this study, to develop an index representing how the responding firms perceive risks, as this may provide additional and interesting insight to the relationship between risks and risk management as the exposure to risk increases.

There are many different classifications of, or ways to categorize risk. Internal, external and network (Jüttner, Peck and Christopher 2003), inbound, operational and outbound risks (Manuij and Mentzer 2008). By the magnitude of their impacts on a firm (Elahi 2013); (Chopra and Sodhi 2014). The authors further describe two types such types of risk faced by supply chains, i.e. recurrent (non-disruptive) risk and disruptive risk, which are distinguished by frequency and severity. Recurrent risk, while potentially costly, are often minor risk which an organization may face in its everyday operation, which may cause temporary breakdown of supply chain flows. Due to this, it is often linked to supply chain efficiency, and the primary concern is to match supply with demand, and to ensure that products are readily available in case of a breakdown, for instance by implementing safety stocks (Chopra and Sodhi 2014); (Elahi 2013). Disruptive risk, on the other hand, are large-scale incidents, which disrupts the supply chain for an extended period of time. Often triggered by hazardous events, these disruptions are extremely costly in terms of resources, productivity and loss of sales. Furthermore, due to the complexity and interconnectedness of supply chains, these risks often trigger ripple effects, referred to as a "domino effect" (Chopra and Sodhi 2014). A domino effect is when an unwanted incident in one area of the supply chain causes unwanted incidents in other areas of the supply chain as well (Chopra and Sodhi 2014). This was the case of "The Albuquerque Accident" where a lightning storm caused a fire at the one of Phillips production facilities, a sub-supplier of microchips to Ericsson. The fire destroyed its inventory of finished products and shut down further production, which six months later was still only 50%. Ericsson was unable to produce and sell one of its key consumer products during a critical period. The disruption was first estimated to cost Ericsson $400 million, but was later calculated to approximately $200 million. Ultimately, the disruption played a major role in Eriksson's decision to leave the mobile phone terminal business (Norrman and Jansson 2004). However, Ericsson was not the only firm affected by this disruption. Nokia, another customer of the plant, immediately began to purchase the available capacity of microchips elsewhere in the market. As a result, Nokia not only protected their production during the supply shortage, but also increased their market share (Chopra and Sodhi 2004); (Elahi 2013). This example illustrates the importance of risk management, and how it can be a source of competitive advantage.

2.5 Risk Management

(Norrman and Jansson 2004) argue that "Risk management is the process whereby decisions are made to accept a known or assessed risk and/or the implementation of actions to reduce the consequences or probability of occurrence". Thus, it has to do with making business decisions despite the presence of uncertainties and risks. To do this firms must manage the risks. Most supply chain management literature focus on 4 stages of managing risk, i.e. identify, assess, monitor and mitigate (Hoffmann, Schiele and Krabbendam 2013); (Miller 1992); (Elahi 2013).

Risk identification has to do with identifying what the risk is, which source it originates from and what drives it. By properly identifying a risk, which source it originates from and which factors drives it, a firm can tailor its risk management effort to the respective risk. **Risk assessment** is the process of evaluating the risk, what is the probability of its occurrence and the magnitude of its consequences, such as its financial impact, or productivity loss. This allow firms to evaluate their approach. There are three approaches mentioned in the literature: 1) Acceptance, the risk is deemed acceptable and the firm will not take any action to reduce it 2) Avoidance, the risk is deemed to great and the firm will avoid the risk. For instance, a firm can choose not to release a new product as the market conditions are too uncertain, thus eliminating the risk associated with releasing the product entirely.

Risk monitoring are activities and processes related to continuously monitoring the risks, for instance is the risk's trend rising or declining, is it still at an acceptable level? If the risk has risen beyond the acceptable level, steps must be taken to reduce it to acceptable levels again, i.e. mitigate the risk. (Hoffmann, Schiele and Krabbendam 2013) define risk monitoring as *"the use of indicators for regularly assessing probabilities of risk occurrence"* and argues that this is an important step because it may provide early warning signs and allow timely implementation of mitigation strategies.

Mitigation strategies are activities and processes which are intended to eliminate or reduce the probability of a risk occurring and/or the impact of its occurrence. There are two main categories of risk mitigation, i.e. reactive and proactive measures (Norrman and Jansson 2004); (Hoffmann, Schiele and Krabbendam 2013); (Thun and Hoenig 2011). Reactive measures are targeting the consequences of a risk, reducing its impact on the organization after the risk actually occurs. While proactive measures seek to reduce the probability for the risk to occur and its impact on the organization before the risk occurs. For example, a firm may choose to source a critical component from multiple suppliers (for instance 60% from supplier 1 and 40% from supplier 2). The probability that one supplier fails to deliver may be regarded as fairly high, however, the risk of both suppliers failing simultaneously is far lower, thus the risk of a supply disruption for the critical component is reduced (proactive). The firm may also choose to maintain a safety stock for the critical component. This reduces the consequences of a supply disruption by allowing the firm to maintain its production (reactive). This is however, a short-term solution, and increases inventory holding costs. Common mitigation strategies include but are not limited to: buffers/safety stocks, multiple sourcing, postponement, flexibility, incorporating excess capacity, use of standard components or substitutes, sharing or transferring risk, pool demand, supplier development and early supplier involvement in new innovations (Hoffmann, Schiele and Krabbendam 2013); (Chopra and Sodhi 2004 and 2014); (Jütner, Peck and Christopher 2003); (Zsidisin and Ellram 2003); (Zsidisin et al. 2004).

(Chopra and Sodhi 2014) describes two strategies to managing recurrent and disruptive supply chain risks, i.e. segmentation and regionalization. Segmentation implies that an organization should use separate sourcing strategies for its products. For instance, while fast moving items should be kept decentralized to ensure fast delivery and reduce transportation cost, slow-moving items should be kept centrally, which reduces inventory-holding cost. Zara, a clothing and accessories retailer based in Spain, have had a tremendous success in sourcing material and services for its trendier product lines from European suppliers (close to its customers) ensuring fast and reliable deliveries of quality items. Enabling Zara to respond quickly to changes in trends and customer preferences. However, this sourcing strategy is expensive, and as such, Zara sources its basic items from low-cost suppliers, as these products don't call for the same level of responsiveness (Chopra and Sodhi 2014). Regionalizing the supply chain implies using separate geographical production sites and/or distribution centers. Thus, if the facilities in one region breaks down, the impacts are contained within that region, rather than the entire supply chain. Further, the facilities in other regions (assuming excess capacity or potential to increase capacity short term) can supply the required units lost in the affected region, ensuring supply despite breakdowns. This was the case when the Tsunami hit Japan in 2011. Japanese automakers entire production capacity was located in the region impacted by the tsunami, resulting in supply shortages around the world. Zara's operations, on the other hand, are designed such that multiple facilities can produce the product portfolio, thus, if one facility breaks down, production can be shifted to another facility, protecting Zara's operations from disruptions (Chopra and Sodhi 2014). Furthermore, the authors argue that increasing transportation costs creates an incentive for replacing global supply chains with regional ones in the future, as it would reduce distance travelled and ultimately the transportation cost.

2.6 Risk in the Supply Chain Management context

Risk in the supply chain context has to do with the recent business trends, such as globalization and outsourcing, which increases competitiveness but increases their exposure to risk (Thun and Hoenig 2011); (Norrman and Jansson 2004); (Zsidisin and Ellram 2003); (Zsidisin et al. 2004); (Harland, Brenchley and Walker 2003); (Jüttner 2005). According to (Zsidisin 2003), supply chain risk are multidimensional constructs. For instance, risk may be associated with damages or consequences of a risk, the likelihood of a risks occurrence, i.e. a firm's exposure or vulnerability to the risk, or uncertainties from which a risk may occur, i.e. its source, for instance political risk (Jütner, Peck and Christopher 2003). Therefore, for the purpose of this paper, the researcher separate between risk, risk sources and risk drivers.

2.6.1 Risk Sources

(Jüttner 2005) argue that "*supply chain risk sources are any variables which cannot be predicted with certainty and from which disruptions can emerge".*

External or internal to the firm (Punniyamoorthy, Thamaraiselvan and Manikandan 2013), direct or indirect (Svensson 2002), internal to the firm, internal to the supply chain and external to the supply chain (Christopher and Peck, 2004). In this study, the researcher applies the definition provided by (Jütner, Peck and Christopher 2003) *"the environmental, organizational or supply chain – related variables that cannot be predicted with certainty and that impact on the supply chain outcome variables".* That is, risk sources, are any uncertainties deriving from elements external to the supply chain, from within the firms' own operations, or internal to the supply chain i.e. from actions taken member(s) of the supply chain or the structural design of the supply chain. Sources of risk are numerous, and can vary from one scenario to the next, however some sources of risk are extensively identified in the literature (Thun and Hoenig 2011); (Norrman and Jansson 2004); (Zsidisin and Ellram 2003); (Harland, Brenchley and Walker 2003); (Jüttner 2005); (Wagner and Bode 2006); (Punniyamoorthy, Thamaraiselvan and Manikandan 2013), however these sources are general and can be broken down further;

- Environmental risk sources
- Demand and supply risk sources
- Process risk sources
- Control risk sources
- Information risk sources

The purpose of this paper is to examine factors influencing supply risks of firms operating in Norwegian industries. Therefore, this study includes three of these risk sources, supply, information, and environmental. Supply risk sources was included as these represent the risks directly affecting firms' ability to receive supplies. Information risk sources was included as the breakdown in either a firm's IT-systems or the supply chain's integrated IT-systems, failure to share important data (for instance real time consumer data), or errors in a firm's forecasts may directly or indirectly impact or influence firms' ability to receive supplies. And finally, environmental sources is included because it may seriously impact firms' ability to receive supplies as discussed above, i.e. cause serious disruptions to supply chains.

2.6.2 Risk Drivers

A risk driver is described by (Thun and Hoenig 2011) and Harnland, Brenchley and Walker (2003) as elements which increases the complexity of a firm's operations, making them more vulnerable to risk, i.e. increasing their risk exposure. Thus, a risk driver is any factor regarded by an organization or an individual as a variable, which increases their exposure to a particular source of risk. For example, just-in-time (JIT) aims to reduce the need for inventory by having scheduled deliveries at the exact time it the components are needed. While JIT reduces the risks associated with inventories, such as holding cost and obsolescence, it increases the risks associated with supply failure, such as stock outs, because the firm don't have a sufficient level of inventory to fall back on in case of supply failure. Thus, JIT, in this context, becomes a risk driver of stock outs. While a risk driver may be defined as any element increasing a firm's or an individual's vulnerability to a particular risk, some key drivers have been identified in the literature: product/service complexity, supply chain complexity, globalization, outsourcing, e-business, lean approaches (Harnland, Brenchley and Walker, 2003; (Thun and Hoenig 2011); Zsisidin et.al. 2005); (Elahi 2013).

2.7 Supply Chain Risk Management

Supply chain risk management (SCRM) has to do with the combined effort of the members of a supply chain to reduce the vulnerability of the supply chain. (Wieland and Wallenburg 2012) define SCRM as;

"the implementation of strategies to manage both every day and exceptional risks along the supply chain based on continuous risk assessment with objective of reducing vulnerability and ensuring continuity".

Thus, SCRM is an extension of traditional risk management practices as it encompasses the risk of upstream suppliers and downstream customers as well as the focal firms own risks (Wieland and Wallenburg 2012).

(Jüttner, Peck and Christopher 2003); (Jüttner 2005) argues that when managing risk within a supply chain, the management process must be a coordinated activity. This is because individual firms may be unable to affect the risk, or it may be too costly to do so. Several authors support this. (Gilbert and Gips 2000) argue that while it is feasible to assess the risk of a suppliers' supplier (tier 3), this gets less practical and expensive further up the supply chain. (Harland, Brenchley and Walker 2003) found that among the supply chains they examined, less than 50% of the risks which could impact the focal firm were visible to them, thus communication and cooperation becomes imperative. (Manuj and Mentzer 2008) argue that risks are linked together so strongly that one risk may originate from or influence the impact of another risk. This is supported by (Elahi 2013) who argue that risks are increasingly interconnected, and that a risk might evolve into other risk categories. (Miller 1992); (Chopra and Sodhi 2014) argue that mitigating one risk may in fact increase the exposure to another risk. For example, reducing inventory reduces associated risks, such as holding costs and obsolescence, but increases the risks of supply failure and stock outs. (Chopra and Sodhi 2004) further argues that an action taken individually by a member of the supply chain to mitigate a risk may increase the exposure of the other members in the supply chain. Based on these arguments, managing risk should be a coordinated effort to reduce the exposure of the supply chain as a whole, rather than each individual firm. Thus, in this study, risk handling is associated its level of supply chain risk management (SCRM).

2.8 Chapter Summary

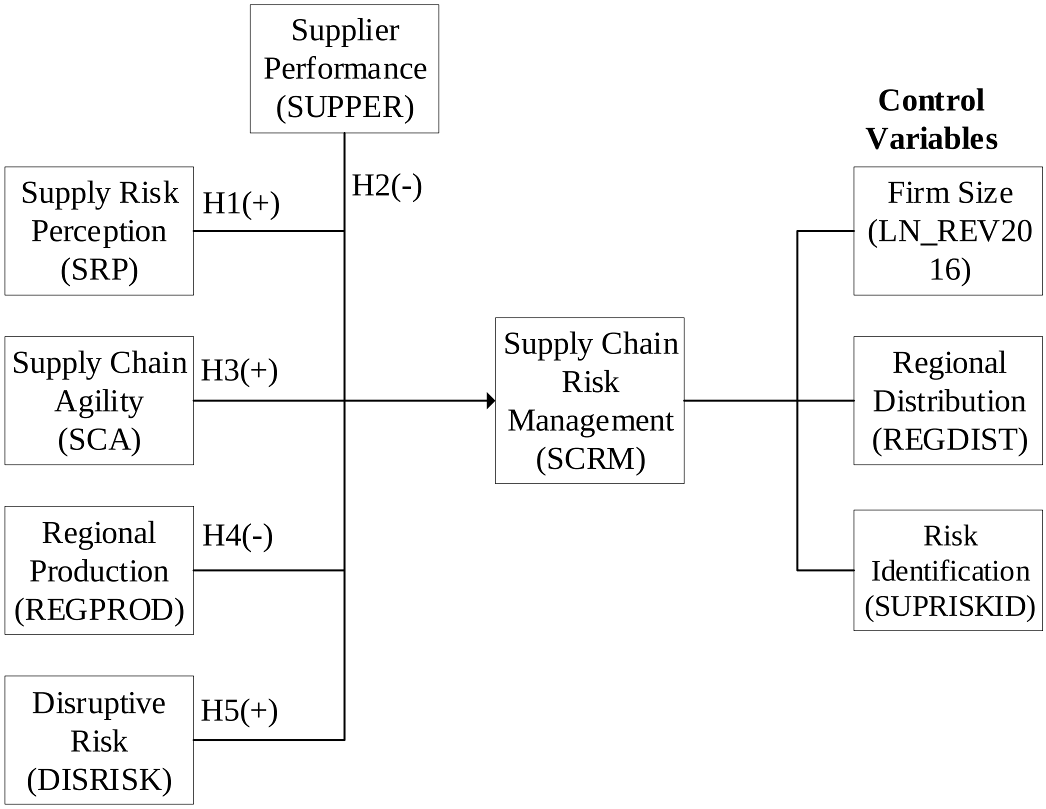
This chapter presented and discussed the theoretical framework and literature applied in this study. The theoretical framework includes supply chains, supply chain management and two widely used supply chain strategies, lean and agile, in addition to risks and risk management. Finally, the theories were merged to form how risk and risk management applies in the context of supply chain, i.e. supply chain risk management.

3.0 Conceptual Model and Hypothesizes

This chapter presents the research model and the hypotheses applied in this study. The purpose of this study is to examine how various factors Supply Chain Risk Management among Norwegian industrial firms. The theoretical background and literature review discussed in the previous chapter is used to derive, and support hypothesizes which will be used to tests these relationships and are further elaborated upon in this chapter.

3.1 Conceptual Model

Figure 3.1 Conceptual Research Model



The research model, presented by figure 4.1 above, illustrates the relationships between the dependent variable, the independent variables, and the control variables. The dependent variable, Supply Chain Risk Management (SCRM), reflects how much the respondents' firms collaborate with their most important supplier to decrease their respective supply risks. The five independent variables, supply risk perception (SRP), supplier performance, regional production, agile strategy and disruptive risk are factors directly influencing the dependent variable. The model also includes three control variables, firm size, regional distribution and risk identification. Firm size is a variable consisting of the respondents' firm's revenue, and it is expected that firms with higher revenue have a higher level of SCRM then firms with less revenue (Hoffmann, Schiele and Krabbendam 2013). Regional distribution is the second element in (Chopra and Sodhi 2014) regionalization strategy. It is a dummy variable, which determine whether the respondents' firm implement centralized or decentralized distribution. Risk identification is a single scale, which indicate the extent to which the respondents' firm collaborate with their most important supplier to identify risks threating the respondents' firm incoming supplies.

3.2 Research Hypotheses

In this section, the hypotheses are presented and grounded in previous literature. There are five hypotheses included in this study, as illustrated in figure 4.1 above.

Hypothesis 1:
Perceived risk is a combination of the likelihood of occurrence and the negative impact associated with the risk, i.e. the consequence. This is expressed by (Norrman and Jansson 2004) as, Risk = Probability x Consequence. As this equation increases so does the perceived risk. (Hoffmann, Schiele and Krabbendam 2013); (Miller 1992); (Elahi 2013) discuss three approaches to risk assessment and discussed previously, risk acceptance, risk mitigation and risk avoidance. A low level of perceived risk would generally be accepted, however as the level of perceived risk becomes higher, the firm would either mitigate the risk or avoid it. Thus, it is expected to see a higher level of SCRM as risk perception increases.

H1: There is a positive association between supply risk perception and supply chain risk management (SCRM).

Hypothesis 2:
As discussed during H1, it is expected that SCRM increase at higher levels of risk perception. However, supply related risks depends on the performance of the supplier. (Thun and Hoenig 2011) used measurement items such as *"Suppliers with high quality"* and *"supplier with a high on-time delivery"*. Both these items were factored into a construct representing preventive SCRM. Thus, a supplier who are always on time, deliver the agreed upon amount of material with sufficient quality would reduce the likelihood of supply disruptions. Therefore, it is expected that suppliers with high performance reduce the perceived risk of supply disruptions. In other words, as supplier performance increases, the magnitude of supply risk perception on SCRM is reduced.

H2: The association between supply risk perception and supply chain risk management (SCRM) becomes less positive when supplier performance increases.

Hypothesis 3:

As discussed in the previous chapter, agility is an increasingly critical characteristic of a supply chain, as it is capable of recovering quickly from disruptions, which are becoming more frequent (Lee 2004). According to (Christopher 2000) and (Christopher and Towill 2000), the focus of agility is to create flexible supply chains which are more responsive to changing market conditions. During their research (Qrunfleh and Tarafdar 2013) proved empirically that agility significantly contributes to the responsiveness of a firm. Furthermore, they also found that postponement, which is an essential strategy within the agile supply chain (Christopher 2000) facilitate responsiveness though greater a higher degree of flexibility. Thus, it is expected that a higher degree of agility is associated with a higher level of supply chain risk management (SCRM).

H3: There is a positive association between the degree of supply chain agility and supply chain risk management (SCRM).

Hypothesis 4:

Disruptive risk are one of two risks discussed by (Chopra and Sodhi 2014) and (Elahi 2013), the other is recurrent risk (Chopra and Sodhi 2014) or non-disruptive risk. (Elahi 2013). The main difference of the two are the frequency of which they occur and severity of the consequences they bring. Recurrent risks have a high frequency often occurring in daily processes, and thus are mitigated through supply chain efficiency (Chopra and Sodhi 2014). Disruptive risks are large-scale incidents often the cause of hazardous events, and therefore do not occur often, i.e. they have a low frequency; however, disruptive risks prevent firms from performing their core activities over an extended period of time and are therefore extremely costly (Chopra and Sodhi 2014); (Elahi 2013). Additionally, risks are complex, and increasingly interconnected, i.e. an unwanted incident may trigger, or be triggered by, other incidents, increasing the impact of a risk (Manuj and Mentzer 2008); (Elahi 2013). Furthermore, because firms are increasingly integrated with and dependent on each other, through outsourcing and globalization (Harland, Brenchley and Walker 2003), risks affecting one link in a supply chain may affect others. These elements are referred to as a "domino effect" where the consequences of a risk ripples into other business- or geographical areas (Chopra and Sodhi 2014).
(Chopra and Sodhi 2014) argue that to mitigate disruptive risks, firms must build resilient and/or robust supply chains, which are able to absorb and/or recover quickly from

disruptions, despite loss of efficiency and additional costs. Therefore, it is expected to see a higher level of SCRM among firms focusing on mitigating disruptive risks.

H4: There is a positive association between the degree of disruptive risk and supply chain risk management (SCRM).

Hypothesis 5:

(Chopra and Sodhi 2014) further discusses two strategies to reduce disruptive risks in particular, one of which is to regionalize the firm’s supply chains, by implementing geographically separate production and distribution centers. That is, instead of having one global supply chain serving all their customers, they suggest firms should implement additional supply chains which scopes are reduced to serving a particular region, e.g. the US, Asia, Europe etc. They argue that this will spread the risk across the different regions and contain potential disruptions to that region, thus reducing the risk of disruptions (Chopra and Sodhi 2014). Thus, in case of a hazardous event, which disrupts productivity of one region occur, other regions could absorb the lost productivity and enable the firm to serve the affected market despite the disruption. Provided there exist excess capacity, or an ability to rapidly increase the scale of production at the other production sites (Chopra and Sodhi 2014). Thus, firms using regional production facilities are expected to have less risk than firms that do not and thus have less need for SCRM.

Further, this would result in smaller and shorter supply chains, i.e. less complex supply chains. As discussed previously the larger a supply chain is, the more complex it is, due to the existence of more flows of material and information (Harland, Brenchley and Walker 2003); (Hoffmann, Schiele and Krabbendam 2013)). Further, the more entities there in a supply chain, the more interactions there are, and therefore more potential areas where a risk can occur. Thus, it can be argued that regional supply chains are exposed to less risk than a global one because they are less complex. Finally, regional production is measured through using a dummy variable. Therefore, it is expected that the level of SCRM is lower for firms using regional production sites (decentralized production) than firms that do not use regional production sites (centralized production).

H5: Supply chain risk management (SCRM) is significantly lower for firms applying regional production than for firms applying centralized production.

3.3 Chapter Summary

This chapter presented the conceptual model used in this study and presented the hypotheses derived from the theoretical framework and literature review. This study includes one dependent variable, supply chain risk management (SCRM), five independent variables, supplier performance (SUPPER), supply risk perception (SUPRISKPERC), supply chain agility (ACS), disruptive risk (DISRISK) and regional production (REGPROD), and three control variables firm size (LN_REV2016), regional distribution (REGDIST) and risk identification (SUPRISKID), used to test the five hypotheses presented and discussed in this chapter.

4.0 Research Methodology

4.1 Intro

(Leedy and Ormrod 2013, 2) defines research as “a systematic process of collecting, analyzing and interpreting information – data – in order to increase our understanding of a phenomenon about which we are interested or concerned”. The research process is a structured process in terms that the research problem is defined, the data is managed, and findings presented according to established frameworks and procedures (Williams 2007).

This chapter discusses briefly the common scientific methods to conducting research, and presents the methodological approach employed in this study.

4.2 Research Method

Research method is defined by (Kothari 2004) as “a method, tool or technique the researcher uses in performing the research project”, while a more comprehensive definition is provided by (Cresswell 2014) “the plans and the procedures of the research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation”. There are three main methods or approaches to conducting research, i.e. qualitative methods, quantitative methods and a mixed method approach. Which approach the researcher should use depends on the characteristics of the required data to solve the research problem. Usually a study requiring textural data employs a qualitative approach, a study requiring numerical data a quantitative approach, while a study requiring both textural and numerical data employ a mixed method approach (Churchill and Brown 2004); (Cresswell 2012); (Williams 2007). This study requires numerical data and thus, applies a quantitative method.

As the name inclines, quantitative research involves measuring quantity or amounts (Kothari 2004); (Leedy and Omrod 2013). Thus, quantitative research approach utilizes research designs that involves numerical or statistical data (Williams 2007). According to (Leedy and Omrod 2013) the purpose of quantitative research is to “establish, confirm, or validate relationships and to develop generalizations that contribute to existing theories”. Thus, quantitative research often starts with theory from which it defines a research problem and draws hypotheses from, the data is collected and analyzed, and the observations used to confirm or disprove the research problem(s) i.e. deductive reasoning.

4.3 Research Design

As discussed above, this study employs a quantitative research approach, therefore, this section will be limited to quantitative research designs. Research design is defined by (Churchill and Brown 2004) as *“The framework or plan for a study that guides the collection and analysis of the data”.* While a study can be conducted without a research design, it is more likely that it will produce findings that are not relevant to the particular research problem, and at the expense of increased effort, time and costs. Thus, preparing a research design is an important step to ensure that the research is conducted efficiently and within the scope of the research problem. There are three common approaches to quantitative research; the exploratory approach, the descriptive approach and the causal comparative approach (Churchill and Brown 2004); (Kothari 2004). Exploratory research seeks to gather data and create knowledge in a field or on a topic, in which nothing or little is previously is known. Causal comparative aim to discover cause and effect relationships among the variables it studies. This study builds on existing theories and therefore applies a descriptive research design.

According to (Churchill and Brown 2004) descriptive design *“emphasizes determining the frequency which with something occurs, or the extent to which two variables covary”.* As descriptive research aim to describe the current state of the research phenomenon it relies on accurate data. Thus, to avoid bias and achieve high reliability the procedure must be carefully planned, and therefore the design is rigid and structured, especially in terms of data collection and sample techniques (Churchill and Brown 2004); (Kothari 2004).

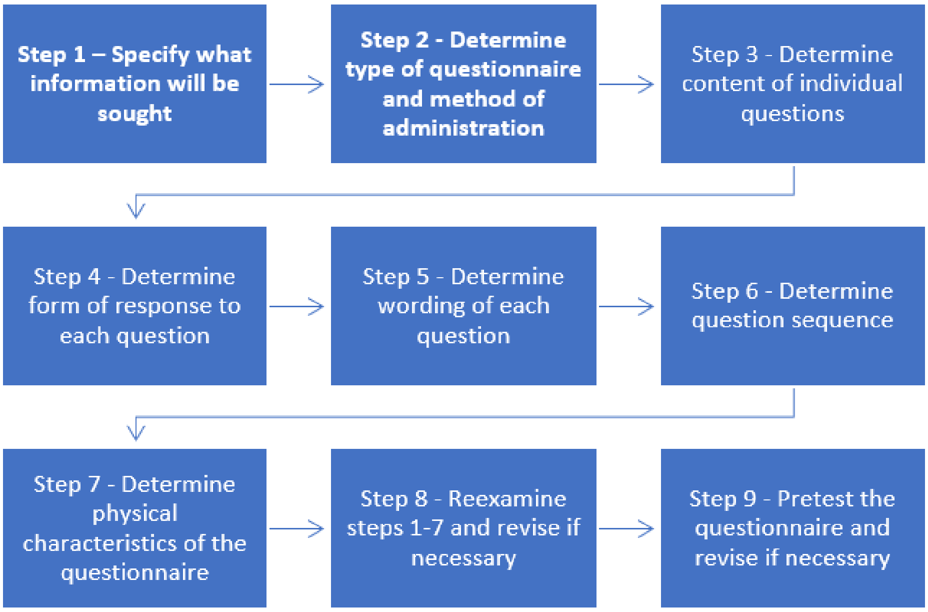
Figur 4.1 Charactheristics of research design. Source (Kothari 2004)

Research Design	Type of study Exploratory of Formulative	 Descriptive/Diagnostic
Overall design	Flexible design (design must provide opportunity for considering different aspects of the problem)	Rigid design (design must make enough provision for protection against bias and must maximise reliability)
(i) Sampling design	Non-probability sampling design (purposive or judgement sampling)	Probability sampling design (random sampling)
(ii) Statistical design	No pre-planned design for analysis	Pre-planned design for analysis
(iii) Observational design	Unstructured instruments for collection of data	Structured or well thought out instruments for collection of data
(iv) Operational design	No fixed decisions about the operational procedures	Advanced decisions about operational procedures.

4.3.1 Questionnaire Development

(Churchill and Brown 2004) outlines a nine-step procedure to developing a questionnaire (see figure 4.3 below). The goal of the guidelines is to aid researchers in developing a questionnaire that will not deter respondents from participating, and which doesn't consist of questions which are leading or ambiguous, resulting in missing values or bias. To develop the survey used in this study, the researcher followed these nine steps.

Figur 4.2 Procedure for developing questionnaires. Adapted from (Churchill and Brown 2004).



Procedure for developing questionnaires. *Adapted from (Churchill and Brown 2004).*

First, previous literature was examined, and the research question were discussed with the supervisor, to determine the information needed to answer the research question and identify key informants. Key informants are identified as personnel with either direct or indirect knowledge of the firm's risk management processes. For instance, personnel within supply chain management, logistics, procurement, production and quality assurance, would be good examples of personnel with direct knowledge. Top management would be good examples of personnel with indirect knowledge, as those working with risk management first hand keep them up to speed. Furthermore, in smaller firms, the general manager may possess firsthand knowledge. The majority of respondents involved in this study are top management. Four parts were developed, 1) General Information 2) Supplier Performance 3) Risk 4) SCRM. The general information consists of three simple questions used to identify which firm the respondent represents, the position the respondent occupies and which branch of industry the firm operates in. This information was used to identify whether key informants were used, extract financial data from the database and to allocate the respondent to one of eleven segments included in the sample of this study.

Part 2, supplier performance, includes six questions, which measures the supplier performance based on the respondents' experience. The questions are based on previous literature (Thun and Hoenig 2011) and using well-known key performance indicators (KPI's) to measure a supplier's performance. Part 3, risk, consists of several questions, concerning different aspects of risk. Environmental Uncertainty (Buvik and George 2000), Risk Drivers, (Thun and Hoenig 2011); (Elahi 2013); (Jüttner 2005); (Miller 1992); (Harland, Brenchley and Walker 2003). Supply Risk, Information Risk and Environmental Risk (Jüttner, Peck and Christopher 2003); (Manuij and Mentzer 2008); (Punniyamoorthy, Thamaraiselvan and Manikandan 2013), these risk sources were included in the study because they may affect inbound logistics. Furthermore, these scales are two sided, asking the respondent to rate the probability and the consequences of the risk, which is further used to create risk indexes following the work of (Thun and Hoenig 2011) and (Norrman and Jansson 2004) definition of risk, *"Risk = probability x consequence.* Part 4, SCRM, consists of several questions, concerning various risk management techniques and to which extent the respondent's firm collaborate with its most important supplier, and its customers to manage its supply risk (Manuij and Mentzer 2008); (Miller 1992); (Jüttner 2005); (Zsidisin 2003).

Second, the survey draft was discussed with the supervisor and fellow students and revised. Some question was removed, while others reformulated. A few double-barreled questions were also discovered and separated into two questions. Third, to further refine the questionnaire, it was tested on some fellow students. It is recommended to test the questionnaire on a small sample which is similar to the target sample (Churchill and Brown 2004), however, given the time limit of this study this was not feasible.

4.4 Data collection

There are two main sources of data when conducting research, primary data and secondary data. Primary data is first hand data gathered by the researcher himself for the specific purpose of solving a research problem. Secondary data are data gathered by someone else for an unrelated purpose. For example, the published worked of other researchers, organizations or public records (Churchill and Brown 2004); (Kothari 2004). For the purpose of this study the researcher developed a questionnaire, as discussed above, to gather primary data more suitable for the research problem. To identify respondents, i.e. firms operating in the Norwegian Manufacturing Industry, a database managed by "Proff Forvalt", a firm which specialize in credit and marketing information, was used. The database allows the user to limit the search based on industry segments, and export contact information and financial data. Eleven industry segments were chosen as shown in table 4.2 below.

4.4.1 Population

A population is defined by (Churchill and Brown 2004) as *"the totality of cases that conform to some designated specifications"*. The eleven segments chosen the database consists of 3653 listed firm. A researcher may either use the entire population, called a census, or a sample, which represents the population (Kothari 2004). A sample is defined by (Churchill and Brown 2004) as *"selection of a subset of elements from a larger group of objects"*. For this study, the researcher has used a sample of the population to gather data from.

4.4.2 Sample frame, sample design and sample size

(Churchill and Brown 2004) defines sample frame as "the list of sampling units from which a sample will be drawn; the list could consist of geographic areas, institutions, individuals, or other units". The sample frame consists of listed units from the same eleven industries as the population and as such is representative, an important criterion according to (Kothari 2004). However, due to elements such as missing contact information and several divisions of the same firm (regarded as duplicates) being included in the population, the sample frame is greatly reduced. For instance, the fishing industry, consisting of 1021 units, only 378 units had readily available contact information. Kothari (2004) argues that there are two different sample designs or techniques, i.e. probability sampling and non-probability sampling. Probability sampling, bases on randomness, and ensures that every unit in the sample frame have an equal opportunity to be included in the sample. Whereas in non-probability sampling each unit in the sample is picked by the researcher. To be certain that the sample included each industry segment the researcher first applied a quota sampling method, which, for convenience, were limited to 200 units per segment. For industries consisting of less than 200 units, a smaller quota were used. Further, to ensure that every unit had an equal possibility to be part of the quota, the author applied a simple random sampling technique. Each unit were randomly given a value between 0 and 1 by using the command "=Random" in Excel and sorted from lowest to highest. Depending on the quota size, for instance 200, the first 200 units with the lowest random values were included in the sample.

Table 4.3 Table 4.2. Segments, population, sample frame and sample size.

Industry	Population	Sample Frame #	Sample Frame %	Sample Size
Mining and Extraction	**315**	**175**	**55%**	**175**
Oil and Gas	**42**	**21**	**50%**	**21**
Fishing	**1021**	**378**	**32%**	**160**
Textile and Clothing	**282**	**239**	**85%**	**200**
Paper and paper products	**38**	**31**	**81%**	**31**
Rubber and Plastic	**175**	**162**	**92%**	**130**
Electronics	**156**	**127**	**81%**	**110**
Machinery and Equipment	**430**	**224**	**52%**	**200**
Metal Goods	**848**	**399**	**47%**	**200**
Chemicals	**110**	**92**	**83%**	**80**
Furniture	**236**	**156**	**66%**	**100**
Total	**3653**	**2004**	**55%**	**1407**

According to (Wang and Wang 2012), it is widely acknowledged that a small sample can result in numerous problems when applying structural equation models (SEM). Furthermore, the authors argue that there is no consensus in the literature of what would be a sufficient sample. Schumacher and Lomax (1996) argue that SEM requires larger samples because of requirements to accuracy of estimates, representativeness and the ability to define latent variables. They further argue that the larger the sample size, the better. This is supported by (Watt and Berg 2002), who claims that sampling errors decreases as the sample size increases, and therefore a desirable sample is as large as possible. The reduction of sampling error for each additional case does diminish however. Schumacher and Lomax (1996), (Wang and Wang 2012) and (Wolf et al. 2013) presents some general rules of thumb regarding sample size reproduced from their literature review. 1) N = 100-150 is considered a minimum when conducting SEM 2) N = 5-10 cases per estimated parameter 3) N = 10 cases per variable when defining the lower bound.

(Greene 1991) recommends a sample size of 50 units, which should be increased depending on the number of independent variables, expressed as;

$$N > 50 + 8m$$

where m = number of independent variables. This study includes six independent variables, and as such, the sample should consist of at least 98 responses.

$$N > 50 + 8x6 = 98$$

(Tabbernick and Fidell 2013), provides a similar equation for estimating a reasonable sample size, expressed as 104 cases + the number of independent variables creates a reasonable sample size, or;

$$N = 104 + m$$

Applying this equation would suggest a reasonable sample frame should consist of a minimum of 110 cases. As this study collect data through email distributed surveys, which usually have a low response rate, a fixed sample size is difficult to determine. However, (Tabbernick and Fidell 2013) suggestion is applied as a lower bound, i.e. 110 cases.

4.4.3 Questionnaire administration and response rate

There are several channels to administer the surveys through such as mail, email, fax, telephone interviews and personal interviews. Personal interviews are most likely to motivate the respondents to answer. However, it carries the highest costs and are usually very time consuming. On the other side, email administered surveys, have the lowest costs and is able to reach a large sample quickly, however, motivating the respondent to answer is challenging, causing this channel to have the lowest response rate. Furthermore, which channel to use is influenced by how dispersed the sample group is and the available infrastructure (Churchill and Brown 2004).
As quantitative methods require a larger sample, the target sample is geographically dispersed, and time is an issue and the survey will be administered through email. However, to make it easier for the respondents to answer, and easier for the researcher to collect and organize the data, the survey itself will be answered through an online survey tool. The email itself was only a request, explaining the purpose of the survey, motivating the respondent to answer, and provide a link the respondent can use to access and answer the survey. The survey tool used to build the survey and gather the data is "Google Forms", as it is free access, and did not require respondents to log in to answer, which may have had deterred them from responding. As the survey is structured and undisguised, distributing it through email is a viable option (Churchill and Brown 2004).

The survey was sent to 1407 firm, however, 56, emails bounced back, resulting in 1351 distributed surveys. The reasons for this may be that the registered emails are no longer in use, or the email were unable to pass through the potential respondent's filter. 152 responses were received; thus, the study have a response rate of 11.2%. Six responses were eliminated due to excessive missing values, duplicates, or the respondent firm no longer engaged in manufacturing, and thus fell outside the scope of the study. Leaving 146 responses in the sample. 146 responses are an adequate sample according to (Tabbernick and Fidell 2013) as 146>110, further it is also within the minimum criteria of 100-150 cases.

4.5 Chapter summary

This study used a database maintained by Proff Forvalt, consisting of firms operating in various Norwegian industry segments. The researcher selected eleven segments to sample from as shown in table 4.2. The questionnaire used was developed according to suggestions in the literature and was administered through e-mail. The questionnaire was successfully distributed to 1351 firms, 152 responses was received, resulting in a response rate of only 11,2%. However, a low response rate is expected in e-mail administered surveys, and number of responses lie within minimum criteria.

5.0 Operationalization, Measurement and definition of variables

5.1 Introduction

This chapter discusses operationalization and measurement of the variables used in the study and presents the measurement model. Further, constructs are defined and grounded in literature and previous research.

5.2 Operationalization and Measurement of Latent Variables

Latent variables are unobserved variations often associated with an underlying concept, often referred to as a construct, which cannot be directly observed or measured (Fayers and Hand 2002); (Byrne 2013). To measure latent variables, it is necessary to operationalize the construct and link it to observable variables that may represent it (Byrne 2013). (Williams unknown) defines operationalization as *"The process of specifying the operations (measures) that will indicate the value of a variable for each case"*. Thus, making the latent variable indirectly measurable by measuring the observed values constituting the construct (Byrne 2013).

There are four levels of measurement with increasingly mathematical precision each variable can be expressed, i.e. nominal, ordinal, interval and ratio ((Churchill and Brown 2004); (Watt and Berg 2002). The most important characteristics are summarized by (Churchill and Brown 2004) in table 5.1 below.

Nominal scale: is a categorical variable, which is used to identify and distinguish between groups based on the presence or absence of an attribute. For example, 1 = Male and 2 = Female can be used to identify and distinguish between the gender of a person, while 0 = non-smoker and 1 = smoker can identify and distinguish individuals who smoke from those that do not.

Ordinal scale: allows the researcher to place variables in a logical order or rank them according to a criterion. For example, tiny, small, medium, big and large is a logical order for increasing size. We can say that medium is a larger size than small, however, we cannot say by how much.

Interval scale: the distance (interval) between variables can be determined. For example, on a scale from 1-7 the researcher can say that 4 is larger than 3 by one unit. Further, if 1 = highly disagree and 7 = highly agree, the researcher can say whether an individual or group agrees to a statement and can also state whether one group agrees more to the statement than another group, based on the scores given. However, this scale does not have an absolute zero point, thus the researcher cannot say that an individual who answers 4 agrees twice as much as an individual who answers 2.

Ratio scale: this scale includes a distinct absolute zero point, which allows for comparison of absolute magnitudes. Weight is a good example of a ratio scale. It is impossible to weigh less than zero, as the object would way nothing, and in terms of weight, not exist. Because zero is an absolute value numbers the researcher can compare numbers, e.g. one can say that 200 kg is twice as heavy as 100 kg.

(Churchill and Brown 2004) and (Watt and Berg 2002) argue that because a higher level of measurement is more precise and allows for better analysis, the researcher should always choose the highest level of measurement practically possible. As it is difficult to include an absolute zero when measuring attitude towards a phenomenon, this study utilizes interval scales.

Table 5.1 Scales of Measurement. Adapted from (Churchill and Brown 2004).

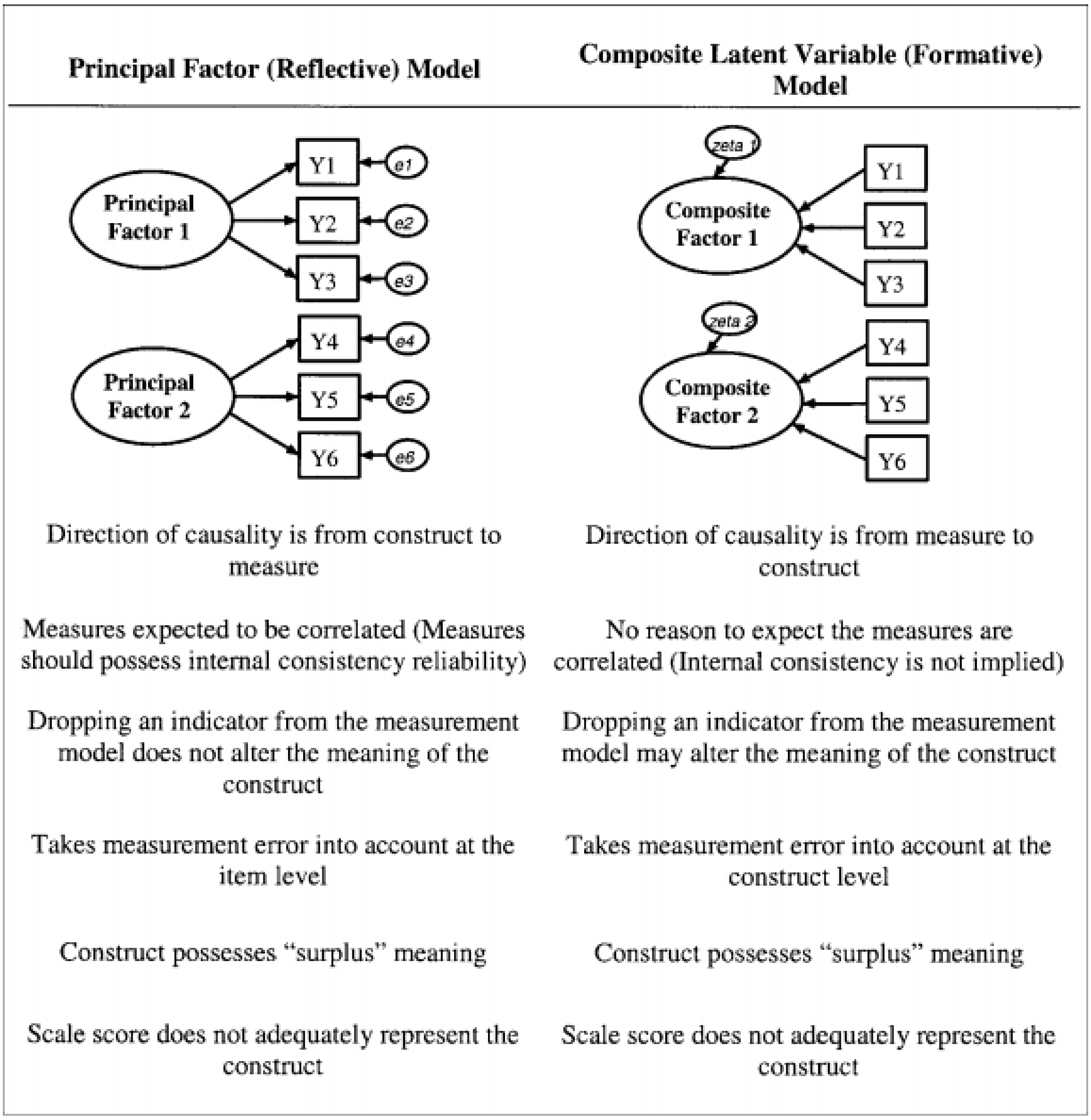
Scale	Basic Comparison	Measures of Average	Typical Examples

Nominal	Identify	Male/Female User/Non-user Occupations Uniform Numbers	Mode
Ordinal	Order	Brand preference Social class Hardness of minerals Graded quality of lumber	Median
Interval	Comparison of intervals	Temperature scale Grade point average Attitude towards brands	Mean
Ratio	Comparison of absolute magnitudes	Units sold Number of purchases Income Age	Geometric mean Harmonic mean

5.3 Measurement Model

According to (Hair et al. 1998: 581) *"a latent variable cannot be measured directly but can be represented or measured by one or more variables (indicators)"*. (Bollen 1989, 180) defines measurement as "the process by which a concept is linked to one or more latent variables, and these are linked to observed variables". Furthermore, (Bollen 1989, 182) defines the measurement model as "a measurement model specifies a structural model connecting latent variables to one or more measures or observed variables. (Bollen 1989) further argues that determining the direction of causality between latent variables and its indicators is problematic. He suggests distinguishing between cause and effect indicators. Cause indicators are observations, assumed to cause a latent variable, while effect indicators are observations caused by a latent variable. In structural equation modeling (SEM) there are two commonly used measurement models to determine the relationship between a construct and its indicators, i.e. the Principal Factor Model (Reflective) and the Composite Latent Variable Model (Formative) (Bollen 1989); (Bollen and Lenox 1991); (Jarvis, Mackenzie and Podsakoff 2003). In the Principal Factor Model (reflective), the causality flows from the construct to the indicators. Thus, the indicators are effects caused by the construct (Bollen 1989), which reflects the variations in the construct (Jarvis, Mackenzie and Podsakoff 2003). According to (Bollen and Lennox 1991), a widely accepted assumption within classical measurement theory is that indicators positively associated with a particular construct are positively associated with each other. The authors found this to be true for effect indicators, but not necessarily for causal indicators. Therefore, removing an effect indicator does not affect the construct validity, assuming that the remaining indicators are sufficient to measure the construct, and are adequately correlated (Bollen and Lennox 1991). In the Composite Latent Variable Model however, the causality flows from the indicators to the construct. Thus, each indicator represents a part of a construct, which aren't necessarily correlated. Therefore, eliminating an indicator is to eliminate part of the construct, and may change the meaning of the construct (Bollen 1989). (Jarvis, Mackenzie and Podsakoff 2003) summarize the two models and their characteristics in table 5.2.

Figur 5.2 Summary of differences between types of measurement models. Source: (Jarvis, Mackenzie and Podsakoff 2003).



Principal Factor (Reflective) Model	Composite Latent Variable (Formative) Model
Direction of causality is from construct to measure	Direction of causality is from measure to construct
Measures expected to be correlated (Measures should possess internal consistency reliability)	No reason to expect the measures are correlated (Internal consistency is not implied)
Dropping an indicator from the measurement model does not alter the meaning of the construct	Dropping an indicator from the measurement model may alter the meaning of the construct
Takes measurement error into account at the item level	Takes measurement error into account at the construct level
Construct possesses "surplus" meaning	Construct possesses "surplus" meaning
Scale score does not adequately represent the construct	Scale score does not adequately represent the construct

5.4 Construct Definition and Measurement Process

This section presents and defines all the variables used in this study and which items constitutes a particular latent construct. This study includes the use of both multi-item and single item variables, for the most part measured by a scale ranging from 1 (low) to 7 (high). All variables are operationalized on a reflective scale. This study includes one dependent variable; supply chain risk management (SCRM), and five independent variables; supplier performance (SUPPER), supply risk perception (SUPRISKPERC), disruptive risk focus (DISRISK), agile supply chain (ASC) and regional production (REGPROD). and Regional

Distribution (REGDIST) and three control variables; firm size (LN_REV2016), regional distribution (REGDIST) and risk identification (SUPRISKID). The variables used in this study are based on previous research literature, as discussed in chapter 3.

5.4.1 The Dependent Variable

Supply Chain Risk Management (SCRM):

This construct consists of six items, concerning to which extent the respondent and their most important supplier collaborate to mitigate supply risk. Because supply risk is the focus of this study, the customer side of SCRM, i.e. downstream supply chain members, are excluded from this construct. The items are measured by a Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. The items are derived from previous research and literature (Manuij and Mentzer 2008); (Miller 1992); (Jüttner 2005); (Zsidisin 2003)

SCRMsup1: Do your firm collaborate with your most important supplier on a regular basis in order to mitigate risk by sharing risk.

SCRMsup2: Do your firm collaborate with your most important supplier on a regular basis in order to mitigate risk by preparing contingency plans.

SCRMsup3: Do your firm collaborate with your most important supplier on a regular basis in order to mitigate risk by improving bottlenecks.

SCRMsup4: Do your firm collaborate with your most important supplier on a regular basis in order to mitigate risk by implementing strategically placed safety stocks.

SCRMsup5: Do your firm collaborate with your most important supplier on a regular basis in order to mitigate risk by postponing commitment of resources until the demand is certain.

SCRMsup6: Do your firm collaborate with your most important supplier on a regular basis in order to mitigate risk by ensuring good information flow.

5.4.2 The Independent Variables

Supplier performance (SUPPER):

This construct consists of five items, concerning the performance of the respondents most important supplier are measured by a Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. (Thun and Hoenig 2011); (Stand 2001).

SUPPER1:	We rarely experience any delay on our incoming shipments.
SUPPER3:	We rarely experience any quality problems on our incoming shipments.
SUPPER4:	We rarely experience any damages on our incoming shipments.
SUPPER5:	We rarely experience any deficits in the amount of items ordered and the amount of items delivered on our incoming shipments.
SUPPER6:	We rarely experience any picking errors on our incoming shipments.

Supply Risk Perception (SRP):

This construct is the mean product of two variables concerning supply risk (probability and consequence), thus it is the respondents total risk perception associated with the particular risk, following (Norrman and Jansson 2004) definition of measurable risk *"Risk = probability x consequence"*. The construct consists of four items, as presented below.

SUPRISKPERC1	$mean(supRISKP1\ x\ supRISKC1)$
SUPRISKPERC2	$mean(supRISKP2\ x\ supRISKC2)$
SUPRISKPERC3	$mean(supRISKP3\ x\ supRISKC3)$
SUPRISKPERC4	$mean(supRISKP4\ x\ supRISKC4)$

Where the respondents have been asked to evaluate the probability of a risk occurring (supRISKP), and the consequences this risk have for the respondent's firm should it occur (supRISKC) based on the work of (Thun and Hoenig 2011); (Miller 1992); (Zsidisin 2003); (Chopra and Sodhi 2004).

supRISKP1/C1	Supplier bankruptcy
supRISKP2/C2	Quality issues on components from supplier
supRISKP3/C3	Delays on incoming shipments from supplier
supRISKP4/C4	Workforce disputes in supplier's organization (e.g. strike)

Supply Chain Agility (SCA)

This variable consists of a single item concerning to which extent the respondent's firm implemented agility in their supply chain. Agility is a strategy, which increases a firm's ability to sustain disruptions (Christopher 2000); (Christopher and Towill 2000); (Qrunfleh and Tarafdar 2013); (Lee 2004). The variable was measured on a scale ranging from 1 = small degree to 7 = large degree.

Regional Production (REGPROD)

This variable consists of a single item concerning whether the respondent's firm utilize several geographically separate production facilities, based on the work of (Chopra and Sodhi 2014). The items data is captured by multiple choice with the options no/yes, i.e. it is a dummy variable, representing whether the respondent implement a centralized or a decentralized approach to production.

Disruptive Risk (DISRISK)

This variable consists of a single item concerning to which extent the respondent's firm focus on mitigating disruptive risks, based on the work of (Chopra and Sodhi 2014) and (Elahi 2013). The item is measured on a scale ranging from 1 = small degree to 7 = large degree.

5.4.3 Control Variables

There are three control variables included in this study, as described below.

Firm Size (LN_REV2016)

This is an independent variable describing the revenue the respondent's firm achieved during the fiscal year of 2016. The data is extracted from the database presented in the previous chapter and calculated into a logarithmic function. It serves an indication on the respondent firm's size, as it is argued that firms with a higher level of revenue implement more risk management (Hoffmann, Schiele and Krabbendam 2013). Furthermore, (Hoffmann, Schiele and Krabbendam 2013) argue that bigger firms build risk management experience faster, because of a higher frequency of operations.

Risk identification (SUPRISKID)

This variable consists of a single item concerning to which extent the respondent's firm collaborates with its most important supplier to identify upstream risks for the supply chain

(Manuij and Mentzer 2008); (Miller 1992); (Jüttner 2005); (Zsidisin 2003). The item is measured by a scale ranging from 1 = small degree to 7 = large degree.

Regional Distribution (REGDIST)

This variable consists of a single item concerning whether the respondent's firm utilize several geographically separate distribution centers, based on the work of (Chopra and Sodhi 2014). The items data is captured by multiple choice with the options no/yes, i.e. it is a dummy variable, representing whether the respondent's frim implement a centralized or a decentralized approach to distribution.

5.5 Chapter Summary

This study uses a structural equation model (SEM) with reflective scales, i.e. the direction of causality is from the construct to the measure. Further, the variables presented in the conceptual model, see figure 4.1, was defined and operationalized according to previous research and literature.

6.0 DATA EXAMINATION, DATA VALIDATION AND MEASUREMENTS ASSESSMENT

6.1 Introduction

This chapter discuss, and present various data examination techniques used to determine the quality of the dataset collected and applied in this study. This is a necessary step to determine the credibility of the dataset, and that it meets the statistical assumptions for regression analysis. Thus, this chapter includes an initial data screening, were missing values and outliers are assessed, the assumption of normally distributed data is examined, and scales are evaluated based on reliability and validity tests. Finally, the overall model fit is evaluated. Brought together these tests determine whether the dataset is applicable for regression analysis.

6.2 Preliminary Data Screening and Cleaning

(Pallant 2013) and (Hair et al. 1998) argue that it is essential to review the data set before performing any data analysis, as data errors, missing values and outliers can disturb the analysis and potentially lead to wrong conclusions.

According to (Pallant 2013) testing the data involves obtaining and interpreting descriptive statistics of the variables in the dataset. These descriptive data include the mean values, standard deviations, range of scores, skewness and kurtosis.

6.2.1 Assessment of Missing Values and Data Errors

Missing data is described as any absence of data in any of the measured variables, in any of the collected cases (Hair et al. 1998); (Schumacker and Lomax 1996). Missing data is a common issue all researchers are faced with, as it is extremely rare to get a complete dataset, especially when the research involves human beings (Schumacker and Lomax 1996); (Hair et al. 1998); (Pallant 2013). Missing data may impose problems on statistical analysis, therefore it is important to evaluate the amount of missing values, whether they are random or caused by a systematic process. Missing values are a systematic process when they are caused by elements external to the respondent, such as data entry errors or data collection problems, or caused by the respondent, such as refusal to answer a question (Hair et al. 1998). Once the missing values are assessed, the researcher must also decide how they should be treated. There are several methods to treat cases with missing values. 1) They can be excluded completely, 2) excluded in operations which involves the variables with missing values or 3) missing values can be replaced (insertion of mean value, most likely value or a similar value) (Schumacker and Lomax 1996); (Hair et al. 1998); (Pallant 2013). The researcher identified two cases of systematic missing data, involving the variables SUPPER2 and REV2016. SUPPER2, an independent variable concerning the average length of delays on incoming shipments, was removed from further analysis due to excessive missing values. LN_REV2016, a control variable concerning firm size, have eight missing values (see table 8.1). The data was unavailable because the respondent chose not to answer which firm he/she represented, and therefore the financial data could not be extracted from the database. The amount of cases with missing values were so low they were deemed insignificant. Therefore, analysis was performed with an option of excluding cases list-wise, i.e. cases which contained missing values were excluded from analysis (Pallant 2013).

(Pallant 2013) stresses that it is very simple to do mistakes when inserting the raw data in the dataset, resulting in data errors. Thus, it is vital to check the data for such errors; to do this the researcher must check whether the minimum, maximum and mean values makes sense. In this study, the data was primarily collected through scales ranging from 1 to 7. As such, no values outside of this interval should exist in the dataset; otherwise, the researcher have made data entry errors. Furthermore, mean values should be within the range of defined intervals. In this study, there are two such intervals, 1-7 for single items, and 1-49 for products of two variables, e.g. the product of probability and consequences of a risk. However, two variables, REGPROD and REGDIST, were captured by multiple choice (no/yes) and used as dummy variables, i.e. coded as no = 0 and yes = 1, thus any number outside this range for these variables are also entry errors. The data was carefully entered and double-checked by the researcher, and no values outside the respective variables range exist (see table 8.1), therefore it is concluded the dataset is clean of errors.

Table 6.1 Descriptive statistics - missing values and range of variables

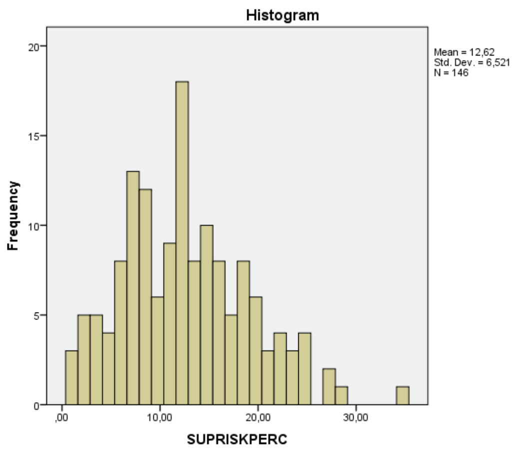
	SCRM	SUPPER	SRP	SUPPRxSRP	REGPROD	REGDIST	SUPRISKID	SCA	DISRISK	LN_REV2016
N Valid	145	145	145	145	144	145	144	144	145	137
Missing	0	0	0	0	1	0	1	1	0	8
Mean	2,98	5,39	12,47	65,67	0,34	0,27	3,60	3,33	3,83	10,61
Std.Dev.	1,16	1,09	6,28	32,83	0,47	0,44	1,71	2,00	1,83	1,77
Minimum	1	1,20	1	1,2	0	0	1	1	1	5,72
Maximum	6	7	29	160,95	1	1	7	7	7	16,29

6.2.2 Assessment of Outliers

An outlier is an observation with extreme value, which significantly differs it from the other observations. (Hair et al. 1998: 64) defines outliers as *"observations with a unique combination of characteristics identifiable as distinctly different from the other observations"*. There are several reasons why outliers occur. (Hair et al. 1998) argue that there are four classifications of outliers 1) procedural error, such as missing data and data entry error 2) result of an extraordinary event, which explains the outlier 3) extraordinary observations, which cannot be explained 4) observations, which are inside the range of the variable, but possess unique characteristics. Schumacher and Lennox (1996) argue that outliers can also be the result of observational error or faulty measurement instrument.

A simple way to identify outliers is to use histograms, to identify observations sitting on their own out on the extremes, and boxplots, where observations outside the "whiskers" are considered as outliers (Hair et al. 1998); (Pallant 2013). This was done by using the explore function in SPSS. SPSS regards any value greater than 1.5 box lengths from the box as an outlier, while observations greater than 3 box lengths from the box are considered to be extreme values (Pallant 2013). However, (Hoaglin and Iglewicz 1987) argues that 1.5 is inaccurate indicator and that approximately 50% of the time, identifies outliers which aren't actually outliers. (Hair et al. 1998) suggest using an indicator of 2.5 for samples with 80 cases or less, and an indicator of 3-4 for larger samples. However, (Hoaglin and Iglewicz 1987) argues that this is too high, and that the best indicator is 2.2. Using boxplots, the researcher identified twelve unique outliers (i.e. values greater than 1.5 but less than 3), one concerning SUPRISKPERC, five concerning SUPPER, and six concerning LN_REV2016. Following (Pallant 2013) the researcher examined the 5% trimmed mean of these variables, which indicate whether the outliers have a significant impact on the mean value. 5% trimmed mean removes the bottom and top 5% of the observations and compare the two mean values, i.e. the group which include these observations (mean) with the group that don't (5% trimmed mean). If there is a big difference between the two mean values, the outliers have a significant impact on the analysis, and the researcher should investigate the outlier further, and consider whether it is necessary to remove it from the dataset (Pallant 2013). SUPPER, which had five outliers, have a mean of 5,39, while the 5% trimmed mean is 5,47, which is not significantly different. Thus, these five outlying values are retrained in the dataset. SUPRISKPERC had one outlier and a mean value of 12,62 while the 5% trimmed mean was 12,40, this difference was considered significant. A histogram, see figure 8.1, also identify this observation as an outlier, and the outlier was removed from the dataset. LN_REV2016, contained six outlying observations. The variable had a mean value of 10,61, the 5% trimmed mean was equal to 10,59 which is very similar, suggesting these observations could be retained. Furthermore, (Hair et al. 1998) argue that observations which are representative in the population, could be retained to ensure generalization. LN_REV2016 represent the various firm size in the population in which both small firms (low revenue) and large firms (high revenue) operate. Thus, these observations are also retrained in the dataset.

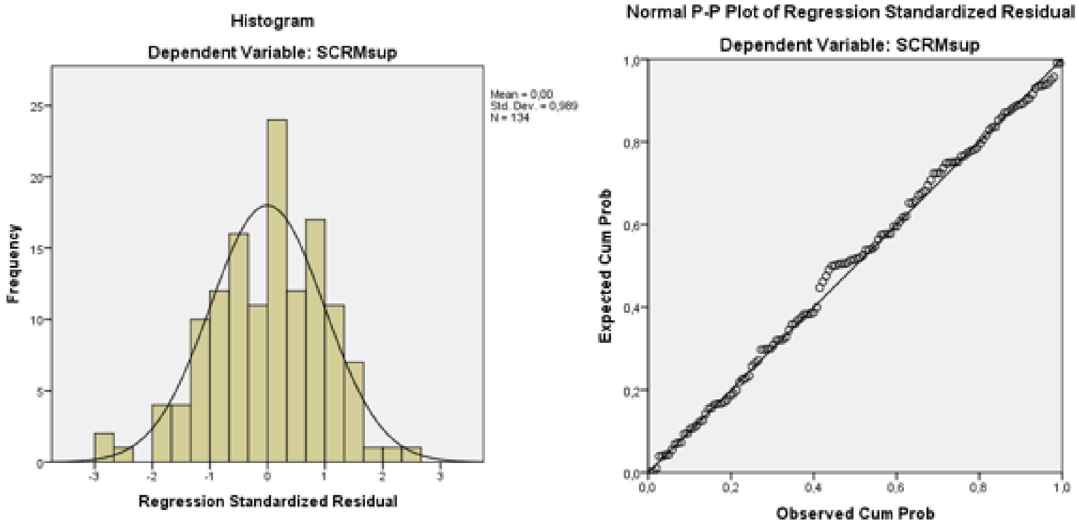
Figure 6.1 Histogram of observations for SRP



6.2.3 Assessment of Normality

Fundamental to multivariate analysis is the normality of the data used, i.e. that the data follows a normal distribution. Regression analysis relies on F and T statistics, which require a normal distribution, thus normality is imperative for the analysis to be valid (Hair et al. 1998). In a normal distribution, the majority of the observations are centered in the middle close to the mean value, with diminishing observations towards the extremes, resembling a bell shape (Hair et al. 1998); (Pallant 2013). Normality can be examined both by graphical methods (histogram, normal probability plot and boxplots) and by numerical methods (skewness, kurtosis and Kolmogorov-Smirnov statistic). The graphical methods are simple to interpret; however, the numerical methods are more objective. It is recommended to use both methods (Hair et al. 1998); (Pallant 2013). In the histogram, the observations should resemble a bell shape as mentioned above, while in a normal probability plot the observations should hug the diagonal line, representing a normal distribution. The researcher used a histogram and a normality plot to check the distribution graphically (see figure 8.2a and b) and skewness and kurtosis as numerical indicators of normality. Skewness is a measure of the symmetry in a distribution; it can be positive, negative or undefined. Positively skewed data are clustered to the left and tails of to the right. A negatively skewed data is clustered on the right and tails of to the left. Kurtosis is a measure of how peaked or flat the distribution is compared to a normal distribution. Positive values indicate a higher peak than the normal distribution, while negative values indicate a flatter peak than the normal distribution (Hair et al. 1998).

Figure 6.2 Illustration of normal distribution a) Histogram b) Normality Probability Plot.



There are many rules of thumb of what acceptable values for skewness and kurtosis are. A perfectly normal distribution has skewness and kurtosis values equal to zero (Pallant 2013), thus the values of skewness and kurtosis should be close to zero. (Hair et al. 1998) suggest that values of skewness should be within ±1, as values approaching and exceeding ±1 are highly skewed. (George and Mallery 2011) argue however, that values within ±1 are considered excellent, but values between ±2 are considered acceptable. While acceptable kurtosis values between ±1 are considered excellent, but values between ±2 are acceptable (George and Mallery 2011), or according to (Kline 2011) values between ±3 are also considered acceptable. The output of Kurtosis and Skewness tests are presented in Table 8.2 below.

Table 6.6.1 Descriptive statistics - Kurtosis and Skewness

	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
SCRM	145	0.004	0.201	-0.652	0.400
SUPPER	145	-1.293	0.201	2.395	0.400
SRP	145	0.378	0.201	-0.412	0.400
SUPPERxSRP	145	0.504	0.201	0.089	0.400
REGPROD	144	0.681	0.202	-1.558	0.401
REGDIST	145	1.053	0.201	-0.904	0.400
SUPRISKID	144	0.112	0.202	-0.979	0.401
SCA	144	0.323	0.201	-1.185	0.401
DISRISK	145	0.012	0.201	-1.069	0.400
LN_REV2016	137	0.243	0.207	0.919	0.411

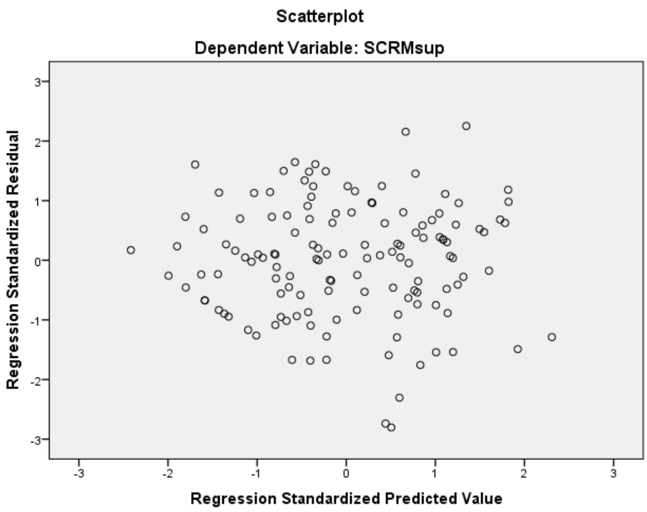
The results show that the dataset is within the accepted indicators for kurtosis, according to (Kline 2011), but two highly skewed variables exist according to (Hair et al. 1998), SUPPER and REGDIST. This is explainable however, as most of the respondent use high performing suppliers, which centers the observations to the right of the scale, while some respondents experience some more problems which then tails of to the left, i.e. a negative skew. I believe however, this represent a normal situation in the real world, and therefore is not concerning. Whereas REGDIST is a yes or no question, i.e. a dummy variable, where most of the respondents answer that they do not use regional distribution centers. This was expected as there are many small firms and local firms included in the sample, and therefore of little concern.

In conclusion, the assumption of normal distribution exists in the dataset used in this study.

6.3 Assessment of Homoscedasticity

To have homoscedastic data is a critical assumption when conducting linear regression, as it refers to the extent in which the dependent variables have an equal level of variance across values of the independent variables in the dataset. The data is said to be homoscedastic when the variance in the error term is constant over a set of variables in the dataset (Hair et al. 1998), i.e. the variance in the value of variable X should be equal at all values of variables of Y (Pallant 2013). According to (Pallant 2013) and (Tabbernick and Fidell 2013), the assumption of homoscedasticity can be assessed by examining a scatterplot. If the data is homoscedastic, the majority of the observations should be concentrated in the center around the zero point, in the shape of a rectangle. Observations outside ±3.3 are considered outliers (Tabbernick and Fidell 2013). The researcher created a scatterplot of the observations used in the measuring model, see figure 8.3 below, which shows that the observations are concentrated around the center in the shape of a rectangle with no values outside ±3.3, thus homoscedasticity is established in the data used in this study.

Figure 6.3 Assessment of Homoscedasticity



6.4 Factor Analysis – Exploratory

A factor analysis refers to a data reduction technique where variables in a large dataset are reduced into a small number of factors. This is done by summarizing correlations, and variables which are closely related are grouped together, i.e. becomes a factor (Pallant 2013). According to (Hair et al. 1998) the objective of performing a factor analysis is to reduce the number of variables which contains information of an underlying concept into a smaller set of variables (factors) with a minimum loss of information. That is, a number of variables which explains a latent variable are reduced to a smaller set of intercorrelated variables (factor) with a minimum loss to explanatory power associated with the latent variable. There are main types of factor analysis, exploratory and confirmatory, the former will be discussed in this section, while the latter is discussed later (Pallant 2013). According to (Pallant 2013) exploratory factor analysis is used in the early stages of a study, to examine interrelations in the variables, thus it is often used to refine scales, where scale items which have a low correlation are removed. In this study an exploratory factor analysis was used to assess whether the items in the same constructs belong together, i.e. are inter-correlated, and whether some of the scale items should be eliminated. An important feature in factor analysis is rotation, which allows the axes of a factor to be rotated, thus finding the best fit between the observations and latent variable. There are two categories of rotation, oblique which allows the factors to be correlated, and orthogonal which do not allow factors to correlate (Hair et al. 1998). The factor analysis in this study was performed with a Varimax-rotation, which according to (Hair et al. 1998) is a good approach for obtaining an orthogonal rotation of the factors.

According to (Pallant 2013), there are two statistical tests in SPSS to determine whether a dataset is suitable for factor analysis, Bartlett's test of sphericity and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. Bartlett's test of sphericity should be significant, i.e. $p < 0,05$, for the dataset to be considered suitable for factor analysis. While KMO, which is an index ranging from 0 to 1, values exceeding 0,6 suggest that the dataset is suitable for factor analysis (Pallant 2013).

Table 8.3 below presents the results of the factor analysis. The items included are supplier performance (SUPPER), Supply Chain Risk Management towards the supplier (SCRMsup) and the respondents supply risk perception (SUPRISKPERC). The factor analysis assigned the items to three separate components (factors) which explains 63,656% of the total variance, with an Eigen Value of 1,692 (see Appendix XXX). (Pallant 2013) claims that Kaisers criterion, or Eigen Value, are one of the most used techniques to determine which factors should be kept for further analysis, where Eigen Values > 1 are retained for further analysis. According to (Hair et al. 1998), a frequently used rule of thumb states that factor loadings exceeding ±0,3 meets a minimum acceptance criterion, factor loadings exceeding ±0,4 are more important and factor loadings exceeding ±0,5 are considered significant. The respective components factor loadings all exceed 0,5 and items were kept for further analysis.

The Bartlett's test of sphericity was found to be significant at a level of 0.00, and KMO was found to be 0,802 which is larger than 0,6. Therefore it is concluded that the dataset is suitable for factor analysis and that the three factors should be used in the further analysis.

Table 6.6.2 Exploratory factor analysis – Factor Loadings and Cross Loadings

	Component		
	1	2	3
SupPer5	**.893**	.004	-.013
SupPer6	**.878**	-.022	.018
SupPer4	**.854**	..028	-.008
SupPer3	**.811**	.022	-.205
SupPer1	**.685**	.067	-.198
SCRMsup3	-.053	**.838**	.201
SCRMsup2	-.084	**.813**	.005
SCRMsup5	.116	**.810**	.105
SCRMsup4	.034	**.761**	.101
SCRMsup6	.170	**.710**	.114
SCRMsup1	-.187	**.585**	.288
SupRiskIndex2	-.179	.081	**.817**
SupRiskIndex3	-.239	.043	**.775**
SupRiskIndex1	.038	.205	**.694**
SupRiskIndex4	.018	.223	**.635**

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
Rotation converged in 5 iterations

6.5 Assessment of Reliability

Reliability of scale indicates how free the scale is from random errors and refers to the extent of which a variable or a construct is consistent over multiple measurements. There are two common methods to determine reliability, the test-retest and Cronbach Alpha. Test-retest is a method where the measurements are performed on the same sample on two different occasions, thus measuring the stability of the responses. Cronbach Alpha, arguably the most used method, tests the internal consistency of the items measured, i.e. the degree to which the items measure the same underlying construct and the internal correlations between the items included in the scale (Hair et al. 1998); (Pallant 2013); (Kline 2011); (Hamid, Sami and Sidek 2017). Given the scope of this study, a test-retest is simply not feasible, due to time limitations; therefore, this study relies on Cronbach Alpha to determine the reliability. The Cronbach Alpha indicator ranges from 0 to 1, with higher values indicating a higher reliability. The literature suggests a minimum value of 0,7 is needed to establish internal consistency, but that the indicator should be 0,8 and higher (Kline 2011); (Pallant 2013); (Hamid, Sami and Sidek 2017). This study includes three scales, which are tested based on Cronbach Alpha, and the results shown in Table 8.4. The Cronbach Alpha suggest that internal consistency and scale reliability is established, as the Cronbach Alpha indicators exceeds the minimum value of 0,7.

Table 6.6.3 Reliability of scale – Cronbach's Alpha

	Cronbach's Alpha	N	%
SupPer	.878	145	100
SCRMsup	.861	143	98,6
SupRiskIndex	.751	145	100

6.6 Assessment of Validity

According to (Churchill 1999) validity is synonymous with accuracy and correctness, i.e validity of scale involves to which degree the variable or the scale measure what it is designed to measure. There is no one way to test validity (Pallant 2013); (Kline 2011), and therefore validity is often concerned with collecting empirical evidence through various tests. The most common indicators used are content validity, criterion validity and construct validity (Pallant 2013). Whereas the most widely accepted forms of validity tests are convergent, discriminant and nomological validity tests, according to (Hair et al. 1998), the two former, are included in this study.

6.6.1 Content Validity

Content validity refers to the extent to which there is a connection between the items constituting a scale and its conceptual definition (Hair et.al. 1998). That is, whether the indicators included in a scale sufficiently captures the aspect of the latent variable. (Hair et al. 1998: 117) states that the objective of content validity is *"to ensure that the selection of scale items extends past just empirical issues to also include theoretical and practical considerations"*. To determine whether the included indicators are sufficient to measure the latent variable are based on expert opinions and judgment (Kline 2011). For this study the researcher examined other literature measuring the same aspect and based the scale development on these, as discussed in section 6.4. This study includes three scales which measure supplier performance, supply chain risk management towards the suppliers, and the respondents' perception of risk. The scale measuring supplier performance is based on previous surveys in the same topic and Key Performance Indicators, as such the researcher would argue that this scale achieves content validity. The scale measuring Supply

Chain Risk Management towards the suppliers, is based on previous literature and theory. While this is a huge topic, I would argue that the scale includes the most important aspects of SCRM, and therefore that the scale is sufficient for the purpose of this study. Risk Perception however is a huge and ambiguous topic, which depends on the context it is applied to and is perceived differently by individuals. As such the scale should include more indicators to capture a bigger aspect of the term than is the case in this study.

6.6.2 Criterion Validity

Criterion validity refers to the extent to which the observations of a measure is related to an external outcome, which it can be evaluated against (Kline 2011). The author further argue that criterion validity exists if the scores of X on Y are large enough to support that the test explains a sufficient amount of the variability. For instance, in this study, high supplier performance is believed to reduce the risk of supply disruptions, and thus the need for the respondent to engage in risk management towards the supplier. This was found to be empirically true, and as such, criterion validity is established.

6.6.3 Construct Validity

Construct validity refers to which degree the observed variables accurately measure the unobserved variance, the latent variable, they are meant to measure. I.e. whether the scales defined and operationalized in the previous chapter, are able to describe the latent variables (Pallant 2013). Construct validity is determined through assessing its relationship to other constructs, both in terms of those the construct is related to (convergent validity) and unrelated to (discriminant validity) (Churchill 1999); (Pallant 2013). (Kline 2011) argue that convergent and discriminant validity involves assessing measures against each other rather than against an external standard.

6.6.4 Convergent Validity

Convergent validity determines to which degree indicators of the same construct are correlated (Hair et al. 1998); (Hamid, Sami and Sidek 2017). The test is empirical, where high correlation indicates that the scale is measuring what it is intended to measure (Hair et al. 1998). A set of variables are convergent valid, i.e. believed to measure the same construct, if they are at least moderately inter-correlated (Kline 2011). According to (Fornell and Larcker 1981) and (Hamid, Sami and Sidek 2017), for convergent validity to be established the average variance extracted (AVE) for each indicator (SCRMsup, SupPer and

SupRiskIndex) should exceed a minimum value of 0,5. To determine the scales AVE, the researcher first conducted an exploratory factor analysis, shown in table 8.4 above, and extracted the factor loading for each indicator, which is used to calculate AVE. The results are shown in Table 8.5. Because each scales AVE exceeds the minimum acceptance value of 0,5 (Hamid, Sami and Sidek 2017) convergent validity is established.

Convergent validity was also tested using AMOS, which is a more precise, because it allows items to correlate. The results of this analysis are shown in Table 8.5a-b. Table 8.5a included 5 items for SupRiskIndex (item 1 through 5), however, AVE did not exceed the minimum value for convergent validity acceptance. Thus, an item, SupRiskIndex5, was removed which increased the AVE to 0,503 which establishes convergent validity, see table 8.5b. Thus, SupRiskIndex5 was removed from further analysis. Because this study uses reflective scales, removing this item does not affect the construct as discussed in the previous chapter.

Table 6.5 *Indicators of convergent and discriminant validity using SPSS*

	CR	AVE	SCRMsup	SupPer	SupRiskIndex
SupPer	.915	.685	**.827**		
SCRMsup	.889	.574	.039	**.758**	
SupRiskIndex	.822	.730	.291	-.206	**.854**

Table 6.6a) Indicators of convergent and discriminant validity using AMOS24

	CR	AVE	MSV	MaxR(H)	SCRMsup	SupPer	SupRiskIndex
SupPer	.869	.528	.156	.882	**.727**		
SCRMsup	.890	.622	.052	.916	-.011	**.789**	
SupRiskIndex	.814	.467	.156	.815	.395	.279	**.684**

Table 6.6b) Indicators of convergent and discriminant validity using AMOS24

	CR	AVE	MSV	MaxR(H)	SCRMsup	SupPer	SupRiskIndex
SupPer	.869	.528	.123	.882	**.727**		
SCRMsup	.890	.623	.057	.916	-.011	**.789**	
SupRiskIndex	.800	.503	.123	.815	.350	.227	**.684**

6.6.5 Discriminant Validity

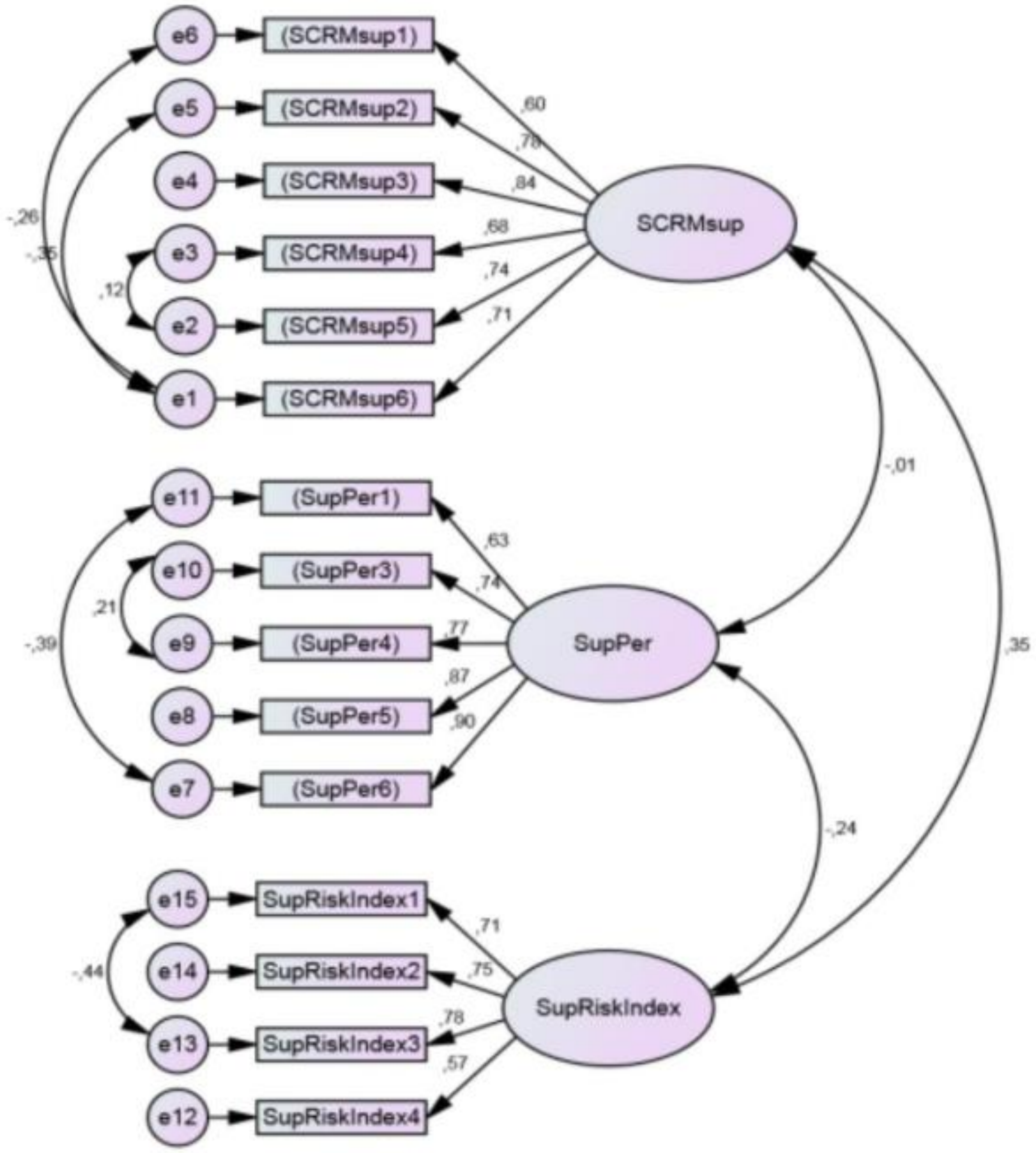
Discriminant validity refers to the degree a construct is empirically different from another construct (Hamid, Sami and Sidek 2017). Thus, this is also tested empirically based on correlation, however, this time the correlations are supposed to be low (Hair et al. 1998).

A set of variables are discriminant valid, i.e. believed to measure different constructs, if they are not too highly inter-correlated (Kline 2011). Discriminant validity can be determined based on cross-loadings of the indicators, the Fornell-Larcker Criterion and the HTMT ratio of correlation, this study uses the two former approaches. The factor loadings are greater than the cross-loadings, see table 8.4, suggesting that the constructs are discriminant valid. However, according to (Hamid, Sami and Sidek 2017) the cutoff point should be higher than 0,7 which is not true for four of the indicators. The Fornell-Larcker Criterion which states that the indicator of a latent construct should have a higher explanatory power than its correlation to other latent constructs (Fornell and Larcker 1981); (Hamid, Sami and Sidek 2017). Therefore, the square root of an indicators AVE should have a higher value than its correlation to another latent construct. This is true for the indicators used in this study, see table 8.5, where the **bald values** represent the square root of the respective indicators AVE, and the non-bald values represent the indicators correlation to the other latent constructs, for instance **0,827** > 0,039 | 0,291. This is also true for the results using AMOS, see table 8.6a-b. Therefore, discriminant validation is established.

6.7 Assessment of the Hypothesized Measurement Model

The purpose of Confirmatory Factor Analysis (CFA) is to verify the factor structure of a set of observed variables. That way, it allows the researcher to test the hypothesis that a relationship between observed variables and their underlying latent constructs exists (Hair et al. 1998). In this study, the CFA has been performed using Amos 24. Figure 8.4 below presents the three-factor model of the analysis.
The values of the relevant metrics for the model fit are as follows: CFI=0.95; TLI=0.93; RMSEA=0.067; SRMR =,0757; PCLOSE=0.084; and GFI=0.897. Following (Hu and Bentler 1999), these values suggest adequate fit. In addition, although Chi-square statistic was significant (X2 =134 d.f = 81, p = 0.00), the normed Chi-square ratio (CMIN/DF) is 1.65:1, which is well below the recommended threshold of 3:1 (Hair et al. 2010). Taken together, therefore, these values confirm the specified factor structure.

Figure 6.5 Confirmatory Factor Analysis using AMOS24



6.8 Chapter Summary

The dataset has undergone various tests to determine whether statistical assumptions are met, and that further analysis will be valid. A few cases with missing values were found, however, they were small in number and therefore is considered insignificant. A few outliers were identified and investigated, this led to the exclusion of one case (#49), while the other outliers did not significantly affect the mean values and therefore retained in the dataset. The assumption of normality is confirmed in the dataset. Three factors were extracted by EFA and passed reliability and validity tests, and the overall model fit was confirmed by CFA in AMOS 24.

7.0 Chapter 7 - Hypotheses Testing and Findings

7.1 Introduction

This chapter involves a regression analysis approach to determine the relationships which exists between the dependent and independent variables included in this study, and to test the hypotheses associated with these variables, as discussed in previous chapters.

7.2 Regression Model

Regression analysis is a statistical procedure to determine how variables are related, i.e. how an independent variable influence a dependent variable. This study involves multiple regression, which is a process that examines how changes in a dependent variable is influenced by changes in two or more independent variables (Hair et al. 1998). The authors further argue that multiple regression is the appropriate method to use when the research problem involves a single dependent variable which is believed to be related to other variables, in this study SCRM. This study examines how the variable, SCRM, among the responding firms operating in Norwegian industries is affected with its relationship to other variables, for instance supply risk perception and supplier performance. Thus, multiple regression is an appropriate method to test the hypotheses discussed in chapter 3, where the value of the variables inter-correlation determines their relationship (Pallant 2013). That is, the extent of an independent variables correlation on a dependent variable determines the magnitude of its influence on the dependent variable. Furthermore, a negative value indicates a negative relationship, i.e. the presence of the independent variable reduces the level of the dependent variable and vice versa for a positive relationship (Pallant 2013). For instance, in this study, it is expected that high risk perception increases the amount of SCRM, i.e. there is a positive inter-correlation between risk perception and SCRM. Therefore, to test the extent the independent variables, with the interaction effect between supplier performance and supply risk perception in particular, influence the dependent variable, a hierarchical multiple regression model is applied (Pallant 2013).

7.3 Assumption of Multicollinearity

Multicollinearity is defined by (Hair et al. 1998) as *"the extent to which the variable can be explained by the other variables in the analysis"*. Further, the authors argue that as multicollinearity increases it becomes more difficult to determine whether the variance in a variable is explained by another, due to higher inter correlations. That is, the variance in a dependent variable is explained by inter-correlations within the two variables rather the associated relationship between the two variables, i.e. the effect imposed on the dependent variable by an independent variable cannot be explained by the independent variable. According to (Hair et al. 1998) and (Pallant 2013), problems associated with multicollinearity exists when the interrelations between variables exceeds a value of 0,9. The interrelationships was assessed by the confirmatory analysis in the previous chapter and found to be low, however, (Hair et al. 1998) and (Pallant 2013) argue that it can be assessed by examining variance inflation factor (VIF), and tolerance values (Pearson's correlation coefficient). Both of which can be computed within SPSS. The acceptance criterion for tolerance are values exceeding 0,10 on a scale from 0 to 1, while VIF values exceeding 10 are elements of concern (Pallant 2013). (Buvik and Andersen 2002) argue that including an interaction effect and the variables constituting the interaction effect in one regression model may cause a multicollinearity problem. To avoid this problem the variables forming the interaction effect can be mean centered. As this study includes an interaction effect and the variables forming it, the researcher followed (Buvik and Andersen 2002) and mean centered the variables. As shown in appendix table 9.1 below, all the tolerance levels of the variables included in the regression model exceeds 0,1 while the VIF levels are well beneath the acceptance level of 10. Thus, it is concluded that it does not exist a problem with multicollinearity within this study.

Table 7.1 *Correlation Matrix with Collinearity Tests*

Factor	1	2	3	4	5	6	7	8	9	10
SCRM	1	.039	.291	-.183	.052	-.058	.548	.335	.431	.314
SUPPER		1	-.206	-.134	.068	.169	.058	.003	-.043	-.061
SRP			1	-.203	-.196	-.165	.044	-.034	.040	.233
SUPPER x SRP				1	-.028	-.032	.070	.038	.054	-.115
REGDIST					1	.643	.089	.054	.066	.049
REGPROD						1	.066	.042	.033	-.011
SUPRISKID							1	.310	.342	.160
SCA								1	.188	-.007
DISRISK									1	.239
LN_REV2016										1
Mean	2.94	.00	.00	-1.32	-1.32	.28	0.34	3.56	3.23	10.58
Std.Dev.	1.19	1.06	6.06	7.73	.45	.48	1.74	2.00	1.87	1.78
Tolerance	n/a	.89	.82	.90	.56	.57	.79	.89	.83	.87
VIF	n/a	1,12	1.21	1.10	1.77	1.75	1.25	1.12	1.20	1.15

7.4 Regression Analysis

To test the conceptual model included in this study and the hypothesized relationships, the following regression model was estimated, see equation 8.1 below.

Equation 8.1

$$SCRM = b_0 + b_1 SUPPER + b_2 SUPRISKPERC + b_3 SUPPER \text{ x } SUPRISKPERC + b_4 REGPROD + b_5 REGDIST + b_6 SUPRISKID + b_7 SCA + b_8 DISRISK + b_9 LN\_REV2016$$

Table 7.2 Hierarchical Regression Analysis with SCRM as the Dependent Variable

Models	**Variables**	**Unstandardized Coefficients (b)**	**t - value**
Model 1: Including control variables • R^2adj = .338 • R^2 change = .353 • F(3.130) = 23.627 • p < .000	(Constant)	.053	.104
	Firm Size (LN_REV2016)	.156	3,258**
	Regional Distribution (REGDIST)	-.013	$-.070^{NS}$
	Risk Identification (SUPRISKID)	.348	7.124**
Model 2: Including main effects • R^2adj = .471 • R^2 change = .150 • F(5.125) = 7.548 • p < .000	(Constant)	.178	.367
	Firm Size (LN_REV2016)	.093	2.073**
	Regional Distribution (REGDIST)	.347	1.567^{NS}
	Risk Identification (SUPRISKID)	.253	5.265**
	Supplier Performance^C (SUPPER)	.119	1.629*
	Supply Risk Perception^C (SRP)	.051	3.851**
	Regional Production (REGPROD)	-.388	1.866*
	Supply Chain Agility (SCA)	.110	2.780**
	Disruptive Risk (DISRISK)	.144	3.282**
Model 3: Including interaction effect • R^2adj = .492 • R^2 change = .024 • F(1.124) = 6.171 • p < .014	(Constant)	.207	.435
	Firm Size (LN_REV2016)	.083	1.873*
	Regional Distribution (REGDIST)	.319	1.468^{NS}
	Risk Identification (SUPRISKID)	. 264	5.579**
	Supplier Performance^C (SUPPER)	.085	1.170^{NS}
	Supply Risk Perception^C (SRP)	.043	3.257**
	Regional Production (REGPROD)	-.391	-1.917*

	Supply Chain Agility (SCA)		
	Disruptive Risk (DISRISK)	.110	2.821**
	Supplier $Performance^C$ x Supply Risk $Perception^C$ (SUPPER x SRP)	.149	3.467**
		-.025	-2.484**

Notes: $mean\ centered\ variable^C$; $not\ significant^{NS}$; $significant\ at\ p < 0.05^*$(one-tailed); $significant\ at\ p < 0.01^{**}$(one-tailed)

Because the analysis in this study includes control variables, main effects and an interaction effect the researcher used a three-step approach to estimate the regression model for hypothesis testing following (Buvik and Andersen 2002). Model 1 includes the control variables only, consisting of Firm Size (LN_REV2016), Regional Distribution (REGDIST) and risk identification (SUPRISKID). Model 2 includes the main effects (independent variables) to test hypotheses H1, H3, H4 and H5. Finally, the third model includes the interaction effect between risk perception and supplier performance to test hypothesis H2. According to (Jaccard, Turrisi and Wan 2003) and (Helm and Mark 2012) the significance of an interaction effect is determined by whether there is a significant change in R^2 between model 2 and 3, and the significance of the interaction terms coefficient. Estimating the model in three steps allows the incremental effect each added variable have on the dependent variable (Jaccard, Turrisi and Wan 2003).

Model 1, including the control variables, explained 33,8% of the variance in SCRM (R^2 = 0.338, p < .000) thus, providing support for the effect the selected control variables have on the dependent variable. Model 2 includes supplier performance, supply risk perception, regional production, agile strategy and disruptive risk, i.e. the main effects. In this model, a significant increase in explanatory power is observed (R^2 = .471, p < .000). similarly, a significant increase in explanatory power is also observed in Model 3as compared with Model 2 (R^2 = .492, p < .014).

7.4.1 The Effect of the Control Variables

As mentioned above, the control variables accounted for 33,8% of the variance in SCRM, with a significance of p < .000. Thus, the analysis support that the control variables have an effect on the dependent variable, supply chain risk management (SCRM). However, individually only two of the control variables were significant, risk identification and firm size. Risk identification (b6 = 0,348 t = 7,170, p < 0,000) indicates that firms with a higher tendency to collaborate with their supplier to identify upstream risk, also have a higher level of SCRM. While firm size (b9 = 0,155, t = 3,270, p < 0,001) indicate that there is a difference in the level of supply chain risk management (SCRM) between bigger firms, in this study, firms with a high revenue, and small firms, as suggested by (Hoffmann, Schiele and Krabbendam 2013).

7.5 Test of Hypotheses

This section presents and discuss the hypothesis testing based on the regression model outlined above (see table 9.2).

Hypothesis 1:

The first hypothesis (H1) is related to how the respondent assess the probability of a risk occurring and the consequence for his or her firm should the risk occur, i.e. the respondent total risk perception. This relationship is expected to be positive. Thus, a high perception of risk is expected to increase the level of SCRM the respondent's implement. The regression analysis show that the coefficient is positive, in addition, it is found to be significant (b_1= 0.043; t = 3,257; p < 0,001). Thus, the analysis strongly support hypothesis 1, supply risk perception is positively associated with SCRM. That is, as risk perception among Norwegian industry firms included in this sample increases, the amount of a SCRM the firm engages in increases, i.e. the more exposed a firm is to supply risks the more the firm collaborate with its supplier to mitigate its supply risks.

Hypothesis 2:

The second hypothesis (H2) involves how supplier performance affects the respondents supply risk perception, and by extension the level of SCRM they implement, i.e. an interaction effect between risk perception and supplier performance. The relationship between risk perception and supplier performance is found to be negative, i.e. as supplier performance increases, risk perception decreases, and thus the need for SCRM decreases with it. Further, this relationship is significant (b_1= -0.025, t = -2.484; p < 0,014). Thus, the analysis strongly support hypothesis two, i.e. that there is a negative relationship between risk perception and supplier performance which weakens the relationship between risk perception and SCRM.

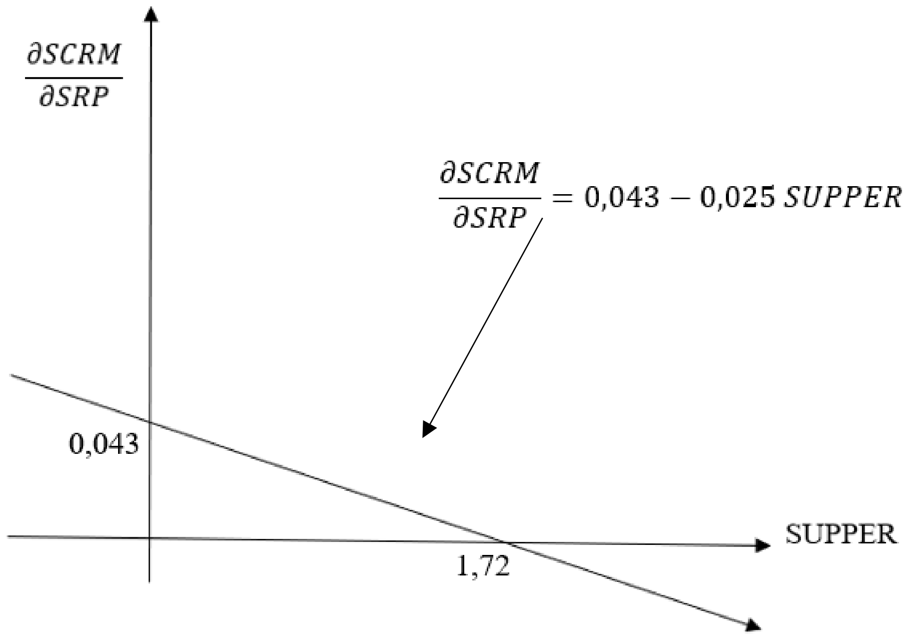
$$\frac{\partial SCRM}{\partial Risk\ Perception} = b_2 + b_3 SUPPER \qquad \text{Equation 7.2}$$

$$\frac{\partial SCRM}{\partial Risk\ Perception} = 0{,}043 - 0{,}025 SUPPER \qquad \text{Equation 7.3}$$

Following (Cohen et al. 2003) and (Hayes 2013) the nature of the moderation hypothesis, i.e. the interaction effect, can be illustrated more clearly by graphing the partial derivative of the regression model 3 with respect to supplier performance.

Based on the results of equation 8.3 above, the partial derivative of a firm's level of SCRM with respect to supplier performance is plotted below, see figure 8.1. The downward sloping line illustrates that an increasing level of supplier performance reduces the effect risk perception impose on a firms SCRM. In other words, as supplier performance increases, the positive relationship between risk perception and SCRM is reduced, i.e. there is less need for SCRM when suppliers perform on a high level. Thus, there is empirical support for hypothesis two, there exist an interaction effect between risk perception and supplier performance, which affects the level of SCRM implemented by Norwegian industry firms. If I substitute in the real mean value of supplier performance (5,39), as these values have been mean centered, I find that the interception between the interaction effect and the x-axis is 7,11 $(5{,}39 + 1{,}72)$. This value is outside the range of the scales used in this study, i.e. there are no cases beyond this point.

Figure 7.1 The association between supply risk management (SCRM) and supply risk perception (SRP) on different levels of supplier performance (SUPPER)



Hypothesis 3:

Recall that hypothesis three (H3) predicted a positive relationship between an Agile supply chain strategy and SCRM. That is, the constructs which constitute an agile strategy is designed to make the supply chain flexible and thus more resilient, which builds risk management into the supply chain design. The analysis shows that the coefficient of an agile strategy is positive and significant (b_7 = 0,110, t = 2,821, p < 0,006), thus providing support for this hypothesis. Adapting an agile supply chain strategy enhances SCRM.

Hypothesis 4:

The fourth hypothesis (H4) involves how a focus on mitigating disruptive risks increases SCRM. As discussed in chapter 4, disruptive risks requires supply chains to be resilient and/or robust they must be able to absorb the risk or recover from it quickly. This require contingency plans and redundancy within the supply chain operations. Therefore, it is expected to be a positive association between disruptive risk and SCRM. The analysis indicates that the coefficient is positive and significant (b_8 = 0,149, t = 3,467, p < 0,001), therefore there is evidence to support this hypothesis.

Hypothesis 5:

The final hypothesis (H5) state that there is a negative association between regional production and SCRM. As discussed in chapter 4, regional production spreads the risk across several geographically separated areas, and it can be argued that regional supply chains are less complex than global ones. Therefore, it is expected to see a negative relationship between regional production and SCRM, which is supported by the analysis which produce a significant negative coefficient, < 0,05 (b_4= -0,391, t = -1,917, p > 0,058). This indicates that firms using regional production have less need for SCRM than firms that do not use regional production.

7.6 Chapter Summary

A standard regression model was used to test the hypotheses derived from previous research and literature. The result indicates that H1, H2, H3, H4 are supported, while H5, is partially supported, i.e. the relationship existed but it was not found to be significant in this sample.

8.0 Chapter 8 - Discussion of Findings, Limitations, Implications and Future Research

8.1 Introduction

This chapter discuss the key findings of the study according to the research questions and literature applied to this study, limitations of the study, its implications and outlines an agenda for further research.

8.2 Summary of Findings

The objective of this study was to examine how selected factors influence supply chain risk management among Norwegian Industry firms. This study includes five such factors: risk perception (Norrman and Jansson 2004); (Thun and Hoenig 2011), supplier performance (Thun and Hoenig 2011); (Stand 2001), regional production (Chopra and Sodhi 2014), Disruptive risk (Chopra and Sodhi 2014); (Elahi 2013), and agile supply chain strategy (Lee 2004); (Christopher 2000); (Christopher and Towill 2000); (Qrunfleh and Tarafdar 2013). A correlation matrix, see table 9.1, shows that all variables except supplier performance, regional distribution and regional production are significantly related to SCRM towards the respondents' suppliers. The overall assessment of goodness of fit for the model is statistically significant at p < .014 R^2adj = .492, t = .435 and F (1,124) = 6.171. Five hypotheses were tested, all five (H1, H2, H3, H4, H5) was empirically supported by the analysis included in this study.

Hypothesis	Coefficient	t – value	Findings
H1: There is a positive association between supply risk perception and supply chain risk management (SCRM).	-.043	3.257	Supported
H2: The association between supply risk perception and supply chain risk management (SCRM) becomes less positive when supplier performance increases.	-.025	-.2484	Supported
H3: There is a positive association between the degree of supply chain agility and supply chain risk management (SCRM).	.110	2.821	Supported
H4: There is a positive association between the degree of disruptive risk and supply chain risk management (SCRM).	.149	3.467	Supported
H5: Supply chain risk management (SCRM) is significantly lower for firms applying regional production than for firms applying centralized production.	-.391	-1.917	Supported

Table 9.1. Summary of findings

8.3 Discussion

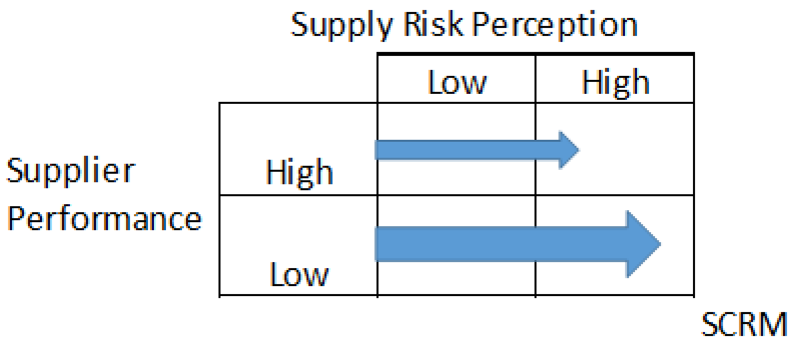
Risk Perception and its influence on SCRM

Risk perception relates to how vulnerable the respondents' firm are to risks. A low risk perception means that the risk has either a low likelihood of occurrence, a low impact on the firm should it occur, or both, and vice versa for a high level of risk perception. This is determined through assessing identified risks (Hoffmann, Schiele and Krabbendam 2013); (Miller 1992); (Elahi 2013). As discussed, the literature suggests three possible outcomes, acceptance, mitigation and avoidance. Low risks are generally accepted as the potential payoff outweighs the potential loss. Risk which are deemed unacceptable are either mitigated, i.e. reduced to an acceptable level through various techniques and strategies, some of which are discussed in this paper, or avoided if the firm is unable to reduce the risk to an acceptable level. Therefore, it was expected to find a positive association between risk perception and SCRM. As a firm's vulnerability to risks increases, their supply chain risk management is also increased. This relationship was proven in the study. Therefore, its concluded that as a firm's risk exposure increases, the firm initiates steps to reduce the likelihood or impact of said risk.

How supplier performance affects risk perception and SCRM

This study includes an interaction effect between a firm's supply risk perception and its supplier's performance. This relationship was predicted to be negative, i.e. as supplier performance increases, the magnitude the supply risk perception impose on a firm's SCRM decreases. The interaction effect was found to be empirical significant and is illustrated graphically in figure 8.1. The downwards slope of the curve indicate a deteriorating need for SCRM as supplier performance increases. Thus, this relationship can be illustrated as in figure 9.1, below. In scenario 1, top-left corner, the supplier is performing on a high level, and the risks associated with incoming supplier are low. In this situation there is a low level of SCRM between the focal firm and its supplier. If we move from situation 1, to scenario 2, top-right corner, the supplier is still performing on a high level, however now the risks associated with incoming supplies are high. All else equal, there will be a small increase in SCRM, as the supplier is performing well, and therefore, the payoff of increasing SCRM is considered to be low. In scenario 3, bottom-left corner, the supplier is performing on a low level, however the risk associated with incoming supplies are low and thus the importance of conducting SCRM is low. If we move to scenario 4, bottom-right corner, all else equal the association of a low performing supplier and high perception of risk have a huge effect on SCRM. The presence of considerable supply risk associated with incoming supplies, the focal firm will increase its SCRM towards the supplier to mitigate these risks, because the payoff between adding risk management and the reduction of risks are significant.

Figure 8.1The level of supply chain risk management for different levels of supplier performance and supply risk perception.



For instance, in the example below, see table 9.2, in situation 1 there is a 10% chance that the incoming supplies will be disrupted. The cost of the disruption for the focal firm is estimated to \$1.000.000. Thus, the perceived cost by the focal firm is $0{,}1\ x\ \$1.000.000 = \$100.000$ because risk is defined as likelihood of loss and significance of that loss (Mitchell

1995), and quantifiable expressed as *probability x consequence* (Norrman and Jansson 2004). If it costs \$100.000 annually to mitigate this risk by half (50%), the return of investment (ROI) is not desirable as it would only reduce the cost for the focal firm's perceived risk by $0{,}05\ x\ \$1.000.000 = \$50.000$. Thus, the ROI is negative $\$100.000 - \$50.000 = -\$50.000$, i.e. the firm would lose money on making this investment. On the other hand, if the risk associated with the incoming supplies getting disrupted was 30%, as in situation 3, all else equal, the perceived risk for the focal firm is $0{,}3\ x\ \$1.000.000 = \$300.000$. Mitigating the likelihood for the risk to occur by half would reduce cost by $0{,}15\ x\ \$1.000.000 = \$150.000$. Now, the focal firm have an incentive to increasing SCRM as it would generate a positive ROI, equal to \$50.000, as $\$150.000 - \$100.000 = \$50.000$. Thus, at high levels of perceived risk the effect of implementing supply chain risk management are high. Turn this around, and the effect of SCRM to mitigate risks associated with incoming supplies, decreases as the supplier's performance increases (i.e. low likelihood of occurrence).

Cost of supply disruption = \$1.000.000

Cost of reducing likelihood of occurrence by half (50%) = \$100.000

Table 8.1 Perceived cost of a supply disruption at different levels of supplier performance.

	Likelihood of supply disruption	Perceived risk before investment	Perceived risk after investment	Return of investment (ROI)
Situation 1	10%	100.000	50.000	-50.000
Situation 2	20%	200.000	100.000	0
Situation 3	30%	300.000	150.000	50.000
Situation 4	40%	400.000	200.000	100.000
Situation 5	50%	500.000	250.000	150.000

Disruptive risk and Agile supply chain strategy and how they influence SCRM.

Disruptive risk, which as discussed are caused by high impact risks with lower frequency, are mitigated through building a more resilient supply chain (Chopra and Sodhi 2014). Therefore, it was expected to find a positive association between disruptive risks and the level of SCRM employed by the responding firms. This relationship was proven in the analysis. Thus, most of the firms included in this study's sample, appear to be aware of disruptive risks and are taking some steps to reduce the likelihood and impact of these. The moderate level (b_7 = 0,110, t = 2,821, p < 0,006), can be explained by the existence of

smaller firms which don't have the revenue to support a higher level of supply chain risk management (Hoffmann, Schiele and Krabbendam 2013). It is also possible, that their inability to implement a higher level of SCRM is due to a low buyer power in their relationship with the supplier, however this must be further studied.
As discussed during chapter 2, an agile strategy focuses on building flexibility. It is a critical success factor in today's volatile business world, as it allows firms to recover faster from disruptions, which have become more frequent (Lee 2004). During their research, (Qrunfleh and Tarafdar 2013) found empirical evidence that supply chain agility significantly contributed to a firm's responsiveness and by extension their performance. The analysis of this study showed a significant positive association between supply chain agility and SCRM, which can be explained by agility incorporating the aforementioned characteristics. And as argued by Chopra and Sodhi (2014), a supply chain must be resilient to mitigate disruptive risks. Therefore, it can be expected to find firms implementing agility in their supply chains in business areas with a high perception of disruptive risks.

This study investigated whether high risk perception resulted in a higher level of SCRM, but what happens in scenarios where risk perception is low, yet the firms have a high level of SCRM, or vice versa?

Figure 8.2.2 Outcome of various alignments between Risk Perception and SCRM

		Risk Perception	
		Low	**High**
SCRM	**High**	1: Overkill	2: Balanced
	Low	3: Balanced	4: Hazardous

In situation 1 (top-left corner) there is a low level of perceived risk, however, the firm is still implementing a high level of SCRM. This may for instance be because the firm have adapted an agile supply chain strategy, which as discussed above, results in a higher level of SCRM. To mitigate risks, especially disruptive risks, are costly (Chopra and Sodhi 2014); (Hoffmann, Schiele and Krabbendam 2013). It requires the firm to make significant investment, and add redundancy in its operation, which reduces efficiency. Therefore, when there is a low level of perceived risk, but a high level of SCRM, the effect of SCRM is low, similar to situation 1 in table 8.2. The firm is spending more money on SCRM than the benefits it receives from the mitigation effects, i.e. this situation is an overkill. The firm should ideally reduce the amount of resources it spends on SCRM.

In situation 2 and 3, the alignment between perceived risks and SCRM is balanced, i.e. High-High (situation 2) and Low-Low (situation 3). These two situations represent the sweet spot between risk perception and SCRM associated with their respective risk levels. In situation 2, the level of perceived risk is high and therefore the firm must take measures to mitigate it. Furthermore, because the perceived risks are high, the effect of SCRM is also more significant. This can be a situation similar to situation 3-5 in table 8.2. The benefits the firm receives from implementing a higher level of SCRM are greater than the resources they must spend to mitigate the risks. Situation 3 is also ideal, because the firm do not spend any resources on SCRM that they do not need. The risks are deemed sufficiently low and the risk is accepted. Finally, situation 4, is the worst-case scenario. The level of perceived risk is high; however, the firm is not implementing a sufficient amount of SCRM. Therefore, the firm is highly vulnerable to disruptions, which can be potentially devastating. This can be due to the risks not being visible to the firm. As mentioned earlier, during their work (Harland, Brenchley and Walker 2003) found that less than 50% of a firm's risk were known to them. Secondly, top management may be reluctant to invest in SCRM. As the effect, or benefit, of risk management do not become clear before after the risk have occurred. Thus, SCRM may be perceived only as additional cost, and in a business world where reducing cost is critical to stay competitive, it become easy to neglect SCRM. A third reason may be simply because the firm do not have the necessary resources to make any investment in SCRM or they may have little power in the relationship with their supplier and therefore be unable to implement SCRM.

Firms who find themselves in scenario 1 should, if possible, try to reduce the resources they spend on SCRM, and move to situation 3. This is because the perceived level of risk is low, thus the cost of maintaining a high level of SCRM outweighs the benefits received from the reduced risk exposure. Firms finding themselves in situation 4 however, should significantly increase their investment in SCRM and move to situation 2. The firms risk exposure is critical, and the firm could potentially be hit by a serious disruption from which it may not be able to recover.

8.4 Managerial Implications

There are several findings in this study worth considering for managers of the firms included in the sample, and by rule of generalization, of firms operating in Norwegian industries. The first consideration is elementary, and states that as perception of risks increases, that is, the firms' exposure to risk, the manager should incorporate a greater degree of SCRM. Second, managers should pursue an agile strategy when designing their supply chain, as this strategy result in more flexible and responsive supply chains. Thus, it is less exposed to risk, for which there is a consensus in the literature. Especially firms focusing on mitigating disruptive risks should implement agility. Third, firms operating on a global scale should consider regionalizing their supply chains as suggested by (Chopra and Sodhi 2014). This strategy was found to reduce the need for SCRM among the firms included in this study. Finally, supplier performance greatly reduces the exposure to supply risks, and thus the need for SCRM to mitigate risks associated with incoming supplies. Therefore, managers should replace suppliers with low performance, or help low performing suppliers change their operations and increase performance. By sourcing their requirements from high performing suppliers, managers can reallocate the resources used to mitigate risks, to other areas of it operations, thus creating a better tradeoff between resources spent and benefits achieved through risk mitigation efforts.

8.5 Limitations

The data used in this study was collected through distributing a questionnaire to Norwegian industrial firms and asking them about their perceived risk and their most important supplier's performance. Thus, it only captures the SCRM effort between the respondents' firm and its tier 1 supplier. As discussed initially, SCRM, extends beyond the immediate relationship between a focal firm and its direct supplier. Therefore, this study fails to capture effects of SCRM further upstream in the supply chain. Further, the analysis in this study does not include downstream supply chain members and therefore do not capture the effects of SCRM between the respondents' firms and their customers. A third issue is the scale regarding supply risks consist of few items. Therefore, many risks are not captured in this study, which could alter the findings, and lead to other significant relationships. Finally, this study fails to establish external reliability.

8.6 Further Research

Additional research into this area should extend beyond a focal firm and its direct supplier. That is, it should capture data directly from a firm's supplier, and ideally the supplier of the supplier as well. However, this is a difficult task as it requires a higher level of communication and cooperation between the researcher and the respondents. It can also be difficult to get a large enough sample; therefore, it may be better to apply a quantitative approach and cross check the findings with the findings in this study. Furthermore, it may also be beneficial to expand on the theoretical background and see how other aspects such as agency theory (Zsidisin 2003), behavioral interdependence, i.e. opportunism (Miller 1992), transaction cost analysis (TCA) and resource dependency theory (RDT) affect perceived risk and SCRM effort amongst Norwegian industry firms.

8.7 Conclusion

The purpose of this study was to examine how various factors influence the level of supply chain risk management (SCRM) among Norwegian industry firms, with respect to supply risks. This study found that risk perception, i.e. a firm's exposure to risk, incorporating agility in the supply chain, and disruptive risks positively influences, i.e. increases a firm's level of SCRM. Whereas, supplier performance decreases the effect that supply risk perception impose on SCRM. Regional production reduces the need for SCRM, which can be explained by the risk of disruptions are spread across several entities. In conclusion, this study identified several factors that influence supply chain risk management (SCRM) among firms operating within the Norwegian industry.

9.0 References

Abdulmalek, A. Fawaz and Jayant Rajgopal. 2007. "Analyzing the benefits of lean manufacturing and value stream mapping via simulation; A process sector case study." *International Journal of Production Economics* 107 (1): 223-236.

Bollen, Kenneth. 1989. *Structural Equations with Latent Variables.* Somerset, US: John Wiley & Sons, incorporated.

Bollen, Kenneth and Richard Lennox. 1991. "Conventional Wisdom on Measurement: A Structural Equation Perspective." *Psychological Bulletin* 110 (2): 305-314.

Buvik, Arnt and John George. 1999. "When does Vertical Coordination Improve Industrial Purchasing Relationships?" *Journal of Marketing* 64 (4): 52.

Buvik, Arnt and Otto Andersen. 2002. "The Impact of Vertical Coordination on Ex Post Transaction Costs in Domesitc and International Buyer-Seller Relationships." *Journal of International Marketing* 10 (1): 1-24

Byrne B.M. 2013. *Structural equation modeling with Mplus: Basic concepts, applications, and programming.* Routledge.

Cohen, J., P. Cohen, S. G. West and L. S. Aiken. 2003. *Applied Multiple Regression/Correlation Analysis for The Behavioral Sciences,* 3rd ed. London: Lawrence Erlbaum Associates.

Chopra, Sunil and ManMohan S. Sodhi. 2004. "Managing Risk to Avoid Supply-Chain Breakdown". *MIT Sloan Management Review* 46 (1).

Chopra, Sunil and ManMohan S. Sodhi. 2014. "Reducing the Risk of Supply Chain Disruptions". *MIT Sloan Management Review* 55 (3): 73-80.

Christopher, Martin. 2000. "The Agile Supply Chain: Competing in Volatile Markets." *Industrial Marketing Management* 29 (1): 37-44.

Christopher, Martin and Denis R. Towill. 2000. "Supply chain migration from lean and functional to agile and customized." *Bradford* 5 (4): 206.

Christopher, Martin. 2011. *Supply Chain Management*, 4th ed. London: Pearson. Chapter 1, page 3. Available at:

http://www.icesi.edu.co/blogs/supplychain0714/files/2014/07/Martin_Christopher_Logistics_and_Supply_Chain_Management_4th_Edition____2011-1.pdf
Churchill, A. Gilbert. 1999. *Marketing Research: Methodological Foundations, 7th ed.* London: The Dryden Press.

Churchill, A. Gilbert and Tom J. Brown. 2004. *Basic Marketing Research, 5th*. Mason, Ohio: Thomson South-Western.

Cresswell, W. John. 2012. *Education research: planning, conduction and evaluating quantitative and qualitative research, 4th ed.* Boston: Pearson Education.

Cresswell, W. John. 2014. *Research design: qualitative, quantitative, and mixed methods approaches 4th ed.* Los Angeles: SAGE.

Elahi, Ehsan. 2013. "Risk Management; the next source of competitive advantage." *Emerald Group Publishing Limited* 15 (2): 117-131.
Fornell, Claes and David F. Larcker. 1981. "Evaluating Structural Equation Models with Unobseravable Variables and Measurement Error." *Kournal of Marketing Research (pre-1986)* 18, 000001; Proquest: 39.

Fayers, M. Peter and David J. Hand. 2002. "Causal variables, indicator variables and measurement scales: an example from quality of life." *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 165 (2): 233-253.

George, Darren and Paul Mallery. 2011. *SPSS for Windows step by step: a simple guide and reference 18.0 update, 11th ed. Boston: Allyn & Bacon.*

Gilbert, A. Gregory and Michael A. Gips. 2000. "Supply-side contingency planning". Security Management 44 (3): 70-74
Greene, H. Alice. 1991. "Supply Chain of Customer Satisfaction." *P&IM REVIEW WITH APICS NEWS, April 1991. The Magazine of Manufacturing Performance.*

Hair, Joseph F. JR., Rolph E. Anderson, Ronald L. Tatham and William C. Black. 1998. *Multivariate Data Analysis*, 5th ed. London: Prentice-Hall International.

Hair, Joseph F. JR., Rolph E. Anderson, Ronald L. Tatham and William C. Black. 2010. *Multivariate Data Analysis*, 7th ed. New Jersey: Pearson Education.

Hamid, M. R. Ab, W. Sami and M. H. Mohamad Sidek. 2017. "Discriminant Validity Assessment: Use of Fornell & Larcker criterion versus HTMT Criterion. *Journal of Physics: Conference series* 890 012163

Harland, Christine, Richard Brenchley and Helen Walker. 2003. "Risk in supply networks." *Journal of Pyrchasing & supply Management* 9: 51-62.

Harrison, Alan and Remko van Hoek. 2008. *Logistics Management & Strategy - Competition through the Supply Chain*, 3rd ed. Harlow: Pearson Education Limited

Hauser, M. Lisa. 2003. "Risk Adjusted Supply Chain Management." *Supply Chain Management Review* 7 (6): 64.

Hayes, Andrew. F. 2013. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression Based Approach*, 2nd ed. New York: The Guilford Press.

Helm, R. and A. Mark. 2012. "Analysis and evaluation of moderator effects in regression models: state pf art, alternatives and empirical example." *Review of Mangerial Science* 6 (4): 307-332.

Hoffmann, Petra, Holger Schiele and Koos Krabbendam. 2013. "Uncertainty, supply risk management and their impact on performance." *Journal of Purchasing & Supply Mangement* 19 (3): 199-211.

Hillson, David. 2003. "Defining Risk and Opportunity." *Iris Intelligence.* Accessed 22.05.2018. Available at: https://www.irisintelligence.com/defining-risk-and-opportunity/

Hoaglin, C. David and Boris Iglewicz. 1987. "Fine-Tuning Some Resistant rules for Outlier Labeling." *Journal of the American Staistical Association* Volume 82 (400): 1147-1149.

Hu, Li-Tze and Peter M. Bentler. 1999. "Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives," *Structural Equation Modeling: A Multidisciplinary Journal* 6 (1): 1-55.

Jaccard, James, Robert Turrisi and Choi K. Wan. 1990. *Interaction Effects in Multiple Regression. Newbury Park, CA: Sage Publications.*

Jarvis, Cheryl Burke, Scott B. Mackenzie and Philip M. Podsakoff. 2003. "A critical Review of Construct Indicators and Measurement Model Misspecifications in Marketing and Consumer Research." *Journal of Consumer Research* 30 (2): 199-218.

Jüttner, Uta, Helen Peck & Martin Christopher. 2003. "Supply chain Risk Management: Outlining an Agenda for Future Research. *International Journal of Logistics: Research Apllications* 6 (4): 197-210.

Jüttner, Uta. 2005. "Supply chain risk management. Understanding the business requirements from a practitioner perspective." *The International Journal of Logistics Management* 16 (1): 120-141.

Kline, Rex B. 2011. *Principles and Practice of Structural Equation Modeling, 3rd ed. London: The Guilford Press.*

Kothari, C. R. 2004. *Research Methodology: Methods and Techniques.* Daryaganj, India: New Age International Pvt. Ltd., Publishers.

La Londe, J. Bernard and James M. Masters. 1994. "Emerging Logistic Strategies: Blueprints for the century." *International Journal of Physical Distribution & Logistics Management* 24 (7): 35.

Lee, L. Hau. 2004. "The Triple-A Supply Chain. *Harvard Business Review* October 2004.

Leedy, D, Paul and Jeanne Ellis Ormrod. 2013. *Practical research: planning and design, 10th ed.* Boston: Pearson Educational

Manuj, Ila and John T. Mentzer. 2008. "Global supply chain risk management strategies." *International Journal of Physical Distribution & Logistics Management* 38 (3): 192-223.

Melnyk, A. Steven, Edward W. Davis, Robert E. Spekman and Joseph Sandor. 2010. "Outcome-Driven Supply Chains." *MIT Sloan Management Review* 51 (2).

Miller, D. Kent. 1992. "A Framework For Integrated Risk Management In International Business." *Journal of International Business Studies* 23 (2): 311.

Mitchell, Vincent-Wayne. 1995. "Organizational risk perception and reduction: a literature revire." *British Journal of Management* 6 (2): 115

Melton, T. .2005. "The Benefits of Lean Manufacturing: What Lean Thinking Has to Offer the Process Industries." *Chemical Engineering Research and Design* 83 (6) 662-673.

Mentzer, T. John, William DeWitt, James S. Keebler, Soonhong Min, Nancy W. Nix, Carlo D. Smith and Zazh G. Zacharia. 2001. "Defining Supply Chaim Management." *Journal of Business Logistics* 22 (2): 1.

Norrman, Andreas and Ulf Jansson. 2004. "Ericsson's proactive supply chain risk management approach after a serious sub-supplier accident". *International Journal of Physical Distribution & Logistics Management* 34 (5): 434-456. https://doi.org/10.1108/09600030410545463

Pallant, Julie. 2013. *SPSS Survival Manual, 5th ed.* New York: Open University Press

Peck, Helen. 2006. "Reconciling supply chain vulnerability, risk and supply chain management." *International Journal of Logistics: Research and Applications* 9 (2): 127-142.

Punniyamoorthy, Murugesan, Natarajan Thamaraiselvan and Lakshiminarayanan Manikandan. 2013. "Assessment of supply chain risk: scale development and validation." *Benmarking: An International Journal* 20 (1): 79-105.

Qrunfleh, Sufian and Monideepa Tarafdar. 2013. “Lean and agile supply chain strategies and supply chain responsiveness: the role of strategic supplier partnership and postponement.” *Supply Chain Management: An International Journal* 18 (6): 571-582.

Schumacker, E. Randall and Richard G. Lomax. 1996. *A Beginner’s Guide to Structural Equation Modeling, 1st ed. Mahwah, N.J*: Lawrance Erlbaum Associates, Imc., Publishers.

STAND. 2001. «Standardiseringsutvalget for Norsk Dagligvarebransje – Service Level – Standard Defintions». Avaiable at: http://www.stand.no/wp-content/uploads/2015/09/STAND007-v1_0-Service-level-Definition.pdf

Svensson, Goran. 2000. “A conceptual framework for the analysis of vulnerability in supply chains.” *International Journal of Physical Distribution & Logistics Management; Bradford* 30 (9): 731-750.

Sørland, Gina Beate and Sarah Økland Wembstad. 2016. “An investigation and comparison of inbound and outbound risk management (SCRM) among Norwegian manufacturing firms.” *Master Thesis, Molde University College, Specialized University in Logistics.*

Tabbernick, G. Barbara and Linda S. Fidell. 2013. *Using Multivariate Statistics, 6th ed.* Boston: Pearson Educational.

Thun, Jörn-Henrik and Daniel Hoenig. 2011. “An empirical analysis of supply chain risk management in the German automotive industry.” *International Journal of Production Economies* 131: 242-249.

Wagner, M. Stephan and Christoph Bode. 2006. “An empirical investigation into supply chain vulnerability.” *Journal of Purchasing & Supply Chain Management* (12): 301-312.

Wang, Jichuan and Xuaoqian Wang. 2012. *Sample Size for Structural Equation Modeling. Wiley Series in Probability and statistics, Structural Equation Modleing, Chapter 7, p. 391-427.* Chichester, UK: John Wiley and Sons, Ltd.

Waters, Donald 2007. *Supply Chain Risk Management - Vulnerability and Resilience in Logistics, 2nd ed.* London: Kogan Page. Available at: https://books.google.no/books?hl=no&lr=&id=-L9us3-Nu2UC&oi=fnd&pg=PR5&dq=Vulnerability%20and%20resilience%20in%20logistics%20Waters%20Donald&ots=oWoQ2oaqCh&sig=h6dOCmDJkIytLYMJIB6rKYaYwhI&redir_esc=y#v=onepage&q=Vulnerability%20and%20resilience%20in%20logistics%20Waters%20Donald&f=false

Watt, H. James and Sjef van den Berg. 2002. *Research Methods for Communication Science, Chapter 6 – Sampling.* Available at: http://www.cios.org/readbook/rmcs/rmcs.htm

Wieland, Andreas and Carl Marcus Wallenburg. 2012. "Dealing with supply chain risks. Linking risk Management practices and strategies of performance." *International Journal of Physical Distribution & Logistics Management* 42 (10): 887-905.

Williams, Carrie. 2007. "Research Methods" *Journal of Business & Economic Research* 5 (3).

Williams, Roger. unknown. Chapter 4. Conceptualization and Measurement. Accessed at: 07.05.18. Available at: https://pdfs.semanticscholar.org/presentation/3b66/1005e9da15174fe5e361dd7b0d1b6515320d.pdf

Wolf, J. Erika, Jelly M. Harrington, Shaunna L. Clark and Mark W. Miller. 2013. "Sample Size Requirements for Structural Equation Models: An Evaluation of Power, Bias, and Propriety." *Educational and Psychological Measurement* 73 (6): 913-914.

Zsidisin, George. 2003. "Managerial Perceptions of Supply Risk." *Journal of Supply Chain Management* 39 (1): 14.

Zsidisin, George and Lisa M. Ellram. 2003. "An Agency Theory Investigation of Supply Chain risk Management." *Journal of Supply Chain Management* 39 (3): 15

Zsidisin, George, Lisa M. Ellram, Joseph R. Carter and Joseph L. Cavinato. 2004. "An analysis of supply risk assessment techniques." *International Journal of Physical Distribution & Logistics Management* 34 (5): 397.

Appendix. 9.1 "Supply Chain Outcomes and Key Design traits". Source: (Melnyk et al. 2010).

SUPPLY CHAIN OUTCOMES AND KEY DESIGN TRAITS

Certain characteristics and practices are essential to addressing a set of objectives that in turn may ultimately lead to achievement of a particular outcome.

OUTCOME	OBJECTIVE	KEY DESIGN TRAITS
Cost	Reduce product costs, ensure timely and reliable delivery and maintain quality.	▪ Reduced use of slack in its three forms — inventory, lead time and capacity. ▪ Standardization of products and processes where possible. ▪ Emphasis on reducing waste and variance across the supply chain. ▪ Modular supply chain design, involving close interaction and integration with immediate customers and first-tier suppliers (other suppliers are expected to manage their own suppliers).
Responsiveness	Respond to changes in demand (volume, mix, location) quickly and at reasonable cost.	▪ Close information linkages with critical customers and suppliers to monitor demand, facilitate/improve forecasting and monitor state of supply. ▪ Excess capacity — redundancy — in the supply chain (especially on the upstream side). ▪ Supply planning to include not only production capacity but also logistics capacity. ▪ Prequalified suppliers. ▪ Emphasis on small-lot production. ▪ Extensive supplier development and supplier assessment systems. ▪ Information systems to coordinate production/information flows.
Security	Ensure that supplies coming through the supply chain are protected from disruption because of external threats. Protect product integrity and consistency.	▪ Emphasis on visibility and transparency, provided through integrated information systems (or, in extreme cases, vertical integration) throughout the supply chain. ▪ Redundancy of resources in case of a problem with a supplier. ▪ Limited number of partners (fewer opportunities/entry points for a possible threat). ▪ Mapping of the supply chain to identify possible weak points. ▪ Comprehensive and integrated supply chain planning and management. ▪ Emphasis on control through certification, extensive auditing or other means.
Sustainability	Provide products through a supply chain that ensures controlled and minimal resource impact, both today and in the future. Ultimately implement and maintain a "cradle to cradle" perspective.[i]	▪ Visibility/transparency throughout the supply chain to ensure that all members are aware of threats or opportunities. ▪ Greater emphasis on the Three Ps (product design, process, packaging). ▪ Integrated supply chain planning and management, in recognition that design must begin with resource extraction and end with product disposal/renewal. ▪ Use of broader performance measurement systems and measures (total cost of ownership, triple bottom line). ▪ Extensive supplier prequalification and assessment to ensure that the "right" suppliers are selected and that they understand what is required. ▪ Extensive use of audits and certification standards throughout the supply chain (ISO 14001). ▪ Introduction of systems for product takeback (reverse logistics) and marketing waste.
Resilience	Develop a system that can identify, monitor and reduce supply chain risks and disruptions, as well as react quickly and cost-effectively. Offer the critical customer "peace of mind."	▪ Emphasis on visibility and transparency, provided through integrated information systems (or, in extreme cases, vertical integration) throughout the supply chain. ▪ Acceptance of the need for excess resources (inventory, capacity, lead times). ▪ Mapping of the supply chain to identify possible weak points. ▪ Integrated supply chain planning and management. ▪ A focus on possible threats not only to suppliers but also to logistics linkages. ▪ Presence of precertified/prequalified suppliers. ▪ Extensive use of contingency planning ("What if?" analysis).
Innovation	Provide critical customers with a stream of products and services that not only are new but also address needs that competitors have neglected or not served well. Provide new ways of producing, delivering or distributing products.[ii]	▪ Development and protection of intellectual property, due to cooperation with key suppliers. ▪ Deliberate presence of excess resources. ▪ Viewing suppliers as sources of "near innovations" — developed to solve problems in other markets but that have to be refined before they can be used to address current customer needs. ▪ Close integration, especially with critical customers and suppliers, so as to innovate jointly. ▪ Encouragement of a wide range of different perspectives and solutions. ▪ Avoidance, during early stages of product development, of specific performance metrics so as not to stifle innovation. ▪ Offering a wide range of supply chain structures ranging from purely modular to purely integrated, depending on the type of innovation being pursued.

Apendix 2

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,802
Bartlett's Test of Sphericity	Approx. Chi-Square	1032,810
	df	105
	Sig.	,000

Appendix 3

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,242	28,280	28,280	4,242	28,280	28,280	3,605	24,035	24,035
2	3,614	24,095	52,375	3,614	24,095	52,375	3,550	23,668	47,704
3	1,692	11,281	63,656	1,692	11,281	63,656	2,393	15,953	63,656
4	,852	5,681	69,337						
5	,745	4,969	74,306						
6	,695	4,634	78,940						
7	,572	3,812	82,752						
8	,468	3,117	85,869						
9	,439	2,924	88,793						
10	,384	2,559	91,351						
11	,352	2,345	93,696						
12	,302	2,013	95,710						
13	,268	1,786	97,496						
14	,213	1,420	98,916						
15	,163	1,084	100,000						

Extraction Method: Principal Component Analysis.

Apendix 4

Component Matrix[a]

	Component		
	1	2	3
SCRMsup3	,717	,431	-,212
SCRMsup1	,651	,179	-,065
SCRMsup2	,612	,389	-,377
SCRMsup4	,569	,458	-,239
SCRMsup5	,565	,554	-,233
SupRiskIndex4	,480	,149	,448
SupPer5	-,438	,739	,242
SupPer6	-,433	,713	,277
SupPer4	-,439	,690	,250
SupPer3	-,486	,680	,048
SupPer1	-,390	,601	-,002
SCRMsup6	,474	,542	-,166
SupRiskIndex2	,572	-,091	,609
SupRiskIndex3	,553	-,163	,573
SupRiskIndex1	,489	,157	,512

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Apendix 5

The purpose of this survey is to collect data for a master's thesis that will build on existing literature about risks and risk management in Norwegian Industry. I do not ask you to

share any sensitive information, all responses will be treated anonymously, and the data collected will only be used for academic purposes.
The questionnaire consists mainly of questions in the form of a scale or multiple choice and will therefore not take a long time to answer.

Part 1 – General

Here I ask that you provide some background information. Which company you represent, which industry your company operate in and which position you currently hold in company.

1.1 Company: ________________________________

1.2 Industry: ________________________________

1.3 Respondents position: ________________________________

Part 2 – Supplier Performance

Here I ask that you evaluate to which degree you agree to the following statements regarding incoming supplies from your most important supplier (1 = highly disagree, 7 = highly agree).

We rarely experience any delay on our incoming shipments.	1	2	3	4	5	6	7
How long do the average delay last (in days)?							
We rarely experience any quality problems on our incoming shipments.	1	2	3	4	5	6	7
We rarely experience any damages on our incoming shipments.	1	2	3	4	5	6	7
We rarely experience any deficits on the amount of items ordered	1	2	3	4	5	6	7
We rarely experience any picking errors on our incoming shipments	1	2	3	4	5	6	7

Part 3 – Risk

Here I ask for your opinion regarding the following statements with respect to uncertainty in the market, risk drivers, likelihood of a risk to occur and the consequence magnitude of the consequences this risk have on your company should it occur.

2.1 In your opinion, to which degree do your company operate in markets where;

The demand for your company's product are highly volatile	1	2	3	4	5	6	7
Products have a short life cycle	1	2	3	4	5	6	7
Your company's most important competitors regularly introduce new products or product changes	1	2	3	4	5	6	7
The production technology changes frequently	1	2	3	4	5	6	7

2.2 In your opinion, to which extent do the following elements contribute to an increased risk for your company? (1 = strongly disagree, 7 = strongly agree)

Too high focus on efficiency	1	2	3	4	5	6	7
Too high focus on cost reductions	1	2	3	4	5	6	7
Lack of information sharing	1	2	3	4	5	6	7
Increased integration with suppliers	1	2	3	4	5	6	7

Increased integration with customers	1	2	3	4	5	6	7
Too high focus on centralized distribution	1	2	3	4	5	6	7
Too high focus on centralized production	1	2	3	4	5	6	7
To high focus on outsourcing of operations	1	2	3	4	5	6	7
Too high product variety	1	2	3	4	5	6	7
Technological innovation	1	2	3	4	5	6	7

2.3 How do you estimate the probability of the following risks and their consequences concerning your company?
Supply risk:
Probability

Consequence

1 2 3 4 5 6 7 Supplier bankruptcy 1 2 3 4 5 6 7

1 2 3 4 5 6 7 Quality problems on 1 2 3 4 5 6 7

products from supplier

1 2 3 4 5 6 7 Delays on incoming 1 2 3 4 5 6 7

shipments from supplier

1 2 3 4 5 6 7 Supplier workforce 1 2 3 4 5 6 7

disputes

1 2 3 4 5 6 7 Accidents at supplier’s facilities 1 2 3 4 5 6 7

disrupting further operations

1 2 3 4 5 6 7 Increased raw material prices 1 2 3 4 5 6 7

Information risks
Probability
Consequence

1 2 3 4 5 6 7 Failure in your own IT-system 1 2
3 4 5 6 7
1 2 3 4 5 6 7 Failure in integrated 1 2 3 4
5 6 7
IT-systems
1 2 3 4 5 6 7 Unavailable information 1 2 3 4
5 6 7
(e.g. point-of-sale data)
1 2 3 4 5 6 7 Delayed information sharing 1 2 3 4
5 6 7
(e.g. point-of-sale data)
1 2 3 4 5 6 7 Use of outdated market 1 2 3 4
5 6 7
information
1 2 3 4 5 6 7 Errors in your own sales 1 2 3 4
5 6 7
forecasts

Environmental risk:
Probability
Consequence
1 2 3 4 5 6 7 Natural disasters 1 2 3 4
5 6 7
(e.g. earthquakes, floods)
1 2 3 4 5 6 7 New regulations 1 2 3 4
5 6 7
1 2 3 4 5 6 7 New technology 1 2 3 4
5 6 7
(e.g. software, machinery)
1 2 3 4 5 6 7 Cyberattacks against your 1 2 3 4
5 6 7
company
1 2 3 4 5 6 7 Strike in the distribution 1 2 3 4
5 6 7
network (e.g. harbor/railroads)

Part 4 – Risk Management

Here I ask you to evaluate to which degree your company implement the following strategies and collaborate with your most important supplier and customer to identify and mitigate risks.

3.1 To which extent do your company practice a Lean Manufacturing strategy? (A strategy which focus on creating cost effective processes with high quality through continuous improvement, and elimination of activities which don't add value to the product. (1 = small degree, 7 = large degree).

1 2 3 4 5 6 7

3.2 To which extent do your company practice an Agile Manufacturing strategy? (A market sensitive strategy which focus on flexibility, and quick adaption to changing customer preferences. Central to the strategy is to postpone customization of products until its demand is known. (1 = small degree, 7 = large degree).

1 2 3 4 5 6 7

3.3. To which extent do your company focus on mitigating continuous risks? (Low impact, high frequency risks which can occur repeatedly, and reduce efficiency and increase costs. For instance, fluctuations in demand and production of components with insufficient quality.

1 2 3 4 5 6 7

3.4 To which extent do your company focus on mitigating disruptive risks? High impact, low frequency risk which can disrupt your ability to perform core activities over an extended period. For instance, machine breakdown and repercussions of natural disasters.

1 2 3 4 5 6 7

3.4 Do your company implement any of the following strategies to mitigate risks? (several options are available)

□ Safety stock
□ Excess capacity
□ Multiple Sourcing
□ Standard components (which can used in many products)
□ Postponement
□ Slacks in the lead times

3.5 Do your company implement geographically separated production facilities, for instance Europe, Asia, USA etc., if one production facility shuts down, other production facilities can absorb the productivity loss.

□ Yes
□ No

3.6 Do your company implement geographically separated distribution facilities, for instance Europe, Asia, USA etc., if one distribution facility shuts down, other distribution facilities can absorb the production loss.

□ Yes
□ No

Please consider the extent to which the following statements are correct: (1 = Strongly Disagree, 7 = Strongly Agree)

3.7 Do your company regularly cooperate with you most important supplier to mitigate risks by;

Sharing risks	1	2	3	4	5	6	7
Create contingency plans							
Improve bottlenecks in the supply chain	1	2	3	4	5	6	7
Implement strategically placed safety stocks	1	2	3	4	5	6	7
Postpone commitment of resources	1	2	3	4	5	6	7
Ensure high information flow	1	2	3	4	5	6	7

3.8 Do your company reguralrly cooperate with your most important customer to mitigate risks by;

Sharing risks	1	2	3	4	5	6	7
Create contingency plans							
Improve bottlenecks in the supply chain	1	2	3	4	5	6	7
Implement strategically placed safety stocks	1	2	3	4	5	6	7
Postpone commitment of resources	1	2	3	4	5	6	7
Ensure high information flow	1	2	3	4	5	6	7