Master's degree thesis

LOG950 Logistics

An investigation and comparison of inbound and outbound supply chain risk management (SCRM) among Norwegian manufacturing firms

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Preface

This master thesis is a final assignment of the Master of Science in Logistic at Molde University College spring 2016. The thesis is a part of a research project at Molde University College, which is initiated by our supervisor Berit Irene Helgheim. For finishing this thesis, much work by exploring a new area of literature has been put down. Furthermore, we have been able to follow the whole research process from start to end, by contribution to developing a questionnaire, administering the data collection, analyzing data and writing the thesis. This process has been very time consuming, but at the same time informative.

We would like to thank our supervisor Berit Irene Helgheim for letting us contribute and participate in the research project *supply chain risk management*. Also, a great deal of gratitude for valuable guidance, discussions and good and constructive advice along the process in developing and completing this thesis. Additionally, the funding that have been provided for hiring bachelor students for collecting data has been invaluable as it is difficult to obtain a good response rate to a questionnaire.

In addition, we would wish to display our gratitude and appreciation to the all the respondent of our questionnaire. Without their willingness to respond to our questionnaire this thesis would not have been possible to complete. Furthermore, the bachelor students that participated in data collection deserves our appreciation for setting aside time to help us.

Summary

Supply Chain Risk Management (SCRM) has through the recent years had an increased focus, and as supply chains is getting longer, vulnerability increases and risks are displayed. Globalization is a major risk driver because of the tendency for outsourcing, and also the firms pursue to achieve competitive advantage through production efficiency. The purpose of this research have been to contribute to the literature of SCRM. The aim of the research has been to investigate Norwegian manufacturing firm's attention to SCRM, and whether there are differences comparing inbound and outbound attention.

Data was collected through a questionnaire constructed to explore the manufacturing firm's tendencies regarding supply chain risk and SCRM. The questionnaire was completed through phone interviews. Further, data from 92 firms was achieved, and a respond rate of 15,08% was obtained. PLS-SEM was used as a method for analyzing the data due to the small sample size. The analyses consists of two models, one for inbound SCRM and one for outbound SCRM. Reflective indicators have been used to display the relationship between the dependent and the independent variables. The overall research area are investigated using ten hypothesis, covering inbound and outbound SCRM.

The findings in this research reveals that for a firm to be able to have a good SCRM both information sharing and collaboration is important aspects, especially regarding suppliers. This research can conclude that Norwegian manufacturing firms pay attention to inbound SCRM, regarding risks upstream in the supply chain related to suppliers. Furthermore, this attention have not been discovered at the same level downstream with respect to customers. A reason for this may be the costs involved upstream in the supply chain. However, if all firms in a supply chain manage risk upstream, risk at each tier will be controlled. Thus, it might not be necessary to emphasize risk in the same degree downstream in the supply chain.

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1.0 Introduction

1.1 Background and Motivation for the thesis

Supply Chain Risk Management (SCRM) has through the recent years had an increased focus (Norrman and Jansson 2004). Today supply chains are getting longer and more complex, and a result of globalization, outsourcing and offshoring, firms control over their supply chain decreases (World Economic Forum 2008). Even a small localized event can impact and cause damages across the global economic system. A major driver of the globalization is the outsourcing tendency, as a result for scarce resources or for achieving comparative advantage by increasing firm's production effectiveness. Barnes (2015) lists up international free trade agreements, growing wealth of developing nations and revolutionary technology developments, to all have major effect on the globalized world. Also, World Economic Forum (2008), states that international and intra-regional trade has increased faster than the global economy has through the last 20 years. This is a result of technology improvement and reduced trade barriers. The need for effective supply chain management is rising, as the distance between supplier and the marketplace is becoming longer and commercial environments are more difficult compared to domestic chains (Chang, Ellinger, and Blackhurst 2015).

Risk comes in many forms and sources of risk can be weather changes, diseases, fires, uncertain demand, inaccurate supply and chain capacity risk. Real world examples of supply chain disruptions are many and when the Swedish mobile phone company Ericsson experienced a fire at a sub-supplier plant in 2000, it took about three weeks before the damages was restored. By this Ericsson lost about $400 million, as they had no back up sub-supplier (Norrman and Jansson 2004). Ericsson learned the importance of managing risk the hard way. Also, Thun and Hoenig (2011) points out that the catastrophe 9/11, the hurricane Katarina, and the tsunami that hit the Indian Ocean in 2004 have made firms increased their focus on SCRM. Additionally, other ordinary day-to-day challenges such as loss of supplier and quality problems have also set an increased focus on managing risk.

In the literature, there exists a gap of comparing inbound and outbound SCRM. This research will investigate Norwegian manufacturing firm's attention to inbound and outbound SCRM and see whether inbound and outbound SCRM is emphasized differently.

According to Ho et al. (2015) previous research has focused on categories of risk, which include macro risk and demand, manufacturing, supply, information, transportation and financial factors. Previous research has had a higher focus on risk covering suppliers. Moreover, there exist a lack of research examining risk related to customers.

Ho et al. (2015) suggests a four-step process of SCRM, including risk identification, risk assessment, risk mitigation and risk monitoring. However, Tang (2006a) states that even though firms tends to agree that supply chain risk mitigation is important, they also agree that little is being done do handle the risk involved. Several researchers has paid attention to factors that can help organizations managing risk. Barratt (2004) points out that collaboration with suppliers and customers is considered as vertical collaboration. A high degree of collaboration across the supply chain for mitigating risk is suggested by Christopher and Peck (2004). In addition, Ho et al. (2015) states that sharing of risk information will be effective if the level of long-term orientation or suppliers trust is high, and especially effective if there exists a high level of shared SCRM understanding between the parties.

Many manufacturing firms have adopted the lean management approach as a way of increasing the efficiency in their operations. However, Waters (2007) explains that organizations pursue for a lean philosophy can on the other hand be a source of risk as the supply chain vulnerability might be overlooked. The lean approach needs environment such as security and predictability (Waters 2007). The opposite of lean management is the flexible agile management. Flexibility is a way of controlling risk as it allows the supply chain to react to unforeseen disruptions as product cycles are getting shorter, market requirements changes quickly and demand is becoming more volatile (Waters 2007). Lavastre, Gunasekaran, and Spalanzani (2012) found through their empirical research of French manufacturing firms that it is through collaboration and information sharing risks in supply chain is managed best. Further, Through a Brazilian research the results showed that supply chain communication is one of three most important practices concerning implementation of SCRM. Zhou and Benton (2007) concluded in their research that delivery performance was significantly influenced by the quality of the information and delivery practice.

Many factors can contribute to supply chain risk, and according to Jia and Rutherford (2010) if one of them. Like this, Sirmon and Lane (2004) and Smagalla (2004) argued that supplier relationship has a potential risk such as the cultural differences between the West and China.

This thesis starts conducting a literature review, regarding supply chain risk and SCRM. Further, analysis will be executed in partial least squares – structural equation modeling (PLS-SEM). Additionally, a research paper is written based on analysis result with the aim of adding new insight in the literature of SCRM.

2.0 Research area

In the literature there is a gap concidering firms attention to inbound and outbound SCRM, and wether there exist differences. The focus of this thesis will be to explore how Norwegian manufacturing firms pays attention to SCRM, and investigate wether there is a difference in attention to inbound and outbound SCRM. By this we have conducted a questionnaire among Norwegian manufacturing firms. Further, for deeper understanding for comparing inbound and outbound SCRM we will develop hypothesis that is based on the literature and use the data collected to state whether these are supported or not supported. In addition, this research will look at firms economic performance and whether this effect firms overall attention to SCRM. Research area are illustrated in figure 2.1.
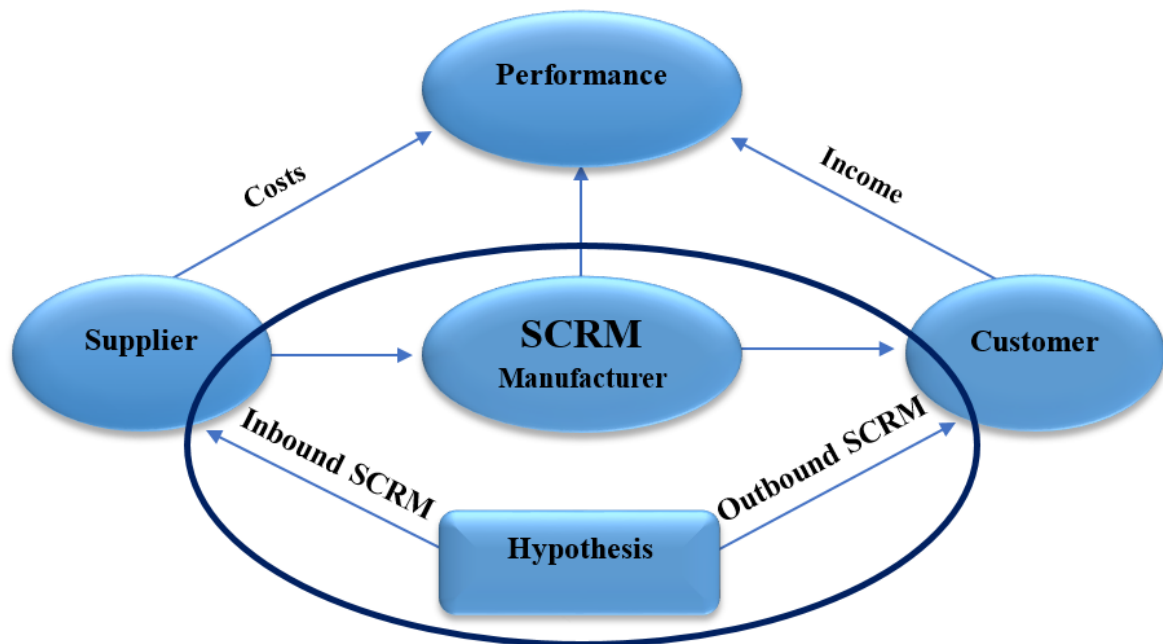
Figure 2.1: Overall research model

3.0 Literature review

3.1 Introduction

According to Creswell (2012) a literature review will include a summary of journal articles, books and other documents describing previous information found in the particular research area, and also document how the study will improve the existent literature on the topic. This chapter will include relevant literature regarding supply chain risk and SCRM. According to Ho et al. (2015) many researchers has focused on SCRM over the years. This chapter will look at what previously researchers have found considering SCRM.

The chapter is divided into subchapters, and in order to set supply chain risk and SCRM in a theoretical context the first part will give an introduction to *supply chain* and *supply chain management*. Further, the next section *supply chain risk* will define and classify supply chain risk. Following, section *supply chain risk management*, gives an overview over SCRM and the processes involved reducing risk within supply chains. Further, *collaboration and information sharing* are discussed as important aspects concerning SCRM. *Relationship distance* explains how different cultures could affect SCRM, and *lean and agile management impact on SCRM* discusses the risk involved adopting such strategies. Additionally, *economic performance and SCRM* discusses performance and the association to SCRM. Finally, hypothesis and research problem is justified based on the literature review.

3.2   Supply Chain

Multiple definitions to supply chain exist in the literature today. Harrison and Hoek (2011, 7) define supply chain as:

> A network of partners who collectively convert a basic commodity (upstream) into finished product (downstream) that is valued by the end-customers, and who managed returns at each stage.

Distribution of finished products through functions of procurement of materials, and transformation of these materials into intermediate and distribution options can be considered as a network that can be defined as a supply chain. The complexity of a supply chain may vary from industry to industry and for product to product. We find supply chains in both manufacturing and the service industry (Bhatnagar 2009). Accordingly, Bhatnagar (2009) explains three types of supply chains. A firm, an immediate supplier and an immediate buyer are what the basic supply chain consists of. The second type of supply chain is called the extended supply chain and consists of buyer, immediate buyer and suppliers of the immediate supplier. All the firms that are involved in the upstream and downstream flow, and from the initial supplier to ultimate buyer are considered as the ultimate supply chain according to Bhatnagar (2009). This refers to what Harrison and Hoek (2011) explains, that supply chain with a complex structure can be explained as supply network. In addition, Waters (2007) explains that complexity of supply chain is increasing, therefore supply networks or supply/demand networks can be used instead of supply chain as it becomes too simple.
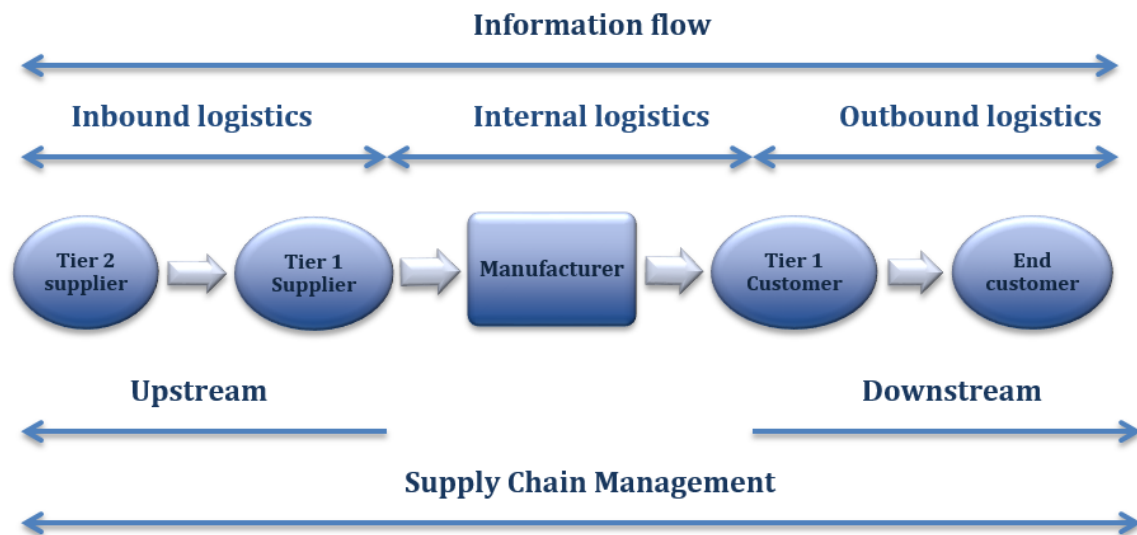
Figure 3.1: The Supply Chain, adapted from Waters (2007) and Harrison and Hoek (2011)

Figure 3.1 shows that many processes can take place in a supply chain. Embedded in the middle of the chain we can see the organization, and other part of the chain must coordinate with its internal processes. Downstream (right) and upstream (left) is the process of flow of material and the end-customers (to the right) has the liberty of placing order whenever he or she wants. When the end-customer has placed its order the system takes over, which means that the whole supply chain is triggered (Harrison and Hoek 2011).

We separate between inbound, outbound and internal logistics, but on both sides of upstream and downstream the supply chain is tiered, which means that there are formed groups in the supply/demand side of the chain. The links between the organization and its upstream suppliers is what inbound logistics has its focus on. Further, the links between the organization and its downstream customers is what outbound logistics focus on. Moreover, planning and control of material flow with boundaries to the organization is what internal logistics is concerned with (Harrison and Hoek 2011). Supply chain management (SCM) is placed at the bottom of the model and the concept is further elaborated in the next section.

3.3   Supply Chain Management

The primary operation strategy among manufactures in the 1950s and the 1960s was to minimize the operation costs through mass production. By following this form of strategy there was no product or process flexibility (Tan 2001). Information sharing and sharing of expertise with customers or suppliers was in addition considered as being too risky and unacceptable. In the 1970s managers set new measures to improve performance within the organizations and the Manufacturing Resource Planning system was introduced. Furthermore, the 1980s consisted of intense global competition (Tan 2001). According to Cooper and Ellram (1993) it was through the inventory management approach that SCM first appeared in the literature in 1982 in form of reduction of inventory (Cooper, Lambert, and Pagh 1997). Low costs, high quality and reliable products with greater design flexibility were forced to be offered by world-class firms due to the intense global competition in the 1980s. For improving manufacturing efficiency Just-In-Time (JIT) was utilized together with other management activities (Tan 2001). In this period the strategic and cooperative buyer-supplier relationship was discovered as a result of little inventory due to JIT, cushion production and scheduling problems (Tan 2001).

Tan (2001) points out that as manufacturers had experiments with different strategic partnerships with their immediate suppliers, the concept of SCM developed. The concept of material management was also carried on by experts in transportation and logistics, and the physical distribution and transportation functions was incorporated. This resulted in SCM as an integrated logistic concept. Best practice of managing corporate resources to include strategic suppliers and the logistics function of the value chain was extended into the 1990s as the evolution of SCM continued (Tan 2001).

As the development of SCM was broadening through the 1980s and the 1990s, Cooper, Lambert, and Pagh (1997) presented a new conceptual SCM framework in their research from 1997, and referred to the SCM as a business process. Output in form of activities that gives a form of value to the customer is what Cooper, Lambert, and Pagh (1997) explains as a business process. Accordingly, some firms have a lack of customer focus, but with the business process approach every process is focused around meeting the customers demand (Cooper, Lambert, and Pagh 1997).

There exist multiple definitions within the research field of SCM. At the Council of Supply Chain Management Professionals we find the following definition:

> SCM encompasses the planning and controlling of all processes involved in the procurement, conversion, transportation and distribution across a supply chain. SCM includes coordination and collaboration between partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, SCM integrates supply and demand management within and between companies order to service the needs of the end-customer.

3.3.1 Supply chain drivers

Regularly improvements with the service level at customers and the internal operating efficiencies of the companies in the supply chain is required for maintaining an effective SCM. Every supply chain has their own market demand and operating challenges. However, decision-making within five typical areas are required. These are production, inventory, location, transportation and information. The effectiveness and the capability of the supply chain will be determined of these factors, and explained further (Hugos 2006).
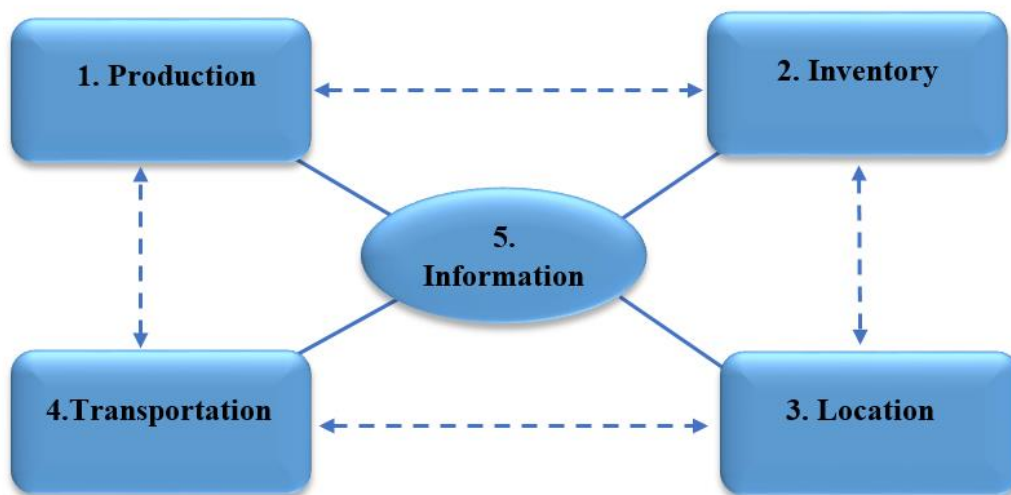
Figure 3.2: Supply risk drivers, adapted from Hugos (2006)

Figure 3.2 shows the five supply chain drivers, and responsiveness versus effectiveness. The capacity of the supply chain that makes and stores products is what production is referred to, and warehouse and factories is the facilities. Trade-off between responsiveness

and effectiveness is typical production decisions that managers need to make. Furthermore, excess capacity is something that factories and warehouses can be built with, and flexibility and quick respond to product demand swings is an advantage. However, Hugos (2006) points out that fluctuation in demand is difficult to handle if all the capacity in the factory is being used. But on the other hand, excess capacity that is not in use is not generating revenue. A result is that operations becomes inefficient the more excess capacity that exists (Hugos 2006).

Inventory is the second of the five important drivers, and as uncertainty in the supply chain exist the main purpose of inventory is to act as a buffer against uncertainty. According to Hugos (2006) inventory is everything from raw material to work in progress to finished goods that are held by manufactures, distributors and retailers and is spread through the supply chain. Also, here the trade off between efficiency and responsiveness must be evaluated by managers. A firm and a whole supply chain can be very responsive and have high level of efficiency if it contains a large amount of inventory. However, the cost of inventory must be kept as low as possible as the creation and storage of inventory comes with a cost (Hugos 2006).

Facilities and warehouses need to be sited, which make the geographical location important. Which activities to perform in each warehouse is an important element to consider for manages. The geographical location of facilities also comes with a trade-off whether an organization should be centralized or decentralized. Hugos (2006) explains that by centralizing the location an organization gain economies of scale and efficiency, but by decentralizing the activities operation becomes more responsive, which means that locations comes closer to the customers and suppliers. Thus, factor such as cost of labour, infrastructure conditions, taxes and tariffs and proximity of suppliers and customers, needs to be taken into consideration when deciding to centralize or decentralize. Location is referred to a strategic decision for an organization because of the strong impact on cost and performance in the supply chain (Hugos 2006).

According to Hugos (2006) movement of raw material to finished goods is referred to as transportation between the different facilities in the supply chain. It is the choice of transportation mode that is the trade-off between efficiency and responsiveness in transportation. An airplane is considered as a fast mode and very responsive form of

transportation, but is more costly compared to ship and rail, which is slower modes of transportation. However, the transportation modes ship and rail is more cost efficient but on the other hand not very responsive. Transportation mode decisions within the supply chain is important, as the transportation cost can be one third of the operating cost in the supply chain (Hugos 2006).

Hugos (2006) points out that to make decisions on behalf of the other four drivers, the fifth supply chain driver information is considered as the basis. For coordinating the activities and operations in the supply chain, information is important. The flow of information and good information should be precise and is important to make good business decisions. The profitability in the supply chain tends to be maximized as a whole if the flow of information is good and precise. How much information to share with other organizations and how much information to keep private within the organization is the trade-off within the supply chain as a whole. An organization can be very responsive if the information sharing about product supply, customers demand, market forecasts, and production schedules is high. On the other hand too much openness regarding information sharing can be used by competitors and hurt the profitability of an organization (Hugos 2006).

Several researchers has focused on supply chain and SCM, but as supply chains get longer and more complex researchers has increased the focus of supply chain risk and SCRM. The following section will provide literature regarding supply chain risk.

3.4   Supply chain risk

Market these days is recognized as turbulent and uncertain, which has an impact on supply chains vulnerability for disruptions (Christopher and Lee 2004). Due to globalization and outsourcing for achieving competitive advantage, supply chains complexity is increasing (Tang and Musa 2011). Hence, the probability of risky events in supply chains has increased, (Harland, Brenchley, and Walker 2003) as long and complex supply chains are slow when responding to changes (Tang and Tomlin 2008). Additionally, uncertainties (Thun and Hoenig 2011), specialization, disintegration (Vilko, Ritala, and Edelmann 2014), shorter product life-cycles (Zhao et al. 2013), unpredictable demand and uncertain supply (Lavastre, Gunasekaran, and Spalanzani 2012) are some contributors to the growth of supply chain risk. Furthermore, natural disasters, accidents and financial volatility has

led to disruptions and losses in supply chains (Tang, Matsukawa, and Nakashima 2012). Waters (2007) explains that risks occurs because of uncertainty related to the future, and risk to the supply chain is unexpected events that could interrupt the flow of materials.

A real world example of a company having experience with an accident causing huge financial consequences is the Swedish mobile-company Ericsson. A ten-minute fire at a small production cell at a sub-suppliers plant in New Mexico in 2000, stopped the production, and it did not start the up again until three weeks after the fire (Norrman and Jansson 2004). After six months, the yield was only 50 percent. As this was Eriksson's only source of this equipment, the annual report announced in 2001 reviled a loss of approximately $400 million. This accident made Eriksson realize the importance of managing risk not only internally, but along the whole supply chain (Norrman and Jansson 2004). Another example of a firm, which has experienced some supply chain disruptions is the computer company Dell. Tang (2006a) describes that Dell experienced a supplier shortage after earthquake in Taiwan in 1999. However, Dell solved their supplier shortage by decreasing their price for their product when selling them to their customers by informing that they could get a price discount when purchasing Dell computer with components from other countries. In 1999 Dell improved their earnings with 41% as they influenced their customers choice during a supply disruption (Tang 2006a).

3.4.1 Defining supply chain risk

Heckmann, Comes, and Nickel (2015) found in a research studying definitions of supply chain risk that a total of 82% of research articles covering supply chain risks did not have any explicit definition. The remaining 18% defines supply chain risk as either the probability and adverse outcome, the probability of an incident or the deviation from the expected (Heckmann, Comes, and Nickel 2015). 52% of the researchers that not had an explicit definition of supply chain risk, implied risk to be an event. Further, existing supply chain risk definitions will be discussed.

Studying previously researcher's definitions of supply chain risk, we find that there are no common definitions at this research scope. Researchers defining supply chain risk tends to customize their definitions in accordance with their research area, and because of this, there exist several definitions covering particular areas within a supply chain or the entire

supply chain. Table 3.1 presents an overview over the definitions found reviewing the literature, including authors and their scope of research. Studying the definitions, we found that several researchers tend to focus on risks in the entire supply chain (Ho et al. 2015; Heckmann, Comes, and Nickel 2015; Ghadhe, Dani, and Kalawsky 2012; Bogataj and Bogataj 2007; Wagner and Bode 2006). However, there is also a tendency among researcher to focus on risks related to inbound supply (Ellis, Henry, and Shockley 2010; Manuj and Mentzer 2008b; Zsidison 2003). Furthermore, when it comes to customers and outbound logistics there are not any particular focus to only this scope.

Authors	Definition of supply chain risk	Scope of research
Ho et al. (2015, 5035)	The likelihood and impact of unexpected macro and/or micro level events or conditions that adversely influence and part of a supply chain leading to operational, tactical, or strategic level failures or irregularities.	Literature review covering the entire supply chain.
Heckmann, Comes, and Nickel (2015, 130)	The potential loss for a supply chain in terms of its target values of efficiency and effectiveness evoked by uncertain developments of supply chain characteristics whose changes were caused by the occurrence of triggering-events.	Studying definitions of supply chain risks, and differences among them. Covering the entire supply chain.
Ghadhe, Dani, and Kalawsky (2012, 314)	Exposure to an event which causes disruption, thus affecting the efficient management of the SC network.	Studying present and future research, covering the entire supply chain.
Ellis, Henry, and Shockley (2010, 36)	Individual's perception of the total potential loss associated with the disruption of supply of a particular purchased item from a particular supplier.	Risks related to inbound logistics and suppliers.
Manuj and Mentzer (2008b, 197-198)	The distribution of outcomes related to adverse events in inbound supply that affect the ability of the focal firm to meet customer demand (in terms of both quantity and quality within anticipated costs and time, or causes threats to customer life and safety.	Risks related to inbound logistics and suppliers.
Bogataj and Bogataj (2007, 291)	The potential variation of outcomes that influence the decrease of value added at any activity cell in a chain, where the outcome is described by the volume and quality of goods in any location and time in a supply chain flow.	General supply chain risk, covering the entire supply chain.
Wagner and Bode (2006, 303)	The negative deviation from the expected value of a certain performance measure, resulting in negative consequences for the focal firm.	General supply chain risk, covering the entire supply chain.
Jüttner, Peck, and Christopher (2003, 7)	Any risk for the information, material and product flows from original supplier to the delivery of the final product for the end user.	Risk related to the flow of information, materials and products.
Zsidison (2003, 222)	The probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety.	Risks related to inbound logistics and suppliers.

Table 3.1: Supply chain risk definitions

Ho et al. (2015) supply chain risk definition cover micro and macro risks, as they both negatively can affect any part of the entire supply chain. Covering both inbound and outbound flow this definition will further be used writing this thesis:

> The likelihood and impact of unexpected macro and/or micro level events or conditions that adversely influence and part of a supply chain leading to operational, tactical, or strategic level failures or irregularities (Ho et al. 2015, 5035).

3.4.2 Categorizing supply chain risk

There are different divisions regarding classifying of supply chain risk types. A literature review has divided supply chain risk into two types, micro-risk and macro-risk. Micro-risks relates to events of internal activities of companies and/or relationships with partners within the supply chain. Macro-risks on the other hand refers to adverse and unusual events or situations that could impact companies negatively (Ho et al. 2015). Another used method by researchers for classifying supply chain risk is to divide risk into three categories, representing internal, network and external. Jüttner, Peck, and Christopher (2003) use this method by categorizing supply chain risk into environmental risk sources, network-related risk sources and organizational risk sources. Manuj and Mentzer (2008b) have further divided these categories into sub-categories of supply chain risks. Based on Jüttner, Peck, and Christopher (2003) figure and research from Manuj and Mentzer (2008b), we have developed a risk category model, illustrated in figure 3.3.
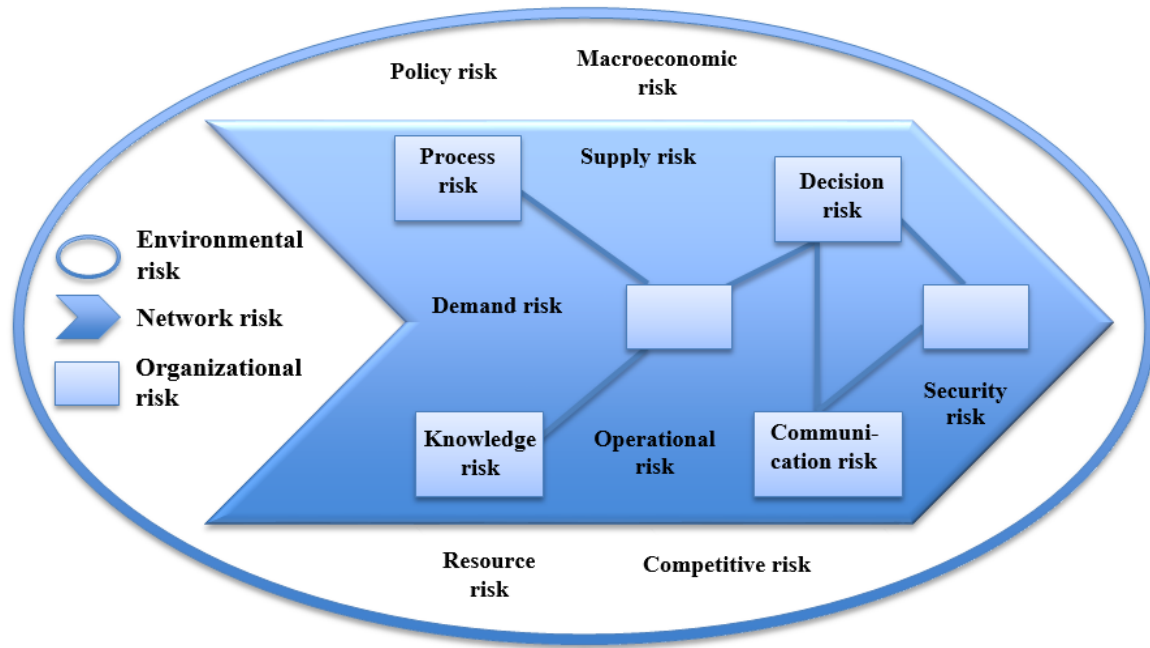
Figure 3.3: Categorization of Supply Chain Risks (Sørland and Wembstad 2016)

Environmental risk includes external risks to the network arising from the supply-chain environment interaction. This could be a result of accidents, socio-political actions or be related to the weather (Jüttner, Peck, and Christopher 2003). Environmental risk sources or external risks could further be divided into four sub-categories according to Manuj and Mentzer (2008b), including macroeconomic risk, policy risk, competitive risk and resource risk. Macroeconomic risk relates to economic shifts concerning wage rates, interest rates, exchange rates and prices. Furthermore, policy risk will relate to unforeseen events of national governments and competitive risk to the uncertainty when it comes to competitors activities in foreign markets. Resource risk are unexpected differences regarding resource requirements in foreign markets (Manuj and Mentzer 2008b).

Studying figure 3.3 and organizational risk, Manuj and Mentzer (2008b) categorizes it into process, decision, communications and knowledge risk. Organizational risk can vary from the labour, as strikes or uncertainties related to production such as machine failure to IT-system uncertainties. Process or procedures can relate to a firms lack of formal procedures or quality assurance system, and decisions can be bureaucratic decision paths and lack of authority. Communication can lead to misunderstandings as a result of different cultures or

languages, and knowledge risk can occur if there is a lack of formal education and training (Manuj and Mentzer 2008b) .

Network risk will be risk arising external to the inter-organization, but internally to the supply chain. This type of risk arises from interactions between different parties within the supply chain. Network risk can also be categorized into four subcategories, concerning supply, operational, demand and security. Supply risk relates to inbound supply that will affect the firm meeting customer demand. On the other hand, demand risk relates to the outbound flow affecting the customer's likelihood to place an order and/or variance in volume and assortment. Operational risk is adverse events within a firm that will affect their ability to produce goods and services, quality of product and/or their profitability. Furthermore, security risk is adverse events that can threaten human resources, operation integrity and information system, which could lead to vandalism, crime and sabotage (Manuj and Mentzer 2008b) .

After categorizing risk into environmental, organizational and network risk, we will further look at the existing literature concerning network risk, related to inbound and outbound logistics. Figure 3.4, adopted from Manuj and Mentzer (2008a) illustrates the supply chain and risk involved internal to the supply chain, referred to as network risk as discussed above. In literature, we find that researchers tend to have a higher focus on supply risk compared to demand risk. The next section will discuss previously research covering inbound and outbound supply chain risks.

Figure 3.4: Network risk, adapted from Manuj and Mentzer (2008a)

3.4.3 Inbound supply chain risk

Ganguly (2013) describes the purchasing function as a strategic level for firm's decision-making, as it contributes to firm's competitive advantage. Inbound risk is an area of supply chain risk that has received much attention throughout the years. Zsidisin, Upton, and Upton (2000) explains that supply risk becomes important when there exist a buyer-supplier relationship, and the purchasing firm in some degree is dependent upon this supplier. Supply risk involves potential occurrence of inbound supply events that could have significant negative effect on the purchasing firm. Zsidisin et al. (2004, 397) defines supply risk as

> The potential occurrence of an incident associated with inbound supply from individual supplier failures or the supply market, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customer life and safety.

Several conditions related to a supplier can cause risky events in a supply chain, such as political events, product availability, supplier distance, supplier capacity, fluctuating demand, technology changes, financial instability and management turnover (Giunipero and Eltantawy 2004). Supply risk can occur in the movement of gods from supplier's suppliers in one end to the focal firm in the other end. According to Manuj and Mentzer (2008a) supplier reliability, single or dual sourcing, centralized or decentralized sourcing, make or buy decisions and security issues are important aspects to consider for supply risks. Even though a strategy involves sourcing from one single supplier may reduce costs, such a strategy could cause disruption in the supply chain and involve risk for the buying firm. Supplier failure could not only affect the buying firm as they not will be able to deliver the goods, but also have consequences further downstream in the supply chain. Chopra and Sodhi (2004) list up supplier bankruptcy as a disruption risk to the flow of material that can cause damages in the supply chain and especially if this is a single source supplier. Furthermore, inflexibility from a supplier can cause delays in the flow of material and can happen if the utilization is high and the supplier cannot respond to changes in demand. In addition, Chopra and Sodhi (2004) discusses procurement risk as risks relating to suppliers, which cover unexpected increases in purchasing cost as a result of exchange

rate or supplier price growths. Increases in supplier prices can be avoided by long-terms contracts, redundant suppliers or in some cases increased inventory.

3.4.4 Outbound supply chain risk

Studying the outbound supply chain risk related to customers, this is a scope that has received less attention from researchers compared to inbound supply chain risk. Outbound risk will relate to firms customers. Sources of demand risk will exist in the movement of goods from the focal firm to the customer's customers (Manuj and Mentzer 2008a). Writing this thesis demand risk will be defined as:

> The possibility of an event associated with outbound flows that may affect the likehood of customers placing orders with the focal firm, and/or variance in the volume and assortment desired by the customer (Manuj and Mentzer 2008a, 139).

Manuj and Mentzer (2008a) lists up sources of demand risk being new product introductions, variations in demand and chaos in the system. However, Fisher (1997) argues that demand risk will vary in what type of product the firm is producing and says that innovative products will have more risks involved compared to functional products. Chopra and Sodhi (2004, 58) lists up receivable risk as a risk category, which is defined as "the possibility of being unable to collect on receivables". If a firm experience receivable risk, a major impact on its performance can occur. A strategy that can avoid this could be to spread the risk across many customers. Another risk category according to Chopra and Sodhi (2004) is forecast risk, which is a consequence of disparity between firms projections and the actual demand. Forecast error could be a result of long lead times, seasonal demand, high product variety and small life cycle of products. In addition, bullwhip effect could cause forecast errors because of information distortion within the supply chain. Bullwhip effects causes and increases distortion in the supply chain moving farther away from the end customer (Chopra and Sodhi 2004).

As we can see an increase in environmental vulnerability that can cause major consequences to firms and disruption through the supply chain, the importance of SCRM has increased. Six journal articles which has been published the last decade, has reviewed

the SCRM literature (Ho et al. 2015). Next section will further present SCRM and the processes involved.

3.5   Supply Chain Risk Management (SCRM)

As supply chains becomes longer, have more possible disruption points and a tendency that local events cause problems in other parts of the chain, SCRM has become more important. The aim of SCRM is to decrease the vulnerability of a supply chain, increase the ability to survive unexpected events, improve sustainability or increase resilience (Waters 2007). Waters (2007, 86) defines vulnerability as "how likely a supply chain is to be affected by risky events".

Among authors, there is no common agreement for how SCRM should be defined. Table 3.2 illustrates different researcher's definitions regarding SCRM, and their scope of research. Lavastre, Gunasekaran, and Spalanzani (2014) studies French firms attention to SCRM and their relationship and collaboration with industrial and supply partners. All the definitions covers the entire supply chain, and the importance of managing risk for all parties involved. However, both articles proposed by Lavastre, Gunasekaran, and Spalanzani (2014) and Norrman and Jansson (2004) focus on supplier relationship as a SCRM strategy. Ho et al. (2015) had their focus on SCRM within the whole supply chain when they reviewed 224 journal articles studying SCRM. This definition cover a four-step procedure concerning the SCRM-process, which further will be used for explaining SCRM. Therefore, this SCRM definition will be used writing this thesis:

> An inter-organisational collaborative endeavour utilising quantitative and qualitative risk management methodologies to identify, evaluate, mitigate and monitor unexpected macro and micro level events or conditions, which might adversely impact any part of a supply chain (Ho et al. 2015, 5036).

Authors	Definition of SCRM	Scope of research
Ho et al. (2015, 5036)	An inter-organisational collaborative endeavour utilising quantitative and qualitative risk management methodologies to identify, evaluate, mitigate and monitor unexpected macro and micro level events or conditions, which might adversely impact any part of a supply chain.	Literature review covering the entire supply chain.
Lavastre, Gunasekaran, and Spalanzani (2014, 3384)	The management of risk that implies both strategic and operational horizons for long-term and short-term assessment.	Empirical investigation studying French companies attention to SCRM.
Thun and Hoenig (2011, 243)	Characterised by a cross-company orientation aiming at the identification and reduction of risks not only at the company level, but rather focusing on the entire supply chain.	Empirical investigation on German automotive industry attention to SCRM. Supply side focus.
Tang (2006b, 453)	The management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity.	Literature review covering the entire supply chain.
Norrman and Jansson (2004, 436)	To collaborate with partners in a supply chain apply risk management process tool to deal with risk and uncertainties caused by, or impacting on, logistics related activities or resources.	Eriksson's experience and SCRM by close supplier relationship.
Jüttner, Peck, and Christopher (2003, 9)	The identification and management of risks for the supply chain, through a co-ordinated approach amongst supply chain members, to reduce supply chain vulnerability as a whole.	Suggesting future research for SCRM in the entire chain.

Table 3.2: SCRM Definitions

3.5.1 The processes of Supply Chain Risk Management (SCRM)

Based on the literature review written by Ho et al. (2015) the SCRM-process will further be divided into four processes as illustrated in the framework in figure 3.5, including risk identification, risk assessment, risk mitigation and risk monitoring.
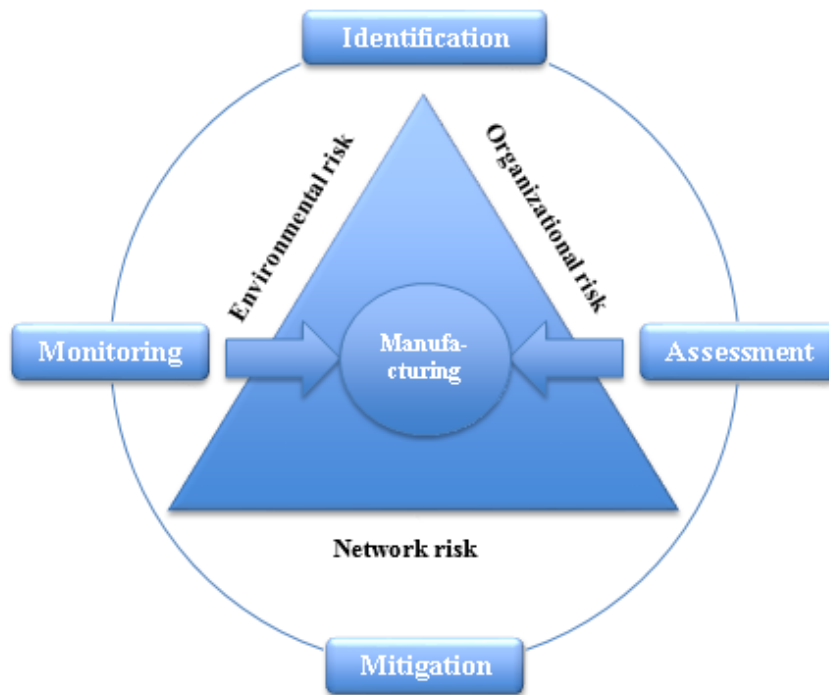
3.5.1.1 Risk identification

Risk identification involves identifying risk types and/or factors, and by doing this decision-makers will be aware of events that may cause disruptions for companies. The main focus of supply chain risk identification will be to recognize uncertainties in the future for being able to implement a proactive management for issues related to risk (Norrman and Jansson 2004). According to Barnes (2015) risk in supply chains can be identified by intelligence, compliance tools and supplier verification audits. A good supplier audit program contributes to identifying risk related to suppliers (Barnes 2015). Supplier audit can either be done by self-assessment, onsite audit or supply chain verification audit. Supplier self-assessment includes self-assessing areas of weakness in the supply chain. An on-site audit process, in comparison, involves wider assessment such as quality agreements, environmental compliance and import compliance and trade security. Barnes (2015) explains that a supply chain verification audit consider many aspects of a supply chain and by this, manufacturing companies can determine the criticality of its suppliers. The verification helps identifying high and low risk suppliers and understanding reasons for this as well as assessing controls for suppliers.

3.5.1.2 Risk assessment

When the risk is identified, the next step will be to assess and prioritize risk for deciding which management actions that will be appropriate for each of the situations (Norrman and Jansson 2004). In order to assess risk, two factors should be considered. These are the probability of an event to occur and the significance of the consequence (Harland, Brenchley, and Walker 2003). The probability of an event to occur will both depend upon the extent of the exposure and the likelihood of a trigger that will realize the risk. Whether the risk is realized or not can be influenced by an organization and individuals and partly by factors beyond their power. The significance of a certain risk can be dependent upon compliance-rules or other different circumstances. Assessing risks involves calculations of probabilities, but other assets like reputation, status or trust can also be affected (Harland, Brenchley, and Walker 2003).

3.5.1.3 Risk mitigation

Risk mitigation includes reviewing the risk profile and suggesting further actions for either reducing the risk profile or securing the company from the potential impacts from the risks (Handfield and McCormack 2008). Tang and Tomlin (2008) suggest five different mitigation strategies based on flexibility, for reducing the negative impacts of the occurrence of risks in the supply chain. These five strategies are multiple sourcing, flexible supply contracts, flexible manufacturing process, flexible product strategy via postponement and flexible pricing strategy. Having multiple suppliers can reduce supply cost risk by being able to order from the supplier offering the lowest price. A flexible supply contract can reduce the supply commitment risk by having the opportunity to adjust the order quantity. By making the process strategy more flexible, product variety could be increased by having the opportunity to produce different products at the same plant (Tang and Tomlin 2008). According to Tang (2006b) market research has shown that product variety could be effective for increasing market share and revenue as it makes it possible to satisfy different customers. Though, a higher level of complexity regarding the manufacturing process, manufacturing inventory costs and production cost can also increase. Additionally, having different products can also increase the inventory costs (MacDuffie et al 1996, sited in Tang 2006b). However, Tang (2006b) suggest to use a common platform for all products as an effort for reducing these costs. One strategy for

this is to postpone the differentiation at a latest possible stage in the manufacturing process. Postponement of differentiation strategy will increase product flexibility for mitigating demand risks. The last strategy is using a flexible pricing strategy, which can influence customer demand and by this reduce demand risk (Tang 2006b).

According to Tang (2006a) there have been several research studies where firms agree that supply chain risk mitigation is important. However, little is being done to handle risk. An example here is consumer health goods care. In 2003, Computer Sciences Corporation performed a survey with a sample size of 142 organizations. The results indicate that 43% of the respondent had no documented contingency plan for disruptions in the supply chain, even though their supply chain was reported as vulnerable. Another example is a research performed by CFO research services. In this survey the sample size was 247, and also in this survey unmanaged supply chain risk was acknowledged by 38% of the respondents (Tang 2006a).

3.5.1.4   Risk monitoring

Risk monitoring will be required if the level of risk is very high. In addition, monitoring will also be required if the risk is not being mitigated and the level of risk occurrence is high (Norrman and Jansson 2004). Handfield and McCormack (2008) argues that the key to risk monitoring is when risk assessment is completed, factors that should be monitored should be identified for quickly reaction. A responsible person and a plan for monitoring risks are important aspects to avoid disruptions. The importance of global monitoring is increasing as a result of accidents that are being reported locally but are causing problems in the entire supply chain (Handfield and McCormack 2008).

For having a well-developed SCRM information sharing and collaboration with partners in the supply chain will be important. The next section will contain literature regarding these aspects.

3.6   Collaboration and information sharing in supply chains

Collaboration consists of different types according to Barratt (2004), namely external vertical collaboration, which consists of suppliers and customers, and external horizontal

collaboration which consists of competitors and other organizations. This is being illustrated in figure 3.6 below.
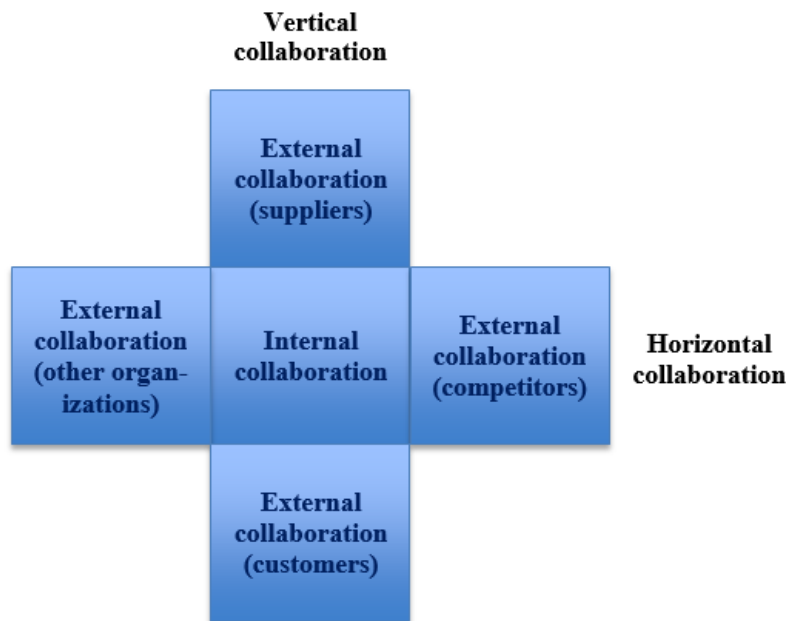
Figure 3.6: Collaboration scope, adapted from Barratt (2004)

Vertical collaboration is what the focus of this thesis will contain. In order to develop closer relationships, integrating process and sharing information with suppliers and customers internal collaboration must be "married" to external collaboration (Barratt 2004).

Christopher and Peck (2004) points out that management of risk has to be network-wide as supply chain vulnerability by definition is a wide concept. For mitigate risk across the supply chain a high level of collaboration would help. From a historical point of view collaboration between supplier and customers has not been common. Collaboration between manufacturer and retailer has started to occur in the industry of fast moving consumer goods (FMCG) (Christopher and Peck 2004).

Conditions where collaborative working among the players in a supply chain becomes possible seems to be one of the challenges. Lavastre, Gunasekaran, and Spalanzani (2012) points out that collaboration between organizations is involved in SCM, and internal (intra-

organizational) and external (inter-organizational) elements are presented as SCM requirements.

Christopher and Peck (2004) explains that information sharing among the players in the supply chain is not part of the history. However, a greater willingness has occurred in the more recent years regarding partnership along the supply chain. That the exchange of information can reduce uncertainty is according to Christopher and Peck (2004) the underlying principle of collaborative working in the supply chain. They also presents in their research that the most serious threat to business continuity is supply chain risks. However, still SCM is not always represented in firms.

Christopher and Lee (2004) describes shared information as the essence to supply chain visibility, and argues that shared information among supply chain partners will increase the power. Christopher and Lee (2004) argues that increased information sharing will reduce uncertainty and by this reduce the need for safety stock and make the system more responsive.

Sharing supply chain risk related information can according to Li et al. (2015) reduce the risk in two ways. Firstly, firms will be able to identify possible vulnerabilities within the supply chain and develop contingency plans for being able to respond if the risk occurs. Secondly, when the risk occurs firms will be provided with status information of the events and results of their mitigation efforts. Li et al. (2015) suggests risk information sharing to be one out of two critical efforts to SCRM, and will be related to closer relationship between the members of a supply chain. Risk sharing mechanism is the other critical joint effort. Risk information sharing will be effective if the level of long-term orientation or supplier trust is high, and especially effective if there exists a high level of shared SCRM understanding between the parties (Li et al. 2015).

Several researchers points out communication and information sharing as important aspects concerning risk. Through a Brazilian research it was found that supply chain communication is one of the three most important practices related to implementation of SCRM (Blos et al. 2009). Result from a French study shows that communication and information exchange are being considered to be one of the best ways to manage risk (Lavastre, Gunasekaran, and Spalanzani 2012). Further, Lavastre, Gunasekaran, and

Spalanzani (2012) research concludes that the key to overall supply chain performance is collaboration.

A positive influence on delivery performance is expected when information sharing can facilitate the information exchange between customers and manufactures. In addition, improved delivery performance is also expected when the information quality increases. By this Zhou and Benton (2007) performed a research about integration of information sharing and supply chain practice in SCM. Their research confirms that delivery performance is significant influenced by information quality and delivery practice. However, with customers it is the other way around and negative significant influence is shown in their research.

To be able to see from one end to another is what Christopher and Peck (2004) explains supply chain visibility as. Inventory, demand and supply conditions and production becomes a clear view for both upstream and downstream activities. In addition, we can add internal visibility. As global competition increases, organizations create cooperative and beneficial partnership with supply chain partners. Generally, tighter integration leads to improved performance and supply chain integration, which may in the end positively affect product and material flow throughout the chain (Wiengarten et al. 2015). Supply chain integration could be defined as:

> The degree to which an organization strategically collaborates with its supply chain partners and manages intra- and inter-organization processes in order to achieve effective and efficient flows of products and services, information, money, and decisions with the objective of providing the maximum value to the customer at low cost and high speed (Zhao et al. 2013, 117).

Internal integration with the business and good collaboration with customers and suppliers is how good visibility of the supply chain is achieved. The visibility of demand is important for obtaining collaborative planning in the supply chain (Christopher and Peck 2004). However, according to Christopher and Peck (2004) marked trends and perception of risk is in addition important information that needs to be shared in the supply chain. Also, a high collaboration of planning with suppliers is required in upstream visibility.

Gimenez and Ventura (2005) points out that supply chain integration could be divided into internal integration and external integration. Internal integration has to be studied within a firm and seeks to improve coordination among functional areas, while external integration include coordination and collaboration with other members of the supply chain. External integration is positively affecting a firm's performance. On the other hand internal integration will not have any directly effect on performance (Gimenez and Ventura 2005).

Trust is a factor that can be important for developing good collaborative relationship with customers and suppliers. However, different cultures among supply chain partners can have negative influence on both collaboration and information sharing. Next section will discuss relationship distance as a factor affecting SCRM.

3.7   Relationship distance

Many factors can contribute to supply chain risk, and trust is one of them. Further, Faisal, Banwet, and Shankar (2006) argues that resources can be created and lead to a competitive advantage if trust is developed through effective communication. Opportunistic behavior can occur between partners in the supply chain, if one of the parties uses the information to its own benefit. Even if there are short-term incentives to act opportunistically, trust prevents supply chain partners to do so (Faisal, Banwet, and Shankar 2006). In addition, long term stability of an organization and its supply chain is what trust also can contribute to (Faisal, Banwet, and Shankar 2006). According to Agarwal and Shankar (2003) there are different types of trust. The first type of trust is referred to as contract trust. This type of trust represent that people are doing what they are saying that they are going to do, which represent a confident expectation. Secondly, self-disclosure trust is explained by that relevant information is shared when it is needed and that it is displayed willingness in engaging in reciprocal sharing and openness (Agarwal and Shankar 2003).

Sirmon and Lane (2004) and Smagalla (2004) argues that cultural distance between supply chain partners negatively could affect long-term relationship. Jia and Rutherford (2010) argues that cultural distance, regarding the Western buyer-Chinese supplier relationship has a potential risk as a result of cultural differences between the West and China. In addition, it is mentioned that the building of mutual trust that will negatively affect long-term coordination, come from cultural distances between supply chain partners.

Effective operations such as lean management removes all slack and increases the supply chain vulnerability. Agile management on the other hand includes supply chain flexibility and allows the supply chain to react to unforeseen disruptions. The next section will describe lean and agiles impact on SCRM.

3.8 Lean and agile management impact on SCRM

When old ideas not seems to work, new ides seem to emerge (Womack, Jones, and Roos 2007). The mass production had its existents in the 1920 and by 1955, mass production had become a common place in countries across the world and big American firms started to loose the competitive advantage. The mass production system had buffers everywhere, and the source of inspiration of lean was the weaknesses that the mass production systems represented (Womack, Jones, and Roos 2007). Lean however, uses less of everything, such as less of inventory on site, half the tools investment, half the manufacturing space and half the engineering hours to develop a new product in half the time (Womack, Jones, and Roos 2007). In other words, the lean production aims to remove all slack from the system. Gattorna (2010) points out that lower cost and prices has been the motivation for firms to pursue "lean" as a solution. When removing all slack from the system, the supply chain gets very fragile (Womack, Jones, and Roos 2007). There is always an increased risk with efficient operations according to Waters (2007), and the supply chain vulnerability might be overlooked as managers tends to focus on the benefits. Security and predictability is what a lean supply chain needs, according to Gattorna (2010).

An example on how lean is practiced is the "heart of leanness" operation called Just-In-Time (JIT). According to Waters (2007) the activities in JIT operations are performed exactly when they are needed, which means not too late and not too early. In addition, JIT operations shows no stock of work in progress, lower risk from waste, interruptions, delays, obsolescence loss which leads to the result of effective way of managing material flow. However, in the reality JIT operations are much more complicated as JIT operations increases the supply chains vulnerability in even the smallest disruptions by removing slack from the operations. A disruption in the supply chain can be a delay, breakdown, accident, surge in demand, new product or a change in product. Reduction of some risks is present using JIT operations when it increases other risks. Too much emphasis on costs

and removing the flexibility in the supply chain to cope with unexpected disruptions is some of the critic lean operations have received (Waters 2007).

Upton (1997, sited in Sawhney 2006, 476) defines flexibility as "the ability to react or transform with minimum penalties in time, cost and performance". Further, Sawhney (2006) distinguish between proactive and reactive flexibility. To get a competitive advantage of the competitors, proactive flexibility can be applied. Reactive use of flexibility allows firms to cope with uncertainty so that the flow of goods does not slow down. Manuj and Mentzer (2008b) explain that in more flexible supply chains options can be discovered faster than its competitors when dealing with uncertain supply and demand. In global chains, flexibility is important as environmental and operating uncertainty can be managed through flexible supply chains. Depending on the risk faced by the supply chain, flexibility should be evaluated as flexibility comes at a cost (Manuj and Mentzer 2008b).

Unforeseen disruptions in both the environment and internal to the firm will be allowed by agile logistics. (Waters 2007). As product cycles are getting shorter, market requirements changes quickly and demand is becoming more volatile, agility is becoming more important (Waters 2007). High customer service is the essential of agile logistics. However, even as agile is seen as a more flexible system than lean operations, agile brings its own set of risks, such as reduced productivity and increased costs (Waters 2007). Nevertheless, supply chains that face high demand or supply risks are more vulnerable when choosing this form of strategy (Manuj and Mentzer 2008b).

Both lean and agile management have their benefits but limitations is also to be found for both of the strategies. The limitations of one of the strategies would appear very strong, as the vulnerability in the supply chain would increase if an organization decides to choose one of the strategies in isolation to the extreme (Waters 2007).

If a disruption occurs in the supply chain, the possibility that it will have an impact on a firm's economic performance is likely. Thereby, the next section will look at literature regarding economic performance measures and SCRM.

3.9 Economic performance and SCRM

As the competitiveness among firms increases, firms needs to work to remain in business and here performance measure is a powerful tool (Williams 2003). Performance measurement can help both parties to better understand what processes works and, which is not working. Based on the measures, strategies can be changed for increasing effectiveness and efficiency. Measurement of performance have throughout the years been used to evaluate the success of firms (Kennerly and Neely 2003). However, researchers have found that the traditional financial performance measures provides little indications of how the performance is achieved, and how it in the future can be improved.

A report performed by the consulting company PwC, explains that disruption in a supply chain can affect the whole supply chain, and firms financial performance (PwC 2013). This happened to Toyota, which after a fire was forced to shut down 18 plants for almost two weeks. This resulted in a lost sale of 70000 vehicles, worth around $325 billion (Norrman and Jansson 2004). According to PwC, firms with a well-developed SCRM will perform better, both operational and financial (PwC 2013). Business Dictionary gives the following definition on performance:

> The accomplishment of a given task measured against preset known standards of accuracy, completeness, cost, and speed. In a contract, performance is deemed to be the fulfillment of an obligation, in a manner that releases the performer from all liabilities under the contract.

In this theses, economic performance measure will be used for studying SCRM, and thereby Business Dictionary definition of economic performance will be used:

> An assessment for an organization of its success in areas related to its assets, liabilities and overall market strength. Many business operators take regular stock on either a formal or less formal basis of the general economic performance of their company to make sure that it remains on the right track financially.

PwC´s report implies that 60% of the asked companies pay minor attention to reducing risk, but instead they are focusing on maximizing profit, minimizing costs and service

levels (PwC 2013). A survey conducted among 510 Chinese manufacturing firms found that risk-sharing mechanism is one out of two joint effort to SCRM, and they concluded that SCRM are positively correlated with financial performance of the firms (Li et al. 2015).

3.10 Hypothesis and research model

Based on the proposed theory, we hereby intend to investigate the hypothesis presented in table 3.3, together with the relevant items number and theoretical variables (independent and dependent).

Hypothesis	Items number	Theoretical variables (independent)	Theoretical variables (dependent)
H1a: There is an association between lean management and inbound delays.	2.4, 2.5, 2.11	Inbound Lean	Inbound delays
H1b: There is an association between lean management and outbound delays.	3.4, 3.8	Outbound Lean	Outbound delays
H2a: There is an association between inbound information sharing and inbound delays.	2.4, 2.5, 2.14 (S2, S4, S5)	Inbound information sharing	Inbound delays
H2b: There is an association between outbound information sharing and outbound delays .	3.4, 3.10 (S2, S4, S5)	Outbound information sharing	Outbound delays
H3a: There is an association between inbound collaboration and inbound delays.	2.4,2.5, 2.14 (S1, S3)	Inbound delays	Collaboration
H3b: There is an association between outbound collaboration and outbound delays.	3.4, 3.10 (s1, S3)	Outbound delays	Collaboration
H4a: Information sharing between supplier and manufacturer will have a positive impact on inbound SCRM.	2.14 (S2, S4, S5, S6-S8), 2.8	Inbound Information sharing	Inbound SCRM
H4b:Informationsharing between manufacturer and customer will have a positive impact on outbound SCRM.	2.14 (S8), 3.10 (S2, S4-S7)	Outbound information sharing	Outbound SCRM
H5a: Collaboration between manufacturer and supplier will have a positive impact on inbound SCRM.	2.8, 2.14 (S1, S3, S6-S8)	Inbound collaboration	Inbound SCRM
H5b: Collaboration between manufacturer and customer will have a positive impact on outbound SCRM.	2.14 (S8), 3.10 (S1, S3, S6-S7)	Outbound collaboration	Outbound SCRM

Hypothesis	Items number	Theoretical variables (independent)	Theoretical variables (dependent)
H6a: Inbound delays will have a negative impact on performance.	2.4, 2.5, operating revenue	Inbound delays	Performance
H6b: Outbound delays will have a negative impact on performance.	3.4, operating revenue	Outbound delays	Performance
H7a: There is an association between performance and inbound SCRM.	2.14 (S6-S8), 2.8, operating revenue	Performance	Inbound SCRM
H7b: There is an association between performance and outbound SCRM.	2.14 (S8), 3.10 (S6, S7), operating revenue	Performance	Outbound SCRM
H8a: There is an association between inbound deliveries and inbound SCRM.	2.14 (S6-S8), 3.1, 3.2, 3.3	Inbound deliveries	Inbound SCRM
H8b: There is an association between outbound deliveries and outbound SCRM.	2.14 (S8), 3.1, 3.2, 3.3, 3.10 (S7-S8)	Outbound deliveries	Outbound SCRM
H9a: There is an association between supplier distance and inbound SCRM.	2.8, 2.10, 2.14 (S6-S8)	Supplier distance	Inbound SCRM
H9b: There is an association between customer distance and outbound SCRM.	2.14 (S8), 3.7, 3.10 (S6, S7)	Customer distance	Outbound SCRM
H10a: There is an association between product variety and inbound SCRM.	1.3, 2.8, 2.14 (S6-S8)	Product variety	Inbound SCRM
H10b: There is an association between product variety and outbound SCRM.	1.3, 2.14 (S8), 3.10 (S6, S7)	Product variety	Outbound SCRM

Table 3.3: Hypothesis, items number and variables

The relationships proposed in this study are presented through the hypothesis presented in figure 3.7. The figure below illustrates the relationships between the dependent variable SCRM and the independent variables. The model captures both inbound and outbound hypothesis, whereas "a" represent inbound and "b" represent outbound. Both information sharing and collaboration are independent variables that are expected to have a positive impact on SCRM, as illustrated in the model. Furthermore, delays are expected to negatively affect firms performance.
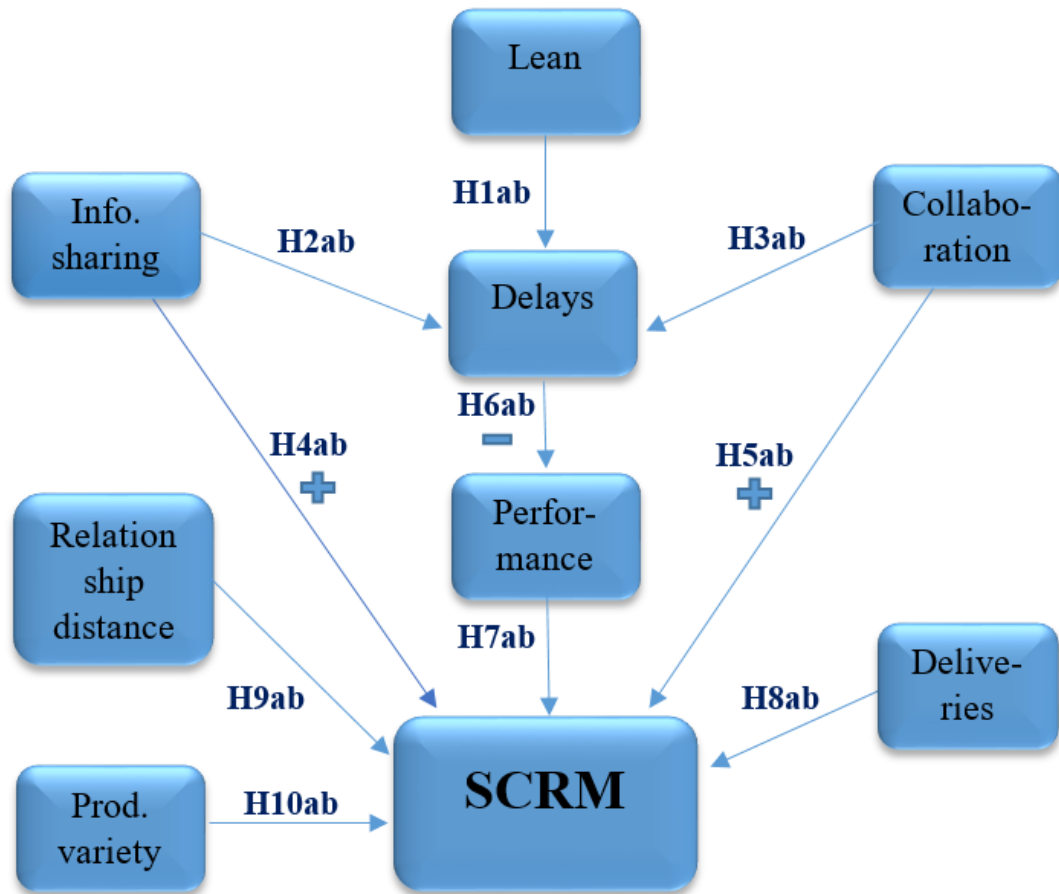
Figure 3.7: SCRM model and hypothesis

4.0 Research methodology

4.1 Introduction

This chapter will explain the methodological approach of this research. A methodology section should include descriptions of subjects, materials and devices used, and in addition the procedures followed for making the study able to be replicated by other researchers (Bordens and Abbott 2008). This chapter is divided into subsections, starting with *research design*. A quantitative approach was used as the main method for data collection, representing a questionnaire among Norwegian manufacturing firms. Further, next section *data collection* will describe the steps in how the questionnaire was developed. *Data collection results* include descriptions of respondent rate and *structural equation modeling* describes the analyzing method and how data was analyzed.

4.2   Research design

The aim of this research is to investigate and compare Norwegian manufacturing firm's attention to inbound and outbound SCRM. Creswell (2012, 3) describes research as "a process of steps used to collect and analyze information to increase our understanding of a topic or issue". Generally, research consists of three steps, whereas the first involves posing a question, the second involves collecting relevant data and at the third step, the question will be answered (Creswell 2012). According to Bordens and Abbott (2008) research could be divided into basic research and applied research. Basic research is "conducted to investigate issues relevant to the confirmation or disconfirmation of theoretical or empirical positions", and applied research "investigates a problem based in the real world" (Bordens and Abbott 2008, 4).

Furthermore, Creswell (2012, 12) describes research design as "types of inquiry within qualitative, quantitative, and mixed methods approaches that provide specific direction for procedures in a research design". A research design will ensure the study will be problem relevant and also use economical procedures (Churchill 1999).

4.2.1   Research goals

According to Ruane (2005) there exist four basic goals of research. These are exploration, description, explanation and evaluation. The main characteristics of each single goal are illustrated in table 4.1.

Research goal	Characteristics
Exploratory research	- Lack of knowledge - Used to clarify concepts - Creating priorities for future research
Descriptive research	Offers detailed picture of a social phenomena
Explanatory research	- Why or how? - Tries to identify causes or effects of social phenomena
Evaluation research	Judge of merits or efficacy

Table 4.1: Research goals

Churchill (1999) explains that an exploratory study may be used to clarify concepts, and the objective is to "gain insight and ideas". As an exploratory research is completed

because of lack of knowledge, the study will be flexible concerning the method used for having insight to the area and hypothesis developed.

4.2.2 Research approaches

There exist three types of research methods; qualitative approach, quantitative approach and the mixed-method approach. Creswell (2014, 4) describes qualitative research as "an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem", while quantitative research on the other hand is described as "an approach for testing objective theories by examining the relationship among variables". The mixed method approach involves both qualitative and quantitative data. As this research will conduct a data collection in order to compare and look at relationships between variables, this will be a quantitative research. For a quantitative research, literature review will be used to justify the problem and play a smaller role compared to qualitative research. Instead, data will be collected from a small number of participants representing a group (Creswell 2012).

4.2.2.1 Quantitative research questions and hypothesis

In quantitative studies, research questions and hypothesis are being used for focusing or defining the purpose the study. Creswell (2014, 108) defines a research question as "interrogative statements or questions that the investigator seeks to answer ", and hypothesis as "predictions the researcher holds about the relationship among variables". Accordingly, Churchill (1999) clarifies that a good hypothesis has clear implications for testing the relationship between the variables. Hypothesis development is an important step in the research process, as it will be used for measures later in the research. Less good hypothesis could make the results from analysis invalid (Churchill 1999).

4.2.3 Primary and secondary data

Hox and Boeije (2005, 593) define primary data as "original data that are collected for a specific research goal" and secondary data as "data originally collected for a different purpose and reused for another research question". When primary data has been collected, new data is added to the social knowledge and also available for reuse as secondary data

(Hox and Boeije 2005). In this case, primary quantitative data will be collected through a questionnaire and secondary qualitative data will relate to previous research. This is illustrated in table 4.2.

	Primary data	Secondary data
Quantitative data	Questionnaire	#
Qualitative data	#	Previous research

Table 4.2: Research strategy and research design

4.3 Data Collection

A questionnaire was decided to use as a method for collecting primary data. The following section clarifies the process from developing the questionnaire to the final result of data collection.

4.3.1 Questionnaire development

Churchill (1999, 329) expresses a nine-step procedure of how to develop a questionnaire. This is illustrated in figure 4.1. This procedure was followed, and in this section we will describe each step and how the questionnaire was developed from start to end.

Step 1: Specify what information will be sought
Step 2: Determine type of quesionnaire and method of administration
Step 3: Determine content of individual questions
Step 4: Determine sequence of questions
Step 5: Determine wording of each questions
Step 6: Determine sequence of questions
Step 7: Determine physical characteristics of questionnaire
Step 8: Reexamine steps 1-7 and revise if necessary
Step 9: Pretest questionnaire and revise if necessary

Figure 4.1: Procedure for developing questionnaires. Adapted from Churchill (1999)

Step 1: What information will be sought

It was decided that SCRM considering inbound and outbound logistics would be the main topic. Additionally, a questionnaire would be completed among Norwegian manufacturing firms for adding new research to the literature as we found a lack of research concerning inbound and outbound SCRM. As this would be an exploratory research and was aiming to discover ideas and insight, such questionnaires could be more loosely structured with an idea of what type of information that should be collected (Churchill 1999). SCRM was decided to be the main dependent variable throughout the research. The independent variables are lean, delays, information sharing, collaboration, relationship distance, product variety, deliveries and performance measures.

Step 2: Determine type of questionnaire and method of administration

Fink (2003) lists up four types of survey instruments: self-administered questionnaires, interviews, structured record reviews and structured observations. For collecting data, it was decided that a questionnaire completed over telephone would be the best opportunity for having a highest possible response rate. As a result of this, the survey was a combination of a questionnaire and interviews. As both the questions and most answers were decided in advance, the interviewer's job were to explain questions if there was

unclear questions. Using interviews could increase the quality of the data as Gillham (2008) lists up quality as a problem related to misunderstandings of questionnaires.

Step 3: Determine content of individual questions

At this stage the latent variable was decided based on previous research, and it was ensured that most concept was covered by several questions or items for ensuring it would be possible to measure after the data collection would be concluded (Churchill 1999).

Step 4: Determine response form to each single question

Most of the questions were to be answered in a five-point likert scale. As the questionnaire both includes questions and statement, the scale differs. When using such a scale it will be important that the scale are fulfilling the requirements for equidistance (Hair et al. 2014). The lowest possible alternative in the scale is number one, and five is the highest possible alternative. When it comes to the statement the scale mostly used was ranging from disagree (1) to totally agree (5). An advantage of this type of question is that statements could be listed, and instructions is only needed to be given in the beginning of a series of statements. These types of questions with statements listed up are used several times throughout the questionnaire.

All questions in the questionnaire were closed, except a few open alternatives where the respondent could write their answer as other. Open questions are characterized by letting the respondent use its own words for answering. Fink (2003) explains that closed questions are more difficult to write compared to open questions, as you must know all the possible answers or response choices. However, when it comes to analysis and interpretation of results, this is easier for closed questions.

Step 5: Determine wording of each single question

When a new topic was introduced, the interviewer was explaining the main purpose of the section. A verbal description was formulated in from of the data collection. Part of the research is based on earlier research, performed by Husdal and Bråthen (2010).

To avoid misunderstandings questions should be formulated simple, in a way that people with different degree of education could understand the formultaion. According to

Churchill (1999) questions should be unmistakable. However, question using simpler wording could also be misunderstood.

It was expected that some of the respondents not would understand the concept of lean management, which was asked in two questions. Because of this, the interviewer was given instructions in how to explain lean management in front of the data collection.

Step 6: Determine sequences of questions

The questionnaire is divided into five different parts, and as a new topic was introduced, the interviewer explained the focus. These five parts was included in the questionnaire:

1. General information
2. Supplier questions
3. Customer questions
4. Transportation questions
5. External risk statement

According to (Churchill 1999) sensitive or difficult questions should be placed late in the questionnaire. Such questions could make the respondent feel threatened and they will turn off. In front of the data-collection, we got access to a database including firm's financial results. By this, we could avoid sensitive questions about financial performance, which could make the respondent not feel threatened from the interviewer.

Step 7: Determine physical characteristics of questionnaire

As the survey was mostly done by telephone interviews, introduction was short. However, an introduction was written in front of the interviews as this is the point where the respondents are convinced to answer the questionnaire and understands the importance of the research (Churchill 1999). The respondent was informed about the topic, and purpose of the research, and that the answers would be treated with full confidentiality.

Step 8: Re-examine steps 1-7 and revise if necessary

As a questionnaire takes time to develop, many drafts were created before the final questionnaire was finished. First, the variable to be measured was developed. After this, questions for measuring these variables was written down. For being sure that all variable would be measured in case of misunderstandings some questions was formulated to each

single variable. These questions would be the indicator of the variables when analyzing the results. In addition, formulation of each single question was considered to ensure that there would be no misunderstandings during the data collection.

Step 9: Pretest questionnaire and revise if necessary

Pretesting a questionnaire is important for having the possibility to see how it actually performs under the right kind of conditions of collection. Churchill (1999, 265) states, "data collection should never begin without adequate pretest of the instrument". In this research, the questionnaire was tested through an earlier research using some of the same questions (Husdal and Bråthen 2010), and during the yearly career day at Molde University College where several companies was represented. The final questionnaire is presented in appendix 3.

4.4   Results of data collection

A database of Norwegian firms was used when finding respondent to participate in the data collection. The list was reduced to only include manufacturing firms, before some specific industries were picked out. The data collection took place in the time period from February 4th to March 15th. Twelve different industries were called and asked to answer the questionnaire. The response rates from different industries are presented in table 4.3. Overall a response rate of 15,08% was achieved.

Industry	Sample size	Response	Response rate
Electronics	64	9	14,06%
Fisheries	66	17	25,76%
Rubber and plastic	32	6	18,75%
Machines and equipment	75	12	16%
Food and drink	190	21	11,05%
Metal goods	28	5	17,86%
Furniture and textile	27	5	18,52%
Oil and gas	23	1	4,35%
Paper and paper products	12	2	16,66%
Ships and equipment	32	12	37,5%
Lumber and equipment	45	1	2,22%
Chemicals	15	0	0%
Other	1	1	100%
Total	610	92	15,08%

Table 4.3: Response from data collection

4.4.1 Data reliability and validity

Bordens and Abbott (2008, 265) defines reliability as "the ability of a measure to produce the same or highly similar results on repeated administrations". One option for increasing the reliability for a questionnaire can be to increase the number of items measuring a construct. However, this can increase the length of the questionnaire and the benefit should be weighted against this (Bordens and Abbott 2008). Another way to ensure and increase reliability can be done by ensuring clear and well-written questions. Validity of a measure is defined as "the extent to which it measures what you intend to measure" (Bordens and Abbott 2008, 128).

4.4.1.1 Questionnaire limitations

During and after the data collection some challenges regarding the questions occurred. According to Churchill (1999) double-barreled question should be avoided as it can make the data useless. Question 2.7 in the questionnaire is an example on such a question as it both asks about consequences if there are delays or damage on incoming orders. By splitting this question into two, the data set would be more correctly and be more applicable for analyzes. Another limitation in the questionnaire that was discovered after data collection was an inverted scale in four of the questions. However, as this was discovered it was fixed before analyzing the data. This applies to question 2.1, 2.3, 3.1 and 3.3.

One option for increasing constructs reliability would have been to add some questions that could have increased items related to one construct, as several construct ended up as single-item constructs. PLS-SEM does not provide the opportunity to measure the reliability to one-single construct. Adding items to avoid single-item construct could have made analyzes more reliable. Another limitation could be that a high share of the respondent was working with purchasing, which decreased the respondent rate in the questions regarding customers.

Missing data is a common problem in research using survey as a tool, and when missing data exceeds 15% of the observations, Hair et al. (2014) describes that the observation

may be removed from the data set. However, in this case missing data is replaced with mean values, as the response rate overall is quite high. Lean, regarding both suppliers and customers has the lowest response with a response rate between 50 and 60%.

4.5 Structural Equation Modeling

According to Bollen (1989, sited in Hair et al. 2012) structural equation modeling (SEM) has given researchers the opportunity to test theories and concepts, which has made it the quasi-standard for studies on management and marketing research (Henseler, Ringle, and Sarstedt 2012). Hair et al. (2012) explains that SEM includes regression-based approaches, like multiples regression, logistic regression and variance analysis applied for confirmatory research. However, SEM could also be used for exploratory research with its factor analysis, cluster analysis and multidimensional scaling.

Kline (2011) suggests a six-step approach when using SEM as an analyzing tool. These are:

1. Model specification
2. Evaluation of model identification
3. Selection of measures and collect, prepare and screen the data
4. Estimation of model
    a. Evaluation of model
    b. Interpretation of parameter estimations
    c. Consideration of equivalent or near-equivalent models
5. Re-specification of model
6. Result-reporting

Kline (2011) states that scoring reliability is important when only having one observed measure, called single-indicator measurement. As there only is one observed measure of the construct, it will be critical that the psychometric characteristics are good. When using more than one indicator for measuring a construct the approach is called multiple-indicator measurement.

There are two types of methods when it comes to SEM; covariance-based techniques (CB-SEM) and variance-based partial least squares (PLS-SEM). Previously research has mostly

focused on CB-SEM, although PLS-SEM lately has expanded in marketing research (Henseler, Ringle, and Sarstedt 2012). According to Henseler, Ringle, and Sarstedt (2012) PLS-SEM has a focus on maximizing the explained variance of the endogenous latent variables in front of reproducing theoretical covariance matrix. PLS-SEM has latent variables that describe the relationships between the latent variables and also the relationships between the latent variables and their indicators.

4.5.1 PLS-SEM

Smart-PLS has smaller sample size requirements compared to CB-SEM (Henseler, Ringle, and Sinkovics 2009), and thus PLS-SEM has been chosen as method in this research. PLS-SEM requires a sample size ten times larger than the largest predictor (Hair et al. 2014). This research sample size would be too small for CB-SEM. According to Jöreskog and Wold (sited in Henseler, Ringle, and Sinkovics 2009, 311) PLS-SEM would be suggested in cases where high complexity and a low degree of theoretical information are available. PLS-SEM would not need strong theory and can be used for theory testing (Gefen 2000). CB-SEM, on the other hand, is more proper in use where more research has been completed for either comparison of results or to empirically confirm hypothesis.

4.5.1.1 Reflective and structural model

PLS-SEM consist of outer and inner models, respectively measurement and structural models (Hair et al. 2014). These are illustrated in figure 4.2. The measurement model indicates the relationships between the constructs and the indicators. Structural model, on the other hand, refer to the inner model and the relationships between the constructs. Measurement model can have reflective or formative indicators. Reflective indicators are based on long tradition of classical testing theory, and can be viewed as a representative sample of the construct, which indicates that indicators should be highly correlated with each other. When using reflective constructs, reliability measures (Cronbach´s alpha, Composite Reliability and Average Variance Extracted (AVE)) illustrate the reliability and correlation of a construct and its indicators (Petter, Straub, and Rai 2007). On the other hand, formative measurement models are based on assumptions that the indicators cause the construct. Formative indicators are used to minimize residuals in the structural relationship (Petter, Straub, and Rai 2007).

Structural Model

Indicator1
Indicator2
Indicator3

Latent Variable 1

Reflective Indicators

Indicator4
Indicator5
Indicator6

Latent Variable 2

Latent Variable 3

Formative Indicators

Indicator7
Indicator8
Indicator9

Measurement Model of the Latent Exogenous Variables

Measurement Model of the Latent Endogenous Variables
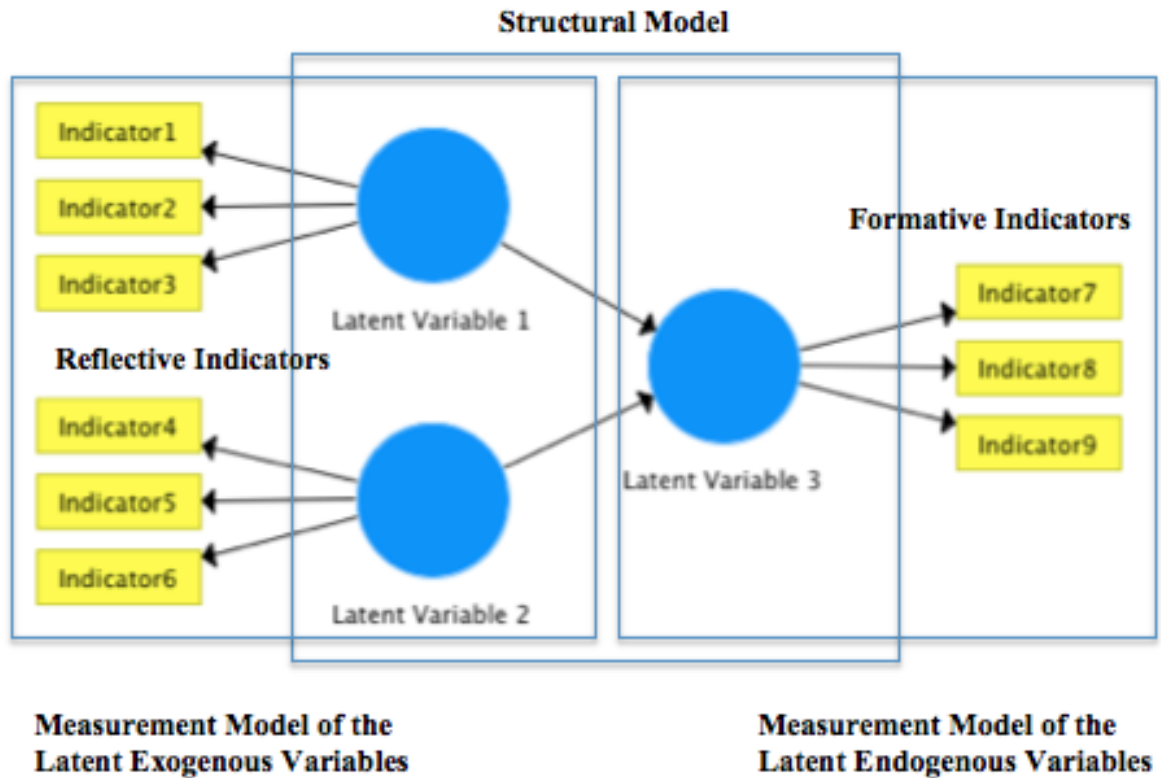
Figure 4.2: PLS-SEM, reflective and structural model

In PLS-SEM there are two types of variables, endogenous and exogenous variables. An exogenous latent variable serve only as independent variables, and endogenous variables serve only as dependent or both independent and dependent. Exogenous latent variables will only have arrows going out from the variables, while endogenous latent variable can either have arrows going in to the variable or both going in and out (Henseler, Ringle, and Sarstedt 2012).

4.5.1.2 Evaluation of reliability in PLS-SEM

4.5.1.2.1 Reflective model reliability

Cronbach´s alpha is used for evaluating the internal consistency reliability. According to Hair et al. (2014, 101) Cronbach´s alpha "provides an estimate of the reliability based on the inter-correlations of the observed indicator variables". Cronbach´s alpha requires a minimum value of 0,7 for being considered as acceptable. However, Cronbach´s alpha is often underestimating the internal consistency reliability, as a result of assuming all indicators to be equal reliable (Hair et al. 2014). Furthermore, PLS-SEM uses indicators

own individual reliability for prioritizing. As Cronbach´s alpha comes with limitations another option measuring internal consistency reliability is composite reliability. Composite reliability bases on that it exist different outer loading and lies between zero and one. Higher values represent higher reliability. Generally, composite reliability is acceptable when the values are between 0,7 and 0,9. However, for an exploratory research values above 0,6 will be acceptable. If the values exceed 0,9, this is an indication that the variables are measuring the same phenomena and will not be desirable (Hair et al. 2014).

Convergent validity is "the extent to which a measure correlates positively with alternative measures of the same construct" (Hair et al. 2014, 102). The outer loadings of the indicators are considered, whereas high loadings indicate that the indicators have much in common. An outer loading should be above 0,708 to be acceptable. However, also indicators between 0,4 and 0,7 should be considered to keep if deleting an indicator not has a positive effect on Composite reliability. Indicators with lower loading then 0,4 should always be removed (Hair et al. 2014). AVE is used to measure the level of convergent validity of the level of constructs. An AVE with a value of 0,5 or higher will indicate that the construct will be explained by 50% or more by the indicators variance (Hair et al. 2014). A single-item construct will only have one indicator, and therefore this reliability measures will not be appropriate. For single-item constructs, it is not possible to assess the measurement model´s reliability and validity (Hair et al. 2014).

Discriminant validity is the degree to which the constructs differ from each other by empirical standards and represent unique and different phenomena (Hair et al. 2014). There are two methods for measuring discriminant validity, whereby one examines the cross loadings and the other compares the square root for the constructs AVE. The first one bases on that the outer loading for an indicator should be higher than the loading to all of the other constructs. The second method, the Fornell-Larcker criterion, is based on that the square root of the AVE should be higher than the highest correlation with any of the other constructs (Hair et al. 2014).

4.5.1.2.2 Structural model reliability

Coefficient of determination (R^2) is used to evaluate the structural model and measures the models predictive accuracy. R^2 is calculated for endogenous variable constructs by the

squared correlations between the constructs and the predicted values, and represent the exogenous latent variable shared effects on the endogenous latent variable (Hair et al. 2014). The value of R^2 varies between zero and one, whereas higher level represents a higher level of prediction. According to Hair et al. (2014) it is complicated to set an acceptable level of R^2 values as both model complexity and research discipline will affect this.

4.5.1.3   Bootstrapping

Bootstrapping is a method used for resampling the data. According to Kline (2011) there are two types of bootstrapping, nonparametric bootstrapping and parametric bootstrapping. PLS-SEM uses nonparametric bootstrapping, as a result of not assuming data to be normally distributed (Hair et al. 2014). Bootstrapping includes creating a larger number of subsamples with replacements from the original data set. Before a new sample is created it will return back to the original population (Hair et al. 2014). Hair et al. (2014) describes that each bootstrap should have the same amount of observation as the original data set. From the bootstrapping results, the t–value will be used for determine the significance of the results from the PLS path model. By a t-value above 1,96, it can be assumed that the path coefficient is significant at a level of 5%. Using 10% level will require a t-value above 1.65 (Hair et al. 2014).

5.0 Operationalization of variables

In this section, dependent and independent variables are defined and relevant items for the variables from the questionnaire will be presented. SCRM is used as the main dependent variable, and independent variables are lean, delays, information sharing, collaboration, performance, deliveries, relationship distance and product variety.

5.1 The dependent variable: SCRM

This research uses SCRM as dependent variable, and will shortly concern firm's attention to reduce risks together with its suppliers and customers. The variable are divided into two, one for inbound SCRM and one for outbound SCRM as two models will be tested. Similar studies have been performed on the German automotive industry (Thun and Hoenig 2011), among French companies (Lavastre, Gunasekaran, and Spalanzani 2012), French industrial firms (Lavastre, Gunasekaran, and Spalanzani 2014) and in the Brazilian electronic industry (Blos et al. 2009). Wiengarten et al. (2015) states that integration within the supply chain together with suppliers and customers are used for managing uncertainty. The question for SCRM in this research are statements, whereas the respondent has given its answer in a five-point likert scale. However, a question about spare suppliers are also asked, as having a single-source supplier will increase the possibility for risk (Chopra and Sodhi 2004) . The items for the dependent variable SCRM, inbound and outbound is presented in table 5.1.

Dependent variable	Item	Question/Statement
Inbound SCRM	2.8	Do you have any reserve suppliers for the most important products that you purchase?
	2.14 (Statement 6)	We and our most important suppliers have procedures which are designed to identify any risks occurring in the value chain.
	2.14 (Statement 7)	We and our most important suppliers have developed strategies for handling disruptions or delays in the value chain.
	2.14 (Statement 8)	We have people with defined areas of responsibility for handling risks.
Outbound SCRM	2.14 (Statement 8)	We have people with defined areas of responsibility for handling risks.
	3.10 (statement 6)	We and our most important customers have procedures which are designed to identify any risks occurring in the value chain.
	3. 10 (Statement 7)	We and our most important customers have developed strategies for handling disruptions or delays in the value chain.

Table 5.1: Questionnaire items for SCRM

5.2 Independent variables

5.2.1 Lean

Even though lean comes with many benefits, such a strategy will increase a supply chains vulnerability and thereby come with many risk. Because of this lean is used as an independent variable measuring the manufacturing firm's suppliers and customer's tendency of using lean management. Items measuring this are presented in table 5.2.

Independent variable	Item	Question/Statement
Inbound lean	2.11	To what extent do your most important suppliers practice the "Lean Principle"?
Outbound lean	3.8	To what extent do your most important customers practice the "Lean Principle"?

Table 5.2: Questionnaire items for lean

5.2.2 Delays

Chopra and Sodhi (2004) lists up delay as a category within supply chain risks, as a result of inflexibility. Based on this, delays is used as an independent variable measuring frequency for delays for both inbound and outbound logistics. Items concerning delays are presented in table 5.3.

Independent variable	Item	Question/Statement
Inbound delays	2.4	How often do goods arrive late from your most important suppliers?
	2.5	How long could a delay last for, on average?
Outbound delays	3.4	How often do delays occur when you send goods to your most important customers?

Table 5.3: Questionnaire items for delays

5.2.3 Information sharing

Lavastre, Gunasekaran, and Spalanzani (2014) found communication and information exchange to be the most important technique used for SCRM among French industrial firms. All items measuring information sharing with suppliers and customers are statements measured in a five-point likert scale, ranging from disagree to totally agree. Inbound and outbound information sharing items are presented in table 5.4.

Independent variable	Item	Question/Statement
Inbound information sharing	2.14 (Statement 2)	We receive routine information when our suppliers have sent their goods.
	2.14 (Statement 4)	We receive routine, immediate notification from our suppliers when delays unrelated to actual transport occur.
	2.14 (Statement 5)	We receive routine, immediate notification from the haulier when delays/disruption relating to transport occur.
Outbound information sharing	3.10 (Statement 2)	We provide our customers with routine information once we have sent their goods.
	3.10 (statement 4)	We provide our customers with routine information as soon as any delays occur.
	3.10 (Statement 5)	The haulier provides our customers with routing notification as soon as any transport delays occur.

Table 5.4: Questionnaire items for information sharing

5.2.4 Collaboration

Wiengarten et al. (2015) argues that supplier and customer integration are important aspects of SCRM. In addition, Lavastre, Gunasekaran, and Spalanzani (2012) found that French companies tends to work together with other partners within the supply chain, if risks are confronted. Christopher and Peck (2004) argues that collaboration between partners in the supply chain will reduce uncertainty as information is shared. Similar to information sharing, collaboration is measured with statements that are answered in a five-point likert scale ranging from disagree to totally agree. The items are presented table 5.5.

Independent variable	Item	Question/Statement
Inbound collaboration	2.14 (Statement 1)	We cooperate with our suppliers on a regular basis in order to reduce the likelihood of delays.
	2.14 (Statement 3)	We have the opportunity to track goods between the time when they leave our suppliers and when we receive them.
Outbound collaboration	3.10 (Statement 1)	We cooperate with customers on a regular basis in order to reduce the likelihood of delays.
	3.10 (Statement 3)	Our customers have the opportunity to track goods as soon as they are sent and until they receive them.

Table 5.5: Questionnaire items for collaboration

5.2.5 Performance

Performance was not measured through the questionnaire. In front of the data collection, we was given access to firm's financial results. However, performance can be measured in many forms. In this case operating revenue were used as the latent variable, shown in table 5.6.

Independent variable	Item	Question/Statement
Performance		Operating revenue (information gathered before data collection).

Table 5.6: Operating revenue

5.2.6 Deliveries

Inbound and outbound deliveries are measured in frequencies of deliveries going in and out, delivery times and urgent orders, as presented in table 5.7.

Independent variable	Item	Question/Statement
Inbound deliveries	2.1	How often do you have deliveries coming in?
	2.2	What are the approximate average delivery times of your most important suppliers?
	2.3	How often do you make use of urgent orders from your most important suppliers?
Outbound deliveries	3.1	How often do you send goods to your most important customers?
	3.2	Delivery is the time which elapses between when an order is placed and the customer receives the goods in question. What delivery times do you offer to your most important customers?
	3.3	How often do you experience urgent orders from your most important customers?

Table 5.7: Questionnaire items for deliveries

5.2.7 Relationship distance

The globalizing world lead to increased distance between manufacturers and their suppliers and customers. Researchers such as Giunipero and Eltantawy (2004) states that

increased distance will increase the uncertainty related to supply continuity because of longer lead times and potential disruption during transportation of goods. In this research supplier and customer distance are measured in country (illustrated in table 5.8) that later has been coded between one and five, whereas higher number implies longer distance.

Independent variable	Item	Question/Statement
Supplier distance	2.10	In which countries are your company's most important suppliers located.
Customer distance	3.7	Which country are your most important customers located in?

Table 5.8: Questionnaire items for relationship distance

5.2.8 Product variety

The item concerning product variety are adapted from Husdal and Bråthen (2010), and respondents are able to use multiple answer. In this research, the measurement is based on how many different product the manufacturing firm are producing. Question and respond alternatives are illustrated in table 5.9.

Independent variable	Item	Question/Statement
Product variety	1.3	How would you describe the production/products of your company? (Alternatives: Standard product make to stock, standard product make to order, specialized product make to order, customized product engineered to order).

Table 5.9: Questionnaire items for product variety

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6.0 Research paper

An investigation and comparison of inbound and outbound supply chain risk management (SCRM) among Norwegian manufacturing firms

By: Gina Beate Sørland and Sarah Økland Wembstad, 2016

Abstract

Supply chain risk management (SCRM) has through the recent years had an increased focus among firms and within the academia. This study builds on theory from SCRM, collaboration and information sharing among partners in the supply chain. The purpose of this study is to compare Norwegian manufacturing firm's attention to inbound and outbound SCRM and see if Norwegian manufacturing firms emphasizes inbound and outbound SCRM differently. A questionnaire responded by 92 firms was completed, and due to the small sample size PLS-SEM was used as an analyze tool. PLS-SEM results indicates that firms tends to manage risk upstream in the supply chain with respect to their suppliers. Comparing to upstream, the same level of attention is not discovered downstream in the supply chain concerning customers. However, if SCRM for all firms in a supply chain manage risk upstream, risk at each tier will be controlled and firms may continue having the same attention. Implications for future research could be to investigate the need for SCRM downstream in the supply chain.

6.1 Introduction

Supply Chain Risk Management (SCRM) has through the recent years had an increased focus (Norrman and Jansson 2004). Supply chains gets longer and more complex, and as result of globalization, outsourcing and offshoring, firms control over their supply chain decreases (World Economic Forum 2008). Even a small localized event can impact and cause damage across the global economic system. Risk comes in many forms and sources of risk can be weather changes, diseases, fires, uncertain demand, inaccurate supply and chain capacity risk. Examples of real world supply chain disruptions are many and when the Swedish mobile company Ericsson experienced a fire at a sub-supplier plant in 2000, it took about three weeks before the damages was restored. By this Ericsson lost about $400 million, as they had no back up sub-supplier (Norrman and Jansson 2004).

Inbound risk is an area of supply chain risk that has received much attention throughout the years. Supply risk can occur in the movement of gods from supplier's suppliers in one end to the focal firm in the other end. According to Manuj and Mentzer (2008a) supplier reliability, single or dual sourcing, centralized or decentralized sourcing, make or buy decisions and security issues are important aspects to consider, studying supply risks. Further, outbound supply chain risks related to customers and sources of demand risk will exist in the movement of goods from the focal firm to the customer's customers (Manuj and Mentzer 2008a).

According to Ho et al. (2015) previous research has focused on categories of risk, which include macro risk and demand, manufacturing, supply, information, transportation and financial factors. Previous research has had a higher focus on risk connected to the supplier side. Moreover, there exist a lack of research concerning outbound risk. The literature does not compare inbound and outbound SCRM. Hence, in difference from other researchers we investigate Norwegian manufacturing firms attentions to inbound and outbound SCRM, and whether there are displayed any differences.

6.2 Literature review

Multiple types of supply chain exists today depending on what type of industry that is referred to, and the reality of many supply chain can be quite complex as the picture of supply chains get more complicated. As a result of turbulent markets, uncertainty (Christopher and Lee 2004) and more complex supply chains, organizations vulnerabilities increases (Thun and Hoenig 2011).

Ho et al. (2015) has conducted a literature review and divided supply chain risk into two types, micro-risk and macro-risk. Jüttner, Peck, and Christopher (2003) categorizes risk into environmental risk sources, network-related risk sources and organizational risk sources. Manuj and Mentzer (2008b) have further divided these categories into sub-categories of supply chain risk. As supply chains becomes longer, have more possible disruption points and a tendency that local events cause problems in other parts of the chain, SCRM has become more important. SCRM process can be divided into a four-step process according to Ho et al. (2015). First risk identification takes place, and the main focus at this step will be to recognize uncertainties in the future for being able to implement a proactive management for issues related to risk (Norrman and Jansson 2004). The next step in the process is to assess and prioritize risk for deciding which management actions that will be appropriate for each of the situations (Norrman and Jansson 2004). In addition, assessing risks involves calculations of probabilities, but other assets like reputation, status or trust can also be affected (Harland and Walker 2003). The third step is risk mitigation. This step includes reviewing the risk profile and suggesting further actions for either reducing the risk profile or securing the company from the potential impacts of the risks (Handfield and McCormack 2007). The fourth and the last step is monitoring, and will only be required if the level of risk is very high or high and not mitigated according to Norrman and Jansson (2004). Handfield and McCormack (2007) argue that the importance of global monitoring is increasing as a result of accident are being reported locally but are causing problems in the entire supply chain. Multiple definitions can be found regarding supply chain risk management. Ho et al. (2015, 2036) defines SCRM as:

> An inter-organisational collaborative endeavour utilising quantitative and qualitative risk management methodologies to identify, evaluate, mitigate and monitor unexpected macro and micro level events or conditions, which might adversely impact any part of a supply

chain.

Figure 6.1 illustrates the overall focus of this research, to compare inbound and outbound SCRM.
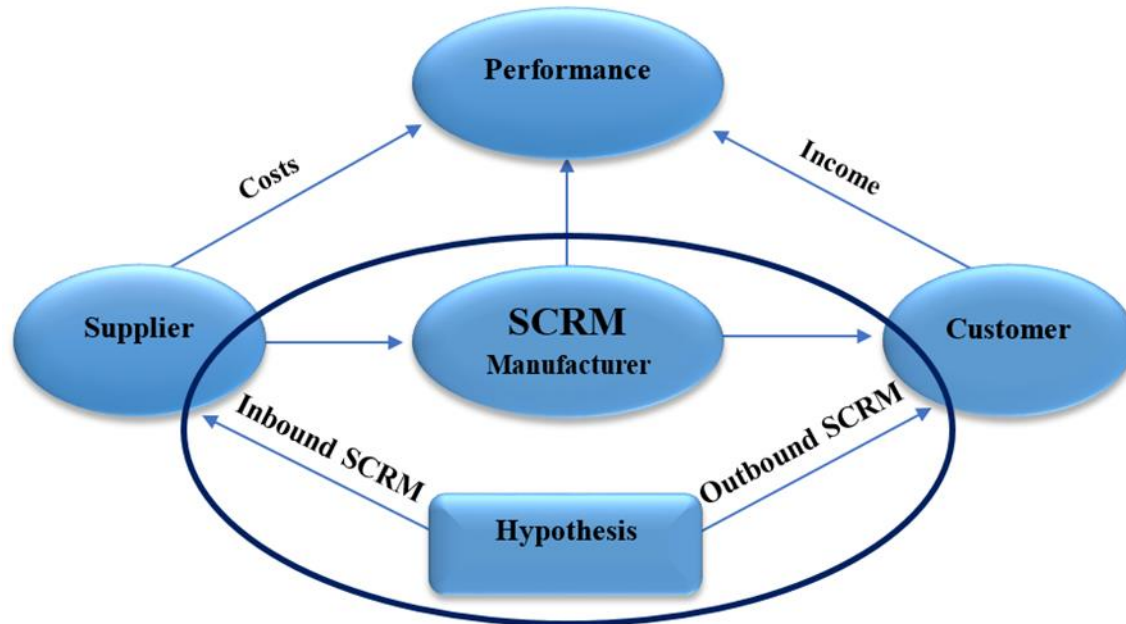
Figure 6.1: Overall research model

6.2.1 Theoretical background for hypothesis

The aim of lean production is to remove all slack from the system (Womack, Jones, and Roos 2007). Consequently, when removing all slack the supply chain gets fragile (Womack, Jones, and Roos 2007). Gattorna (2010) points out that lower cost and prices has been the motivation for firms to pursue the "lean" as a solution. The "heart of leanness" operation called is Just-In-Time (JIT). The activity in JIT operations are performed exactly when they are needed, which means not too late and not too early. In addition, JIT operations shows no stock of work in progress, lower risk from waste, interruptions, delays, obsolescence loss which leads to the result of effective way of managing material flow. However, in the reality JIT operations are much more complicated as it will increase the supply chains vulnerability in even the smallest disruption by removing slack from the operations. Waters (2007) points out that efficient operation increases the risk, as the supply chain vulnerability might be overlooked by managers. By this, we propose following hypothesis:

H1a: There is an association between lean management and inbound delays.
H1b: There is an association between lean management and outbound delays.

A research performed by Zhou and Benton (2007), results indicated that delivery performance are significantly correlated with information quality and delivery practice inbound. However, it was also found that information sharing had a negative impact on delivery performance and delivery practice downstream in the supply chain. By this, we formulate the following hypothesis:

H2a: There is an association between inbound information sharing and inbound delays.
H2b: There is an association between outbound information sharing and outbound delays.

The relationship between delays and collaboration is also an interesting aspect, and thereby following hypothesis are formulated:

H3a: There is an association between inbound collaboration and inbound delays.
H3b: There is an association between outbound collaboration and outbound delays.

According to Christopher and Lee (2004) shared information among partners in the supply chain is the essence to supply chain visibility and a risk-reducing effort that will increase the power of the parties involved. A Brazilian research found that communication is one out of three important practices studying SCRM (Blos et al. 2009). Also a French study specifies the importance of information sharing and collaboration regarding risk (Lavastre, Gunasekaran, and Spalanzani 2012). The research concluded that communication and information exchange was considered to be the best ways of managing risks in the supply chain. However, level of long-term orientation or supplier trust will affect the effectiveness of risk information sharing. Trust can lead to competitive advantage if it is well developed through effective communication. Nevertheless, trust and information sharing can also lead to opportunistic behavior whereas one of the parties uses the information for their own benefit (Faisal, Banwet, and Shankar 2006). Christopher and Peck (2004) explains that the willingness to share information has occurred in the recent years, as is can contribute to reduce uncertainty in the supply chain. According to Li et al. (2015) risk

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information sharing is one out of two important aspects regarding SCRM. Thereby, hypothesis 4 is proposed:

H4a: Information sharing between supplier and manufacturer will have a positive impact on inbound SCRM.
H4b: Information sharing between manufacturer and customer will have a positive impact on outbound SCRM.

Collaboration consists of different types according to Barratt (2004). Collaboration with customers and suppliers is referred to as vertical collaboration. Furthermore, collaboration with competitors internally and non-competitors is referred to as horizontal collaboration. In order to develop closer relationships, integrating processes and sharing information with suppliers and customers, internal collaboration must be "married" to external collaboration. In this paper the focus will be on vertical collaboration (Barratt 2004).

Christopher and Peck (2004) points out that management of risk has to be network-wide as supply chain vulnerability by definition is a wide concept. For mitigate risk across the supply chain a high level of collaboration would help. From a historical point of view collaboration between suppliers and customers has not been common. Collaboration between manufacturer and retailer has started to occur in the industry of fast moving consumer goods (FMCG) according to Christopher and Peck (2004). Lavastre, Gunasekaran, and Spalanzani (2012) points out that collaboration between organizations are what supply chain management (SCM) involves, and internal (intra-organizational) and external (inter-organizational) elements are presented as what SCM requires. In addition Faisal, Banwet, and Shankar (2006) explains that trust is a factor that can contribute to supply chain risk. This proposes the following hypothesis:

H5a: Collaboration between manufacturer and supplier will have a positive impact on inbound SCRM.
H5b: Collaboration between manufacturer and customer will have a positive impact on outbound SCRM.

According to a report performed by the consulting firm PwC, disruption within a supply chain will affect the financial performance significantly (PwC 2013). Chopra and Sodhi (2004) categorizes delays as a risk, which can occur as a result of high utilization or other causes of stubbornness in the supply chain. It is likely to believe that delays, both inbound and outbound will negatively affect firm's economic performance. By this, we propose the following hypothesis:

H6a: Inbound delays will have a negative impact on performance.
H6b: Outbound delays will have a negative impact on performance.

In addition, results from the consulting company PwC (2013) also indicates that firm with a well-developed SCRM will perform better, both operational and financial compared to companies that have lower capabilities considering risks. The survey accomplished by PwC (2013) implies that 60% of companies pays minor attention to reducing risks. A high share of these companies is focusing on strategies related to profit maximization, cost minimizing or service levels. Research conducted among Chinese manufacturing firms by Li et al. (2015) found that risk-sharing mechanism is one out of two joint effort to SCRM, which has a positive correlation to firm's financial performance. It is likely to believe that companies having higher profit will have a higher focus of SCRM. By this, we propose following hypothesis:

H7a: There is an association between performance and inbound SCRM.
H7b: There is an association between performance and outbound SCRM.

Late deliveries could have huge consequences for the entire supply chain and the importance for timely deliveries has increased. Single-source of supply will involve risks if any disruptions occur in the supply chain (Chopra and Sodhi 2004). It is likely to believe that the frequencies of inbound and outbound deliveries will affect the potential for disruption in the supply chain, and that firms having higher frequency of deliveries will pay more attention to SCRM. In addition, rush orders could affect firms risk attention. Thus, following hypothesis are proposed:

H8a: There is an association between inbound deliveries and inbound SCRM.

H8b: There is an association between outbound deliveries and outbound SCRM.

Faisal, Banwet, and Shankar (2006) explains that many factors can contribute to supply chain risk, and trust is one of them. Moreover, building up resources can lead to a competitive advantage if trust is developed through effective communication. Furthermore, opportunistic behavior can occur between partners in the supply chain. Even if there are short-term incentives to act opportunistically, trust prevents supply chain partners to do so (Faisal, Banwet, and Shankar 2006). Different types of trust can be found according to Agarwal and Shankar (2003). Contract trust represent that people are doing what they are saying that they are going to do, which represent a confident expectation. Moreover, self-disclosure trust is explained by that relevant information is shared when it is needed and that it is displayed willingness in engaging in reciprocal sharing and openness (Agarwal and Shankar 2003).

Jia and Rutherford (2010) argue that the Western buyer-Chinese supplier relationship has a potential risk such as the cultural differences between the West and China. In addition, Sirmon and Lane (2004) and Smagalla (2004) mention that the building of mutual trust that will negatively affect long-term coordination comes from cultural distances between supply chain partners. Thereby, we propose following hypothesis:

H9a: There is an association between supplier distance and inbound SCRM.
H9b: There is an association between customer distance and outbound SCRM.

According to Manuj and Mentzer (2008b) a flexible supply chain can discover options quicker when it comes to uncertain supply and demand compared to its competitors. Tang and Tomlin (2008) suggest a flexible product strategy, by increasing product variety in one plant. This strategy will be an effective strategy for increasing market-share by being able to serve different customers (Tang 2006b). However, this can lead to increased costs when it comes to production and inventory (MacDuffie et al 1996, sited in Tang 2006b). Also postponement of product differentiation is suggested as a mitigation strategy, by delaying the point of differentiation until late in the manufacturing process. A firm will by this be able to change product as the market changes, during the process. Tang (2006a) describes the postponement strategy as a contingency

plan that make the supply chain able to reconfigure the product quickly in cases if a disruption occurs. By this, following hypothesis are formulated:

H10a: There is an association between product variety and inbound SCRM.
H10b: There is an association between product variety an outbound SCRM.

Based on literature review and hypothesis, a model is developed (illustrated in figure 6.2). Testing the hypothesis will take place separately considering inbound and outbound in two single models. The model captures both inbound and outbound hypothesis, whereas "a" represent inbound and "b" represent outbound.
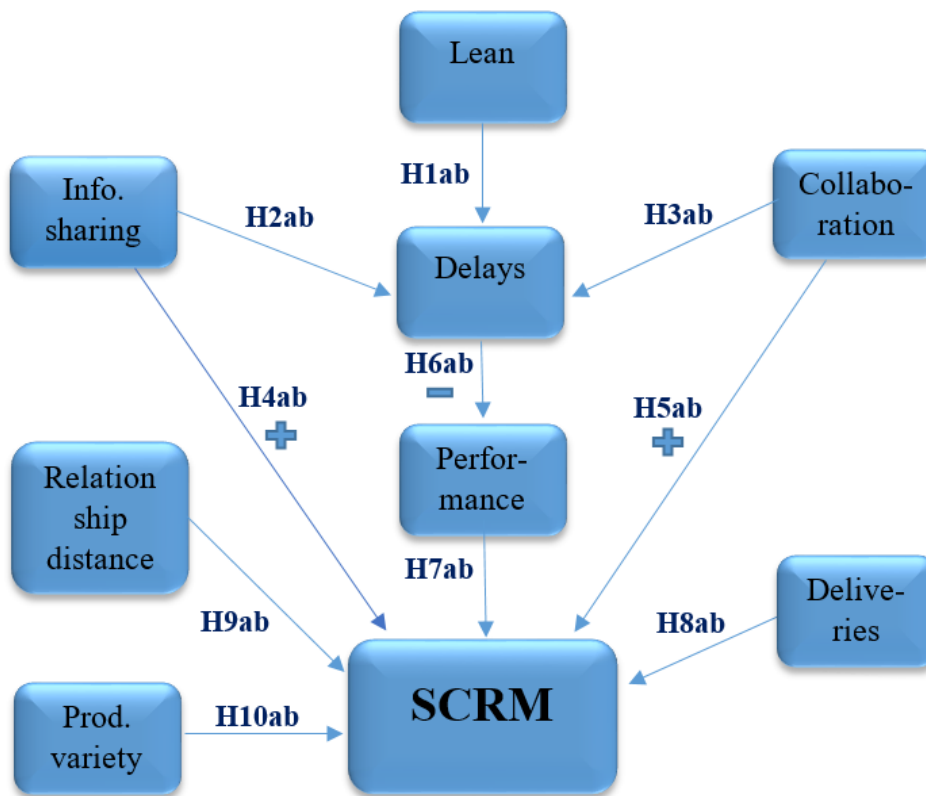
Figure 6.2: Research model with hypothesis

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6.3 Research methodology

A questionnaire following the step recommended by Churchill (1999) was developed. The questionnaire contained closed questions, and most questions had a five-point likert scale as response form. The data collection was completed as phone interviews among Norwegian manufacturing firms, and achieved a total response of 92 firms, representing 15,08% of the response rate. Response rate with respect to the industries are illustrated in table 6.1.

Industry	Sample size	Response	Response rate
Electronics	64	9	14,06%
Fisheries	66	17	25,76%
Rubber and plastic	32	6	18,75%
Machines and equipment	75	12	16%
Food and drink	190	21	11,05%
Metal goods	28	5	17,86%
Furniture and textile	27	5	18,52%
Oil and gas	23	1	4,35%
Paper and paper products	12	2	16,66%
Ships and equipment	32	12	37,5%
Lumber and equipment	45	1	2,22%
Chemicals	15	0	0%
Other	1	1	100%
Total	610	92	15,08%

Table 6.1: Questionnaire response rate

6.3.1 Analyzing tool

Partial least squares – structural equation modeling (PLS-SEM) was used as method for analyses, as this is a common method with smaller sample sizes. According to Jöreskog and Wold (sited in Henseler, Ringle, and Sinkovics 2009, 311) PLS-SEM is recommended in cases where a lower degree of theoretical information are available, and for testing models with high complexity. PLS-SEM will maximize the explained variance of the endogenous latent variables after estimating the partial model relationship (Henseler, Ringle, and Sarstedt 2012).

The PLS model consist of two models, measurement and structural model. The measurement model represent the outer relationships between the constructs and their indicators, and the structural modal represent the inner relationships between the different constructs (Hair et al.

2014). Indicators can either be reflective or formative. Reflective indicators represent the constructs and indicate that the indicators are highly correlated with each other, and formative indicators assume that the indicators are causing the construct (Petter, Straub, and Rai 2007). However, in this research reflective indicators will be used. Using reflective constructs, Cronbach´s alpha, Composite reliability and Average Variance Extracted (AVE) are used as reliability measures. Cronbach´s alpha is used for evaluating consistency reliability, and a minimum value of 0,7 is required for being considered as acceptable. However, Cronbach´s alpha comes with limitations as it often underestimates the internal consistency reliability (Hair et al. 2014). An alternative method for measuring internal consistency reliability is Composite reliability. A Composite reliability value between 0,7 and 0,9 is acceptable, but if it exceeds 0,9 this is an indication that the variables are measuring the same phenomena. For an exploratory research, a Composite reliability above 0,6 will be acceptable. Convergent validity considers the outer loadings and evaluate whether an indicator correlates positively with other indicators of the same construct. AVE is used to measure the convergent validity of the level of a specific construct. An AVE value above 0,5 will indicate that the construct is explained by 50% or more by the variance of the indicators (Hair et al. 2014). Using a single-item construct, the reliability cannot be measured. The indicators and the outer loadings should be above 0,708, but indicators between 0,4 and 0,7 should also be considered and be kept if deleting them not has an effect on Composite reliability. Discriminant validity is used to measure the degree to which a construct differ from the other and represent unique and different phenomena (Hair et al. 2014). Two methods are used for measuring discriminant validity. The first one is based on that the outer loading for an indicator should be higher than the loading to all other construct. The second method, Fornell-Larcker, is based on that the square root of AVE will be higher than the correlation to the other constructs (Hair et al. 2014)

6.4 Analyzes

The research model was tested for both inbound and outbound logistics, and the results are presented in figure 6.3 for inbound and figure 6.4 for outbound. This section will look at reliability and validity for both the inner and outer model.
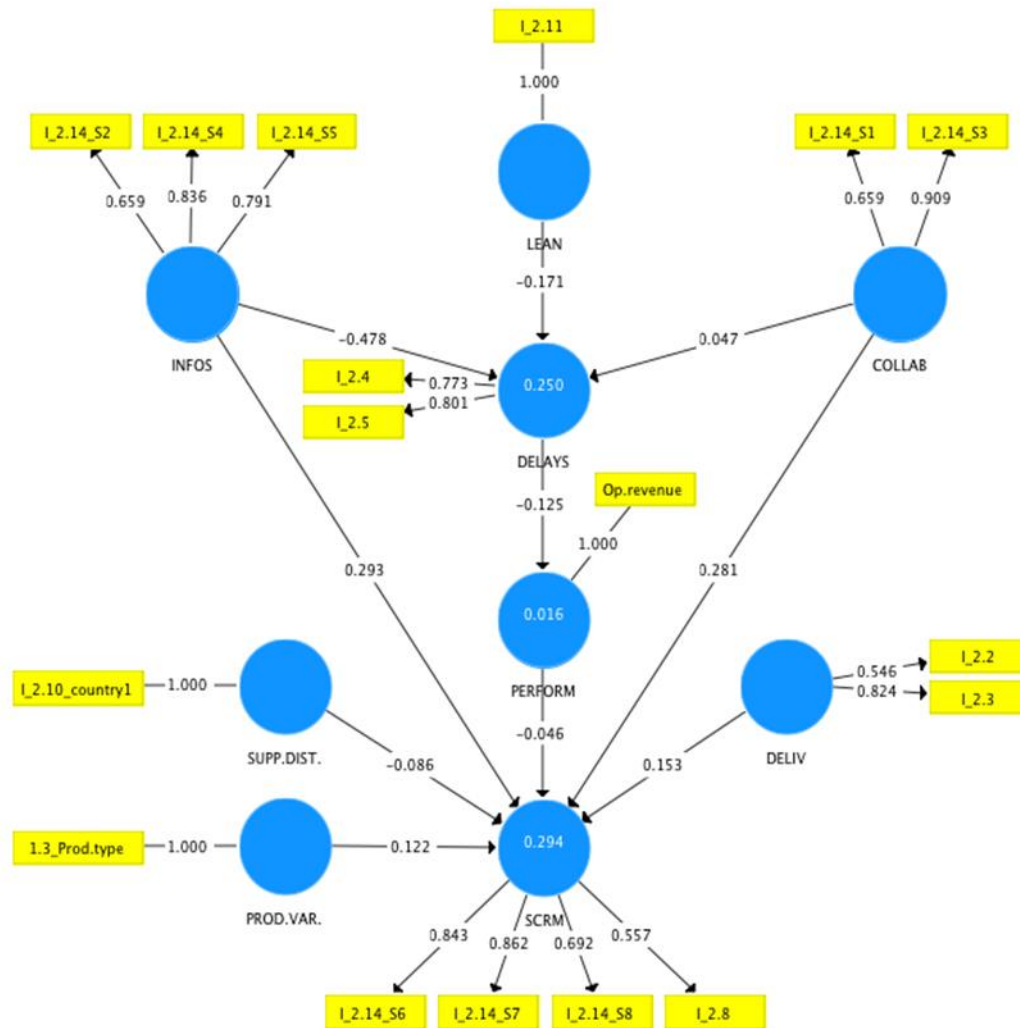
Figure 6.3: Research model, inbound SCRM
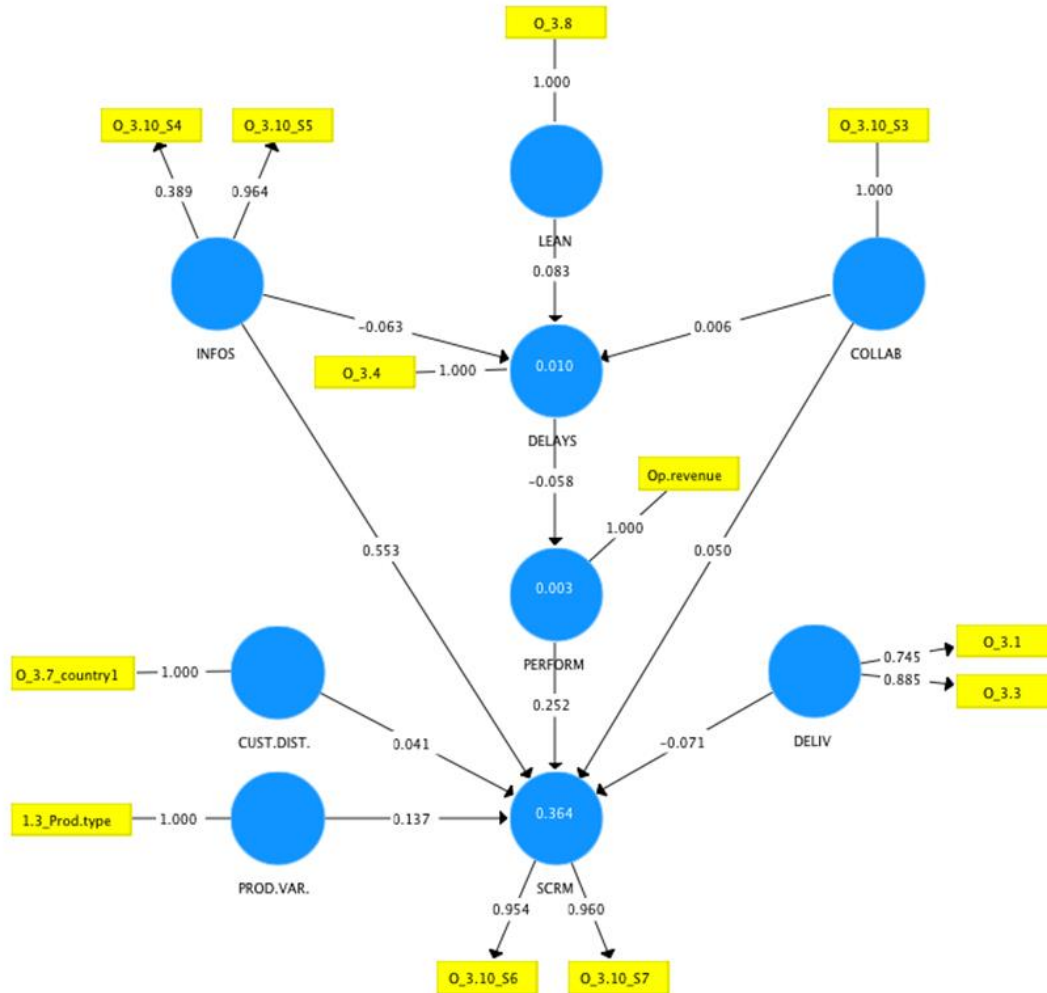
Figure 6.4: Research model, outbound SCRM

6.4.1 Reflective model

In this research one low indicator is removed from the inbound model and four low loadings are removed from the outbound model, as the values are lower than 0,4. However, one loading of 0.389 is kept as it is close to 0,4 and relevant for the information sharing construct for the outbound model. In summary, eleven of the indicators are below 0,7 and the additional 23 are acceptable with respect to recommendations. A summary of the indicators are presented in appendix 2 and 3.

Table 6.2 presents the reliability of each of the variables in the outer model with respect to Cronbach´s alpha, composite reliability and AVE. All variables except one are reliable

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considering composite reliability and AVE, as the results are above 0,6 for Composite Reliability and 0,5 for AVE. Deliveries indicates low reliability measures for all three reliability measures. Furthermore, outbound SCRM has Composite Reliability higher than 0,90, which indicates that the indicators measure the same phenomenon and make the indicator invalid to measure SCRM. Also, information sharing for the outbound model has a composite reliability between 0,6 and 0,7, which in this case could be acceptable as it is an exploratory research. Studying Cronbach´s alpha only SCRM is considered to be reliable with a value higher 0,7. However, composite reliability will be more appropriate to use as Cronbach´s alpha comes with some limitations. The reliability measures are presented in table 6.2. Regarding the single-indicator constructs there are no measurement method for evaluating the reliability and validity, and because of this these variables are not included in the table.

Variable	Cronbach´s alpha	Composite reliability	AVE
Inbound model			
Delays	0,388	0,765	0,620
Information sharing	0,648	0,808	0,586
Collaboration	0,443	0,768	0,630
Deliveries	-0,021	0,491	0,325
SCRM	0,742	0,832	0,561
Outbound model			
Information sharing	0,232	0,666	0,541
Deliveries	0,516	0,800	0,669
SCRM	0,908	0,956	0,916

Table 6.2: Reflective model reliability

The discriminant validity results indicates that the criteria for such a test is met, as each of the constructs has higher outer loading to itself compared to the loading on the other constructs. The results from the convergent validity tests are presented in appendix 2.

6.4.2 Structural model

Studying the explained variance for each of the constructs, both inbound and outbound SCRM has the highest results, respectively 0,294 and 0,364. The R^2 results is illustrated in appendix 2.

6.4.3 Test of hypothesis

For testing the hypothesis, an algorithm test is completed in Smart-PLS. However, the significance of the relationships between the variables is tested through a t-test completed by bootstrapping. Based on the t-value and p-value from bootstrapping result, each hypothesis is supported or not supported. The hypothesis with its path-coefficient, t-value and p-value are presented in table 6.3.

Hypothesis	Relationships	Path coefficient	t-statistic, 500 bootstrapping	P-value	Conclusion
H1a	Inbound lean → Inbound delays	-0,171	1,783	0,075	Supported*
H1b	Outbound lean → Outbound delays	0,083	1,014	0,311	Not supported
H2a	Inbound information sharing → Inbound delays	-0,478	3,579	0,000	Supported**
H2b	Outbound information sharing → Outbound delays	-0,063	0,690	0,491	Not supported
H3a	Inbound collaboration → Inbound delays	0,047	0,421	0,674	Not supported
H3b	Outbound collaboration → Outbound delays	0,006	0,062	0,950	Not supported
H4a	Inbound information sharing → Inbound SCRM	0,293	2,541	0,011	Supported**
H4b	Outbound information sharing → Outbound SCRM	0,553	4,913	0,000	Supported**
H5a	Inbound collaboration → Inbound SCRM	0,281	1,929	0,054	Supported*
H5b	Outbound collaboration → Outbound SCRM	0,050	0,615	0,539	Not supported
H6a	Inbound delays → Performance	-0,125	0,841	0,401	Not supported
H6b	Outbound delays → Performance	-0,058	0,748	0,455	Not supported
H7a	Performance → Inbound SCRM	-0,046	0,476	0,634	Not supported
H7b	Performance → Outbound SCRM	0,252	2,115	0,035	Supported*
H8a	Inbound deliveries → Inbound SCRM	0,153	1,121	0,263	Not supported
H8b	Outbound deliveries → Outbound SCRM	-0,071	0,661	0,509	Not supported
H9a	Supplier distance → Inbound SCRM	-0,086	0,879	0,380	Not supported
H9b	Customer distance → Outbound SCRM	0,041	0,494	0,621	Not supported
H10a	Product variety → Inbound SCRM	0,122	1,116	0,265	Not supported
H10b	Product variety → Outbound SCRM	0,137	1,178	0,239	Not supported

P-values: * ≤ 0,1 ** ≤ 0,05

Table 6.3: Test of hypothesis

6.5   Discussion

The purpose of this research was to investigate and compare SCRM concerning firms attention to inbound and outbound logistics. The research was investigated in the context of Norwegian manufacturing firms. Next section will discuss each hypothesis based on results presented in analyzes from previous section. Additionally, we will look at results from the tested models, and conclude whether there is a difference in attention to inbound and outbound SCRM.

6.5.1   Lean

The results from analysis will support hypothesis 1a, which indicates that having a lean supplier will decrease a manufacturing company's inbound delays. In contrast, the results do not support hypothesis 1b as the results indicate that having a lean customer will increase outbound delays. However, this result are not significant, which can be explained by a low response rate on the relevant item and a low variance in responses. The path-coefficient shows that inbound delays are explained 17% negatively by lean. According to Waters (2007) lean comes with many risks. However, this study indicates a positive effect from lean, which might be a result of the "heart of leanness" operation JIT. In this research the average supplier using lean is 3,08 (appendix 1). This can be interpreted as the suppliers are using lean to some extend. According to Waters (2007) the risk of using lean will increase when organization uses the strategy to the extreme. Firms using lean will in accordance with the results from PLS-SEM analysis have a positive effect on manufacturing firms, regarding inbound delays. However, using lean to the extend will decrease the supply chain ́s flexibility and reduce its ability to transform if a disruption occur (Waters 2007). As the firms in this research tends to not have suppliers using lean to the extend, their flexibility can help reducing delays and by this positively affect supply chain risk.

6.5.2   Information sharing and collaboration

The results from analyzes shows that hypothesis 2a is supported, which implies that information sharing between manufacturer and supplier will reduce inbound delays. Delays will have negative impact on the entire supply chain, which will increase the risk involved (Chopra and Sodhi 2004). The PLS-SEM results indicates that information sharing is affecting delays negatively by 47%.

This displays the importance of good information sharing between a supplier and a manufacturer in the supply chain, as low or less precise information sharing will increase delays. The result confirms previous research completed by Christopher and Lee (2004), which concluded that information sharing would reduce uncertainty and also the need for a safety stock. According to Zhou and Benton (2007) outbound delays would be reduced by information sharing between manufacturer and customer as stated in hypothesis 2b. The path-coefficient from information sharing to outbound delays are lower than it is to inbound delays, with its negative effect of 6%. However, the analysis does not support this, as the results not are significant.

Christopher and Peck (2004) points out that a high level of collaboration in the supply chain will help to mitigate risk. Hence, collaboration among the partners in the supply chain has been seen to present a challenge. In this research collaboration seems to have a low impact on both inbound and outbound delays, with reference to hypothesis 3. Wiengarten et al. (2015) argues that tighter integration among the parties in a supply chain will have a positive effect on the product and material flow within the supply chain. This research cannot confirm these results as neither of the two hypotheses is supported.

Hypothesis 4a and 4b is both supported, and implies that inbound and outbound SCRM is positively correlated with information sharing between manufacturers and their suppliers and customers. Li et al. (2015) points out that risk information sharing is one out of two critical efforts to SCRM. Shared understanding for SCRM among the parties within a supply chain can together with trust and relationship length, benefit the parties by reducing risk and its impact. In this study, results implies that SCRM is positively affected in a larger degree regarding outbound information sharing (55%) compared to inbound information sharing (29%). Li et al. (2015) also argues that information sharing will positively affect risk in two ways, firstly by identifying vulnerabilities for developing contingency plans, and secondly by status information and mitigation results. Analyzes from previous section indicates that Norwegian manufacturing firms have a higher degree of information sharing regarding SCRM with its customers, compared to its suppliers. However, as risk can occur at any point throughout a supply chain, both inbound and outbound SCRM is important.

Analyzes indicates that collaboration and SCRM are significant studying the inbound model as stated in hypothesis 5a. Inbound SCRM is 28% explained by collaboration between manufacturer and supplier. As Christopher and Peck (2004) points out to mitigate risk across the supply chain, collaboration would have a positive effect. Analyzes in PLS-SEM confirms this relationship as there is a positive correlation between collaboration and SCRM. Analyzes regarding outbound collaboration between manufacturer and its customers present lower results compared to the inbound results (0,5%). This can indicate that firms tend to use more effort to collaborate with its suppliers for managing risk. However, hypothesis 5b for outbound collaboration and SCRM is not significant and the hypothesis cannot be supported.

Risk sharing mechanism is one important aspect concerning SCRM according to Li et al. (2015). This makes collaboration and information sharing essential strategies working with SCRM, which is confirmed in this analysis. A good SCRM process will include risk identification, assessment, mitigation and monitoring. However, as supply chains are vulnerable to disruptions, studies indicates that not all firm has developed a documented contingency plan if a potential disruption in the supply chain should occur.

6.5.3 Performance

Hypothesis 6, which concerns the relationship between inbound and outbound delays and firm's performance illustrates that both inbound and outbound delays have a negative impact on manufacturer's economic performance, respectively 12,5% for inbound and 5,8% for outbound. This illustrates the importance of having a SCRM as delays is a risk that occur as a result of inflexibility (Chopra and Sodhi 2004). However, results from analyzes are not significantly confirmed. This leads to hypothesis 7, regarding performance affect on inbound and outbound SCRM. Performance seem to have a positive significant impact on inbound SCRM, by 25,2%. This corresponds to a Chinese research conducted by Li et al. (2015), which states that there is a correlation between SCRM and a firm's financial performance. Having a good SCRM involves risk sharing and by this collaboration and information sharing with supply chain partners. According to Wiengarten et al. (2015) tighter integration will again have a positive impact on performance and supply chain integration. As discussed above, SCRM involves good

collaboration and information sharing, and this study confirms that performance will positively affect outbound SCRM. This can indicate that firms with a higher performance will have a higher attention to develop good SCRM strategies. Studying the results from the outbound model, results shows that the association between performance and outbound SCRM are lower, at 15,3%. This indicates that firms with a higher economic performance tends to pay extra attention to managing risk upstream together with its suppliers, compared to downstream with its customers. However, hypothesis 7 is not supported and no conclusion could be made.

6.5.4 Deliveries

Hypothesis 8 investigates the relationship between inbound deliveries and SCRM. For inbound SCRM, deliveries seems to have a positive impact. This can indicate that firms with a higher delivery frequency inbound, also seem to pay more attention to SCRM. This can be a result of high frequency being related to higher probability of disruption. The construct of deliveries also include rush orders, and a higher frequency of this may be a result of disruptions in other part of the supply chain. Hypothesis 8b concerning outbound deliveries effect on SCRM, the results are opposite from what was discovered from inbound results. Outbound deliveries has a negative effect on outbound SCRM by 7,1%. This indicates that the higher the frequency of deliveries is to customers, less attention is paid to outbound SCRM. This can be a results of manufacturers tend to focus on inbound deliveries and risks involved. However, even though the results indicates differences between inbound and outbound SCRM for manufacturers, neither of the hypothesis is supported, as they are not significant.

6.5.5 Relationship distance

Hypothesis 9 in this research is not supported in PLS-SEM analyses. Yet, many of the respondents in the questionnaire states that they use suppliers and have customers outside the West. Cultural distance between supply chain partners could negatively affect long-term relationship (Sirmon and Lane 2004; Smagalla 2004). Jia and Rutherford (2010) argues that cultural distance, regarding the Western buyer-Chinese supplier relationship has a potential risk as a result of cultural differences between the West and China. As the respondents mention Asian

countries for both suppliers and customers, assumptions can be made regarding increased risk such as language misunderstandings. In addition, longer distance can contribute to make it more difficult to build and maintain closer relationship with customers and suppliers. Therefore, as a result of longer distance of supplier and customer, trust can be an issue among the supply chain partners. In addition, language differences can contribute to low information sharing and thereby reduced focus on SCRM processes among the partners in the chain. Even though neither of the inbound and outbound hypothesis 9 is supported, it is still likely to believe that with a larger sample size they would be supported. The respondent could state five countries where their most important supplier was located and the same for their customers. In the analysis, there is displayed a small variation in the answer as many of the respondents only answered one country instead of five. For many of the respondents, Norway was the only country where both suppliers and customers was located. It is likely to believe that a higher variation in the sample size could have made the hypothesis significant.

6.5.6 Product variety

Tang and Tomlin (2008) suggest a flexible product strategy for mitigating risk. By this, firms may reduce the risks by producing a variety of products at the same plant. Another strategy is postponing the process of differentiation, and by this increase the flexibility. Hence, the manufacturing firms will have the possibility to react to market changes or changes in orders. Hypothesis 10 states that there is an association between product variety and SCRM. By studying analysis result this could not be confirmed in this research, as either hypothesis 10a or 10b is supported. Even though neither of the hypothesis are supported, it is likely to believe that firms that have high product variety has an increased focus on SCRM. Nevertheless, according to Tang (2006a) product variety could be a SCRM strategy for increasing firm's flexibility. However, as the sample size in this study is 92 there is a probability that the hypothesis would display a significant result with a higher amount of respondents.

6.5.7 Comparing inbound and outbound SCRM

Many of the inbound hypotheses that have been tested thorough the model is supported and significant. However, studying the outbound model plural of the verified hypotheses is not significant and the hypotheses cannot be supported. Furthermore, information sharing's effect on SCRM are significant for both of the models, and indicates that this explains more for outbound than for inbound SCRM. These results indicates that sharing information with its supply chain partners would be important for having a good SCRM. Moreover, information sharing with customers will be more important than information sharing with suppliers for have a well-developed SCRM. Furthermore, collaborations impact on SCRM are higher with suppliers than it is with customers. The fact that many of the hypothesis for the outbound model not are significant can be explained by low variation in respond and lower respond for outbound deliveries compared to inbound deliveries. As several of the hypothesis inbound are supported and significant compared to the hypothesis outbound, this can imply that firms tend to manage risk upstream in the supply chain in a larger degree than downstream. This is referred to what Sawhney (2006)

Previous literature regarding SCRM tends to focus on inbound supply chain risk, which can contribute to explain the findings in this study. A reason for using more resources for managing risk upstream in the supply chain, may be that this is where firms cost is generated. However, as manufacturing firms tends to focus on inbound SCRM this may have a domino effect upstream in the supply chain, which can make risk at each tier in the supply chain be managed. By this we can ask the following question: is it necessary for firms to pay attention to SCRM downstream? The domino effect is illustrated in figure 6.4.
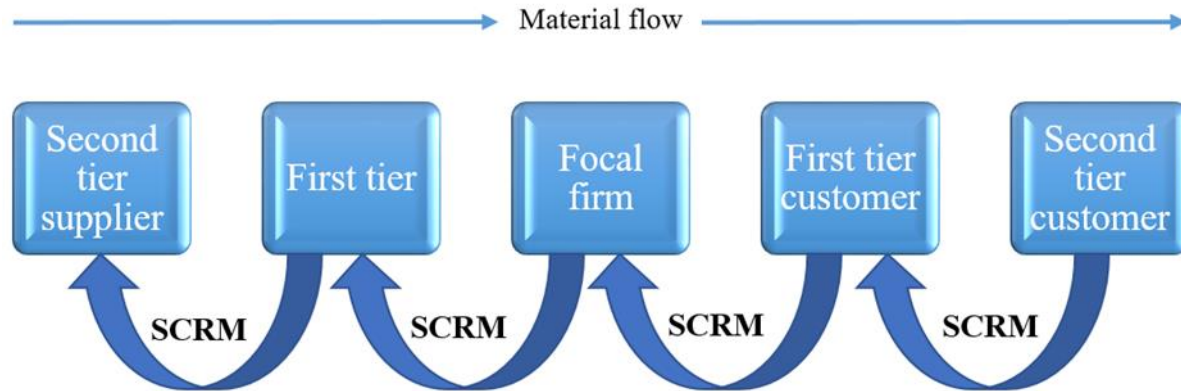
Figure 6.5: Domino effect in upstream SCRM

6.6 Conclusion

As a result of increased potential for supply chain disruptions, both researchers and firms tends to focus on SCRM. However, earlier researches have found that for many firms little is being done to handle supply chain risks. Because of this, this study has tried to investigate how Norwegian manufacturing firms manage risk upstream and downstream in the supply chain, and whether there are significant differences comparing firm's attention to inbound and outbound SCRM. Analyzes completed in PLS-SEM indicates that both information sharing and collaboration are important aspects for having a good SCRM. Through the research we have found that SCRM upstream are important, which indicates that firms pay more attention for reducing risks related to its suppliers. If each level in a supply chain pays attention to upstream SCRM, risks at each tier will be controlled and managed. Therefore, emphasizing risks downstream in the supply chain may not be necessary and companies can carry on managing risk upstream.

6.7 Limitations

The hypothesis that not was supported in the outbound model could be a result of many single item constructs in the model, but also a result of the small sample size. Another explanation could be that a high share of the respondents was working in purchasing department, which decreased the respondent rate regarding questions related to customers. After conducting the data collection, a double-barreled question was discovered, covering both delays and damages on incoming

orders (question 2.7). This can make the question useless for further analyzes. However, this question was not further used when analyzing the data.

6.8 Further research

This research could have been extended to a larger sample size for achieving a higher significance in the results. A suggestion for further research can be to study the need for SCRM downstream in the supply chain as SCRM is already being managed upstream.

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Appendix

Appendix 1: Descriptive statistics

Question	Responds	Mean	Std. Dev.
1.3: Total products	92	1,74	0,959
2.1: Inbound deliveries	92	5,18	1,374
2.2: Inbound delivery time (days)	82	29,41	43,384
2.3: Inbound rush orders	92	2,24	1,455
2.4: Inbound delays	90	1,94	0,916
2.5: Duration inbound delays	83	3,33	1,668
2.8: Spare supplier (yes/no)	91		
2.9: Most important suppliers	89	25,81	45,654
2.10: Distance to most important supplier	90	1,77	1,050
2.11: Lean suppliers	53	3,08	1,371
2.12: Total readiness if inbound delays	92	2,30	1,184
2.14: Statement 1	91	4,33	1,055
2.14: Statement 2	91	3,79	1,216
2.14: Statement 3	90	3,42	1,398
2.14: Statement 4	90	3,38	1,277
2.14: Statement 5	90	2,87	1,439
2.14: Statement 6	92	3,26	1,452
2.14: Statement 7	91	2,99	1,402
2.14: Statement 8	92	3,40	1,512
3.1: Outbound deliveries	92	4,24	3.013
3.2: Outbound delivery time (days)	84	91,07	193,122
3.3: Outbound rush orders	91	2,52	1,840
3.4: Outbound delays	83	1,99	0,904
3.6: Most important customers	80	27,91	50,402
3.7: Distance to most important customer	84	1,60	1,336
3.8: Lean customers	47	3,21	1,587
3.10: Statement 1	86	4,31	1,087
3.10: Statement 2	82	4,29	1,272
3.10: Statement 3	79	3,51	1,526
3.10: Statement 4	85	4,53	0,853
3.10: Statement 5	75	3,21	1,464
3.10: Statement 6	81	3,56	1,500
3.10: Statement 7	82	3,55	1,371

Appendix 2: Analysis

Indicator reliability, inbound SCRM:

Constructs	Range levels	Lower than 0,6	0,6-0,7	0,7-0,8	Higher than 0,8	Comments
Lean	1				1	Single item construct
Delays	0,773-0,801			1	1	High loadings
Information sharing	0,659-0,836		1	1	1	One loading lower than 0,7. However, acceptable result.
Collaboration	0,658-0,909		1		1	Acceptable loadings, though one is lower than 0,7.
Performance	1				1	Single item construct
Supplier distance	1				1	Single item construct
Product variety	1				1	Single item construct
Deliveries	0,027-0,823	2			1	One very low loading that will be deleted, and one lower than 0,6. This will be kept, as it will be relevant for the research. After removing the item, no major change in the loading.
SCRM	0,557-0,862	1	1		2	Acceptable loadings, though one is lower than 0,5, but kept as it will be relevant for the research.

Indicator reliability, outbound SCRM:

Constructs	Range levels	Lower than 0,6	0,6-0,7	0,7-0,8	Higher than 0,8	Comments
Lean	1				1	Single item construct
Delays	1				1	Single item construct
Information sharing	0,100-0,976	2			1	Two low indicators, whereas one will be deleted. The other (0,389) will be kept as it will be relevant for research.
Collaboration	0,095-0,995	1			1	One very low indicator, which will be deleted. The construct will then be a single item construct.
Performance	1				1	Single item construct
Customer distance	1				1	Single item construct
Product variety	1				1	Single item construct
Deliveries	-0,214-0,835	1		1	1	One low loading, which will be deleted. High loadings afterwards.
SCRM	-0,187-0,953	1			2	One low loading, which will be deleted. Very high loading afterwards.

Discriminant validity, inbound SCRM:

	COLLAB	DELAYS	DELIV	INFOS	LEAN	PERFORM	PROD. VAR	SCRM	SUPP. DIST
COLLAB	0,794								
DELAYS	-0,226	0,787							
DELIV	-0,017	0,276	0,570						
INFOS	0,570	-0,468	-0,212	0,766					
LEAN	-0,001	-0,218	0,013	0,097	1,000				
PERFORM	0,144	-0,125	-0,209	0,168	-0,144	1,000			
PROD. VAR	0,154	0,046	0,072	-0,032	0,122	-0,111	1,000		
SCRM	0,460	-0,321	0,092	0,424	0,049	-0,004	0,150	0,749	
SUPP. DIST	-0,029	0,375	0,137	-0,177	-0,072	0,029	0,256	-0,096	1,000

Discriminant validity, outbound SCRM:

	COLLAB	DELAYS	DELIV	INFOS	LEAN	PERFORM	PROD. VAR	SCRM	SUPP. DIST
COLLAB	1,000								
DELAYS	0,190	1,000							
DELIV	-0,004	0,285	1,000						
INFOS	-0,046	-0,084	-0,018	0,818					
LEAN	0,128	-0,079	-0,059	-0,119	0,735				
PERFORM	-0,019	-0,004	0,080	0,123	0,041	1,000			
PROD. VAR	-0,032	-0,115	-0,058	0,088	-0,082	0,024	1,000		
SCRM	-0,090	0,015	0,183	0,067	-0,055	0,107	-0,111	1,000	
SUPP. DIST	0,111	-0,014	0,024	-0,111	0,536	-0,064	0,179	0,070	0,957

R^2:

Latent variable	R^2
Inbound model	
Inbound delays	0,250
Inbound performance	0,016
Inbound SCRM	0,294
Outbound model	
Outbound delays	0,010
Outbound performance	0,003
Outbound SCRM	0,364

Questionnaire relating to risks and delays

Part 1: General part

1.1   Company name_____

1.2   Position_____

1.3   How would you describe the production/products of your company?
        Answer:
        Standard product, make to stock _____
        Standard product, make to order ____
        Specialized product, make to order____
        Customized product, engineered to order   ____
        Combination of two or more, which one? _ _ _ _ _ _ _ _ _ _

Part 2: Questions for suppliers
In this part of the questionnaire we would like you to base your answers on the most important or strategic products that you purchase.

2.1[1]   How often do you have deliveries coming in?
        Answer:
        Several times per day
        3 times per week
        2 times per week
        Once a week
        Every 14.day/infrequent
        Don't know

2.2   What are the approximate average delivery times of your most important suppliers?
        Answer:
        Delivery time is   ____days
                                ____weeks
                                ____month

2.3[2]   How often do you make use of urgent orders from your most important suppliers?
        Answer:
        2-3 times per week
        Once a week
        Every 14.day

---

[1] Inverted scale
[2] Inverted scale

Once a month
More infrequently
Don't know

2.4   How often do goods arrive late from your most important suppliers?
Answer:
1 = very rarely   2   3   4   5 = almost always   Don't know

2.5   How long could a delay last for, on average?
Answer:
1day   2 days   3 days   4 days   More than 4 days   Don't know

2.6   How often do you receive damaged goods from your most important suppliers?
Answer:
1 = very rarely   2   3   4   5 = almost always   Don't know

2.7   What are the consequences for your company if deliveries arriving from your most important suppliers are delayed or damaged?
Answer:
None___
Production stops___
Larger economic loss for our company ca in EUR_____
Delay for the rest of the supply chain ____
Economic compensation from the supplier as day tickets (payment), ca in EUR_____
Loss of sale for our customers____
Hiring extra workers on evenings/weekends___
We have to organize faster and more expensive transportation to reduce the delay___
Other (specify)_____
Don't know ___

2.8   Do you have any reserve suppliers for the most important products that you purchase?
Answer:
Yes ___   No____   Don't know

2.9   How many suppliers are considered to be your company's most important suppliers?
Answer::
Number_____   Don't know

2.10   In which countries are your company's most important suppliers located (several options)
Answer:
1)   2)   3)   4)   5)   Don't know

2.11   To what extent do your most important suppliers practice the "Lean Principle"?
Answer:
1= limited extent   2   3   4   5 = Largely   Don't know

2.12 Do you have contingencies for late deliveries from your most important suppliers?
Answer: We have (one or more)
Buffer inventory___
Other suppliers____
Slack in the lead time____
Other product to substitute with ____
Working evenings and weekends____
Other (specify)_____
Don't know___

2.13 If you are informed about delays/disruptions, how do you receive such notifications?
Answer:
Telephone_____
Fax_____
e-mail _____
electronic order system _____
Other (specify)_____
Don't know_____

2.14   Please consider the extent to which the following statements describe the exchange of information between your company and your most important suppliers:

(Scale 1= highly disagree, 5=totally agree)

We cooperate with our suppliers on a regular basis in order to reduce the likelihood of delays

1=disagree   2   3   4   5= agree

We receive routine information when our suppliers have sent their goods

1=disagree   2   3   4   5= agree

We have the opportunity to track goods between the time when they leave our suppliers and when we receive them

1=disagree   2   3   4   5= agree

We receive routine, immediate notification from our suppliers when delays unrelated to actual transport occur

1=disagree   2   3   4   5= agree

We receive routine, immediate notification from the haulier when delays/disruption relating to transport occur

1=disagree   2   3   4   5= agree

We and our most important suppliers have procedures which are designed to identify any risks occurring in the value chain

1=disagree   2   3   4   5= agree

We and our most important suppliers have developed strategies for handling disruptions or delays in the value chain

1=disagree   2   3   4   5= agree

We have people with defined areas of responsibility for handling risks

1=disagree   2   3   4   5= agree

Part 3: Customer-related questions
In this part of the questionnaire we would like you to base your answers on the most important or strategic products that you purchase.

3.1[3]   How often do you send goods to your most important customers?
    Answer:
    Every day
    2 times per week
    3 times per week
    Once a week
    Every 14.day
    Don't know

3.2   Delivery is the time which elapses between when an order is placed and the customer receives the goods in question. What delivery times do you offer to your most important customers?
    Answer:
    Delivery time is: ____days
                        ____weeks
                        ____months
                    Don't know

3.3[4]   How often do you experience urgent orders from your most important customers?
    Answer:
    2-3 times per week
    Once a week
    Every 14.day
    1 time per month
    More infrequent
    Don't know

3.4   How often do delays occur when you send goods to your most important customers?
    Answer:
    1 = never   2   3   4   5 = almost always   Don't know

3.5   What are the consequences if deliveries made to your most important customers are late?
    Answer:
    No consequences___
    The customer becomes correspondingly delayed___
    Economic loss for the customer_____
    Economic loss for my company, we will have to pay day tickets ca in EUR_____ per day
    Increase in costs, we have to compensate with faster and more expensive transport____
    Increase in cost due to hiring workers at evenings and weekends___
    Other (specify)_____

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[3] Inverted scale
[4] Inverted scale

3.6   How many customers do you consider to be your most important customers?
        Answer: Number_____

3.7   Which country are your most important customers located in?
        Answer:
        1)   2)   3)   4)   5)   Don't know

3.8   To what extent do your most important customers practice the "Lean Principle"?
        Answer:
        1 = Limited extent   2   3   4   5 = Largely   Don't know

3.9   What type of customers do you deliver to?
        Answer:
        1) Corporate/Business customer ____
        2) Make to stock____
        3) Directly to end customer____
        4) Deliver to a wholesaler____
        Other (specify)_____
        Don't know____

3.10   Please consider the extent to which the following statements describe the exchange of information between your company and your most important customers:

(Scale 1= highly disagree, 5=totally agree)

We cooperate with our customers on a regular basis in order to reduce the likelihood of delays

1= disagree   2 3 4   5= agree

We provide our customers with routine information once we have sent their goods

1= disagree   2 3 4   5= agree

Our customers have the opportunity to track goods as soon as they are sent and until they receive them

1= disagree   2 3 4   5= agree

We provide our customers with routine notification as soon as any delays occur

1= disagree   2 3 4   5= agree

The haulier provides our customers with routine notification as soon as any transport delays occur

1= disagree   2 3 4   5= agree

We and our most important customers have procedures which are designed to identify any risks occurring in the value chain

1= disagree   2 3 4   5= agree

We and our most important customers have developed strategies for handling disruptions or delays in the value chain

1= disagree   2 3 4   5= agree

Part 4: Transport
The questions in this part are related to incoming deliveries from suppliers and outgoing deliveries to customers. Once again we would like you to base your answers on your most important suppliers and customers.

4.1   How often are delays caused by the transport infrastructure? The causes could include bad/icy roads, closed mountain passes, cancelled ferries, etc.
        Answer: Approximately average per year_____ (for example once a year, 2 times per year etc.)
        Don't know

4.2   On average how long are goods delayed as a result of transport delays?
        Answer:
        ca_____days per delay   Don't know

4.3   Who is normally responsible for incoming deliveries?
        Answer:
        Supplier_____
        Our selves_____
        A combination of the two_____
        Don't know

4.3   Who is normally responsible for outgoing deliveries?
        Answer:
        The customer
        Our selves_____
        A combination of the two_____
        Don't know

4.5   Who normally organises deliveries for which we are solely responsible?
        Answer:
        The company
        Sources the transportation service as a package
        A combination of the two_____
        Don't know

4.6   Is more than one mode of transport normally used for deliveries made by your most important suppliers?
        Answer:
        Yes_____   how many_____   No___   Don't know

4.7   Is more than one mode of transport normally used for deliveries made to your most important customers?
        Answer:
        Yes_____   how many_____   No___   Don't know

4.8   How often have you had to stop production due to transport delays?
       Answer:
       Never___
       1 time per week___
       1 time per month___
       1 time per half a year ___
       1 time per year___
       Other:_____
       Don't know

4.9   If goods cross any borders, how many days does delivery increase by (due to customs
       clearance and documentation?
       Answer:
       No delay   1 day   2 days   3 days   4 days   Don't know

4.10   In the event of unforeseen events or delays, who covers the cost of late delivery? (sender,
       recipient, transporter)
       Answer:
       sender____
       recipient ____
       transporter____
       Don't know

4.11   Does your transporter have any joint venture agreements relating to reloading if a vehicle
       is damaged?
       Answer:
       Yes____   No____   Don't know

Part 5: External factors
In this part of the questionnaire we would like to ask you questions about external risk factors

5.1 Disruptions (external risks):
We would like you to assess the likelihood of any events occurring. On a scale of 1 to 5, how likely do you think it is that any of the following events will occur? (Scale 1 = highly unlikely and 5 = highly likely)

1.	Natural disasters	1= highly unlikely 2 3 4 5= highly likely
2.	Armed conflicts	1= highly unlikely 2 3 4 5= highly likely
3.	Terrorism	1= highly unlikely 2 3 4 5= highly likely
4.	Unstable political circumstances	1= highly unlikely 2 3 4 5= highly likely
5.	Accidents (e.g. fire, explosions)	1= highly unlikely 2 3 4 5= highly likely
6.	Suppliers/subcontractors going into liquidation	1= highly unlikely 2 3 4 5= highly likely
7.	Suppliers/subcontractors going on strike	1= highly unlikely 2 3 4 5= highly likely
8.	Transport problems	1= highly unlikely 2 3 4 5= highly likely
9.	Import and export restrictions	1= highly unlikely 2 3 4 5= highly likely

5.2 If any of the events mentioned above actually occur, what would the consequences be? You can rank the degree of severity on a scale of 1 to 5. (Scale: 1 = minimum financial consequences and 5 = serious financial consequences)

1.	Natural disasters	1= min fin cons 2 3 4 5= ser fin cons
2.	Armed conflicts	1= min fin cons 2 3 4 5= ser fin cons
3.	Terrorism	1= min fin cons 2 3 4 5= ser fin cons
4.	Unstable political circumstances	1= min fin cons 2 3 4 5= ser fin cons
5.	Accidents (e.g. fire, explosions)	1= min fin cons 2 3 4 5= ser fin cons
6.	Suppliers/subcontractors going into liquidation	1= min fin cons 2 3 4 5= ser fin cons
7.	Suppliers/subcontractors going on strike	1= min fin cons 2 3 4 5= ser fin cons
8.	Transport problems	1= min fin cons 2 3 4 5= ser fin cons
9.	Import and export restrictions	1= min fin cons 2 3 4 5= ser fin cons