Supply chain disruptions caused by natural catastrophes

- An explorative study of 83 international organizations -

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Executive Summary

As modern supply chains are becoming increasingly dispersed around the globe in lengthy network structured supply chains, they are also becoming increasingly designed and managed for costefficiency and leanness. The reason for this development can be traced back to the competitive edge and increase in financial performance that firms hope to achieve. This brings complexity, rigidness and a high vulnerability towards risk. One of these risks is that supply chains are becoming increasingly vulnerable towards natural catastrophes. The trend is that natural catastrophes are increasing in frequency and impact, especially in North America and Asia - where many echelons of modern supply chain networks are represented. Consequently, the exposure of modern supply chains towards natural catastrophes is increasing, which is amplified by their design and management. This brings about a supply chain natural catastrophe return risk paradox. Given the existence of this paradox, this research paper seeks to explore if companies will undergo transformations and alter their supply chain strategies to reduce the exposure and impact of natural catastrophes on their supply chains. Using an explorative research approach based on 75 questionnaires responses and 8 in-depth interviews with supply chain managers and corporate executives international organizations, this paper concludes that half of the companies have been impacted by a natural catastrophe in past ten years mostly outside their locus of control, and mostly with a less severe consequence for the organization than is described in the literature. Consequently, natural catastrophes may pose more of a mid-probability and mid-impact risk than has previously been assumed. Given this, more than half of the companies have undertaken changes in their supply chain strategies in the past, either as a reaction to a previous experience or an observation in the external environment. These have focused mostly on decreasing the risk through supply chain management or design rather than trying to reduce the overall exposure through shifting the supply chain location. Companies were mostly motivated internally through profit, sales, or reputation, whereby perception - or a change therein - did not play an important role. Furthermore, the research found that equally as many companies will continue to undertake supply chain changes in the future, of which most of them would carry out similar changes for similar reasons as in the past. This comes to show that these companies are undergoing continuous transformation in their supply chain strategies. Consequently, the increasing impact and frequency of natural catastrophes has caused international organizations to undergo transformation from one configuration to a new configuration and will continue to make them transform in the future.

Copenhagen, October 2012

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List of abbreviations

Арр	Appendix
BCI	Business Continuity Institute
ВСР	Business Continuity Planning
CRED	Centre for Research on the Epidemiology of Disasters
EM-DAT	Emergency Events Database
ERP	Enterprise Resource Planning
ICT	Information and Communication Technology
UNISDR	UN International Strategy for Disaster Reduction
WEF	World Economic Forum

"Even the finest sword plunged into salt water will eventually rust."

- Sun Tzu, The Art of War, ca. 500 B.C.E

Section 1: Introduction

This first chapter seeks to provide an introduction to the paper. It does so by beginning with a description of two cases that provided the initial inspiration to conduct explorative research. This is then formalized into a research motivation, by describing the research context and gaps. The research aim and questions follow. The section concludes with an overview of the paper.

1. Research inspiration

Between July and December of 2011 a significant portion of the Kingdom of Thailand was hit with a hydrological natural catastrophe, namely flooding. During this time, 65 of Thailand's 77 provinces were affected by floods, causing 884 fatalities, leaving millions homeless, damaging Bangkok and many companies international supply chains, and leaving behind a total of \$45.7bn in damage (AON Benfield, 2012; Roughneen, 13.04.2012). The impact that the floods had on international supply chains brought forth a discussion about the potential mismatch between recent supply chain strategy and the impact that natural catastrophes can have on these amongst a variety of stakeholders (The International Economy, 2011).

In Japan in March 2011, an earthquake triggered a nine meter high tsunami (USGS, 2012b) that caused the nuclear failures in the Fukushima Nuclear Power Plant (NASA, 2012), 15703 fatalities, 4647 missing and 5314 injured (ibid). The total economic loss was estimated to be US\$ 309bn (ibid).

The reason why supply chains were impacted on an international level, can be related back to the location of certain supply chain echelons in flooding or earthquake prone areas, as well as the overall interlinks of these supply chains in Thailand and Japan with the international playing field (BCG & Wharton, 2006). Many of the companies located in Thailand that were affected by the floods in a direct manner, were also located in areas that are vulnerable to flooding (AON Benfield, 2012). This caused a total of 7510 manufacturing plants in a total of 40 provinces to be damaged (ibid). Out of these, the Ayutthaya Province, which makes up 7% of the Thai economy and 15% of the country's manufacturing output, was one of the most severely impacted regions, where 900 out of the 2150 factories (41%) were damaged (ibid). As mentioned previously, many of these companies are linked into international supply chains, due to the favorable working conditions that prevail in the country (The Wall Street Journal Online, 03.11.2011). Given these interlinks of Thai

supply chain echelons on an international level, the damages to these reached beyond the boarders of the Kingdom (The Wall Street Journal Online, 03.11.2011). This occurred mainly within the electronics, medical equipment, automotive, food and beverage and sectors (ibid), some of which are illustrated below.

As a consequence of the floods, many companies had to halt production and thereby incurred massive supply shortages (The Wall Street Journal Online, 10.12.2011; Western Digital, 2011). Nine Japanese automotive companies had to halt production due to the floods (AON Benfield, 2012), which resulted in a loss of 6000 vehicles a day (ibid). For example, Toyota had to stifle production in all of its Thai plants due to shortages in the supply of parts, which created bottle necks and forced the company to stifle production (The Wall Street Journal Online, 10.12.2011). Hana Semiconductor, a prominent producer of semiconductors, had its factory located in the Ayutthaya province and thereby forced to halt production (Evertiq, online: 01.07.12a; Evertiq, online: 01.07.12b). This caused Texas Instruments and Microchip, their main customers, to change the location of their supplier's production to other better-suited locations (ibid). Another electronics company, namely Western Digital, also stifled production of its hard disks due to the flooding of its production sites (Evertiq, online: 01.07.12a; Evertiq, online: 01.07.12b). The disruption forced the company to increase production of hard drives in their Malaysian manufacturing facility and in other locations (Western Digital, 2011).

As to be seen in the forth-mentioned case examples, natural catastrophes can have an impact on the supply chains of companies on an international level. These cases, alongside many other natural catastrophes that have brought with them similar issues (e.g. Hurricane Katrina 2005; Volcano Eyjafjallajökull 2010), provided for the inspiration to conduct explorative research.

2. Research motivation and research task

The frequency and impact of natural catastrophes has increased (EM-DAT, 2012; Munich Re, 2012a). The impact that they cause is vast and broad, ranging from the ceasing of lives, to the destruction of property, and the stifling of business activity (EM-DAT, 2012). The economic loss from natural catastrophes marked an ultimate high in 2011 amounting to USD 435 billion (Aon Benfield, 2011). The region of the world that was hit the hardest was Asia, where earthquakes and floods where the dominating type (MunichRe, 2012a, EM-DAT, 2012). At the same time as the world is seeing an increasing impact and frequency of natural catastrophes, there is also an

increasing damage (e.g. BCI, 2011) and vulnerability of supply chains to these threats (e.g., Sodhi et al., 2012). Contrasting the forth-mentioned trends within natural catastrophes and supply chains brings about a paradox as to what is occurring within companies versus what is occurring in their external environments. This brings rise to the question if conventional supply chain strategies can be sustained in the natural catastrophe prone environments that companies face. The following chapter seeks to provide an overview of the research motivation and research task that underline this paper and that have been summarized in Figure 1: Research Motivation & Research Task.

Research Motivation		Research Task		
Research Context	Research Gaps	Research Aim	Research Question	Research Sub-Questions
	Natural Catastrophes			Configuration
Increasing occurrence of natural catastrophes with an increasing impact, also on supply chains especially in Asia and North America	Micro-level impacts of natural catastrophes, such as on supply chains, are sparsely studied	Micro-level impacts of tural catastrophes, such s on supply chains, are sparsely studied Contribute to the understanding of the impact that natural catastrophes can have on supply chains		If so, what kind of supply chain disruptions do natural catastrophes cause for international organizations and what are the consequences of these?
	Supply Chain Practices			Transformation
Supply chain strategies are increasingly designed and managed for cost-efficiency as well as becoming globally dispersed with linkages to natural catastrophe prone areas	Holistic view of supply chain strategies and supply chain strategy change is sparsely studied	Contribute to the research on a holistic view of supply chain strategies, and supply chain strategy change with regards to external influences	bo international organizations change their supply chain strategies based on the previous experience or observation of the supply chain disruptions that natural catastrophes can cause?	If so, why do international organizations decide to change their supply chain strategies based on supply chain disruptions caused by natural catastrophes?
Paradox				Change configuration
Increasing disruption, damage and impact of supply chains due to the occurrence of natural catastrophes	Holistic view of natural catastrophes' effect on supply chain strategies, as well as change in supply chain strategies, is sparsely studied	Contribute to the research on how supply chain strategies change with respect to natural catastrophes, and the reasons why these change in a given way		If so, how do international organizations change their supply chain strategies and what consequences do these have?

Figure 1: Research Motivation & Research Task

2.1. Research motivation

The research motivation of this paper is a sum of the research context (i.e. the trends within natural catastrophes and supply chain strategies that lead to the paradoxical development previously described) and the research gaps (i.e. the missing parts in the academic literature relating to natural catastrophes, supply chain strategies and the paradoxical development previously described) that have been identified. These will now be described in the following.

2.1.1. Research context

This paper is motivated by two conflicting trends that can be observed within companies and their external environment. Within companies, there is a continued strategy of dispersing supply chain around the globe, such as to areas that are exposed to natural catastrophes through common strategies such as global sourcing, offshore-outsourcing, or offshore-manufacturing, as well as designing and managing these supply chains for an increased focus on efficiency and cost reductions, through strategies such as just-in-time manufacturing, lean inventories, or single source suppliers, that lead to increasing complexity and vulnerability to external threats (e.g., Sodhi et al., 2012, BCG & Wharton, 2006). Within the external environment, there is an increasing occurrence of natural catastrophes, especially in Asia-Pacific and North America (EM-Dat, 2012; Munich Re, 2012a) that is leaving behind an increasing impact (ibid) to society in general and businesses in specific. As has been observed in the past, as for example during the forth-mentioned hydrological disaster in Thailand or the geophysical disaster in Japan in 2011. These natural catastrophes can have a severe impact supply chains, which became disrupted or damaged through these events (e.g., AON Benfield, 2012; Roughneen, 13.04.2012; The International Economy, 2011). It is assumed, that modern supply chain strategies are the reason why the supply chains of companies got exposed and severely impacted by these catastrophes (e.g., BCG & Wharton, 2006). Given this, the paper is motivated to explore if firms will or have undertaken changes in their supply chain strategies to cope with their external environment.

2.1.2. Research gap

From the review of the literature, it seems that there has been an extensive amount of research conducted by both public and private organizations on the causes, occurrence and impact of natural catastrophes (Munich Re 2012a, WEF 2012a, EM-DAT 2012). However, it seems that from the review of the studies available within the scope of this paper that there is a lack of research conducted that focuses on the micro-level impacts of natural catastrophes on supply chains, where one of the few studies that was found is a series of sequential studies by the Business Continuity Institute (BCI, 2011). However, this study does not explicitly focus on natural catastrophes, but on causes of supply chain disruptions in general (ibid). Furthermore, it also only examines the impact that it had on the company and not the type of change (ibid). Additionally, it is to be remarked that the response profile of the BCI (2011) study is not the same as will be targeted within this study, where a strong representation from professional or financial services companies as well as not supply chain managers was present (ibid). This explorative research study will aim at trying to

receive responses from a more diverse set of industries and receive answers pre-dominantly from persons in charge of the supply chain or the company in general. As such, this sparse amount of research is a motivation to focus research efforts in this direction.

From an extensive review of the academic literature that is based both upon literature, such as by those that have been undertaken by Jain et al. (2010), Spens & Wisner (2009), and Guinipero et al. (2008), it can be said that the discipline of studying supply chains is one that is still in its infancy and where a great deal of fragmentation and uncertainty over the contents and scope of the field prevail. As such, it has been found that many of the studies focuses solely on specific elements of the supply chain, relating these to other specific elements or justifying their implementation with regards to other variables, such as financial performance or the like (Jain et al. 2010; Spens & Wisner 2009; Guinipero et al. 2008). However, it seems that very few studies proceed with a holistic view of the supply chain by taking a snapshot of how supply chains have become manifested within companies (ibid). As such, there is a research gap in terms of research that studies the types of supply chain strategies that are conventional within companies (ibid). Furthermore, too many of the current studies focus on how to improve the current supply chain elements, rather than trying to provide for a future direction of the development of supply chains (Christopher, 1998). These research gaps provide for an underlying motivation of this paper to research about the current supply chain strategies that prevail in companies, how these have and will continue to change due to the occurrence of natural catastrophes.

From the review of the literature it seems that there are few studies that show how natural catastrophes impact supply chains and especially how supply chains have changed as a result of a natural catastrophe (e.g. Sodhi et al., 2012). Furthermore, there are little studies focusing on how companies are assessing and preparing their supply chains for risk, as well as to uncover actions that companies should undertake to cope with risks (e.g. Sodhi et al., 2012). These research gaps provide for a further research motivation of this paper.

It is hereby important to note that previously, much research has been conducted on the operational side of supply chain risk, where the focus has been put on the risks that occur frequently and that have low impact on business operations. However, the focus on high impact-low probability risks has been neglected in the past (e.g. Vanany et al., 2008; Chopra et al. 2004). Recent scholars have touched upon the topic of high impact-low probability risk (e.g. Barth, 2004; Brindley, 2004; Wagner et al., 2008; Kleindorfer et al., 2005) in relation to risk management processes and

management perception, however there is an overall deepening of the field in relation to natural catastrophes and supply chain strategy change needed. Another identified gap in the supply chain and supply chain risk field is management perception (Sodhi et al., 2012; Zsidisin, 2003b). Management perception has been seen as an important vehicle for acting on disruption risk but many scholars note that management perception in relation to risk is an area for future research (ibid). This is a research gap that provides for a further motivation of this paper. As such, the paper is also motivated to explore the actual transformation that a firm undergoes.

As to be seen there is an extensive amount of research gaps as well as interesting stimuli from the research context that combine together to form the research motivation. This will result in the research task, to be discussed in the following sub-chapter.

2.2. Research task

Having established the research motivation, the next step is to define the research task. The research task has been divided into the research aims that then following into main and sub-research questions, as outlined in Figure 1: Research Motivation & Research Task.

2.2.1. Research aim

Given the research context as well as the research gaps that have been identified, the aim of the research is to satisfy both of these. As such, the research seeks to contribute to the understanding of the impact that natural catastrophes can have on supply chains, contribute to the research on a holistic view of supply chain strategies, and supply chain strategy change as a consequence of natural catastrophes, and the reasons why these change in a given way.

2.2.2. Research question

To fill the theoretical and empirical gaps identified in the current research, this paper sets out to answer the following overarching research question: *Do international organizations change their supply chain strategies based on the previous experience or observation of the supply chain disruptions that natural catastrophes can cause?* Given the fact that the breadth of this research question, the following sub-chapter will bring forth three sub research-questions, which are also in line with the theoretical framework of this paper.

2.2.3. Research sub-questions

To identify if the increasing occurrence and impact of natural catastrophes is cause enough for multinational companies to change their supply chain strategies, and to further determine how and

why these supply chain strategies have been changed, it has been decided to split the overarching research questions into the configuration, the transformation and the transformed configuration. These three elements correspond with the theoretical framework that is used to guide this research (see Section 2).

2.2.3.1. First sub-research question

To determine if natural catastrophes are causing companies to change their supply chain strategies, it is necessary to determine the impact that natural catastrophes can have on supply chains determines by their configuration and to bring forth the type of disruptions that they cause. The reason for this is to ensure that there is a stimulus for a change to occur. As such, the first sub-research question is as follows: *If so, what kind of supply chain disruptions do natural catastrophes cause for international organizations and what are the consequences of these?*

2.2.3.2. Second sub-research question

Given that there is a stimulus for change (i.e. natural catastrophes have an impact on supply chains) the next step is to determine the process that this stimuli undergoes within the organization before a decision will be taken on the actual outcome of the change. This has been coined as the transformation and is concerned about the perception that managers have of the previously defined change stimulus (i.e. the impact of natural catastrophes on supply chains) and to try to crystalize the motivational factors of the decision that will then lead (or not lead) towards a strategic change to occur within the organization. As such, the second sub-research question is as follows: *If so, why do international organizations decide to change their supply chain strategies based on supply chain disruptions caused by natural catastrophes*?

2.2.3.3. Third sub-research question

Having defined the change stimulus (i.e. the impact of natural catastrophes on supply chains) as well as the transformation (i.e. the perception and motivational factors), the final step is to discover if and what type of change will occur. This has been termed the transformed configuration and seeks to explore if any changes in the supply chain strategies will be or have been undertaken. If they have been undertaken then the next step is to determine the consequences that this had for the firm. As such, the third sub-research question is as follows: *If so, how do international organizations change their supply chain strategies and what consequences do these have?*

3. Paper outline

Having described the research motivation and research task, the final chapter will now bring forth the steps to be taken to answer the questions posed, and can be seen in Figure 2: Paper Outline & Structure.

The introduction of the paper, begun by explaining two cases that served as an underlying inspiration to conduct explorative research within the chosen field of study. This inspiration has then been formalized into a research motivation that was subdivided into the research context and the research gaps. Subsequently these made up the research task, consisting of the research aim, the main research question, and the sub-research question. Having provided an introduction to the research paper, the following chapter on the theoretical framework (see Section 2) will provide the theoretical grounds on which the paper is grounded.

As has been outlined previously, the theoretical framework is structured into the configuration, the transformation and the transformed configuration. The choice as to why this approach was used will be described in the section that deals with strategy formation, where a detour into the subject matter will be taken. Within the first part of the theoretical framework, namely the change stimulus, the paper will seek to provide an understanding of the supply chain natural catastrophe return-risk paradox under scrutiny by discussing the two developments with regards to natural catastrophes and supply chain strategies. From the natural catastrophe perspective, natural catastrophes will be defined and the probability and impact of natural catastrophes will be discussed. This results in the risk element. Form the perspective of the supply chain strategies the supply chain design (e.g. lean manufacturing, just-in-time), management (e.g. supplier integration) and location (e.g. outsourcing, offshoring decisions) will be discussed. As these have been done to improve the performance of the firm, these result in the return element. These two strands of theory bring together two important considerations, namely return from supply chain strategies versus risk from natural catastrophes. As such, putting this together results in the supply chain natural catastrophe return risk paradox, that marks the configuration. After having identified this supply chain natural catastrophe return risk paradox, as the stimuli for change, it is important to understand the transformation that leads (or does not lead) to a transformed configuration. As such, the company's perception of the risk that natural catastrophes pose with regards to the returns that can be gained from their supply chain strategies will be analyzed alongside the different motivations for strategic change to occur. This will be done from different angles, such as decision theory that will assist in outlining influencers of managers' decision making to better understand what drives this type of decision-making, as well as strategic change theory. Being aware of this transformation, allows for the theorizing of different possibilities on how firms are able to change or not change, termed the transformed configuration.





The theoretical framework will bring the paper to a formulation of a set of hypotheses that are centered on the overall research question and the three sub-research questions. Thereafter, the methodology will be described together with a detailed presentation of the approach behind the questionnaire and interviews that have been conducted. Preceding this, the hypotheses will be tested through the primary research conducted both on a quantitative and a qualitative level. These findings will then be discussed in terms of the theoretical framework and the implications that these may have for managers followed by a conclusion.

Section 2: Theoretical Framework

To provide an answer to the research questions posed, it is necessary to understand the status quo within the research relating to the topic under study, from which to generate a theoretical framework that can be used to propose hypotheses and design the research that will be used to answer the research question and serve the research aim.

4. Introduction to theoretical framework

As has been described in Chapter 2.2.2, the theoretical framework stands in line with the main and sub-research questions. As such, the theoretical framework is subdivided into the configuration, the transformation and the transformed configuration, as depicted in Figure 3: Theoretical Framework.



Figure 3: Theoretical Framework

The reason why the research questions, the theoretical framework and the research as a whole is designed according to the three phases of configuration, transformation and transformed configuration will be explained. As has been explicated in chapter 2.2.2, the overall research question sets out to explore if changes in the external environment of a firm (i.e. natural catastrophes) is causing firms to change their strategy (i.e. supply chain strategy). As such, the research is centered on trying to explore if a situation external to the firm will cause the firm to change its supply chain strategy. Consequently, the essence of the paper is about strategy change and formulation based on occurrences in the external environment, a decision that is undertaken by the management. Therefore, to discuss strategic change of supply chains within the context of the paper it is necessary to understand what is meant by strategic management, strategy formation and to provide a description of the strategy formation process through the configuration school, as brought forth by Mintzberg et al. (1998).

4.1. Strategic management, strategy and strategy formation

Classical strategic management theory is seen as "the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals" (Chandler, 1969:13). Other scholars define strategic management as objectives originating at the top that aims to guide the company into a sought after position in the market (Ansoff, 1965; Andrews, 1971). These definitions are all founded on the basic premises that strategy is a rational act (Barry et al., 2008). This view of strategy has received much criticism and the view of strategy-as-practice has emerged as a response to it, where actors in companies are not rational and rather influenced by other factors such as politics, behavior and other contextual factors (Barry et al., 2008; Mintzberg, 1991, 1994a).

Mintzberg et al. (1985) identifies strategy as "a pattern in a stream of decisions" with a special focus on the intention and plans of the leaders in organizations and what the actual outcome of these strategies are. Thus, strategy is viewed as "a top-down process of formulation followed by implementation" (Barry et al., 2008:368). Strategies are likely to emerge as a consequence of chance events, through interaction with the external environment or through behaviors (Mintzberg, 1973). Thereby, this notion also goes against the rational process of logical planning. To overcome the definition barrier of strategy in strategic management, Mintzberg proposed in 1987 five definitions of strategy that can be used in several different contexts and combinations. Thus, strategy can be defined as plan, ploy, pattern, position and perspective (Mintzberg, 1987). *Strategy*

as a plan refers to a set of guidelines that should guide action (ibid). It consists of two premises: the plan is made prior to when the action should apply and the plan is made with a certain purpose in mind (ibid). Strategy as a ploy refers to plots made by organizations with the intention to outmaneuver competitors so that the organization can achieve a competitive advantage (ibid; Porter, 1980, 1985). Strategy as a pattern involves the final outcome of the plan set out. Thus, it is a "pattern in a stream of actions" (Mintzberg, 1987:12). Patterns appear even though the plan is not fulfilled, thus one needs to separate between the intended, realized, deliberate and emergent strategy (ibid). However, patterns are the outcome no matter if intentions are involved or not (ibid). *Strategy* as a position involves associating the organization with the environment it is operating in to generate rents, to obtain its niche or live in its domain (ibid). Thus, the position involves "the place in the environment where the resources are concentrated" (Mintzberg, 1987:15). Strategy as a perspective involves the internal preconception of the way the organization operates and how it views the world. It can be compared to the personality of an individual. The perspective aspect of strategy refers to that it is a concept that only exists in the minds of the parties involved and it is invented and intangible in nature. It is further important to understand that strategy as a perspective is shared by the employees of the organization and can thus be labeled as the collective mind. The definitions put forward are highly interrelated and involved, meaning that one definition of strategy gives rise to another one and so forth with no certain order, thus it is to a large extent context specific. Mintzberg (1987) concludes this article by stating that each of the definitions complement each other and it assist us in understanding strategy from various perspectives.

Strategy formation can be seen as an evolutionary process that encompasses many actors from various levels in the organization, thus known as the process school of strategy formation (Bower et al., 1983, 1991). This way of viewing strategy has been known as "*dynamic theory of strategy as a multi-level process evolving over time*" (Barry et al., 2008:368). In his early works, Mintzberg (1973) also identify the importance of strategy making as a process and he puts forward three modes that this can be done (1) Entrepreneurial mode, (2) Adaptive mode and (3) the Planning mode. The adaptive mode is the most relevant in this paper as it relates to how an organization can adapt to complex environments by taking small steps to shape strategy (ibid). Strategy making within the adaptive mode entails four major features. Firstly, there is a large pool of powerful members, unions, managers, owners, and government agencies etc. making clear goals nonexistent (ibid). Secondly, in this mode of strategy making, the organization is reactive rather than proactive in dealing with external forces (ibid). Thirdly, decision-making is done with incremental small steps

based on continuous feedback from the environment (ibid). Forth, each decision is treated separately, making the nature of decision-making in this mode fragmented (ibid). A company that is facing a fast changing, complex environment and that possess many different important stakeholders should make use of the adaptive mode. Mintzberg (1973) concludes by arguing that an organization might not only utilize pure forms of strategy-making modes, rather argues that organizations should mix and match the types of modes that best fit their needs.

In sum, there are many definitions of strategy, strategic management and strategy formation. It is argued that all are true in their own field and niches (Mintzberg, 1987). It is hereby to be noted that the forth-mentioned definitions of strategy and strategic management is not an exhaustive discussion. The definition best suited for strategy and strategic management is the evolutionary, strategy-as-practice and non-rational view.

4.1.1. Configuration school of strategy formation

Mintzberg et al. (1998) summarized that there are 10 different schools of strategy formation, each of which takes a different view. In Mintzberg et al. (1998) these various schools are described. The tenth school of strategy formation is the configuration school, which incorporates all the views of the previous schools and sees strategy formation more as a transformation process where each strategy view has its own time and place (Mintzberg et al., 1998). This school of strategy formation also provides the underlying basis for this research paper. Given that this school of thought claims that every school is valid but in its own time and place. Chapter 6 will discuss some of these schools of thought, which will later on be tested for their relevance in terms of the context under study.

The configuration school involves two states, one that describes configuration (context surrounding the organization) and another relating to transformation (strategy-making process) (Mintzberg et al. 1998). It is argued that transformation always happens after configuration (ibid). The configuration school relates to the temporal stability that a strategy possesses which can be influences by factors that make it change into a new temporal state for the organization (ibid). This view is further touched upon in Actor-Network Theory (ANT), which relates to identifying problems and finding the right actors to solve them (Callon, 1986). Seeing as ANT poses that a network of actors only can possess temporal stability (Latour, 1984), which makes the problematization of one time period the cause for problems in another (Callon, 1986).

The configuration school states that an organization possesses a stable configuration during a period of time, which is adopted as it fits to the context (Mintzberg et al., 1998). Subsequently this gives rise to specific strategies adopted by the organization (ibid). Transformation is argued to occur in periods that will affect the stability and lead the organization into another stable period (ibid). These periods, configuration followed by transformation, can be named patterns e.g. certain life-cycles of an organization (ibid). Seen from the configuration school of thought, strategic management is meant to ensure stability over the long run or to provide strategies that can be adapted (ibid). Thus, ensuring not to ruin the organization through the disruptiveness associated with an organization's existence (ibid). The strategy making process is one encompassing a *"conceptual designing or formal planning, systematic analyzing or leadership visioning, cooperative learning or competitive politicking, focusing on individual cognition, collective socialization, or simple response to the forces of the environment: but each must be found at its own time and in its own context"* (Mintzberg et al., 1998:305). Strategies are then formed in terms of patterns, plans or ploys that is matched with the time and contextual element (ibid).

The configuration approach is further deepened by Pettigrew (1987), who puts forward a framework for strategic change that encompasses content, context and process. Context is made up of outer and inner context, the outer context being social, economic, political and competitive environments where the company is operating and the inner context is the structure within the company e.g. culture, values, political views etc. (ibid). Content is looking at the specific elements that are under scrutinization, the change element. The process is the actions, reactions and interactions that the employees of the company take to move the company from its current state to the wanted future state (ibid). Pettigrew (1987) adopts a view that is dynamic, iterative, multilevel process within the organization and with emerging strategies that come into play due to people's interests and the environment around. Thus, similar to that of Bower (1970), Mintzberg (1978) and Burgelman (1983) change is seen as something shaped by "continuity and change, actions and structures, endogenous and exogenous factors as well as the role of chance and surprise" (Pettigrew, 1987:658).

4.2. Configuration school of strategy formation and link to research study

The configuration school asserts that there is a state of configuration (i.e. context) and a state transformation (i.e. process) and that the former happens before the latter, which then brings the firm from one temporal state into another (Mintzberg et al., 1998). Therefore, it has been decided to

structure the paper into the configuration, where the current supply chain trends and natural catastrophes frequency and impact will be discussed in the form of a paradox that may provide the impetus for change. Following this, the transformation will be described by discussing the various schools of strategy formation and how they may come to influence the new state of configuration. Having discussed this, the transformed configuration (i.e. the new state of configuration) will bring forth possibilities on how the strategy could be formulated.

5. Configuration

The first sub-chapter of the theoretical framework, namely the configuration, aims to unravel the existence of a natural catastrophe supply chain risk-return paradox. This will be done by, on the one hand, providing an overview over conventional supply chain strategies along the lines of supply chain location, design and management and by explicating how they create an increase the degree of supply chain risk and performance. On the other hand, it will provide an overview of natural catastrophes frequency and impact trends. By merging these two strands of research together will bring forth the natural catastrophe supply chain risk-return paradox that provides the stimuli for supply chain strategy to transform or not transform within the given corporations.

5.1. Supply chain strategy trends

This chapter seeks to provide a non-exhaustive overview of some of the most important trends in supply chain strategies and to show how some of these have increased or decreased the supply chain risks, such as those arising through natural catastrophes, as well as supply chain performance. To provide for an educated overview of these strategies, the chapter will commence with a definition of the most important terms. This will be followed by a brief overview of the different schools in the supply chain literature. Following this, an overview of the most important trends in supply chain strategy along those that determine the exposure to natural catastropher risk (i.e. location factors) and those that either increase or decrease the impact that these can have (i.e. supply chain design and coordination elements) will be given. From this, it will become evident that these have increased the performance of supply chains on one side, but increased their vulnerability to risk on the other. From this, a discussion of supply chain performance and supply chain risk will follow. Having provided this, the various trends along the lines of performance and risk will be discussed. The chapter will conclude with a summary of the most relevant findings of this theoretical discussion in relation to the context under study.

5.1.1. Supply chain terminology

To provide for an educated discussion of supply chain strategies, it is necessary to define the most important terms used: namely the supply chain, supply chain strategy, supply chain management and supply chain design. This will be done in the following sub-chapters.

5.1.1.1. Definition of the supply chain

According to the research done by Guinipero et al. (2008), one of the first to mention the term 'supply chain' was Forrester (1961), who defined this as an interacting flow of information, material, and capital, which according to Simon (1962) interrelate in a complicated manner. This abstract definition is built upon by Christopher (1992) and related to the organizational context where it is defined as a "network of organizations that are involved, through upstream (i.e. supply sources) and downstream (i.e. distribution channels) linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumers." Based on these forth-mentioned definitions, this paper will be based on the "ultimate supply chain", meaning the entire chain from raw material to the end-customer, as well as the taking into account of the associated services along the chain (Brindley, 2004), will be considered as a part of the supply chain.

5.1.1.2. Definition of supply chain strategy

Supply chain strategy has been widely defined along the continuum of tactical to strategic concepts. Some scholars define it as a cost focused process and flow of goods (Scott et al, 1991). On a more strategic level it is referred to as decisions that are strategic and relate to how to optimally run the supply chain either in-house, outsourced or through various transportation modes to name a few. (Chopra et al, 2007). Other scholars argue that supply chain strategy involves clear communication and coordination as well as ensuring a long-term orientation (Katz et al, 2003). Rose et al (2012:9) define the supply chain strategy as a *"deliberate and/or emergent conceptual framework by which a company involves its supply chain and supply chain members in its efforts to reach its own corporate strategic objectives"*. This is the one used in this paper as it encompasses a diverse set of tactical and strategic efforts.

5.1.1.3. Definition of supply chain management

Having defined the supply chain, and before embarking on a definition of the management of supply chains, it is necessary to remark that based on a recent review of the literature by Guinipero et al. (2008) and an older review by Christopher & Peck (2004) there is still much discussion

regarding the supply chain management definition. This is partially as many terms in supply chain management overlap one another and originate from multiple disciplines (Storey et al., 2006; Guinipero et al., 2008). Sodhi et al. (2012:6) define it as *"the management of material, information, and financial flows through the supply chain"*, which confirms Forrester's (1961) definition in Chapter 5.1.1.1. From an operational level, supply chain management is concerned about the best operational performance and includes tracking and optimizing performance metrics relating to the timing of production (e.g. time to market), costs (e.g. material costs) and customer satisfaction measures (e.g. product and service quality) (Sodhi et al., 2012:6). On a strategic level, it involves ensuring profits, revenue growth, market share and return on assets (ibid). Combining the forthmentioned, Brindley (2004:6) defines supply chain management as *"a multi-disciplinary and multi-functional set of activities, which deals not only with the more physical and tangible attributes and activities (e.g. logistics) but equally the more behavioral and intangible dimensions (e.g. relationship building and management)."* When referring to supply chain management the definitions by Sodhi et al. (2012) and Brindley (2004) will be utilized.

5.1.1.4. Definition of supply chain design

Supply chain design is concerned with undertaking decisions and developing plans on a strategic level with regards to the location and allocation of capacities and tasks to facilities, channels of supply and distribution, organizing the different linkages (Kouvelis et al., 2006), and undertaking make or buy decisions (Fine, 2000). These decisions are part of a dynamic process and that is integrated with system design of product/service and manufacturing/delivery (Kouvelis et al., 2006).

5.1.2. Schools of supply chain thinking

Given the above definition of the supply chain, Ritchie et al. (2001) asserts that there are four distinct perspectives from which one can assess and understand a supply chain: (1) structural, (2) systems, (3) strategic and (4) relationships. The structural perspective takes a very linear and consequently uni-directional view of supply chains (Ritchie et al, 2001). The systems perspectives on the other hand takes that position and efficiency from raw material to end customer is important (Cooper et al, 1997). The strategic perspective is heavily focused on obtaining and enjoying a competitive advantage in the long run (Porter, 1985). Recently the relationship perspective of the supply chain has emerged as a new way of understanding the supply chain (Brindley, 2004). It relates to keeping and maintaining relationships on an operational and strategic level (Ritchie et al,

2001). The four different perspectives of supply chains are seen to be as compatible and provide different understandings of similar matters (Brindley, 2004). It is important to note that the different perspectives of supply chains foster the understanding of the forth-mentioned definition.

5.1.3. New approach to supply chain thinking in the natural catastrophe context As the review of the literature within the scope of this paper exemplified that researchers have not yet broken down the study of supply chain strategies with regards to the natural catastrophe risk context, this paper will take a novel approach. Brindley (2004) and The Royal Society Group (1992) assert that risks affecting supply chains are related to the chance of such a risk occurring and the impact that it will have. This is undermined by Harland et al. (2003) who claim that the probability of a risk occurring depends on the exposure of something to the risk. As such supply chain strategies will be considered from the perspectives of those that are related to the probability and impact of natural catastrophes. As natural catastrophes occur in specific locations, if supply chain echelons are located in natural catastrophe areas, then exposure to such risks exists. If no elements are located in such areas, there is no exposure of the supply chain to such risks. As such, supply chain location drives natural catastrophe risk exposure and determines impact probability. Given this, the impact on supply chains, is determined by how it is managed and designed. Taking this approach to thinking of supply chains in the natural catastrophe context, the paper will distinguish between supply chain strategies regarding exposure (i.e. supply chain location) and impact (i.e. supply chain design and supply chain management) to be seen in Figure 4: Risk Exposing, Reducing and Amplifying Supply Chain

Risk Exposure	Risk Amplification/ Reduction		
Location	Design	Management	
 Global Sourcing Offshoring Offshore Outsourcing 	 Single sourcing Just-in-time Inventory-optimization Outsourcing Agility 	 Collaboration and integration Communication Risk management Contingency planning 	

Figure 4: Risk Exposing, Reducing and Amplifying Supply Chain Strategies. Source: Own creation based on literature.

5.1.4. Overview of the development of supply chain strategies

Based on the previously described way of thinking of supply chain strategy within the supply chain context, this section will now provide an overview of the most prominent supply chain trends since and show how these have lead supply chains to become increasingly vulnerable to risk. Given the limited amount of space, some references will be made to App. 15.1.1.

5.1.4.1. Overview of supply chain trends

Supply chain management as a term was first coined in the 1980's (Jain et al., 2010) after which it became increasingly used (Oliver & Webber, 1982). Christopher & Peck (2004:1) assert that in the 1980's supply chain management was "response to change in prevailing trends in business strategy", where organizations focused on creating value to end-customers and shareholders (Christopher & Peck, 2004). In the 1990's the focus was on total system efficiency (Christopher & Peck, 2004; Lambert et al., 1998) and re-organizing business processes, whereby supply chain management was focused on fast flow of goods and services and integrating cross-functionally (Christopher & Peck, 2004). Here, electronic resource planning systems became increasingly demanded (Jain et al., 2010). From this the focus on establishing a competitive advantage through increasing value and decreasing costs through a global supply chain became increasingly popular (ibid). Since the 1990's supply chain management has developed at a very fast pace (Burgess et al., 2006). This 200's mark an increasing amount of manufacturing and distribution being outsourced to focus on core competencies (Jain et al., 2010). Following this, collaboration and sharing information throughout the supply chain became more important and adopted (ibid). As seen in this possibly lead to increasing performance of supply chains (e.g., Hofer et al., 2012), but also an increasing amount of complexity and vulnerability to risk (e.g., Erlam et al., 2008). This is to be seen in Figure 5: Supply chain trends

Era	Trends	Supply Chain Design	Supply Chain Location	Supply Chain Management
80s	General	Supply chain management term coined ¹ , increasingly used ² , and important as reaction to trend of cross-functional management and value creation for customers and shareholders ³		
	Specific	Outsourcing non-core activities to decrease costs ¹⁸	Offshore manufacturing in low cost countries at single sites ³⁶	Supplier relationships at arm's length and in form of contracts ¹⁸
90s	General	Focus on process re-organization and integration, increasing efficiency and speed of flow through entire system ³ as well as an increasing prominence of the discipline as a whole ⁴ Focus competitive edge (i.e. adding value and decreasing costs) through globalization of supply chain ¹		
	Specific	Just-in-time to decrease cost ¹⁵ Outsourcing core activities to decrease costs and add value ^{18,19} thereby leading to strategic outsourcing ^{20, 21}	Offshore outsourcing starting to become interesting ^{18, 19, 20, 21} and increasingly prevalent ^{38, 39,40} Global sourcing becoming increasingly prominent ¹⁸ e.g. low cost country sourcing ³²	Supplier relationship increasingly important ^{20, 21} and collaborative not competitive ^{28, 29} ERP systems increasingly used ¹ and ITC enables offshore outsourcing ¹⁸
00s	General	Development of supply chain discipline increasing in pace ⁵ Increasing focus on cost-cutting, especially due to financial crisis ¹³ , cost effectiveness and efficiency ¹⁰		
	Specific	Outsourcing core activities ^{1,18} and services ²² Inventory reduction to decrease cost and increase efficiency ^{3,14} Just-in- time continuing ¹⁵ (Single) sourcing increasing and important for cost reduction ¹³ and increase efficiency ^{13,14} Lean production and distribution increasing ⁹	Offshore production tends to be set up in a network of globally dispersed production sites ^{8, 34, 35} Offshore outsourcing moving from solely manufacturing to business processes ⁴¹ where cost not only motivating factor ^{e.g., 42} Global sourcing increasingly prominent ^{7, 30, 31} (China, USA,	Supply chain relationship increasingly focused on collaboration, cooperation and information sharing ^{1,18} Barriers to outsourcing are continuously being reduced ²³ Risk management is becoming increasingly important as supply chains are becoming more
		uistribution mercasing	and Germany are top location ³¹)	important to performance ^{xx}
Now	General	Focus on cost reduction, cost-efficiency and cost-effectiveness ^{4, 1, 15} Increasing interest in importance of supply chain management ^{6,8} as essential part of strategy ⁷		
	Specific	Outsourcing of core and non core activities, inventory reduction and optimization, just-in-time and single sourcing	Offshore production in network structure across globe, offshore outsourcing of core and non core activities, global sourcing	Increasing collaboration, cooperation and sharing of information throughout entire supply chain
	Outcome	Uncertainty of focus on cost-reduction on actual cost-reduction outcome ^{e.g.11, 15, 33} Increasing complexity and vulnerability of supply chains to risk ^{e.g. 12, 32, 3, 22, 26, 27, 34, 35, 14, 43, 13, 14} Call for increasing focus on supply chain agility to manage uncertainty ¹⁷		

¹Jain et al. (2010), ²Oliver & Weber (1982), ³Christopher & Peck (2004), ⁴Lambert et al. (1998), ⁵Burgress et al. (2006), ⁶Storey et al. (2006), ⁷Guinperio et al. (2008), ⁸Aschinder et al. (2008), ⁹WEF(2012a), ¹⁰Christopher & Towill (2002), ¹¹Hofer et al. (2012), ¹²WEF(2012d), ¹³KPMG (2012), ¹⁴WEF(2012c), ¹⁵Makelprang & Nair (2010), ¹⁶Holweg (2011), ¹⁷Lee (2004), ¹⁸Hättönnen & Eriksson (2009), ¹⁹Morgan (1999), ²⁰Alexander & Young (1996b), ²¹Quinn & Hilmer (1994), ²²Erlam et al. (2008), ²³Doig et al. (2001), ²⁴Kotae et al.,(2008a, b), ²⁵Anagnostou, 2004, ²⁶Handley & Benton (2009), ²⁷BCG & Wharton (20XX), ²⁸Matthyssesn & Van de Bulte 1994, ²⁹Carr, 1999, ³⁰Eyeoftrasnsport (2009), ³¹SCM World (2011), ³²Trent & Monzcka (2003), ³³Petersen et al. (2000), ³⁴Stank et al. (1999), ³⁵Stank & Goldsby (2000), ³⁶Ørberg-Jensen (2009), ³⁷Nayyar (1978), ³⁸Farrel (2005), ³⁹Levy (2005), ⁴⁰Sidhu & Volbreda (2011), ⁴¹Ward (2004), ⁴²Martinez-Noya & Garica-Canal (2011), ⁴³Hutzschenrueiter et al. (2011)

Figure 5: Supply chain trends

5.1.5. Supply chain risk

Having asserted that vulnerability to risk has increased the following will discuss risk. As risk definition varies according stakeholder (Zsidin, 2003a; Christopher & Peck, 2004) ranging from strategic (Simons, 1999) operational (Meulbrook, 2000; Simons, 1999), supply (Meulbrook 2000; Smallman, 1996) to customer (Meulbrook, 2000) risk. The following will discuss supply chain risk, and specifically disruption risk.

Before doing so, a definition of risk must be established. March & Sapira (1987:1404) and Shapira (1995:3) define it as *"the variance of the probability distribution of outcomes"*, which is commonly used (Zsidin, 2003a). Harland et al. (2003:52) define it *"as a chance of danger, damage, loss, injury or any other undesired consequences"*. Yates & Stone (1992) categorize it into (1) components, (2) importance and (3) ambiguity. Mitchell (1995:116) specifies this as *"the probability of loss and the significance of that loss to the organization or individual"* where risk = probability of loss * significance of loss. The definition by Mitchell (1995) will be used.

5.1.5.1. Supply chain risk definition and classification

Based on Mason-Jones & Towill (1998) supply chain risk can be divided into demand, control, process and environmental risk. Wagner et al. (2008) propose five similar classifications of risk alongside demand, supply, as well as regulatory, legal and bureaucratic, infrastructure, and catastrophic risk. Kleindorfer & Saad (2005) narrows this into two categories: supply and demand coordination and regular activity disruption. Tang (2006) categorizes it as operational and disruption supply chain risk. According to their study of the general (e.g., Fisher et al., 1997; Fine, 2000; Levi et al. 2001; Lee 2002; Saad, 2003) and more specific (e.g., Kleindorfer & Wu, 2003; Cachon, 2003; Kraiselburd et al., 2004; Gerchak & Wang, 2004) supply chain literature, Kleindorfer & Saad (2005) most studies focus on supply and demand coordination risk. This paper adds to the literature on disruption risk, as is discussed below.

5.1.5.2. Supply chain disruption risk

Kleindorfer & Saad (2005) claim that the risk of disruption to the regular activities of a supply chain is centered around (1) risks arising from the regular operations (such as the failure of production equipment etc.) as well as (2) risks arising from external influences (e.g. natural catastrophes, political issues, terrorism etc.). Tang (2006) categorizes disruption risk as being either caused by humans or nature and manifesting themselves in terms of attacks of terrorism, crises in the economy, earthquakes, typhoons etc. Disruption risk as is defined by Wagner et al., (2008)

relates to an event that has a tremendous impact on a certain area and is caused by a natural phenomenon such as a natural catastrophe. Kleindorfer & Saad (2005), research has increasingly focused on the risks of disruption in the past years. They claim that the reason for this is related to previously iterated supply chain trends (i.e. lean focus, globalization etc.) that are the cause for an increasing vulnerability to external disruptions (ibid). Tang (2006) states that more often than not, the impact caused by disruption risks is much higher than that of operational risks. The importance is underlined by Hendricks & Singhal (2005) who found that supply chain disruptions have a negative influence on company financial performance versus competitors not experiencing disruptions, consequently making it increasingly important to study.

To quantify a definition of supply chain risk, Brindley (2004) proposes the following definition: Supply chain risk = probability of an event occurring * the severity of its impact on the business. Figure 6: Classification scheme of risk events. depicts this relationship according to the types of risks that a company can incur into four quadrants along the lines of one the axes that represents the probability and the other axes that represents the impact (Brindley, 2004).



Source: Classification scheme of risk events. Adapted from Brindley (2004)

Figure 6: Classification scheme of risk events

The risks in the upper part are defined as operational risks (Knemeyer et al., 2009), which are have low impacts but likely to occur more frequently (ibid). High-impact and low-probability events, such as disruption risks are related to earthquakes, terrorist attacks, flooding, droughts that cause an unexpected disruption to the flow of products in the supply chain (Knemeyer et al., 2009; Kleindorfer et al., 2005). These are depicted in the bottom left corner of the matrix (ibid).
5.1.6. Supply chain performance

One of the main trends within supply chain management is that it has increased in its importance within the firm (Storey et al., 2006) as it can help a firm to obtain a competitive advantage (Martin, 2000; Li et al., 2006) and shape its ability cater to the difficult demands of customers and the competitive pressures in their markets (Trent & Monczka, 2003; Li et al., 2006; Lambert, Cooper and Pagh 1998). For example, by shaping shareholder value because it is able to shape working capital, revenue and costs of operation (Ellinger et al., 2011). As such, Lambert & Cooper (2000) come to assert that competition is not between firms anymore but between supply chains. This makes it an essential part of many firms' corporate strategy (Guinipero et al., 2008). Supply chain performance will be discussed more intensely in the individual supply chain strategies to follow.

5.1.7. Supply chain design strategies

Having provided the general supply chain strategy trends and their consequences the following chapter will provide a detailed discussion on some important supply chain strategy trends clustered along design, location and management. Supply chain design strategies in this sub-chapter.

5.1.7.1. Lean and just-in-time strategies

Lean production and distribution has becoming increasingly important, acting as the fundament of a global economy (WEF, 2012a; Christopher & Peck, 2004).) by minimize waste and increasing efficiency (Womack et al., 1990) and vulnerability to risk (WEF, 2011d). Lean management strategies can be kanban, just-in-time, total quality management etc. (Hofer et al., 2012) as well as kaizen, 5S or standardized work processes (Ryeson et al., 2011). They are often regarded as, what Hofer et al. (2012), coin the *"gold standard"* of supply chains (e.g., Guinipero et al., 2005; Goldsby et al., 2006) due to the importance of efficiency and effectiveness (Christopher & Towill, 2002). However, the performance benefit remains debated. Despite difficulties and expenses of implementation, many firms have just-in-time (JIT) strategies for cost savings (Makelprang & Nair, 2010). Similar to the forth-mentioned relationship between lean strategies and performance benefits, the same follows for JIT (see App. 15.1.1.1 for details). Despite uncertainty, JIT remains a common practice (Makelprang & Nair, 2010).

5.1.7.2. Inventory optimization strategies

Inventory optimization has received a great deal of interest (Eyeoftransport, 2011), mostly because excess amounts of inventories are often seen as waste (Christopher & Peck, 2004) and due to the fact that a reduction of buffer stock levels reduces costs and increases efficiency (WEF, 2011c).

However, this is also the cause for an increasing vulnerability to risks (WEF, 2011c) and as such an increase in the slack (and hence inventory) would be beneficial to protect against threats from natural catastrophes (Christopher & Peck, 2004).

5.1.7.3. Single-sourcing strategies

According to KPMG (2012) one of the currently major business challenges in industries is to cut costs, which has begun since the global financial crisis of 2008 and has become important in the procurement function (KPMG, 2011). The main phenomena is that many companies have seen a reduction in the number of suppliers (Christopher & Peck, 2004), which is recommend to reach a number that is dependent upon on the certainty of supply or demand (Kouvelis et al., 2006). Often times, this is single sourcing, which has advantages from a quality, cost and efficiency perspective but poses a threat in terms of risk and vulnerability (Christopher & Peck, 2004; WEF, 2011c) due to the limited amount of alternatives (WEF, 2011c). Currently, the inclusion of hidden costs and risk, such as those of natural catastrophes, are underrepresented for managers in their decision-making (Holweg, 2011). Holweg (2011) calls for the inclusion of these types of environmentally hidden costs. However, the issue with these types of hidden costs it remains challenging to forecast their occurrence and consequently to include them in risk calculations (Holweg, 2011). As a consequence of the limited amount of alternatives that single-source supply encompasses (WEF, 2011c) and the limited ability to include hidden costs (Holweg, 2011), the increasing focus on lean single-sourcing supply chains is increase the risk that (international) supply chains are confronted with (Christopher & Peck, 2004; WEF, 2011c).

5.1.7.4. Outsourcing strategies

Outsourcing can be broken down into national and international outsourcing (see App. 15.1.1.2 for details), where this chapter will focus on a general level and international outsourcing will be discussed in chapter 5.1.8.3. The development of outsourcing has been vast and is discussed in App. 15.1.1.3. Yet, what can be said from today's standpoint is that after 2000, outsourcing is increasingly prevalent with many companies focusing on the core of their operations (Hättönen & Eriksson, 2009), making outsourcing a norm and not a differentiating factor (Lawton & Michaels, 2001). This is amplified through the little barriers to engage in outsourcing (Doig et al., 2001). This brings with it the need to focus on cooperation, collaboration and co-development (Hättonen & Eriksson, 2009). Competitive advantage can be gained through the effective and efficient production of goods and services through external suppliers, i.e. outsourcing (Kotabe et al.,

2008a,b; McCarthy & Anagnostou, 2004 in Javalgi, 2009) as vertical relations can either reduce costs or add value for the end customer (Cooper et al., 1997; Lambert et al., 1998). Cost reductions on a short-term level are one of the main reasons why firms decide to outsource operations on a national or international level (Corbett, 2005; Doig et al., 2001; Ellram et al., 2008). However, cost reductions are only a part of the implications for a firm deciding to outsource. The overall cost structure and the risk exposure is also impacted and ought to be considered in decision-making (Ellram et al., 2008). Ellram et al. (2008) found that the risks that companies connect with outsourcing are those of the market, specifications that are incomplete, performance measurement issues, and other risks that are relevant to the offshoring relationship etc. The risks of external threats in the environment are not considered (ibid). However, transaction cost economics states that an increasing volatility in the external environment and in the market environment will motivate firms to undertake operations within the boundaries of the firms (Kaufmann & Carter, 2006; Vidal & Goetschalckx, 2000; Williamson, 1985).

5.1.8. Supply chain location strategies

Having discussed supply chain design strategies on a general level, this chapter will discuss some of these strategies in terms of location and especially internationalization of supply chains. This will be done in the same manner as previously. On a general level, and in terms of the risks posed by an increasing amount of internationalization, the WEF (2011c) asserts that both specialization in the form of manufacturing becoming centered in certain areas of the world, which brings with the issue of processes being easily interrupted in the case of a negative event, as well as globalization in the form of offshoring and offshore outsourcing bring with them the issue that local risks will have globally reaching effects (WEF, 2011c). This will be discussed in more detail in the following.

5.1.8.1. International sourcing strategies

Sourcing on a global level is a supply chain practice with increasing prominence (Eyeoftransport, 2011), that has been making supplier and buyer relationships progressively international (Guinipero et al., 2008). This is carried out due to the positive results that are believed and that can be gained (Trent & Monczka, 2003; Rajagopal & Bernard, 1991; Birou & Fawcett, 1993; Kotabe, 1994). Furthermore, Holweg et al. (2011) claim that the decline in transportation costs and with the advent of increasing globalization, global sourcing has become more prominent within companies. As such, decreasing barriers have been the reason why global sourcing has risen since the 1980's (Holweg et al., 2011). However, Trent & Monzcka (2003) claim that many companies do not have a

true estimate of the total, i.e. that incur due to logistics etc. Furthermore, the fact that currencies and languages vary to the domestic base makes international sourcing more complicated (Howell & Soucy, 1991; Vickery et al., 1993; Min, 1994; Murphy & Daley, 1994a, b) and risky, where Trent & Monzcka (2003: 609) argue that: *"extended material pipelines, longer material ordering lead times, relying on new and unfamiliar sources of supply and total costs that may far exceed unit costs"* pose risks for companies. This is continued by Christopher & Peck (2004) who argue that an increasing amount of global sourcing brings with an increasing vulnerability and exposure to risk. Further information on global sourcing is to be found in App. 15.1.1.4.

5.1.8.2. Offshore production and manufacturing strategies

The offshoring of elements of a firm's value chain has been a phenomenon of the past decade (Ørberg Jensen, 2009). Manufacturing at a single site has been changed to a network that is geographically dispersed around the globe (Arschinder et al., 2008; Stank et al., 1999; Stank & Goldsby, 2000). This has developing from more low-end simple manufacturing to more advanced parts of the value chain (Andersen, 2006; Maskell et al., 2007). As such, in a survey of 750 supply chain managers, it was found that, 30% produce/manufacture/assemble below 10% of their produce outside of their home country, while 45% produce more than half outside of their home country and 24% produce between 10% and 50% outside (SCM World, 2011). Yet, despite the fact that offshore production is a prominent supply chain practice, Lutz & Carter (2006) claim that the research of manufacturing in relation to international supply chain management is still quiet underrepresented. From a summary of the literature offshoring Temouri et al., (2010) emphasize that location specific aspects are the reason for the offshoring to occur. Temouri et al. (2010) claim that for high-tech companies it is firm-specific knowledge as well as ownership advantages that may be the decisive factor as to why firms offshore. However, geographical dispersion increases the complexity of managing and coordinating such a network that at the end of day brings value to the end-customer (Stank et al., 1999; Stank & Goldsby, 2000). Explanations of why offshoring has become so prominent can be found in App. 15.1.1.5.

5.1.8.3. International outsourcing strategies

Financially motivated through the opportunities to reduce operational costs (Lewin & Volbreda, 2011), the 1960's marked the birth of cross-boarder offshoring primarily manufacturing activities into low-cost countries (Nayyar, 1978). With the increasing development of communication technology in the 1990's firms were not only able to relocate their activities and processes across

national boundaries, but furthermore also across firm boundaries. This marked the era of offshore outsourcing (Farrell, 2005; Levy, 2005; Sidhu & Volbreda, 2011) of both simple manufacturing and more advanced value adding activities and processes (Horvit, 2004; Lewin & Peeters, 2006a; UNCTAD, 2004). With an increasing realization that distinct knowledge and talent pools prevail in offshore locations (Martinez-Noya & Garcia-Canal, 2011), firms have come to recognize offshoring benefits far beyond financial motives (e.g. Dossani & Kenney, 2003; Erber & Sayed-Ahmed, 2005; Farrell, 2005; Levy, 2005; Lewin & Peeters, 2006a;). This increasing attractiveness for companies to increase the amount and breadth of offshored activities and processes has not only increased the complexity of their operations but also the demand for the competences to deal with these (Hutzschenreuter et al., 2011). Explanations of why offshore-outsourcing has become so prominent can be found in App. 15.1.1.5. This has also increased the vulnerability to risk (Silvia et al., 2011).

5.1.9. Supply chain management strategies

Having provided a detailed discussion of some of the most prominent supply chain design and supply chain location strategies, this chapter will discuss some of the most important supply chain management strategies, which will also be evaluated in terms of the supply chain risks and supply chain performance.

5.1.9.1. Coordination and communication strategies

Supply chain management is increasingly focused on cooperation rather than competition (Matthyssens & Van den Bulte, 1994; Carr, 1999). Coordination is considered an essential element of a well-functioning supply chain (Ballou et al., 2000) as the different members of the supply chain must collaborate to provide value to the end customer, which is especially important in situations of high supply chain complexity (Aschinder et al., 2008). Such a supply chain coordination system, as defined by Aschinder et al. (2008: 317), includes an: "an explicit definition of processes, responsibilities and structures aligned with overall objective of whole supply chain to bring together multiple functions and organizations". This coordination along the supply chain can be seen in terms of resource sharing (Narus & Anderson, 1996), risk and reward sharing (Lambert et al., 1999), responsibility (Ballou et al., 2000), holistic view of coordination at many levels of the company (Larsen, 2000), workflow and resource dependency (Lee, 2000), mutuality (Simatupang et al., 2002), joint promotional activities, forecasting (Larsen et al., 2003), and join decision-making, and benefit sharing (Hill & Omar, 2006). According to Arschinder et al. (2008), Fisher et al. (1994) and Horvath (2001) coordination issues (or a lack thereof) can be the cause for underperformance of

a supply chain. Put positively, according to Fisher et al. (1994), Lee et al. (1997), and Horvath (2001) and as summarized by Arschinder et al. (2008: 319) there are many benefits of effective supply chain coordination such as elimination of excess inventory, reduction of lead times, increased sales and improved customer service to name a few. Though it is agreed that coordination is beneficial towards the performance of an organization, the high adaption costs of information sharing and aligning organizational information sharing systems may come at a high cost (Zhao & Wang, 2002).

5.1.9.2. Disruption risk management strategies

The WEF (2012c) asserts that the world is in a constant state of volatility and this volatility is increasing in impact, frequency and length. However, based on their research, the WEF (2012c) also contends that only 10% of the executives interviewed about supply chains believe that their firm is able to deal with supply chain disruptions. According to a study conducted by Cudahy et al. (2012) of Accenture, only 11% of their survey respondents claimed that they manage supply chain risk in an active manner and only 18% use supply chain risk management systems. This is further underlined by the research done by the Eyefortransport (2011), where the biggest challenge facing Chief Supply Chain Officers in 2010 and 2011 was demand variability and forecasting, as was indicated by 42%. Risk and disruption management was only indicated as a challenge by approximately 14% (ibid). Furthermore, McKinsey's (2010) Global Survey on Supply Chain Management finds that of the 639 respondents only 16% of the companies have the reduction of risks as a top supply chain priority. Despite being low in absolute terms, this is an increase from the past, where it was only 14%. As such, the majority in the surveys from 2006 to 2010 believes that supply chain risk has increased in the past and will only continue to increase mildly in the future with Asian companies showing the highest concerns for risk (McKinsey, 2010). Christopher & Peck (2004) find that often times decisions that are taken on a corporate strategy level and affect the supply chain are often taken in disregard to the impact on the vulnerability of the supply chain; e.g. global sourcing. However, Christopher & Peck (2004) show that many supply chains are at greater risk as is perceived by supply chain managers. This is an issue that will be further underlined in the following chapters.

5.1.9.3. Contingency planning strategies

Business contingency planning is becoming increasingly important (Christopher & Peck, 2004), as is displayed based on a survey conducted with over 650 respondents, where BCI (2011c) found that

only slightly over 10% of the chief procurement or supply chain officers have shown any interested in business continuity plans in 2011, compared to Chief Operating Officers of which over 50% show an interest. Furthermore, the survey conducted by BCI (2011c) with over 650 respondents shows that in only 16% of the major decisions taken, business continuity planning was considered. This is underlined by the research done by Christopher & Peck (2004) who find that it is often not taken into account within the entire supply or demand network. Woodman & Hutchings (2011) find that in 2011, 45% of the responding companies claimed that they were able to deal with extreme weather disruptions through business continuity management on a general level. However, only 19% of the companies are able to deal with supply chain disruptions using business continuity management (ibid). BCI (2011c) depicted a series of drivers for business continuity management, ranging from regulatory, customer, competitive or management requirements, previous direct or indirect experiences, or insurance rebates. Of these, regulatory and legal requirements are the prime reason for business continuity management, followed by customer and competitive requests and previous experiences (BCI, 2011c).

5.1.9.4. Agile supply chain strategies

The issue with high speed and low cost supply chains is that these are often not able to respond to changes in demand or supply, hence they are not agile (Lee, 2004). Furthermore, Lee (2004) asserts that supply chains ought to be efficient, but to outcompete rivals requires more than this, and this requires them to be agile. Supply chain agility, throughout the entire supply chain network, is important and is defined by visibility and velocity where the former involves the ability to 'see' up and downstream and the latter refers to the total time it is necessary to take a product from its origins to the end customer (Christopher & Peck, 2004). Furthermore, agile supply chains must include a high degree of responsiveness, flexibility and adaptability (Christopher, 2000). As such, an agile supply chain is able to be responsive to its environment and be dynamic it is reactions, also on a network level (Intaher, 2010) and is able to react quickly to changes in supply and demand (Lee, 2004). In terms of being able to create such a supply chain, Lee (2004) says that information sharing, supplier collaboration, postponement, inventory of essential parts, dependable logistics and a good team are important to create agile supply chains. Braunscheidel & Suresh (2009) summarize from a review of the literature that firms must increasingly focus on agile supply chains to stay competitive (Christopher, 2000; Christopher and Towill, 2001; Zhang et al., 2002, 2003; Chopra and Sodhi, 2004; Kleindorfer and Saad, 2005; Swafford et al., 2006). This is further amplified by the fact that firms are globally active and are thus impacted by events around the world (Lee, 2004).

Consequently, the WEF (2011d) identifies agility as the most important factor to successfully cope with a supply chain disruption.

5.1.10. Summary of supply chain strategies

In summary of this chapter on supply chain strategies, it can be said that supply chain management as a discipline of study and managerial practice has developed significantly over the past decades. The recognition that the supply chain can add to the performance and competitive advantage of a firm has brought forth supply chain strategies that aim at decreasing costs, increasing the return and overall attempting to add to the competitive advantage of the firm. However, these supply chain strategies that have been undertaken in the light of the positive effect they have on the firm, they have also brought an increasing complexity and vulnerability to risk, summarized in Figure 7: Summary of supply chain strategies.

Supply Chain Strategies				
Туре	Strategy	Return	Risk	
Location	Outsourcing	Increase	Increase	
	Sourcing	Increase	Increase	
	Offshoring	Increase	Increase	
Design	Outsourcing	Increase	Increase	
	Single Sourcing	Increase	Increase	
	Inventory Optimization	Increase	Increase	
	Just-in-Time	Increase	Increase	
Management	Supplier Collaboration	Increase	Decrease	
	Risk Management	N/A	Decrease	
	Contingency Planning	N/A	Decrease	
Sum	N/A	1	1	

Sources: Compiled sources from previous chapters

Figure 7: Summary of supply chain strategies.

Chapter 5.2 will describe the risk that natural catastrophes pose, which will be followed by a discussion of the specific risk that natural catastrophes pose for supply chains in chapter 5.3.

5.2. Natural catastrophe risk

The risk of natural catastrophes for international supply chains is increasing (e.g. Wagner et al., 2008); yet remain undermanaged by many managers (e.g. Loyds, 2011; Kunreuther et al., 2008). The risk is manifested in the fact that the impact of natural catastrophes (i.e. the monetary and human damage that they cause) as well as their frequency (i.e. probability of occurrence) is increasing (e.g. MunichRe, 2012a; EM-DAT, 2012). This is especially the case in certain regions of the world, namely the North America and South-East Asia (e.g. MunichRe, 2011c). These regions are also home to many internationally active and globally interconnected companies, as well as their supply chains (e.g. Lloyds, 2011). As such, the risk of natural catastrophes impacting international supply chains is increasing. However, despite the fact that the impact on supply chains is large, the aspect that the relative probability of occurrence of such events is considered as being low, natural catastrophes are seen as low probability and high impact risks that are consequently often disregarded by managers (e.g. Brindley, 2004). To following chapter will begin by defining and classifying natural catastrophes. Then, based on the supply chain risk matrix (see chapter 5.1.5.2) natural catastrophe probability and impact of occurrence will be discussed, also from a regional perspective. This will then be summarized within the supply chain risk matrix.

5.2.1. Natural catastrophe definition and classification

To provide a ground for further discussion, the following sub-chapter will provide a brief definition and classification of the different types of natural catastrophes. Based on the United Nations International Strategy for Disaster Reduction, a natural catastrophe is defined as "*a natural process or phenomenon that may cause loss of life, injury or health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage*" (UNISDR, 2009:24). As such, the emphasis here is on the "*natural process or phenomena*" (ibid) - hence, not 'man-made' - and the "*damage*" (ibid) that this will cause for an array of affected entities. EM-DAT, The International Disaster Database, defines these catastrophes according to: (1) amount of people affected (100+), (2) number of fatalities (10+), (3) declaration of an emergency situation and (4) need for international assistance (EM-DAT, 2012). As such, a natural catastrophe will only be reported if one of the above mentioned criteria are met. Having defined natural catastrophes, EM-DAT (2012) and MunichRe (2011a) then classify natural catastrophes into different five different sub-categories, as depicted in App. 15.1.2.1¹.

¹ EM-DAT (2012) considers all oft the five sub-categories depicted. However, MunichRe (2011a) does not consider biological

5.2.2. Natural catastrophe probability

The world has seen an increase in the amount of natural catastrophes (EM-DAT, 2012; MunichRe, 2012a). This can be seen in App. 15.1.2.2 and 15.1.2.3, which display the number of reported natural catastrophes between 1900 and 2011, and 1980 and 2010 respectively (EM-DAT, 2012; Munich Re, 2012a). Between 1900 and the 1950's, the occurrence of natural catastrophes was relatively low and increased thereafter (EM-DAT, 2012). From 1980 onwards, the last three decades have seen a much steeper increase, with a total number of 133 events in 1980 to over 350 events by the end of 2010 (ibid). This trend is also shown in the data set provided by MunichRe (2012a), to be seen in App. 15.1.2.3. Yet, due to different reporting standards between EM-DAT (2012) and MunichRe (2012a), the latter reports 650 more natural catastrophes (i.e. approx. 1000) than the former. Despite the difference in reporting standards the trend (i.e. the main message) remains the same (ibid). As such, the same trend holds when removing geo-physical natural catastrophes and thereby only looking at weather natural catastrophes as to be seen in App. 15.1.2.4. Though not as strong a trend as solely looking at the time period between 1980 and 2011, when analyzing the occurrence of "Great Natural Catastrophes", as depicted in App. 15.1.2.5, it is also possible to observe an upwards trend in the time period between 1950 and 1980 (MunichRe, 2012b). In final, one may conclude that the number of natural catastrophes has been increasing over the time period in which natural catastrophes were reported (MunichRe, 2012a; MunichRe, 2012b; EM-Dat, 2012).

Asia and North America have the highest number and strongest trend of an increasing frequency of natural catastrophes (MunichRe, 2011c). With 32%, the number of natural catastrophes occurring in the Asian region is the highest in the world, when compared to other continents in the time period between 1980 and 2010, as shown in App. 15.1.2.13 (ibid)². The second and third highest number regions affected by natural catastrophes are North America and Europe, with 24% and 21% of all events between 1980 and 2010, respectively (ibid).³ Africa, South America and Australia/Oceania, have far less events, with 9%, 7% and 7% respectively (ibid). This high occurrence of natural catastrophes in Asia (ibid) is further underlined by a particularly strong trend in the given time

catastrophes as natural catastrophes.

 $^{^{2}}$ Despite the fact that a more up to date data-set of MunichRe (2012d) is available, it was decided to use the data set from 2011, namely MunichRe (2011c) as the newer version does not differentiate between North and South America.

 $^{^{3}}$ According to a dataset from EM-DAT (2012) that encompasses only the time period between 1990 and 2011, Asia had more losses than the Americas and significantly more than Europe. The reason for this discrepancy with the MunichRe (2011c) data set may be related to the major disasters in Kobe 1995 and the array of disasters in 2011. Irrespective of this, the general message remains the same.

period (ibid). This can be seen in App. 15.1.2.11 that shows the number of general natural catastrophes in Asia between 1980 and 2011 and App. 15.1.2.12 that shows the development of the number of weather related natural catastrophes in Asia in the same time period (ibid). The North American and Caribbean region also shows a very strong trend for the number of weather related natural catastrophes in the time period between 1980 and 2010 (ibid) as to be seen in App. 15.1.2.14. As such, these two regions display the strongest trend in the increase in the amount of weather related natural catastrophes (ibid). The other regions of the world (i.e. Europe and Africa) also show an upward trend, though not as significant, with South America having the least amount of trend in the increasing amount of weather related catastrophes (ibid).

According to a report by Oxfam, written by Jennings (2011), an actual increase in the amount of natural catastrophes, and changes in the reporting of natural catastrophes are some of the reasons why natural catastrophes have been increasing. An actual increase in the amount of natural catastrophes relates to climate changes and its impact on the frequency and intensity (Jennings, 2011). Climate change can be argued to have an affect on the meteorological, hydrological and climatological types of natural catastrophes. The World Bank (2004) supports the fact that climate change is a driver of the actual increase in natural catastrophes and further adds that environmental degradation may also be seen as a cause. Furthermore, seismologists argue that geophysical types of natural catastrophes are not impacted by climate change; rather these cycles have remained steady over time (World Bank, 2004). Changes in the reporting methods and reporting capabilities of natural catastrophes are another reason why natural catastrophes have been reported to increase (Jennings, 2011). It is arsgued that information technology, democracy, press freedom, and increased awareness has led to a steep increase in the amount of reported natural catastrophes (ibid). In sum, not only is it the increase and exposure to natural catastrophes - hence, a real increase - but also the ability to report this increase that has led to an overall rise in the number of natural catastrophes over the past 110 years of reporting.

5.2.3. Natural catastrophe impact

The impact of natural catastrophes has been increasing (MunichRe, 2012a). This can be seen in App. 15.1.2.7 that shows the development of both insured and uninsured losses caused by all types of natural catastrophes around the globe between 1980 and 2011 (ibid). The same trend holds true for the amount of uninsured losses (MunichRe, 2012a). However, there are some distinctive anomalies in the data set, such as the multitude of disasters that occurred in 2011 (i.e. floods in

Thailand, earthquake in Japan), the hurricane Katrina in 2005 in New Orleans, or the earthquake in Kobe in 1995 (ibid). Nonetheless, the trend holds (ibid). When analyzing only the weather related natural catastrophes, as shown in App. 15.1.2.8, some of the anomalies are taken out of the data-set and consequently the trend of an increasing amount of losses that occur due to weather related natural catastrophes holds (MunichRe, 2012a). A study by AON Benfield (2011) over the time period between 1980 and 2011 shows that the top 10 natural catastrophes with the largest economic damage all occurred in the period between 1995 and 2011, as can be seen in App. 15.1.2.9. The economic losses due to natural catastrophes was the highest in 2011, when the world was hit by a total of 253 separate disasters that amounted to a total loss of USD 435 billion, as to be seen in App. 15.1.2.10 (Aon Benfield, 2011). This further contributes to the conclusion that the impact of natural catastrophes has increased over the past years (Munich Re, 2012a).

Despite Asia having the highest occurrence of natural catastrophes, North America has incurred the most monetary losses (Munich Re, 2011c) As such, and as to be seen in App. 15.1.2.13, with 40% of all losses between 1980 and 2010, North America has faced the highest monetary impact in comparison to Asia, which has incurred 38% of all monetary losses in the same time period (ibid). Europe in turn, has experienced 16% of all losses, Australia/Oceania 3%, South America 2%, and Africa 1% (ibid). It is assumed that the reason for the difference in the amount of natural catastrophes and the impact (i.e. monetary losses incurred) may be linked to the economic development (and hence the amount of assets and capital) in the respective regions.

Asia and Africa have incurred the highest amount of fatalities due to natural catastrophes (MunichRe, 2011c). As such, when looking at impact from the perspective of the loss of human lives, Asia has incurred 51% of the total amount of lives lost due to natural catastrophes in the time period between 1980 and 2010 (ibid), as to be seen in App. 15.1.2.13. This is followed by Africa, which holds 27% of the total share of worldwide fatalities (ibid). The reason for this may be linked to the high population density in Asia (Worldometer, 2012), as to be seen in App. 15.1.2.6 as well as the level of economic development in Africa (e.g., to reduce the number of fatalities caused by severe periods of drought).

The exposure of people to natural catastrophes, is as argued by Jennings (2011), one of the main determinants of a catastrophe's increasing in impact (such as previously established by EM-DAT (2012). As such, with an increasing world population of 1.10% annually – and having reached above 7 billion inhabitants by 2012 – the exposure to natural catastrophes is increasing (Jennings,

2011). This is linked to the fact that many of the natural catastrophes are occurring in Asia (MunichRe, 2011c), which, as depicted in App. 15.1.2.6, also has one of the highest population densities in the world (Worldometer, 2012). In sum, an increasing exposure to natural catastrophes, linked together with its definition of affecting people, is the reason for an increasing frequency.

5.2.4. Risk typology of natural catastrophes along supply chain risk matrix

Having provided a definition and classification of the different types of natural catastrophes, and having provided an overview of how these have developed in terms of their probability and the impact of occurrence, this sub-chapter will attempt to provide a typology of these risks along the supply chain matrix brought forth in chapter 0. However, before being able to provide a definite typology of these risks, it is to be noted that there are different opinions based on different research. These will be discussed in the following.

5.2.4.1. Probability of occurrence

Knemeyer et al., 2009 and Kleindorfer et al., 2005, come to assert that natural catastrophes are lowprobability risks. Based on the conflicting research conducted by Woodman & Hutchings (2011) there is a clear increase in those companies that experienced disruptions due to extreme weather, which is shown by the fact that in 2002 18% and in 2011 64% of the responding firms experienced such a disruption, on a general level. This finding is also different to that of Knemeyer et al. (2009) and Kleindorfer et al. (2005) as it comes to show that natural catastrophes may be causing disruptions more frequently⁴. Based on a survey conducted with 469 experts, The WEF(2012a) finds that unprecedented geophysical destruction and persistent extreme weather are seen as midlikelihood environmental risks. Furthermore, they also find that the perception of persistent extreme weather is cognitively related to rising greenhouse gas emissions (ibid), which is also seen as one of the top five risks in terms of their likelihood of occurrence. It is hereby interesting to note, that the research also found that, where environmental risks were the main concerns in terms of likelihood in 2011 (i.e. metrological and hydrological risks), and partially also in terms of impact (i.e. climatological risks) this has been replaced by socioeconomic risks in 2012 (i.e. rising greenhouse gas emissions) (ibid). Thus, there is a clear mismatch in research regarding the type of probability that is associated with a natural catastrophe.

⁴ It is hereby to be noted that this assertion is based not only on supply chains in specific, but the business in general (Woodman & Hutchings, 2011).

5.2.4.2. Impact of occurrence

Knemeyer et al., 2009 and Kleindorfer et al., 2005, come to assert that natural catastrophes are high-impact risks. This is contended by the research conducted by Woodman & Hutchings (2011) who found that only 34% in 2011 claimed that they perceive that the impact of natural catastrophes on their supply chains is large. In 2002 it was 25% that claimed this would be large, with a peak occurring in 2008 and fluctuating in-between (ibid). Given that the findings of Woodman & Hutchings (2011) are based on perception, their findings do not relate to the actual impact caused; however it is important to mention this findings as it is different to that brought forth by Knemeyer et al. (2009) and Kleindorfer et al. (2005). The WEF (2012a) finds that unprecedented geophysical destruction and persistent extreme weather are seen as mid-impact environmental risks.

5.2.4.3. Probability and impact of occurrence

As to be seen, the opinions of where to place natural catastrophes along the supply chain risk matrix seem to vary. An explanation of this could be related to the research methods employed, as well as the time horizon and the consequential amount and impact of natural catastrophes that occurred in a given time period. However, despite this, the paper will take a similar stance as Knemeyer et al. (2009) and Kleindorfer et al. (2005) and see natural catastrophes as high-impact and low-probability risks. As such, natural catastrophes will be placed in the bottom-left quadrant of Figure 8: Classification scheme of natural catastrophes as is shown below.



Source: Classification scheme of risk events. Adapted from Brindley (2004)

Figure 8: Classification scheme of natural catastrophes

5.2.5. Summary of natural catastrophe risk

In sum, Asia and North America are the regions with the largest share of the number of natural catastrophes and largest shares of monetary losses in between 1980 and 2011 (MunichRe, 2011c). This is coupled with strongest trends of increasing number of events (ibid). Asia and Africa have faced the highest impact in terms of fatalities (ibid). As such, these regions are important to observe with regards to natural catastrophes and they impact that the may have on businesses. Given that the same developments as have been described in the above analysis persist in the future, it can be assumed that the number of natural catastrophes as well as the monetary losses caused will continue to increase, especially in Asia and North America. Furthermore, given the findings of this discussion in this section, natural catastrophes will be depicted as low-probability and high-impact risks. Having discussed developments within supply chain and natural catastrophes, the following section will bring these two elements together.

5.3. Supply-chain natural catastrophe return-risk paradox

Having extensively discussed supply chain strategy trends from the perspective of those that concern supply chain design, location and management as well as having described the trends with regards to the probability and the impact of a natural catastrophe occurring, this section will now bring these two elements together in what has been coined the supply chain natural catastrophe return-risk paradox.

5.3.1. Supply chain disruption due to natural catastrophes

Based on the research conducted by the WEF (2012c), the most often cited cause of supply chain disruptions are those caused by natural disasters, as can be seen in prominent examples such as the volcanic ash cloud over Europe in 2010 (WEF, 2011d) the flooding in Thailand or the tripledisaster in Japan in 2011 (WEF, 2012a). An example of how vulnerable companies can be is shown in the triple disaster in Japan, where car manufacturers in Detroit got affected as they sources microchips from one company in Japan that was damaged during the disaster (WEF, 2012a). With no alternative supplier the car manufacturer had to freeze the production for a period of time thereby leading to inability to meet the demand (ibid). The reason for this is linked to the supply chain strategies, that have been iterated in the previous chapter, that have made supply chains increasingly lengthy (e.g., Sodhi et al., 2012; Silvia et al., 2011; Peck & Jüttner, 2002), complex (e.g., Sodhi et al., 2012; Silvia et al., 2012; BCG et al, 2012; WEF, 2012c, 2011d) and interconnected, (e.g., Wagner et al., 2006, Sodhi et al., 2012; BCG et al, 2012; WEF, 2012c, 2011d; Hendricks & Singhal, 2005; SCRLC, 2011; WEF, 2012a, 2012c), which has made them more vulnerable to risks, such as those posed by natural catastrophes (e.g., Peck, 2005; BCI, 2011; Hendricks & Singhal, 2005; Kneyemer et al., 2009; Simchi-Levi et al., 2009).

5.3.2. Probability, location and type of supply chain disruption due to natural catastrophes

The fact that natural catastrophes can disrupt supply chains is shown in a study conducted by the Business Continuity Institute (BCI) (2011), The study was conducted with 377 respondents from a variety of industries, countries and business functions, of which financial services and government organizations from the United Kingdom are the dominating type, which focused on disruptions to supply chains and yielded some interesting results with regards to this paper (ibid). The survey found that, only 15% did not experience any supply chain disruption in 2011, whereas 85% experienced a disruption (ibid). Further, 61% of all the respondents experienced a disruption that was related to a natural catastrophe. When regarding solely supply chain managers as respondents, 48% claimed that their firm's supply chain had been impacted by a natural catastrophe in 2011. Of these natural catastrophes, the majority was weather-related (71%) and the lesser amount was geophysical-related (29%). In terms of geophysical related catastrophes, earthquakes and tsunamis are the primary reason for disruptions in Asia, secondary in Australia and New Zealand and tertiary in the USA (ibid). As such, in 2011, the Japanese and New Zealand earthquake and tsunami affected 20% of all the respondents in numerous countries and sectors of the BCI (2011) survey. In manufacturing, earthquakes and tsunamis were the second main reason for disruptions in 2012 (ibid). In the United Kingdom, USA, Australia & New Zealand adverse weather conditions where the primary and in continental Europe the secondary cause of disruptions (ibid). Within the retail and wholesale, IT & communications, transport & storage as well as in the government sector adverse weather was the primary reason for disruptions (BCI, 2011). Furthermore, it was found that by the BCI (2011) that a large proportion of the disruptions occurred within the first or second tier of suppliers. As such, of the 265 respondents, 61% claimed that the supply chain disruption occurred in the first, 30% in the second and 9% in the third tier of their supply chain (BCI, 2011).

As can be seen from the review of the research conducted with regards to the occurrence, impact and location of natural catastrophes, there is a clear upward trend in terms of the frequency at which these catastrophes occur and the impact that these have (MunichRe, 2011; EM-Dat, 2011; WEF, 2012c). In terms of the frequency and impact of occurrence, this is especially the case for weather related catastrophes and holds true especially in Asia-Pacific and North America (ibid).

Based on the above discussion and the theoretical findings from the previous chapters, it is possible to put forth some hypotheses with regards to the probability, type and location of supply chain disruptions due to natural catastrophes. As has been discussed in the previous chapter and also brought forth in this chapter, there seems to be an overall disagreement with regards to the probability that a supply chain will become disrupted by a natural catastrophe. From the theoretical discussion, it seems that an increasing amount of evidence seems to suggest that natural catastrophes and supply chain disruptions due to natural catastrophes occur more frequently than is expected. However, given the fact that some of the studies have only taken a one-year view (e.g. BCI, 2011), it may be the case that anomaly exists within the results. As such the hypotheses will focus on a 10-year period, rather than just one year. Furthermore, given the findings of BCI (2011) that many of the supply chain disruptions did not occur within the firm's locus of control, this will also be taken into consideration. In terms of where in the study of the supply chain the natural catastrophe will have a disruptive effect, the findings of the BCI (2011) as considering supply chains as being networks (i.e. McCutcheon & Stuart 2000; Corsten & Kumar 2005; Christopher & Peck, 2004). With regards to the location of the impact, the findings from the Business Continuity Institute, WEF, EM-Dat and Munich-Re seem to suggest higher probabilities in North America and Asia.

5.3.1. Impact of supply chain disruptions due to natural catastrophes

Of the 377 respondents to the BCI (2011) study 17% experienced one million or more Euros in damage due to supply chain disruptions in general. In 85% of the cases the cost of the worst disruption was under one million Euros. In 14% of the cases it was between one and ten million Euros (BCI, 2011). It is to be added that 32% experienced significantly more damage due to weak supply chains (ibid). In terms of the type of consequences, the main consequence was a loss of productivity, revenue and increased costs. In the long-run, the consequences were concerns held by shareholders, and reduction in the firms reputation (BCI 2011).

In their analysis of the long-term economic impact that natural catastrophes have on corporations, Hendricks & Singhal (2005) find that firms underperform at 40% under their normal average stock return in the year before, after or during the announcement of a natural catastrophe impacting their firm. Furthermore, they find that the risk of equity also increases, which is 13.50% higher on average (Hendricks & Singhal, 2005). The risk of supply chain disruptions can have an effect on a multitude of different stakeholders and consequently holding the risk may also increase the cost of capital that the firm incurs. Furthermore, the equity of the firm may decrease in attractiveness. The

chances of financial vulnerability and the firm not being able to meets its financial commitments also increase with the risk of natural catastrophes increasing. Employees, shareholders, buyers and suppliers – and especially those of risk averse nature – may feel uncomfortable in dealing with a firm that is holding a lot of risk and may thus require extra compensation or assurances to deal with this firm. This in turn increases the firm's cost of conducting its business (Hendricks & Singhal, 2005). Furthermore, as the risk increases the credit rating of the firm may also increase and it may become increasingly expensive to raise capital (Hendricks & Singhal, 2005). There are heavy economic consequences of natural catastrophes on firms and these effects tend to be slow in their recovery (Hendricks & Singhal, 2005). Consequently, Hendricks & Singhal (2005:51) call for firms to "carefully analyze the trade-offs between lower costs and negative economic consequences associated with higher risks of disruptions". Based on the above findings, as well as those of the previous chapters, the following hypotheses with regards to the impact of supply chain disruptions will be put forth. With regards to the specific consequence that a supply chain disruption due to a natural catastrophe has on an international organization the overall consequences will be negative in terms of profit, reputation, sales with existing customers and number of customers. Based on the above discussion, the following hypotheses will be formulated (see Figure 9)

Dased 0	ii the above	discussion,	the following	g nypotneses	will be formu	liated (see Fig	gule 9).

	Hypothesis
1A	International organizations face a medium probability to experience an indirect or direct supply chain disruption due to a natural catastrophe within a ten year period of time.
1B	International organizations will experience more indirect than direct supply chain disruptions due to natural catastrophes.
1C	International organizations will experience supply chain disruptions due to natural catastrophes pre-dominantly in Asia and North America.
1D	As indirect disruptions occur more often than direct disruptions, international organizations will experience supply chain disruptions due to natural catastrophes more often but with less impact than may be expected
1E	The disruptive impact of natural catastrophes on supply chains has a negative consequence in terms of the firm's profitability, sales with existing customers, number of customers, and the reputation of the firm

Figure 9: Hypotheses (Configuration)

5.3.2. Summary of the supply chain natural catastrophe return-risk paradox

Supply chains of today are increasingly complex, interconnected and exposed to risk. At the same time the risk of natural catastrophes are increasing and the impact is becoming bigger. This gives rise to a return risk paradox in relation to the supply chain that challenges the common supply chain trends in international organization of today. This makes the situation unsustainable and should trigger a change in the way supply chains are set up.

5.4. Conclusion

Following Mintzberg et al. (1998), the configuration has now been described and given the paradox that has been described, this provides for an potential stimuli for companies to revise their current supply chain strategies and go from one temporal state to another. The process that the firm has to undergo before it goes from one stage to another is the strategy transformation process (ibid), which will be described in the following chapter.

6. Transformation

Having outlined the state of configuration, this section seeks to provide an overview of the transformation process that the firm must undergo to go from one state of configuration to another state of configuration (Mintzberg et al., 1998). As has previously been established, the configurations school claims that each of the other schools of strategy have their time and place and that these are incorporated within the configuration school. This section present the most relevant schools of strategy formation with regards to the research study. These provide the basis from which management perception and other decision-making theories that are linked. Combined, these serve as a foundation from which different types of new configurations can originate.

6.1. Ten schools of strategy formation

This chapter will cover the schools of thought of the strategy formation process put forward by Mintzberg et al. (1998) who wrote this book to try to bring together ten different views on strategic management by acknowledging their own limited perspective. Due to the scope of the paper, some schools are not relevant and can therefore be found in the Appendix 15.4.4 further reference. The review is not exhaustive but ought to give an overview of how strategic management is viewed in the academic sphere. This paper will focus on the parts of the different schools that are relevant for strategic change in face of uncertainty and exogenous factors.

6.1.1. Cognitive school

The cognitive school relates to how human beings perceive and take decisions on strategy formation, thus it is drawing much on cognitive psychology and digging into the minds of people (Mintzberg et al., 1998). The main scholars that have contributed to this field of research are Simon (1960), March et al. (1958) and Khaneman et al. (1979). The cognitive school possesses two wings of thought, one that is positivistic in nature and tries to portray an objective picture of the world

(Mintzberg et al., 1998). The second wing is subjective in nature where strategy is seen as an interpretation of the world (ibid). The cognitive school acknowledges that humans are faced with certain biases that influence their decision-making process and strategy formation. Furthermore, the cognitive school acknowledges the collective system of an organization and that employees, especially managers, are information workers (ibid). Since employees are information workers, the information gets distorted the more layers it goes through in the organization (ibid). Another part of the cognitive school is the use of mapping to formulate strategies (ibid). These maps provide reference points, structures and help to organize knowledge (Khaneman, 1992). The cognitive school provide potential to contribute significantly to strategic management and especially in terms of how concepts develop in a person's mind (Mintzberg et al., 1998). This school of thought brings in the important aspect that humans possess biases and that these cognitive elements need to be understood if one wishes to understand strategy formation (ibid).

6.1.1.1. Decision theory

Decision theory is centered around the human activity of making decision that are directed by a certain goal which is defined by Hansson (1994:6) as "goal-directed behavior in the presence of options". There are both normative and descriptive decision theories, where the former refer to "how decision should be made" and the latter about "how decisions are actually made" (ibid:6). Rationality is a central and commonly agreed theme throughout decision theory scholars. Every person is assumed to be rational and pursues decisions that enable them to be a rational decision maker (ibid).

When a manager takes a decision, the outcome of that decision is not only dependent on the decision taken and how it is implemented throughout the organization (Hansson, 1994). It is also dependent on a number of extraneous factors that are outside the control of the manager (ibid). In this paper, the extraneous factors that are relevant are the risk of natural catastrophes' affecting the company. In order for a person to take a decision, one standard way to evaluate the alternatives is through a decision matrix (ibid). The decision matrix includes the potential outcomes when extraneous factors are taken into account (ibid). The matrix is assigned with utilities to enable the decision maker to make the decision that maximizes his/her utility in the given alternative (ibid).

Throughout time and from previous research on behavior of managers, individuals have been seen as risk averse decision makers (March et al., 1987). This refers to that the managers tend to pick alternatives that they know beforehand provide a certain outcome instead of an alternative with an uncertain outcome (ibid). Risk preference can be a factor of ones personality, however this is not certain as research has shown that mood (Hastorf et al., 1982), feelings (Johnson et al., 1983) and problem framing (Tversky et al., 1981) can influence the way a person perceives and act towards risk. Traditional decision theory stipulates that ones choice is dependent on the trade-off between risk and expected return (March et al., 1987). Thus, managers with risk averse personality will be inclined to give up some of the expected return for lower risk. On the other hand, the risk taking manager will be willing to take a higher risk and might thereby loose some of the expected return to increase the variation in the trade-off (ibid). Shapira (1986) identify large variations of individuals' risk taking behavior across individuals and contexts. Shapira (1986) states that the reason why it varies across individuals is due to the incentive schemes in place and personal experience.

6.1.1.2. Decision-making in relation to risk

As the research paper looks into natural catastrophe risk, decision-making in relayion to risk is relavant to understand. Common decision-making theories will be elaborated on including normative models.

Expected utility theory

Expected Utility Theory, which states that people, who are faced with a risky decision, assess the severity and the likelihood of the outcome and integrate this information into an expectation-based calculation to make a decision (Loewenstein et al., 2001). Expected utility theory is the main tool for risk in relation to decision-making (Hansson, 1994). Expected utility theory is known as a normative decision making model that involves rational choice (Kahneman et al., 1979). Expected utility theory is based on preferences and three different axioms (1) ordering, (2) continuity and (3) independence (ibid). Ordering refers to completeness, something that is preferred to something else, and transitivity, related to the ordering of preferences that is done in a rational way (ibid). Continuity refers to indifference between alternatives and independence refers to that a person will have the same preference if the gambles are presented independently from each other (ibid). If a person possesses all of these axioms, then they are assumed to be rational decision makers (ibid). A person who is rational will look at its value function and only choose prospects that give them the highest return (ibid). Thus, a rational decision maker aims to maximize their expected utility (ibid). Expected utility theory only considers the final states of value function and therefore, it does not only look at gains or losses (ibid). Furthermore, expected utility theory assumes that each individual is risk averse and thus possesses a concave utility function (ibid).

Human biases in risky decision-making

Many scholars argue that expected utility theory does not provide adequate formulation of a person's choices (e.g., Camerer et al., 1989; Kahneman et al., 1979; Bell, 1983). Decisions regarding risky situations that associated with low probabilities, such as natural catastrophes, should use a decision-making tool that is not of a normative nature (Camerer et al., 1989). The reason is because research has shown that individuals face difficulties to assess risk that is associated with low probability (Barth, 2011). Additionally, early management studies on risk assessment identify that individuals do not assess, use or trust probability models of risk, which expected utility theory concerns (March et al., 1987). Outcomes that can have tremendous impact but possess low probabilities are, more often than, not ignored (ibid). Mitchell (1995) argues that there are three ways that managers do not see uncertainty about positive outcomes as an important part in the assessment of risk (ibid). Rather, they assess gains when evaluating if an alternative is attractive. Second of all, managers tend to be loss (Kahneman et al., 1982) or regret averse (Bell, 1983), meaning that they do prefer gains to losses. Third of all, managers do not wish to quantify risk with a single number (March et al., 1987).

Furthermore, expected utility theory has been shown to be inadequate because research has shown that people tend to use heuristic rules to estimate probabilities, which leads to biases (ibid). The conjunction fallacy is one such bias, which deals with a person's perception of the plausibility of the event. When there exists a more detailed description of an event it is perceived to be more likely to happen (Tversky et al., 1983). Other biases that can influence how a manager takes decisions are: confirmation bias, anchoring and loss aversion (Kahneman et al., 2011). Confirmation bias relates to the behavior of a person to neglect evidence that stand against that person's opinion (ibid). Anchoring means that a person relies too heavily on one piece of information to take a decision (ibid). Loss aversion means that managers become risk averse and too precautious (ibid). Projection bias is another bias that was introduced by Loewenstein et al. (2003), which state that people tend to form their beliefs of future events based on their feelings of today. Thus, they might underestimate the emotional feelings of trauma that they would experience in face of a catastrophe, which leads to less investment in mitigation efforts and preparation measures (ibid).

Further criticism toward expected utility theory can be found in the work of Kahneman et al. (1979), whom identify situations where the axioms of the theory are violated. They propose an

alternative model to be used when taking decisions under risk, namely Prospect theory (ibid). Kahneman et al. (1979) argue that when a person makes a decision under risk, they choose between prospects and gambles. In expected utility theory one only cares about the final utility of ones assets and only by adding a prospect that increases their utility will be accepted, otherwise not. Thus, in expected utility one ignores gains and losses (ibid). Camerer et al. (1989) identify four main ways that make prospect theory different from expected utility theory (1) people value losses and gains from reference points, (2) people are worse off if loss and gains are represented by the same value and people are risk-averse towards gains and risk-seeking towards losses, (3) people make options easier to understand through an editing phase and (4) there is non-linear relationship with weighing of probabilities, thus people either give higher weight to low probabilities or ignore them entirely. Another violation can be described by the certainty effect, which means that people "overweigh outcomes that are considered certain, relative to outcomes which are merely probable" (Kahneman et al., 1979:265). Additionally, to enable easier decision making between choices, it is common that people only look at the parts of the choices that are different to each other (ibid). This can influence the preference over choices as the decomposition of the options trigger different preferences (ibid). This is also known as the isolation effect (ibid).

Kunreuther et al. (1997) put forward another view on managerial decision-making by examining how catastrophic events can impact managerial decision-making through reference points. Reference points are defined as "specific values or states of the world used to judge alternative proposals" (Kunreuther et al., 1997:405). The reference point of a manager highly depends on the manager's risk perception, however research has shown that it is most often related to the status quo of the company (ibid). A manager is likely to have many reference points that serve as the basis for a decision being made (Kahneman, 1992). Kunreuther et al. (1997) further argue that a company might assess the worst-case scenario as their reference point only after a catastrophic event. However, the worst-case scenario would not have been focus of attention prior to the catastrophic event (ibid). It has therefore been proven that managers are reluctant to take action until there is a crisis situation that makes a situation unsustainable (ibid). Kunreuther et al. (1997) further argue that constraints are likely to have a large effect on managerial decision-making in an organization e.g. capital constraint. Constraint can be anything from budget limitations to international expansion constraints. Kunreuther et al. (1997) identify a dynamic organizational decision making model that can assist in making choices in the face of catastrophic events (See App. 15.2.3). Based on this the following hypotheses have been put forth (see Figure 10: Hypotheses regarding perception.)

	Hypothesis
2A	Perception change of the impact and likelihood of natural catastrophes as well as the perception regarding investing in to the assessment and management of natural catastrophe risk will explain supply chain strategy changes
2B	Perception of the likelihood of natural catastrophes has changed
2C	Perception change of the likelihood is stronger where supply chain disruptions caused by natural catastrophes have been previously experienced
2D	Perception of the impact of natural catastrophes has changed
2E	Perception change of the impact is stronger where supply chain disruptions caused by natural catastrophes have been previously experienced
2F	Perception of investing into assessing and managing the risk caused by natural catastrophe despite the low likelihood of occurrence will tend towards not investing rather than investing
2G	Perception of investing into assessing and managing the risk caused by natural catastrophe despite the low likelihood of occurrence will tend more towards investing for organizations previously having experienced a supply chain disruption

Figure 10: Hypotheses regarding perception

6.1.2. Learning school

The learning school refers to strategists that learn through time, individually and collectively (Mintzberg et al., 1998). The learning school wishes to answer the questions "How do strategies actually form in organizations?" (ibid:177). It was inspired by the work of Lindblom (1959), which put forth arguments that violated the main premises of rational management. The school argues that you do not need to be manager to partake in the strategy process rather anyone in the organization can assist in the process (ibid). It has emerged through various themes and bodies of literature. It started out from disjointed incrementalism (Lindblom, 1959) that never ended up being able to fully explain strategy formation and later on moved to logical incrementalism, introduced by Quinn (1980a,b) that was made up by incremental changes that got molded together into conscious strategies (ibid). In this theme, the organizations were seen as being made up of subsystems (Mintzberg et al., 1998). Strategic management was the actual decisions being made in each of the subsystems and the aim to obtain a consensus and common pattern (ibid). The other theme was that of evolutionary theory (Nelson et al., 1982), which focuses on subsystems but rather on interaction between them than on the leadership. Here, change comes about through routines that are seen as "repetitive patterns" ensures that the organization functions optimally (Mintzberg et al., 1998:182). Strategic venturing is another process, which refers to the increased innovation and entrepreneurial spirit associated with new ventures (ibid). The reason for this innovation and entrepreneurial spirit lays the autonomy and freedom to pursue ideas (Mintzberg et al., 1998). The main conclusion is that strategies come from many levels in the organization, which has come to be classified as the "Bower-Burgelman Process Model of Strategy Making" (Bower, 1970; Burgelman, 1980).

Another stream of research within this school is emergent strategy (Mintzberg et al., 1998). Mintzberg et al. (1985) have conceptualized intended and deliberate strategies into realized strategy if the strategy is set into action (see App. 15.2.1). However, if the intended strategy does not become deliberate, thus by taking the appropriate action, then it becomes an unrealized strategy. Furthermore, there might be other influences that change the way the deliberate strategy is formulated and thus becomes an emergent strategy, which is not guided by any intention. This conceptualization is a way to identify the strategy formation process, how companies formulate their strategy based on various influences. It is argued that a pure deliberate strategy, meaning that the realized strategy forms exactly as intended, is highly unlikely to occur in organization. A pure emergent strategy means that there is order and action but no intention of it. Thus, the pure emergent is also unlikely to exist in an organization. Instead of finding pure forms of either strategy, they state that there are strategies in between these two perfect states. Mintzberg et al. (1985) identify several strategies that are between the continuum of pure deliberate to pure emergent. These have been identified as the planned, the entrepreneurial, the ideological, the umbrella, the process, the unconnected, the consensus and the imposed strategy (See App. 15.2.2 for description of each strategy). In this paper the imposed strategy is the one that has most relevance and is therefore elaborated on. Mintzberg et al. (1985) put forward imposed strategies as something that is influenced from the outside environment and that forces the organization into taking certain action. The imposed strategy means that the environment dominates how the organization should take action, however this imposition can also be implicit through imposing boundaries for the firm that the firm thereafter internalizes which makes the strategy in the end deliberate (ibid). Mintzberg et al. (1985) argue that the emergent type of strategy, the one mentioned in this paper as imposed strategy, is touching upon the notion of strategic learning. Whether a company is able to learn from previous strategies and the interplay with the environment. They go on to argue that the emergent strategy happens when a company takes one action at a time and learn from each step to form a pattern. Emergent strategy does not refer to a state of chaos, rather it is seen by Mintzberg et al. (1985:271) as "unintended order". They argue that it is important that the management of an organization is open, flexible, responsive and willing to learn, especially when operating in unstable and complex environments (ibid). By being open, the managers can take action on an emergent strategy even before they fully grasp the situation. They name it as "responding to an evolving reality" (Mintzberg et al., 1985:271). Strategy formation is something that should occur in a strategic learning feedback loop, where experiences, environment and intentions go together to form the strategy of a company (ibid). However, Mintzberg et al. (1998) argue that learning cannot be by itself rather it needs to be combined with actions and reflection. Weick (1979) who states that learning is about making sense of the past has proposed this view of retrospective sense making. Thus, one moves away from the traditional view of thinking before action to a world that is *"enacted"* where one can only define reality through interpreting the past (Mintzberg et al., 1998:198). According to the learning school, strategies become real through a cycle of patterns, plans and perspectives that ultimately guide behavior (ibid). The learning school provides a well grounded opposite view to the rational schools of thoughts (Design, Planning and Positioning) (ibid).

Even though the learning school provides new views of strategy formation in organizations, it has still received some criticism (Mintzberg et al., 1998). For example, if an organization is facing a crisis situation, being focused on learning from it might not serve the organization well (Mintzberg et al., 1998). Rather it might be best to in that instance to have a strong leader with a clear vision (ibid). Learning can also drive the organization into strategic drift, which means that the organization moves away from their core strategies (ibid). Too high focus on learning can push the organization into developing strategies that was never intended (ibid). Learning can also be time consuming and in the end expensive (ibid). Despite its downsides, the learning school of thought provides simple methods to strategy formation and has contributed with the processual learning, collective and individual, view of strategy (ibid).

6.1.2.1. Organizational learning

Organizational learning (see App. 15.2.9 for details) refers to knowledge creation across an organization that is communicated and incorporated into the strategy and the management of the organization (Kim, 1998). Individual learning is a subset of organizational learning and the organization can only learn if the employees embody their learning's with the organization's beliefs, routines and strategies (Kim, 1998). Organizational learning can be defined as being dependent on the routines of the company, previous paths and history as well as targets the company has set for itself (Levitt et al., 1988). Companies tend to foster learning by looking at the past and let that guide behavior going forward. Kahneman et al. (2011) support this statement by acknowledging that previous learning and decisions taken when they make decisions influence managers. They define this fact as the sunk-cost fallacy phenomenon, which means that people tend to continue on a path because money/time/effort already has been invested into it (ibid). It is further argued that companies learn from previous experiences that contribute to changing the decision process in the

company (Kunreuther et al., 1997). Prior to a catastrophic event, a company might have been stuck in a competency trap that guided them in how to act, take decisions and comply with certain rules of thumbs. However, after the catastrophic event, the company will be able to renew their way of acting and decision-making. Nonaka (1988) agrees with this point and states that an organizational crisis does not have to be a negative thing. Rather it can assist in developing new learning and provide a sense of self-renewal, thus it should be regarded as a creative process (Nonaka, 1988). Kim (1998) further states that companies are said to be more prone to undertake changes when they have been faced with a crisis. In order to undertake change, companies need to make sure that they the right tacit and explicit knowledge to overcome the crisis situation fast (ibid). It might even be possible for companies to turn a crisis situation into a growth opportunity and higher competitiveness vis-a-vis competitors (ibid). The Lawson convenience store in Japan was one success story from the triple disaster (WEF, 2012a). Lawson was able to continue its operation and reduce financial losses (ibid). The company had learned from the Kobe earthquake disaster and they implemented a detailed disaster recovery plan, which was reassessed twice a year (ibid). Lawson now makes use of a network approach with distributed leadership enabling every manager to make critical decisions (ibid). Kim (1998) put forward arguments that the more previous exposure a company has to a crisis situation, the higher amount of organizational learning the company will develop and more innovation can become the outcome. He goes on to argue that the more crisis events the company has been exposed to the more they are aware of their performance gap, namely what it takes to perform better to a similar crisis in the future (Kim, 1998).

6.1.3. Power school

The power school is founded on the notion of strategy formation being based on certain influencers such as micro and macro influencers (Mintzberg et al., 1998). The influential scholars in this school of thought were Allison (1971) with his contribution of internal politics as micro influencers, Pfeffer et al. (1978) on macro power and Astley (1984) on *"collective strategy"* as a macro influencer.

It refers to strategy making as a political process within the organization that involves certain types of games e.g. budgeting game, lording game, sponsorship game, whistle-blowing game etc. Thus, this is known as the micro power influencer of an organization. The political process of strategy formation involves many actors that have their own interest in mind rather than a common, unified one (Mintzberg et al., 1998). This can thereby influence the strategy formation process (ibid).

Additionally, it acknowledges the macro power influencing organizations. Thus, pressure from suppliers, customers, buyers, unions, competitors are influencers to an organization that can influence the strategy formation (ibid). One tool that organizations can undertake to be able to understand and map the pressures from external forces is through a stakeholder analysis (ibid). Furthermore, research within the power school has identified strategic maneuvering as one way to control the behavior of external players (ibid). This topic has been debated by Porter (1980) in his book on Competitive Strategy. This is similar to one of the five P's of strategy, namely ploy (ibid). Within this school one can also find literature on network type of strategies. Thus, raising the awareness to the thoughts of collective strategy, strategic alliances and strategic sourcing (ibid).

In the power school scholars do not acknowledge leadership, culture and strategy to a large extent (Mintzberg et al., 1998). Rather the only focus is on power influencers, however Mintzberg et al. (1998) argue that this is not enough in strategy formation, which might lead to that the organization misses patterns forming through time. Politics within organizations is important to ensure that necessary change is undertaken, however it can also obtain too much focus where other issues that are more important are disregarded (ibid). Putting criticism aside, this school will be present in many situations in strategy formation especially when an organization goes through periods of major change or of flux, where the power of actors will influence no matter what (ibid).

6.1.4. Environmental school

The environmental school views the organization as passive and sees the environment as dictating the terms (Mintzberg et al., 1998). The environment was involved in the positioning school however it was rather seen as economic forces (ibid). The environmental school further states that the environment is the main actor in formulating strategy (ibid). It is imperative for organizations to remain passive to the environment and adapt accordingly, otherwise they might get *"selected out"* (ibid:288). Leadership is seen more as possessing a passive role that has the role of making sure to understand the external environment and adapt accordingly. This phenomena often leads to companies differentiating themselves in certain specific niches and operate in clusters. Contingency theory is the foundation to the environmental school and it asserts that the organization is dependent on some contextual factor, in this case the environment (Mintzberg, 1979). Population ecology is another approach in which the environmental school takes inspiration from (Hannan et al., 1977). Population ecology argues that an organization obtains its structure and character directly after having been founded and not through adaption as contingency scholars believe (Mintzberg et al., 1998). The environmental school further considers institutional theory that looks at the environment

either as bring made of economic (e.g. money, land, machinery) or symbolic resources (e.g. reputation, leaders past achievements etc.) (ibid). The organization need to live up the normally highly complex, norms set by the interaction between key stakeholders. This needs to be done to ensure success of the organization.

Institutional theory uses the term institutional isomorphism (Meyer et al., 1977), which relate to the process of imitation. It is divided into three types: coercive, mimetic and normative (ibid). Coercive isomorphism relates to pressures to live up to regulation and standards (Mintzberg et al., 1998). Mimetic isomorphism refers to organizations copying other successful organizations (ibid). Normative isomorphism relates to professional experience influence e.g. expert opinions (ibid).

Oliver (1991) put forward critic to institutional theory and identifies five strategic responses to deal with environmental influences and pressures. These are (1) acquiescence, (2) compromise, (3) avoidance, (4) defiance and (5) manipulation (ibid). The element of contingency theory in environmental school has its downsides as it views the environment too abstractly (Mintzberg et al., 1998). Furthermore, it is argued that an organization does not face a complex and turbulent environment at all times, rather it is occurring in phases and periods (ibid) much like with natural catastrophes.

6.1.5. Summary of strategy formation schools

The schools of thought put forward exemplify how diverse the literature on strategy formation and strategic change is and has been throughout time. Evidently, it has been important to cover the various schools to be able to fully understand the strategy formation process. However, not all of these schools of thought are relevant for this paper. The schools of thought that are most relevant and important for the purpose of this paper is the power-, cognitive-, learning-, and environmental schools. The power school is seen to be relevant as the company may transform based on micro or macro influences, such as competitors or the like. The cognitive school is relevant due to the acknowledgement of managers' role in strategy formation process, which this paper emphasizes. The learning school of thought is relevant to acknowledge as it is argued that organizations learn from previous natural catastrophes. The environmental school fits the scope of this paper as it acknowledges external forces impacting organizations that lead them to react e.g. the influence of a natural catastrophe and other external influencers. This is also what this paper aims to convey. These are vital to be able to understand how this paper see the strategy formation process in an organization and to be able to draw conclusion upon the primary research collected.

6.2. Conclusion

As to be seen, each school of strategy formation takes a different view of how an organization will pass from one configuration to another. The type of formation process that firms will undergo will also determine how they will change their supply chain strategy within the light of natural catastrophes. The types of changes that could be undertaken will be discussed in the following.

7. Transformed configuration

Having brought forth the supply chain natural catastrophe return risk paradox, as well having discussed the transformation process that international organizations may go through to better manage supply chain disruptions due to natural catastrophes in the future, the paper will now bring forth some potential changes that firms may undergo to better deal with supply chain disruptions.

As has been shown in chapter 5 there is a mismatch in terms of trends within supply chain strategies and the increasing impact and probability of natural catastrophes. Taking this as a point of departure and in consideration of the type of transformation that a firm will undergo, some of the potential changes will be discussed. However, as it has not been possible to locate any studies dealing with change in the supply chain due to a natural catastrophe, this chapter will have a somewhat hypothetical approach in nature. To circumvent this, the chapter will try to draw upon literature pertaining to related fields of study.

To provide for a structured discussion of the potential changes a firm could undergo, the classification scheme of supply chain trends, as to be seen in Figure 5 and natural catastrophes, as to be seen in Figure 7 will be used. In these figures the supply chain trends have been divided into those pertaining to the location, design and management of the supply chain and the natural catastrophes have been classified along their probability and impact of occurrence. As has been previously argued, the occurrence of natural catastrophes, alongside their probability and impact of occurrence, is location specific. As such, it can be hypothesized that supply chain location is related to the probability (mostly) and impact of natural catastrophes. Given that a part of the supply chain is located in an area affected by a natural catastrophe, the supply chain design and the supply chain management then determine the actual disruptive impact that the natural catastrophe can have on the supply chain. This is shown in Figure 11: Supply chain strategy trends and natural catastrophe trends.



Figure 11: Supply chain strategy trends and natural catastrophe trends

Given this way of conceptualizing the relationship between supply chain trends and natural catastrophes, the different change options will be discussed along those pertaining to the supply chain location, supply chain design and supply chain management. What has just been discussed assumes that the firms will actually undertake change. However, given the discussion put forth in chapter 6, it is not a given that firms will change based on an event such as a natural catastrophe. As such, it is necessary to, apart from the previous outlined, also discuss if the company will actually undertake and change or not. This discourse will be brought forth in the following sub-chapter. According to Sodhi et al. (2012) companies can apply three approaches to supply chain risk: (1) accepting, (2) avoiding and (3) mitigating. By accepting the risk that refers to the company doing nothing other than relying on the insurance company if a supply chain disruption would occur (ibid). By *avoiding* the risk the company takes preventive measures (ibid). Even though these approaches can be sufficient in terms of certain risks, Sodhi et al. (2012) argue that companies are mostly focused on *mitigation* approaches, that refer to minimizing the impact that a risk pose. Within the context of the paper, the avoidance of risk is mostly related to the supply chain location strategies where the mitigation of the risk is mostly related to the supply chain design and supply chain management. These will be discussed in the following.

7.1. Supply chain strategy change

From one perspective, supply chain strategy change may be unlikely. According to the review of the literature of Klibi & Martel (2009) many firms have become increasingly aware of the necessity to increase the robustness of their supply chains after the events of the 9/11 or the Hurricane Katarina in New Orleans. However, despite this awareness, few firms have actually done anything about it (Lee, 2004; Sheffi, 2005). The reason being that many of the strategies have been implemented to increase their performance (ibid) as previously described. Trying to make their supply chains more robust will negatively influence these efforts (Hendricks & Singhal, 2005). Furthermore, according to Simchi-Levi et al. (2009), those risk, which are most unknown, and the most difficult to control are natural catastrophes, which are difficult to predict in terms of their likelihood of occurrence and consequently makes them a challenge to be managed (ibid) and consequently change the supply chain strategies accordingly. From this perspective, companies may not change their supply chains in the face of natural catastrophes.

From another perspective, supply chain strategy change is more likely. The WEF (2012c) remarks that many of the world's supply chains are not flexible enough to deal with the permanent volatility in the world as they were built on the premises of stability. In a study conducted by the BCI (2012), 92% of the 17 companies interviewed stated that they had reviewed their supply chain strategies after the earthquakes in Japan and New Zealand in 2011, of which 70% changed their supply chain strategies thereafter (BCI, 2012). Though not necessarily from a perspective of change, but rather awareness, according to McKinsey's (2010) Global Survey on Supply Chain Management, environmental concerns will become a significantly higher priority in the future. However, there is a nearly equal split between companies that feel prepared and those that do not feel prepared to deal with increasing environmental concerns over the coming five years (McKinsey, 2010). Given that companies decide to react upon their unpreparedness, this will also trigger them to change their supply chain strategies. However, as found by Lee (2004) and Sheffi (2005), awareness may not necessarily lead to action.

As is illustrated in the above discussion, there are different views with regards to supply chain change in the face of natural catastrophes. Given findings by BCI (2012), Lee (2004), Sheffi (2005), and McKinsey (2010) the following hypotheses 3A and 3B will be brought forth. Having discussed the supply chain strategy change from a general perspective, the following will discuss the supply chain strategy change by focusing on the individual strategies.

7.2. Supply chain location and natural catastrophe probability and impact

As was previously established, the location of the supply chain is a major concern in terms of natural catastrophes. Consequently, and based on the 17 companies interviewed after their impact from the Japan and New Zealand earthquake of 2011, those that changed their supply chain strategies focused on getting supplier from new regions, moving services, and localizing manufacturing (BCI, 2012). As to be seen, some scholars also share this view. As such, Knemeyer et al. (2009) states potential countermeasures that could prevent the supply chain from being severely hit by catastrophic event. His arguments touch upon configuration decisions. Companies operating in high natural catastrophe prone areas should consider to shifting their location of facilities to areas with low natural catastrophe risk (ibid). McGrath & Hoole (1992) claim that multiple plants around the world are of benefit to the organization. Furthermore, Simchi-Levi et al. (2009) also recommend building room for extra capacity in different nations and areas, or shift parts of the production to other places with spare capacity, which will also allow an increasing amount of global coordination and flexibility versus competitors (ibid). Sirkin (2011) further proposes the strategic measures of localizing the organization's supply chain to ensure low disruption. Thus, organizations should make use of local manufacturing processes, which would enable them to cater to local demands and at the same time reduce the operational risk (ibid). Based on this, the hypotheses 4A, 4B and 4C will be formulated.

7.3. Supply chain design and natural catastrophe impact

According to their review of the literature on operations management, Benito et al. (2010) claim that firms can increase their ability to deal with uncertainty in the environment by increasing the flexibility of their supply chains (e.g. Swamidass and Newell, 1987; Prater et al., 2001; Chang et al., 2002; Llorens et al., 2005; Martinez and Perez, 2005). This may lead firms to focus increasingly on agility and create hybrid supply chains, which as brought forth by Trmack & McCormack (2009), are the best type of supply chains from a practical point of view as they incorporate the flexibility and responsiveness of an agile supply chain and the reliability and low variability of a lean supply chain. Based on the research of the 17 companies interviewed from the BCI (2011) study after their impact from the Japan and New Zealand earthquake of 2011, those that changed their supply chain strategies focused on reviewing stock levels and diversifying their supply (BCI, 2012). Furthermore, in 74% of the cases, the respondents of the BCI (2011) claim those just-in-time/ lean practices are part of the cause for the disruptions to occur. McGrath & Hoole (1992) as well as

Simchi-Levi (2009) come to add that excess capacity and amount of redundancy is advisable (McGrath & Hoole, 1992). Sodhi et al. (2012), Simchi-Levi (2009) and Knemeyer et al., (2009) complement this by recommending keeping strategic stock. This strategy involves keeping stock only at certain locations where several nodes and supply chain partners in the supply chain can easily utilize the stock (Sodhi et al., 2012). In the face of a catastrophic disruption, these stocks can be utilized in the affected areas that enable a fast response mechanism (ibid).

Furthermore, Simchi-Levi et al. (2009) also recommend that in situations of more control and certainty it may be sensible to hedge out the supply by for example increasing the number of suppliers. Sodhi et al. (2012) complement this by recommending utilizing a flexible supply base to overcome the issues of using a single supplier that can limit the success in the case of a major disruption. The flexible supply base can ensure that a company can sustain its production and supply of materials if a disruption were to occur. Sodhi et al. (2012) put forward a supply chain alliance network as one extreme form of such a flexible supply base that can act as a "safety net" (ibid: 100). Other scholars have also acknowledged the multiple supplier strategy as a superior one. Sirkin (2011) states that differentiating sources of supply and ensuring that there is at no time only one key supplier is crucial. This multiple sources approach to supply chain management can assist in making companies less vulnerable to catastrophic events (ibid). He goes on to argue that the suppliers should be separated by distance and to a certain extent be independent suppliers (ibid). Hofmann et al. (2005) continues on a similar line of argument and state that the most common approach to mitigating supply chain disruptions is to make use of a dual source strategy. Thus, ensuring that there is never one single supplier that is providing major parts for the final good (ibid). Martha et al. (2002) add by emphasizing the need to possess alternative sourcing contracts for critical components of a product. However, seeing as supply chain management is much about controlling costs, keeping a dual/multiple sourcing strategy alive might be costly (Silvia et al., 2011). Thus, it might not be an option for some companies. For these companies, a tailored risk management approach should be implemented as proposed by Chopra et al. (2004). This also falls in line with Lee's (2004) definition of the triple-A supply chain, where one element is concerned about being able to adapt to changes through agility. Based on these findings, hypotheses 5A, 5B, and 5C have been formulated.

7.4. Supply chain management and natural catastrophe impact

Supply chain strategy changes with regards to management may also be changed. These will be discussed in the following.

Business contingency planning (BCP) is an integrated part of business continuity management, which ensures that risks and vulnerabilities are identified throughout an organization (Jones, 2011). BCP involves the response activity undertaken after an incident has occurred (ibid). BCP can be seen as an instruction or a roadmap that directs an organization's actions in response to a disruption (ibid). Additionally, one can see a business continuity plan as an emergency plan to manage a disruption in your organization (Lavell, 2004). BCP aims to reduce the impact of a disruption on an organization and make the disruption manageable (ibid). Acknowledgement has been made that there are no international accepted standards for how to conduct business continuity planning (Momani, 2010). Time is crucial with supply chain disruption risk (ibid). Sodhi et al. (2012) argue that companies need to have systems in place that enables the company to respond in a timely manner to ensure low disruption. BCI (2012) found that only 8% of all of the suppliers have BCP in place and less than the majority checks their effectiveness (BCI, 2012). These firms also increased their focus on BCP (BCI, 2012). Consequently, hypothesis 6A has been formulated.

Strategic supply chain risk management relate to top management decisions on design or coordination aspects of the supply chain (Sodhi et al., 2012). Supply chain risk management should be defined as a multidisciplinary area that is consisting of four steps: (1) identifying risk, (2) accessing risks, (3) mitigating risk and (4) responding to risks (ibid). BCI (2011) found that supply chain risk management is becoming increasingly important for short and long term. As such, 28% of BCI (2011) respondents claim they have to prove to their customers that their supply chains are resilient; this is an upward trend. The survey of the 17 companies impacted by the earthquakes in Japan and New Zealand in 2011 claimed that they increased their scanning of customers and suppliers (BCI, 2012). The relevance for this paper is actions taken prior to or as a response to natural catastrophes. Thus, focus will only be put on mitigation of risk and responding to risks.

Another tool is simulation, which enables the company to model the effect that a potential disruption could have on the supply chain (Levy, 2005; Knemeyer et al., 2008). Thereby, ensuring that the company can minimize the impact of the disaster if they know where and how it would affect the supply chain. Another tool that is proposed by Wu et al. (2007) is to make use of Disruption Analysis Network (DA_NET) to model how the disruption affects the supply chain.

Another simulation technique is that of scenario planning, which can be defined as a process that enables managers to make an educated guess and to understand the implications of a certain decision or action (Ringland et al., 2006). Scenarios can be helpful in providing insight into how to prepare for a certain future and assist managers in taking decisions that are better and more effective (Ringland et al., 2006, Wack 1985). Scenario planning can be seen as a tool to influence manager's perception of a certain decision, action or direction. Scenario planning has for a long time been considered as a strategic tool and aiding the long-term decisions of a company (Deep et al., 2010). However, due to the increasing risks facing companies, companies are forced to take important decisions for the short term. Thereby, making scenario planning an important tool (ibid). This results in hypotheses 6B and 6C.

Changing communication and monitoring up and down the supply chain was a change undertaken by some of the 17 companies surveyed after the earthquakes in Japan and New Zealand in 2011 (BCI, 2011). Increasing collaboration in the supply chain network will reduce risk and can be done through information sharing and planning (Christopher & Peck, 2004). This is complemented by McGrath & Hoole (1992) who claim that effective communication systems and knowledge of the current inventory, suppliers, and factories is necessary to make this work. Simchi-Levi (2009) suggests creating a supply chain community that is able to adapt by possessing the same type of culture and consequently be able to react quicker, together. A part of this is also de-centralized decision-making, which can improve the resilience and responsiveness to a disruption risk (Cohen et al., 2007) and increase reliability (Roberts et al., 1994) due to information regarding potential issues being closer to the issue (ibid). It is important to ensure real-time information and information transparency throughout the supply chain (Silvia et al., 2011). This focus on communication also falls in line with Lee's (2004) definition of the triple-A supply chain, where one element is concerned about aligning interests along the supply chain. Based on this finding, the hypothesis 6D has been formulated.

7.5. Other supply chain strategy changes

Apart from the previously mentioned changes in the supply chain strategies, it is possible to find further strategy change recommendations in the literature. However, given the limited amount of space in this paper and the ambition to circumvent lengthy surveys, some of these strategies will be presented and considered as "other" within the research design in the following section. These are to be found in App. 15.3.1.
Having provided a theoretical discussion of the configuration with regards to the supply chain natural catastrophe return risk paradox, the strategy formation process an organization may undergo, provided a review of the literature discussing supply chain strategy change, and formulated hypotheses based on this, the following section is concerned with further exploring the topic under scrutiny, prove the hypothesis stipulated, as well as to provide an answer to the general and sub-research questions.

7.6. Conclusion

As to be seen from the above discussion, an array of possibilities to shift away current supply chains strategies from the type of supply chain strategies described in Chapter 5 that will allow them to become less vulnerable to the risk of natural catastrophes, and possibly even circumvent these. These has been formulated in a set of hypotheses displayed in Figure 12. The explorative research will attempt to discover if and which type of the above changes will be undertaken.

	Hypotheses
3A	International organizations will change their supply chain strategies as a response to a natural catastrophe if they have experienced a supply chain disruption due to a natural catastrophe previously.
3B	International organizations are less likely to change their supply chain strategies as a response to a natural catastrophe if they have not experienced a supply chain disruption due to a natural catastrophe previously.
4A	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will shift current facilities away from natural catastrophes prone areas.
4B	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will stop setting up new facilities in natural catastrophes prone areas.
4C	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will decrease the number of suppliers from natural catastrophes prone areas.
5A	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will increase their inventory of finished goods.
5B	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will increase their inventory of raw materials.
5C	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will increase their number of suppliers
6A	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will increase their focus on contingency planning.
6B	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will increase their focus on risk management.
6C	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will impose risk management on their suppliers.
6D	Of the international organizations that decide to change their supply chain strategy as a response to a natural catastrophe, they will improve their supply chain communication.

Figure 12: Hypotheses (Transformed configuration)

8. Conclusion to theoretical framework

The current configuration that companies face, where supply chain strategies have become increasingly lean, complex, vulnerable to risk and interconnected around the globe – thereby adding to the return of companies - and where natural catastrophe are becoming an increasingly occurring and devastating phenomena that, as has been illustrated, are becoming a rising source for supply chain disruptions – thereby adding to the risk exposure of companies – bring forth a return risk paradox and a consequent call for transformation. Depending on the strategy transformation process that the firm will undergo, as has been described through the different schools of strategy, the supply chain strategy change will or will not be undertaken. Given that companies decide to transform their current configuration, alterations in the supply chain strategy may emerge. The types of changes have been described along the dimensions of supply chain management, supply chain design and supply chain location changes. Changing the former two will mitigate the risk and the impact, changing the latter will eliminate the risk and reduce the probability for disruptions to occur. The research undertaken will further explore this and try to understand if and how firms are going from one state of configuration to another through their transformation process.

Section 3: Research

The section will cover the methodology and results, as well as a discussion of these and will conclude with limitations and further research steps.

9. Methodology

The methodology is vital to provide a framework for answering the research problem and other questions identified through the research process (McDaniel et al., 2002:63; Kerlinger, 1986: 279). This underpins the importance of this chapter and provides a control mechanism for the research activity (Chisnall, 1997:31).

The methodological approach used in this paper is one of induction combined with elements of deduction. Langley (1999) argues that when using process data (e.g. events, activities and choices over time), one should not limit oneself to only inductive or deductive research; rather a combination or simultaneous use is encouraged. Induction is a research strategy that starts with an observation and from that develops theory (Bryman et al., 2003). Deduction starts from theory and

then turns to findings (ibid). The former example was the way this paper came about, with an observation in the world. The researchers identified that natural catastrophes have been occurring more frequently in the recent years and their impact has been bigger for both societies and for businesses (Munich Re, 2011a). Specifically, the Tohuko earthquake in Japan and the flooding in Thailand in November 2011 were the drivers and motivations. After conducting more research about natural catastrophes, the authors enabled to see that there is in fact an increasing pattern of natural catastrophes occurring. This finding led to some tentative hypotheses about natural catastrophes impact on businesses.

Deduction has been applied in the later stages of the project, when more research and information was gathered. Theory was available to underpin the pattern that was seen in the market and enabled concrete hypotheses to be made. Thereafter, the research phase began with real life examples of how natural catastrophes can impact companies; these trends and stories were uncovered through interviews and online survey.

9.1. Research design

The research design refers to the blueprint of the research and includes choice of research approach, research methods and data analysis.

The nature of this study is explorative, as the specific topic has not been researched previously. Explorative research refers to a study that sets out to uncover patterns, ideas and hypotheses about an unknown or premature topic (Yin, 1994; Richey et al., 2007). The purpose is to obtain knowledge and develop preliminary theories that can be relevant for future studies, as it is understood that an explorative study cannot provide definite answers to the topic (Richey et al., 2007). Explorative research can be based on quantitative and/or qualitative techniques with the purpose to obtain large amounts of data and impressions about the topic under scrutiny (ibid).

The data of this paper is based on process research, where the focus is on events, activities and choices that occur over time and comprises mainly storytelling about these events, activities and choices (Langley, 1999). Since the aim of this paper has been to infer choices about strategy formulation, which is a complex process, this research has been comprised of both a qualitative and quantitative approach with high levels of iteration between the techniques based on obtained findings (Berg, 2001). With the purpose to conduct an explorative study, as the topic is new and rather unstudied, the authors conducted interviews to uncover stories, feelings, specific actions and detailed real-life examples (Patton, 2002). Thus, the purpose is to obtain high quality data that can

be interpreted through narratives. However, as interviews possess certain limitations of generalizability, a survey was conducted o uncover trends among a larger sample (Blumberg et al., 2008). Furthermore, as an explorative study aims to obtain masses of data to uncover patterns and future hypotheses, an online questionnaire was seen as an optimal research tool and a good complement to the more in-depth nature of the interviews. The population under scrutiny was specifically supply chain professionals or experts with many years of experience in the field preferably with a management position. The sample obtained was used to make inferences on the population (Berg, 2001).

Previously, qualitative and quantitative methods were not suppose to be combined and utilized together, rather they were seen as mutually exclusive conceptual paradigms (Rossman et al., 1994; Waysman et al., 1997). However, in recent years many scholars have seen the benefit of combining these two approaches to cope with complex problems that are best understood by combining the qualitative and quantitative lens (Waysman et al., 1997; Krishna et al., 1999). It is further argued that by combining research methods, the study become sturdy and superior to a single method study (ibid). Rossman et al. (1984, 1991) put forward three reasons why combining research methods is the superior option: to validate the methodologies through triangulation; to ensure deep and rich analysis; and to uncover paradoxes and new knowledge that would otherwise be overlooked. The main aim by combining these two methods is to, as Greene et al. (1989) puts it, to expand the research. Thus, learn and uncover different phenomenon in the same study. In this paper, this will be exemplified through the in-depth stories uncovered through the interviews conducted and the generalizability of natural catastrophes impact on supply chain strategies unfolded through the online questionnaire. The second aspect that acted as another underlying reason for conducting mixed-method research is development (Greene et al., 1989). This refers to the continuous development of the methodology as time and research passes. In this research study, the first interview was the basis for many of the questions in the online questionnaire. Thus, one can understand the research process as consisting of three phases. Phase 1 of the research was the initial interview with a CEO of a semi conductor company. Phase 2 comprise2d of our distribution of our online questionnaire and Phase 3 consisted of our interviews with senior managers in the supply chain profession. The third aspect that was a motivating factor for our research design was elaboration (Waysman et al., 1997). By combining the research methods, one obtains more complex and detailed information making it possible to draw a more comprehensive picture by drawing on many sources of information, thus making use of methodological triangulation (ibid; Thomas, 2004). Thereby, adding more to the field of supply chain management.

In accordance with the combination of research methods, this paper makes use of other secondary sources of data. Archive documents, company material, previous studies and newspaper articles have been widely used. To ensure that the research process was objective when searching for secondary data sources, keywords were used mainly to guarantee no terminological biases (Berg, 2001). Constant comparison between theory, archive documents and research findings was conducted to be able to follow the process of triangulation (McCann et al., 2003). Triangulation enhances the quality of the study by combining several methodologies in one study (Denzin, 1978). This paper does not only make use of methodological triangulation but also data triangulation and theory triangulation (Thomas, 2004). Data triangulation refers to obtaining data from different people, places and in different time periods (ibid). Theory triangulation means to combine different types of theories to guide the research (ibid).

In qualitative research the interviewer is the important tool that ensures that the research is sound and credible (Glofshani, 2003). In quantitative research on the other hand, it is the scales and instrument construction that ensure credibility (ibid). A qualitative study that possesses a high level of quality can ensure that the readers understand a situation that would otherwise be interpreted as confusing (Eisner, 1991:58). The qualitative nature of the study serves the purpose of *"generate an understanding"* whereas the quantitative research has a *"purpose of explaining"* (Stenbacka, 2001:551). A qualitative study will not be evaluated upon the same criterion as a quantitative study when it comes to the quality of the study. Rather a qualitative study will be evaluated upon credibility, neutrality/confirmability, consistency/dependability or applicability/transferability (Lincoln et al., 1985). In quantitative research it is centered around reliability and validity (Golafshani, 2003). Reliability refers to whether the results of the research can be replicated (ibid). Validity refers to the applicability and accuracy of the measurement being used and if these measurements are evaluating what they suppose to evaluate (ibid).

9.1.1. Limitations to mixed-methods research design

To fully utilize the benefits of a mixed-methods approach one must be skilled in designing, analyzing and interpreting the findings of the combined methods (Waysman, 1997). Thus, it demands several specific skills that can be difficult to acquire in a team (ibid). However, this study has been conducted with a two-man team with diverse set of skills and qualities, ensuring that the mixed-methods approach can be fully utilized. Another limitation is the time duration of such an

approach. It is time consuming to prepare, conduct and analyze the findings from such a research (ibid). Additionally, the research might put forward contradictory findings that can hinder or challenge the basic assumptions of the research (ibid).

9.2. Data collection method: Online questionnaire

To be able to answer the problem statement and the identified hypotheses, an online questionnaire will be performed. The reason for using a questionnaire is to uncover information and sentiments about a certain topic (Mc Daniel et al., 2002:163). In order for a questionnaire to be of high quality, a diverse set of respondents is needed with meaningful answers (Blumberg et al., 2008:278).

Questionnaires come in many various types making it difficult choosing the one that provides a perfect fit to the aim of the research. Questionnaires can be conducted over the phone, face-to-face, email or Internet (Blumberg et al., 2008). When choosing the method providing the best fit, one needs to assess the following aspects (1) the information that is needed, (2) the sample, (3) participation and (4) resources e.g. time and budget (Hair et al., 2003:272). By determining these different aspects in relation to this research, one can conclude the best-suited approach of questionnaire method.

The information that is sought to provide an answer to the problem statement is data regarding the impact that natural catastrophes have on current supply chain strategies and its potential future effect on the supply chain. Furthermore, information regarding if the perception of managers to act on these disruption risks has changed over recent years due to increase of natural catastrophes is important to understand. Thus, it is vital to obtain a large set of respondents coming from different types of industries, countries and nationalities.

The sample needs to be able to understand the questions and to be able to answer, thus possess the right type of knowledge to contribute to the research (Blumberg et al., 2008). This research is focusing on supply chain strategy, thus making supply chain professionals with a higher rank, such as manager, senior manager or executive level, relevant targets. It is assumed that possessing this rank, one is exposed to strategic matters on a daily basis. However, as this sample can be challenging to reach, the questionnaire can be extended to people with several years of experience within the field of supply chain management but that do not possess a management position. It is assumed that several years of work experience ensure that the person possesses a clear picture of strategic issues within supply chain management and can form their honest opinion about the topic.

Participation in the questionnaire is likely to be highest if it is performed online. The reason for this is due to the flexibility to answer the questionnaire when it is best suited and it would be challenging obtaining a worldwide sample through personal contact, due to time difference and conflicting schedules (Hair et al., 2003). Thus, making the online distribution of the questionnaire the superior one.

To ensure high response rate and high level of comfort in responding to the questionnaire, ultimate transparency is needed throughout the questionnaire. This is ensured through the explicit introduction covering the purpose, motivation, research design and anonymity towards the respondents. Anonymity is important and respondents cannot be identified based on name, gender or age. It is possible, for the ones that are interested in the research, to state their email upon completion of the questionnaire however this is entirely voluntary. Furthermore, throughout the questionnaire, definitions and headings ensure to make the questions as understandable as possible.

Resources refer to time and money that the researchers possess to conduct the research (Hair et al., 2003). Conducting questionnaires on the phone or face-to-face is time consuming and deems much resources. In this regard, the online questionnaire is an optimal tool as it is simple to administer and provides the possibility to send out to a large group of people in one instance, thus it needs less time invested to succeed (Hair et al., 2003; Mc Daniel et al., 2002). Online questionnaire provides a cost efficient alternative with low resource intensity, potential for high response rates and the possibility to reach a wide range of respondents across the world (ibid).

The arguments put forward clearly outlines that online questionnaire is the most feasible option that can enable a sound research within the scope of this project.

9.2.1. Questionnaire design

Having presented the methodology of the questionnaire, it is now important to understand how the questionnaire was built in terms of the process used, types of questions and scales applied. This can be seen in App. 15.6.

9.2.1.1. Process

To design the questionnaire, much knowledge of relevant theories and trends in the market was acquired. This information served as a basis for how to construct the questionnaire. The actual process of designing the questionnaire was of high iterative nature, meaning that many of the questions, ordering and scales were based on information from the first interview (phase 1) and

previous accepted questionnaire designs within the area of focus. The first step of the design of the questionnaire was to develop the methodology described in the previous chapter (Walonick, 2010). Thereafter, the questionnaire was developed in the online survey tool, Surveyexact, that enables easy, effective and professional questionnaire building. Having constructed the questionnaire, a pilot testing was completed with seven respondents. The pilot testing served as a tool to ensure that the questions were understood correctly and guaranteed any other issues to be corrected (ibid). The questionnaire was edited according to the feedback given (ibid). Finally, the questionnaire was sent out to the research sample.

9.2.1.2. Type of questions

There are two types of questions that can be asked, either open-ended or close-ended questions (Chisnall, 1997:144). By using open-ended questions, the respondent can answer the question as they see fit (ibid:145). Making use of open-ended questions can ensure elaborate and colorful answers, however it might lead to misinterpretations and wrong answers (ibid). Thus, from the researcher's perspective, this alternative might lead to loss of information and low quality output (Chisnall, 1997:136). Open-ended questions pose a greater constraint on the researcher in terms of analyzing the responses, as it is time consuming and higher workload to codify the answers (ibid). However, as the nature of the research in this paper is dependent on specific situations and actions, some open-ended questions are applied.

Close-ended questions are more limiting than open-ended questions, as response alternatives are given and the respondent can only pick from the alternatives specified (Chisnall, 1997). Close-ended questions are subject to fewer misinterpretations due to the lower degree of freedom in answering the question (ibid). However, one can argue that close-ended questions can provide for biases as the respondent might not find the answer alternative that he/she is looking for and the respondent might pick an alternative that is not the optimal one. The researchers have overcome this bias with the inclusion of 'other' in each question. Thus, ensuring that the respondent can always fill in the response that they see fit the best.

The questionnaire is designed with a combination of open-ended and close-ended questions, where both limitations of the question designs have been taken into account and overcome where possible. In general, the questionnaire serves the purpose of testing the hypotheses identified, thus various questions will be asked to be able to accept or reject the hypotheses. Furthermore, the questionnaire will add to the theoretical discussion by asking certain questions purely related to contextual theory. As the questions posed are vital for the outcome of the questionnaire (Chisnall, 1997), their formulation need to be considered in great detail and ensured that questions are posed that are easy to understand with little room for own interpretation (ibid). Therefore, unfamiliar words and expressions have been avoided. Questions have been kept short and precise, to prevent the respondent from being lost by lengthy questions (ibid). Acknowledgement has been taken to what the respondents feel about the topic and questions have been asked in accordance with this. This enhanced the motivation for the respondent to answer the questions (Blumberg et al., 2008).

9.2.1.3. Measurement scales

Throughout the questionnaire the Likert scale is the dominating scale used. By adopting the likert scale, every participant answers questions about their attitude to a certain topic by making use of a scale ranging from for example agree to disagree. The answer alternatives possess a number that enables interval data to be generated (Blumberg et al, 2008). These scores are summed and an average generated that give the overall measurement of the topic under scrutiny (ibid). The reason for adopting the likert scale to a large extent, is due to ease of computing averages imperative for the statistical analysis (ibid). Furthermore, the averages provide the opportunity to do comparisons across the entire sample or individual samples (ibid).

Having understood that the way of phrasing questions is imperative for the quality of the research, especially in terms of misinterpretations of wording etc., previous questionnaire designs have been the basis for some of the questions used in this study to the extent possible. The scales used were selected based on overall reliability of the study conducted. Seeing as this topic is rather unexplored with little previous research conducted, many of the questions had to be customized according to the purpose of this study. In general, the questionnaire is designed in such a way that depending on the respondents' answers, the questionnaire will funnel the respondent in corresponding chapters to match the answer of the respondent. This makes the questionnaire complex to understand but easy and professional on behalf of the respondent.

9.2.1.4. Background information

Background information is a standard introduction to any type of research and is purposeful to make correlation analyses (Blumberg et al, 2008). The list of alternatives for many of the questions included in this chapter have been inspired by Lloyd's risk index conducted on risk in supply chains and on general guidelines for basic background information (Lloyds, 2011). The second part of the background information, focused mainly on the company's operations, has been customized to fit

this study. The three first questions are relating to regions of activity related to sourcing, producing and selling products. Thereafter, two questions are included that ask about power of the company relative to suppliers and customers. These questions are based on the Porter's five forces concept of bargaining power of suppliers and customers (Porter, 2008). Lastly, the chapter of background information ends with a yes/no question regarding assessment of risk followed by an open-ended question for description of the strategies.

9.2.1.5. Natural Catastrophes impact

The chapter on past impact of Natural Catastrophes covers the type of impact the incident has on the supply chain of the company and its suppliers, which has been customized with to fit this study. This general structure was inspired by the initial interview conducted (see App. 15.5.1) as discussion was centered on both the disruption of company's supply chain but also on the suppliers'. The list of alternatives was compiled by the researchers based on heavy research on previous examples of supply chain disruptions. Having asked the sample of the past impact, it is important to ask what the consequence was of this impact. The scale used in this question is a 5-item likert scale, ranging from strongly increased to strongly decreased, with the possibility for answering 'don't know' to the three sub-questions. The sub-questions were relating the company's reputation, sales with existing customers and number of customers. The alternatives were picked based on the initial interview (see App. 15.5.1) and from real-life examples of companies previously affected by a natural catastrophe.

9.2.1.6. Natural Catastrophe perception change

Managerial perception has been researched based on three statements relating to change of perception, likelihood of natural catastrophes impacting your company and whether time/money invested pays off. These three statements were selected based on the study conducted by Barth (2011), who specified his research on managerial perception of disruption risk.

9.2.1.7. Past Natural Catastrophe supply chain change

This chapter of the questionnaire researched what the three main changes were that the company in question undertook. The list of alternatives have been clustered according to main topic e.g. facilities, sourcing, inventory, communication and risk management to ensure no misinterpretation. The list of alternatives used in the question has been inspired by the article by Knemeyer et al. (2009). On each of the alternatives there is the possibility to write more information if the respondent wishes to add further detail. Thereafter, the motivation of these changes undertaken is

examined through a list of alternatives clustered around internal and external motivations. The initial interview uncovered trends that competitive pressure could be one motivation for undertaking change. Therefore, this was researched by asking if competitors undertook any change and if yes, what three main changes were undertaken. Thus, being formulated in the same way as the previous question to guarantee ease of understanding the question and maintaining high response rate.

9.2.1.8. Future Natural Catastrophe supply chain change

The questionnaire ends with a final chapter on what future changes the company will conduct if any. If they will undertake any changes, the three main supply chain changes will be asked for. Thus, once again maintaining the same type of question as previously asked about supply chain change.

9.2.2. Limitation to online questionnaires

The fact that one cannot control whom the respondent is, poses a major limitation (Blumberg et al., 2008; Ilieva et al., 2002). In this paper, this limitation was overcome by ensuring to send out the questionnaire through relevant forums and groups on social media sites e.g. Linkedin and Xing. Another limitation is the low response rate generally obtained through an online questionnaire (Ilieva et al., 2002). Many targets tend to see questionnaires as time consuming and as spam, thus many target avoid answering such questionnaires (ibid). This limitation was minimized by sending out the questionnaire through personal contacts and through the snowball effect. (Blumberg et al., 2008) Also, the questionnaire was only sent to relevant targets where one could assume that they had a personal interest of the research findings. Therefore, the research findings were promoted as a gift upon completion of the research to the ones that were interested.

Another aspect that is difficult to overcome with online questionnaires is the risk for misinterpretations of words and definitions (Blumberg et al., 2008). Every person interprets wording differently especially if the questionnaire is distributed on an international basis, as many do not master the English language in the same way (ibid). Therefore, the authors ensured to provide definitions of words and topics, where it was necessary. Another way to overcome this limitation would have been to translate the survey into the various languages where distribution would take place. However, due to the time consuming nature of this inquiry, it was seen as impossible to conduct, as the questionnaire would be distributed globally. Additionally, by making use of pre-existing scales and questions, have contributed to reduce misinterpretations (ibid).

However, own customized questions to the research were needed making them a risk for misinterpretations. However, these questions were produced with a high level of due diligence.

Another limitation of an online questionnaire is the risk of it not representing the entire population that you are researching. This limitation has been overcome with a multimode strategy of utilizing emails, forums and social networks, to ensure as large exposure as possible (Ilieva et al., 2002). Willingness to participate in the research is another common limitation and risk of a qualitative study like a questionnaire (Blumberg et al, 2008). People might not want to participate as they (1) do not understand the point of the research, (2) mistrust or fear of participating or (3) find the questions too sensitive to answer (Blumberg et al., 2008). The research in this paper refers to previous experiences and actions taken in response to a natural catastrophe. This information might for, an executive person, be seen as sharing a business secret or competitive advantage. Making it barrier for answering the questionnaire and might result in respondents dropping out of the questionnaire. However, as the research is entirely anonymous this lowers the barrier of people taking part in the questionnaire.

9.3. Data collection method: Semi-structured interviews

Having outlined the extensive quantitative method, it is now necessary to describe the qualitative method used, namely semi-structured interviews. A research interview is based on interpersonal conversation between two people about a topic of mutual interest (Kvale, 1996b). Knowledge evolves through the interaction and dialogue between the two people (ibid). The research interview is not guided by a checklist rather an "unwritten script" (ibid:124). The interview guide serves the purpose to indicate the topics covered and the order of them in the interview (ibid). In this research study, the guideline was divided up into five chapters with carefully worded questions. The authors acted as an objective prober that did not try to influence the interviewee, thus similar to the miner metaphor (Kvale, 1996a). However, as mentioned previously, the authors acknowledge that biases are inevitable. The interviewer possesses an important role in the interview and their interpersonal skills can be crucial for the success of the interview (Patton, 2002). To successfully collect information from a qualitative method, like an interview, one needs to follow the following four parameters (1) get close to situation and relate to the person, (2) capture what is being said and body language, (3) include pure descriptions of people's interactions and (4) include direct quotations from the interviewees' (Patton, 2002). Preparing for the interview in advance is vital for its success, in terms of interaction and outcome of knowledge (Kvale, 1996b). A skilled interviewer should be

an expert in the topic being studied and have good sense of human interaction (ibid). An interview uncovers the what, why and how. Furthermore, prior to the initial interview, the researchers should have given consideration on how to analyze the data from the interview (ibid). Furthermore, one must acknowledge the feelings of the interviewee, as they might have anxiety or tension about how the research findings will be used (ibid).

The sample for the semi-structured interviews was similar to that of the questionnaire, namely management to executive level persons working within the supply chain profession. The sample should possess years of work experience within the field to and the company does not have to have been affected by a natural catastrophe.

The sampling for the interviews has been based on random sampling and convenience sampling (Blumberg et al, 2008). Cold calling and email contact has been made to set up interviews with companies in Sweden, Denmark, Germany and Japan. Furthermore, contacts and snowball sampling techniques have been utilized (ibid). This has been done due to time and money constraints.

9.3.1. Semi-structured interview design

Having understood the positive and negative aspects of semi-structured interviews, it is important to uncover the methodology used where the process and type of questions will be the focus.

9.3.1.1. Process

To design the semi-structured interview protocol, existing theories, research articles and newspaper articles served as inspiration. As the target sample was executive and manager level persons, much consideration was made to the formulation and precise nature of the questions. Furthermore, the protocol was developed and tested for language, wording and understanding with an external person.

The interview targets were provided with information material prior to the interview to ensure that the interview targets understood the research topic (Kvale, 1996b). The interviews were from 45 minutes to one hour in duration with many opportunities for the interviewee to discuss and share stories of previous experiences with natural catastrophes in their organization. The context was explicitly stated in the beginning of the interview (ibid). The initial interview served as a control measure for our questions and for the understanding. After the initial interview some of the questions were revised and some removed due to redundancy and relevance. Thus, the interview process has been highly iterative. Being open to feedback in the end of the interview is important for future interviews and for covering other issues the respondent might have (ibid).

To analyze the findings from the interviews, a thorough process was conducted. Initially, the interviews were transcribed to ensure that all details could be uncovered (Esterberg, 2002). Secondly, the transcription was coded for specific words that were reoccurring, rough categories that belong together and other keywords, also known as open coding (ibid). This enables the authors to uncover, among the eight interviews, if a common theme, category, overall phenomenon or specific wording was used (ibid). Thirdly, focused coding was used, meaning that each line was analyzed one by one to identify clusters of codes, repeating codes and larger themes among codes. The coding process was clustered into categories that were inspired by the work of Bogdan et al. (1998). This can be seen in Figure 13.

Category	Content
Context	Background information on the company and interviewee, supply chain design/coordination, supply chain strategy (sourcing, dependence on suppliers etc.), power structures in the supply chain
Situation	Natural catastrophes influence on the company, what type of natural catastrophes pose risk for the company, the exact event that occurred
Respondents perspective	How the respondent define the situation, respondent's emotions of the situation, typical phrases used in relation to the situation
Respondents perception	Respondent's perception of natural catastrophes
Process during event	Specific events that the company undertook as response of the natural catastrophe
Supply chain strategies change	The type of supply chain strategies changes that the company undertook as response of the natural catastrophe, the competitors' supply chain strategies changes that were undertaken as a response to the natural catastrophe
Future supply chain strategies change	The type of future supply chain strategies changes that the company will undertake as a response of natural catastrophes, the competitors' future supply chain strategies changes that will be undertaken as a response of natural catastrophes

Figure 13: Interview coding

Lastly, the remaining themes from these processes were put into an overarching table for all of the interviews (ibid). Interviews were conducted until they did not add further to the research, thus theoretical saturation was reached (Blumberg et al, 2008).

9.3.1.2. Types of questions

The interviews were guided by an interview protocol that served more as a tool for inspiration with only some questions that were obligatory to for the interviewee to answer. The protocol consisted of 15 questions with a similar structure as the questionnaire. It was divided up into the same chapters as the questionnaire with (1) Background information, (2) Natural Catastrophe impact, (3) Natural Catastrophe perception change, (4) Past Natural Catastrophe supply chain change and (5) Future

Natural Catastrophe supply chain change (see App. 15.5.9). Since the semi-structured interview is flexible, not all questions were answered but only the ones that were relevant for the interviewee and their company.

9.3.2. Limitations of semi-structured interviews

Semi-structured interviews possess certain limitations. The first limitation is relating to the risk of obtaining information and stories that are biased to a certain person's experience, values or culture (Blumberg et al, 2008). The second limitation of semi-structured interviews is the problem of replicating the study and obtaining the same answers (ibid). As many of the answers to an interview are personal and might be shaped by previous experiences, the exact same answers might not be obtained if the same study was to be conducted at another point in time. The third limitation is one of lack of generalizability (Blumberg et al, 2008). Lastly, the interviewer can influence the interviewe and interviewee in the way of posing questions (ibid). This can change the way the interviewee answers and thus, makes the study unreliable.

10.Results

Having described the methodology the chapter will present the research results. Given the fact that a mixed study approach was undertaken through the combined use of questionnaires and interviews, the results chapter will be structured accordingly.

10.1. Questionnaire results

The analysis of the questionnaire results commences with information on the raw data modification, response rates, data analysis approach, and background information. The results will be presented thereafter.

10.1.1. Data modification and response rates

To create a workable set of answers, the data had to be modified. Due to the limited space available, these modifications are discussed in App. 15.4.1.1. A total of n=107 responses beyond the first page were collected between June and July 2012. Upon data cleansing, n=75 were used in the final analysis, of which n=65 answered all questions. Yet, as n=75 contributed significantly they are used in the analysis (see Figure 14: Frequencies of Questionnaire Responses).



Figure 14: Frequencies of Questionnaire Responses

10.1.2. Data analysis

Given the explorative nature of the results, it was decided to – apart from a analysis of the data as given by the questionnaire – to also conduct a factor analysis. The reason for this is that the many of the questions in the questionnaire had multiple answer possibilities, meaning that when trying to find the relationship between the answers to two questions, a large amount of relationships would need to be analyzed. In order to simplify this, a factor analysis was conducted, whereby the questions to the multiple-response items where aggregated into a variety of factors.

Based on both the factor analysis as well as the direct output from the questionnaire, relationships were tested using both a contingency analysis (i.e. Pearsons Chi-Sqaure, Liklihood-Ratio Chi-Square and Fischers Exact test) as well as a correlation analysis (i.e. Pearsons Chi-Square etc.).

In order to analyze the data, the statistical analysis program JMP by SAS has been employed. Based on the recommendations on using JMP by McMurry (1992) the statistical data has been presented accordingly. However, given the scope of the paper, not all of the details can be exhibited in their full detail within this paper. Therefore, a bulk is to be found in the appendix.

Furthermore, and in line with general approach of statistical data analysis taken within the social sciences it has been decided to test all relationships based on a 95% confidence level. Unless otherwise specified, this will be the standard.

10.1.3. Background information

The majority of respondents hold senior positions within the supply chain, operations and sourcing function with considerable work experience. The main industries are manufacturing, energy and natural resources, and logistics; though many industries are represented⁵. Furthermore, 13% of all are countries and all continents are represented, with Germany and the USA being the main ones. Given the strong trading activity of these two countries, this further enhances the international scope of the paper. The majority has annual global revenue under \$1bn, though many with more than \$1bn participated. Given that the respondents hold senior positions within different industries and countries, this ensures that the respondents as individuals will not only have a good overview of their respective fields but as a group will represent different views due to their diverse backgrounds. Overall this adds to the overall validity of the results. Given that the majority is within the supply chain (etc.) function, this brings the results closer to the desired population. However, given the

 $^{^{5}}$ Due to the limited sample size it was not possible to test across for relationships across different industries and countries and other variables in the background data.

small sample size versus the extensively large population, it is questionable to what degree the results can be generalized. Yet, given the explorative nature of the study, the ultimate aim is not to present confirmative results but rather be indicative in nature, which is possible given the background information of the respondents – as is described above.

Key supplier and buyer dependency is high or very high. There is an even split between those companies with and without risk assessment, where scenario planning is most used. Main regional dependencies are upon Western Europe and North America as well as Asia for sourcing and production. Factor analysis shows that North America, Western Europe and South Asia have the highest dependencies, followed by Asia-Pacific and China (see Figure 15: Overall regional dependency. Based on factor analysis) (see App. 15.4.1 for details).



Figure 15: Overall regional dependency. Based on factor analysis

10.1.4. Main findings

Realizing that the nature of an explorative study means that the presentation of the results may be very complicated in nature, it has been decided to provide a brief summary of the results and an answer to the overall research question in order to foster the reader's understanding of the following chapter. As has been stipulated, the overall research questions asks: *Do international organizations change their supply chain strategies based on the previous experience or observation of the supply chain disruptions that natural catastrophes can cause?* The research clearly indicates that international organizations' supply chains have been disrupted more frequently and with a lesser

consequence than stated by parts of the literature, and that the type of impact is more indirect than direct. Irrespective of the previous experience or observation of supply chain disruptions caused by natural catastrophes, companies have changed their supply chain strategies and will continue to do so in the future. The main types of change are centered on supply chain management, followed by design and location. Companies tend to undertake the same type of changes future than they have done in the past. The reason to undertake supply chain change is not attributed to a previous supply chain disruption, perception or perception change. However, types of supply chain changes can be attributed to types of previous supply chain disruptions, buyer or regional dependencies, as well as consequences of previous disruptions and internal motivations.

10.1.5. Configuration

The first sub-research is concerned with the question: *If so, what kind of supply chain disruptions do natural catastrophes cause for international organizations and what are the consequences of these*? Based on the results described below, it can be asserted that the majority of the randomly sampled questionnaire respondents as well as the interview respondents had been impacted by a natural catastrophe in the past ten years, of which indirect prevail direct disruptions, occurring mostly in North America and Asia, and bearing less severe consequences than may be expected. The results will be discussed below and statistical details can be found in App. 15.4.2.

Based on the n=75 respondents, in 54.6% (n=41) of the cases, the supply chain was either disrupted directly or indirectly by a natural catastrophe in the past ten years. A smaller amount (45.3%, n=34) was not disrupted (see Figure 16: Past Impact of Natural Catastrophes). Most disruptions occurred in 2011 in the USA and Japan as earthquakes, tsunami or hurricanes (see App. 15.4.2.1). Tsunamis and earthquakes occurred in Japan in 2011. Hurricanes occurred in the USA in 2005, 2006, 2008 and 2011. Regarding the supplier's supply chain disruption, n=37 of the n=41 companies that had been impacted themselves, indicated that n=31 of their supplier's had also been impacted and n=6 cases had not been.



Figure 16: Past Impact of Natural Catastrophes

The factor analysis (see App. 15.4.2.2) of the impacted companies resulted in three factors in order of occurrence: (1) inbound and outbound logistics (n=26), (2) inventory damage and facility damage (n=13), (3) no disruption (n=1). Production input did not fit (see Figure 17: Type of past natural catastrophe impact on the company. Based on factor analysis).



Figure 17: Type of past natural catastrophe impact on the company. Based on factor analysis

Using descriptive analysis, inbound (n=26) and outbound (n=17) logistics, and missing production inputs (n=14) occurred the most, followed by facility (n=9) and inventory (n=9) damage. Suppliers mostly faced outbound (n=21) and inbound logistics issues (n=18), followed by facility damages (n=17) missing production inputs (n=16) and inventory damages (n=13) (see App. 15.4.2.3).

The question regarding the consequences was answered by n=38 respondents. For the majority, supply chain disruptions did not have a consequence in terms of their reputation, sales with existing customers, number of customers, or their profitability. When there was a consequence, this was more negative than positive for sales with existing customers, number of customers and profitability and more positive than negative for the reputation (see App. 15.4.2.4). There is no relationship between the supply chain disruption and the consequence. However, a possible relationship between outbound logistics and sales with existing customers may exist. However, given that many cells in the contingency table analysis had a low representation (i.e. some cells had a count less than five) there is a Chi-Square suspect. Consequently the significance of the results with regards to the relationship may not be certain (see App. 15.4.2.4).

On the basis of the above analysis, the rejection or non-rejection of the hypothesis with regards to the first sub-research question are summarized in Figure 18: Hypothesis of first sub-research question

Hypothesis	Торіс	Accept/ Reject Hypothesis
1A	Medium probability of supply chain disruptions	Accepted*
1B	Indirect overweigh direct supply chain disruptions	Accepted*
1C	North-American and Asian presence cause for higher supply chain disruptions	Accepted
1D	Medium probability and impact of supply chain disruptions	Accepted*
1E	Consequences are negative	Rejected*

* These hypotheses have been accepted or rejected solely on the basis of a frequency analysis. The acceptance or rejection should therefore be viewed accordingly

Figure 18: Hypothesis of first sub-research question

10.1.6. Transformation

The second sub-research question asks: *Why do international organizations decide to change their supply chain strategies based on supply chain disruptions caused by natural catastrophes?* Based on the results below it was found that perception regarding the impact and likelihood of natural catastrophes having changed and the overall perception of the respondents tending towards investing time and money in order to assess and manage the risk of natural catastrophes, there is no relationship between this and the decision to undertake supply chain change. It was found that indirect supply chain disruption issues will be met by supply chain design and supply chain management changes. Also, producing and sourcing in areas with high natural catastrophe risk will

cause an increase in the number of suppliers and decrease number of suppliers from areas with high natural catastrophe risk.

A contingency analysis accompanied by a Pearson Chi-Square test shows that there exists no significant difference in the distributions of the supply chain change and the change in perception of the impact {*Pearson* $x^2(5, N=68)=6.74$, p=0.24 and *LR* $x^2(5, N=64)=10.12$, p=0.07}, as well as the general perception to the paying off of the invested time and money to manage and assess the risks of natural catastrophes {*Pearson* $x^2(5, N=64)=4.80$, p=0.44}.

Of the n=37 respondents that faced supply chain disruptions the majority agreed (n=16, 43,2%) or strongly agreed (n=11, 29.7%) that this changed their perception of the impact that natural catastrophes can have on supply chains. Few disagreed (n=3, 8.1%) or strongly disagreed (n=3, 8.1%), did not agree or disagree (n=3, 8.1%) or did not know (2.7%). Of the n=33 that did not experience a disruption the majority agreed (n=14, 42.4%) or strongly agreed (n=9, 27.2%), few disagreed (n=2, 6.0%), and did not agree or disagree (n=8, 24.2%) making the responses similar (see Figure 19: Perception change of natural catastrophe impact, with disruption (left) and without disruption (right)



Figure 19: Perception change of natural catastrophe impact, with disruption (left) and without disruption (right)

Of the n=36 respondents that had supply chain disruptions, most agreed (n=14, 38.8%) or strongly agreed (n=10, 27.8%) that this changed their perception of natural catastrophe likelihood. Few disagreed (n=2, 5.5%) strongly disagreed (n=4, 11.1%), neither agreed or disagreed (n=5, 13.9%) or did not know (n=1, 2.7%). Of the n=33 respondents that did not have a disruption, the majority agreed (n=13, 39.9%) or strongly agreed (n=8, 24.2%), few disagreed (n=4, 12.1%) or did not agree or disagree (n=8, 24.2%). The responses are very similar (see Figure 20: Perception change of natural catastrophe likelihood, with previous natural catastrophe experience (left) and without

previous natural catastrophe experience (right).



Figure 20: Perception change of natural catastrophe likelihood, with previous natural catastrophe experience (left) and without previous natural catastrophe experience (right)

Of the n=36 respondents that had supply chain disruptions, the majority disagreed (n=13, 36.1%) or strongly disagreed (n=8, 22.2%) that natural catastrophes are unlikely to happen and thus invested time and money to manage and assess these risks does not pay off. Few agreed (n=2, 5.5%) or strongly agreed (n=5, 13.9%), some did not agree or disagree (n=7, 19.4%) or did not know (n=1, 2.7%). Of the n=33 respondents that did not have a disruption, the majority disagreed (n=14, 42.4%) or strongly disagreed (n=6, 18.1%), few agreed (n=4, 12.1%) or strongly agreed (n=2, 6.0%), some did not agree or disagree (n=5, 15.1%). The answers are very similar (see Figure 34).



Figure 21: Perception of low likelihood of occurrence and invested time and money for risk assessment and management to pay off, with previous experience (left) and without previous experience (right)

With regards to the relationship between the change in perception of the likelihood and impact of natural catastrophes and the perception of the invested time and money to assess or manage these risks paying off despite the low probability of occurrence, a statistically significant relationship was

found. Further, there is a relationship between companies that encountered a facility and inventory damage and those that experienced a change in their perception towards the impact that natural catastrophes can have on their supply chains. This is manifested in a function of y=0.25 + 39x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is 0.35 and is also statistically significant ($p=0.0299^*$) at the 95% confidence level. The mean is at 0.34 and 0.39 for x and y respectively. Further, a relationship between buyer dependency and the change in perception of the impact and likelihood can be found. This does not exist for supplier dependency. A statistically significant relationship can be found between change in perception of the likelihood/investment trade-off and a consequence on reputation can be found. Furthermore, a statistically significant relationship can be found between change in perception of the likelihood and impact as well as the perception of the likelihood and impact as well as the perception of the likelihood investment trade-off and the consequence on sales with existing customers and the number of total customers can be found. However, no relationship between profit and perception can be found (see App. 15.4.4.1 for details).

Based on these findings, the following conclusions with regards to the hypothesis can be drawn: (see Figure 22).

Hypothesis	Торіс	Accept/ Reject
2A	Perception change of the impact and likelihood of natural catastrophes as well as the perception regarding investing in to the assessment and management of natural catastrophe risk will explain supply chain strategy changes	Rejected
2B	Perception of the likelihood of natural catastrophes has changed	Accepted*
2C	Perception change of the likelihood is stronger where supply chain disruptions caused by natural catastrophes have been previously experienced	Rejected
2D	Perception of the impact of natural catastrophes has changed	Accepted*
2E	Perception change of the impact is stronger where supply chain disruptions caused by natural catastrophes have been previously experienced	Rejected
2F	Perception of investing into assessing and managing the risk caused by natural catastrophe despite the low likelihood of occurrence will tend towards not investing rather than investing	Rejected*
2G	Perception of investing into assessing and managing the risk caused by natural catastrophe despite the low likelihood of occurrence will tend more towards investing for organizations previously having experienced a supply chain disruption	Rejected

* These hypotheses have been accepted or rejected solely on the basis of a frequency analysis. The acceptance or rejection should therefore be viewed accordingly

Figure 22: Hypothesis regarding perception and perception change

Past and future change motivation was structured (see App. 15.4.4.1 and 0) according to two factors (based on a factor analysis) ranking from (1) profit, sales with existing customers, number of customers, reputation to (2) competitor pressure. Stakeholder demand was not represented (see Figure 23: Motivation, previous supply chain change. Based on factor analysis and Figure 24: Motivation, future supply chain change. Based on factor analysis). Based on a contingency analysis and a correlation of factors, there is a relationship between profit, sales with existing customers, number of customers and reputation motivation in the past and the future (see App. 15.4.4.8).



Figure 23: Motivation, previous supply chain change. Based on factor analysis



Figure 24: Motivation, future supply chain change. Based on factor analysis

Based on a correlation of the factors (see App. 15.4.4.5) a relationship between profit, sales with existing customers, number of customers and reputation motivation and the following changes were found: (1) impose risk management practices on suppliers, improve supply chain communication, increase focus on supply chain risk management and contingency planning, (2) increase number of suppliers and raw material inventory, (3) stop setting up new facilities in natural catastrophe areas and increase raw and finished goods inventory, and (4) increase focus on contingency planning.

Through the use of a contingency analysis, the following relationships between motivation and type of change were found (see App. 15.4.4.6) (1) a shift in facilities and profitability, (2) increasing

number of suppliers and sales with existing customers, the number of customers and the competitor pressure, (3) imposing risk management practices and profitability and reputation, (4) increase in the raw and finished goods inventory and sales with existing customers (5) improvement in supply chain communication and profitability, sales with existing customers, the number of customers, reputation and stakeholder demands, (6) increasing supply chain risk management and profitability, number of customers, reputation, stakeholder demand and competitive pressure, (7) increasing focus on contingency planning and profitability, sales with existing customers, number of customers, reputation, stakeholder demand and competitor pressure.

The following statistically significant relationships are found between past consequence and type of change at the 95% confidence level using contingency analysis (see App. 15.4.4.10 for details): (1) reputation and sales with existing customers possibly influences a shifting facilities away from natural catastrophe areas, (2) sales with existing and the number of customers possibly influences finished goods inventories, (3) number of customers and profit stops setting up new facilities in natural catastrophe prone areas.

Based on correlation of factors, relationships between facing outbound and inbound logistics issues and imposing risk management practices on suppliers, improving supply chain communication, increasing supply chain risk management and contingency planning was found. The relationship is represented by y=0.45x+0.53, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.33 and is significant at the 95% level with $p=0.0037^*$ (n=75) and mean of 0.36 and 0.69 respectively for X and Y. The R² is 0.11. Contingency analysis confirms this at the 95% confidence level: (1) inbound logistics issues led to supply chain communication improvement and increase contingency planning focus, (2) outbound logistics issues led to improve supply chain communication and increase finished goods inventory, (3) missing production input led to improve supply chain communication (see App. 15.4.4.3). Based on the above, the following conclusions with regards to the hypotheses can be drawn (see Figure 25).

Hypothesis	Торіс	Accept/ Reject
2L	Indirect supply chain disruption issues will be met by changes with regards to supply chain design and supply chain management	Accept*
2M	Direct supply chain disruptions will be met by changes with regards to supply chain location	Reject*

* These hypotheses have been accepted or rejected solely on the basis of a frequency analysis. The acceptance or rejection should therefore be viewed accordingly

Figure 25: Hypothesis with regards to supply chain disruption type and supply chain change

A contingency analysis reveals a possibly statistically significant relationship between supplier dependency and shifting current facilities and stop setting up facilities in natural catastrophe areas as well as imposing risk management on suppliers. However, given the low count of cells in the contingency analysis, this is not guaranteed. No other relationships between buyer and supplier dependency with type of changes was found (see App. 15.4.4.9 for details).

On the basis of a correlation analysis based on factors it was found that companies with strong sourcing, producing and selling dependency upon Asia Pacific increased finished goods inventory and not their focus on supply chain risk management. Companies with a strong sourcing and producing dependency upon Africa decreased their overall exposure to natural catastrophes. Firms with a strong sourcing and producing dependency upon the Middle East increased their risk management and contingency planning and imposed risk management practices on suppliers and improved their supply chain communication (see App. 15.4.4.9 for details). A statistically significant relationship was found between (1) increasing the number of suppliers and sourcing from North America, China, South Asia, Asia-Pacific and Africa as well as (2) decreasing sourcing from natural catastrophe areas and sourcing from South Asia, Asia-Pacific, and Africa. A statistically significant difference in the distribution of (1) increasing raw material inventory and sourcing from Western Europe, (2) increasing finished goods inventory and sourcing from Africa, and (3) increasing supply chain risk management focus and sourcing from China was found (see App. 15.4.4.9 for details). Imposing risk management practices on suppliers, improving the supply chain communication, shifting current facilities, or increasing the focus on contingency planning does not relate to regional sourcing dependencies. A statistically significant relationship was found between (1) increasing the number of suppliers and producing in Western Europe and Africa, (2) increasing the focus on contingency planning and producing in Northern America, (3) increasing supply chain risk management focus and producing in China (negative) and Asia-Pacific (positive relationship), as well as (4) increasing finished goods inventory and producing in Asia-Pacific. A

correlation based on factors reveals that strong sourcing, producing and selling dependency upon North America and the Middle East leads to (1) increasing the contingency planning focus (2) increasing contingency planning and risk management focus as well as supply chain communication and imposing risk management on their suppliers. Strong sourcing and producing dependency on Africa increases raw and finished goods inventory and stops setting up facilities in natural catastrophe areas (see App. 15.4.4.9 for details).

10.1.7. Transformed configuration

The third sub-research question asks: *How do international organizations change their supply chain strategies and what consequences do these have?* Based on the results described below, it was found that most companies changed their supply chain strategies yet having previously experienced supply chain disruptions due to natural catastrophes does not explain the decision to undertake supply chain changes. However, having changed in the past explains changing in the future. Changes undertaken relate mostly to supply chain management, to the lesser supply chain design and to the least supply chain location changes.

Of the n=68 respondents to the question regarding supply chain change, the majority (n=52, 76%) indicated that they did, whereas fewer (n=16, 24%) indicated that they did not change. It was found that there is no statistical difference between those companies that had previously experienced a supply chain disruption and those that had. This is shown by a contingency analysis where $\{Pearson x^2(1, N=68)= 2.002, p=0.1570, LR x^2(1, N=68)= 2.011, p=0.1562\}$ as companies that have changed in the past, will do so in the future $\{Fisher's Exact Test, Right: p=0.9559; Fisher's Exact Test, Right: p=0.1296; Fisher's Exact Test, 2-Tail: p=0.2517\}$.

Of those that changed, a factor analysis was conducted (see App. 15.4.3.1), where four clusters were found in order of popularity: (1) impose risk management on suppliers, improve supply chain communication, increase focus on risk management, increase focus on contingency planning, (2) increase the finished goods inventory and do not increase the focus on supply chain risk management, (3) increase the number of suppliers and increase the raw material inventory, and (4) shift current and stop setting up new facilities as well as decrease the number of suppliers from natural catastrophe prone areas (see Figure 26: Types of supply chain change. Based on factor analysis).



Figure 26: Types of supply chain change. Based on factor analysis

A descriptive analysis reveals that the most prominent change undertaken was to increase the focus on contingency planning (n=29), improve supply chain communication (n=26), increase the number of suppliers (n=26), and increase the focus on supply chain risk management (n=21). The next set of responses relates to imposing risk management practices on suppliers (n=15), increase raw material (n=11) and finished goods inventory (n=10). The least occurring are shifting facilities (n=6), stop setting up new facilities (n=4), and decreasing sourcing from areas with natural catastrophe risk (n=4) (see Figure 27: Type of past supply chain changes. Based on simple frequencies).



Figure 27: Type of past supply chain changes. Based on simple frequencies

Based on these findings it can be asserted that hypothesis 4A, 4B and 4C can be rejected since their occurrence is very low. Hypothesis 6A, 6B, 6C and 6D can be accepted due to their high occurrence. Hypothesis 5A, 5B and 5C can also be accepted, though not with such high certainty as the others due to their mid-level occurrence.

The type of past supply chain change undertaken by competitors was looked at from the perspective of those companies that undertook change. Based on a factor analysis (see App. 15.4.3.2) four factors emerged, in order of popularity: (1) impose risk management practices on suppliers, increase focus on supply chain risk management and increase focus on contingency planning, (2) shift current, stop setting up new, and decrease suppliers from natural catastrophe prone areas, as well as increase the finished goods inventory, (3) stop setting-up facilities and decrease the number of suppliers in natural catastrophe prone areas and increase raw material inventory, and (4) increase the number of suppliers and improve supply chain communication (see Figure 28).



Figure 28: Past supply chain changes of the company's competitor. Based on factor analysis

The existence of a relationship between competitor and company change was tested. Using a factor and a correlation analysis, there are relationships between following: (see Figure 29).

Previous Supply Chain Change - Company	Previous Supply Chain Change – Company's Competitor
Reduction of the exposure to natural catastrophe prone areas	Stop setting up facilities and decrease the number of suppliers from natural catastrophe prone areas
Impose risk management, improve supply chain communication, increase risk management and contingency planning	Stop setting up facilities and decrease the number of suppliers from natural catastrophe prone areas, as well as increase the raw material inventory
Impose risk management, improve supply chain communication, increase risk management and contingency planning	Impose risk management, increase risk management and contingency planning
Impose risk management, improve supply chain communication, increase risk management and contingency planning	Shift current facilities away and decrease suppliers from natural catastrophe prone areas, as well as increase the finished goods inventory
Impose risk management, improve supply chain communication, increase risk management and contingency planning	Improve supply chain communication

Figure 29: Relationship between previous company and competitor changes

Based on the contingency analysis, at the 95% confidence level, a statistically significant difference between changes of the competitor and company has been found with a shift and stopping of setting up new facilities and decrease suppliers from natural catastrophe prone areas, increasing the number of suppliers, increase risk management practices, improve supply chain communication, increase focus on supply chain risk management and contingency planning (see App. 15.4.3.3 for details).

To determine if there is a statistically significant differences in the consequences experienced between those companies that undertook a change and those that did not, the results from the four different re-routings of the survey have been aggregated. Based on factors and a correlation analysis it was found that (1) imposing risk management on suppliers, improving supply chain communication, increasing risk management and contingency planning lead to profit decrease, (2) increasing the number of suppliers and the raw material lead to profit and reputation decrease, and (3) increasing finished goods and not undertaking risk management lead to both a reputation and sales with existing customer increase. Based on a contingency analysis, the act of undertaking supply chain change lead to reputation and sales with existing customers increasing or staying constant, as well as number of customers and profit decreasing or staying constant (see App. 15.4.3.6 for details).

Based on a contingency analysis there is a statistically significant difference between those companies changing in the past and the future {Pearson $x^2(1, N=65)= 13.579$, p=0.0002*, LR $x^2(1, N=65)= 13.113$, p=0.0003*} as companies that have changed in the past, will do so in the future {*Fisher's Exact Test, Right: p=0.0005*; Fisher's Exact Test, 2-Tail: p=0.0005**}. With an odds ratio of 9.975, the odds of undertaking future change and not doing so in the past are higher, than undertaking no future supply chain changes and having done so previously.

Future supply chain change was structured into three factors, in order of popularity: (1) impose risk management practices on suppliers, improve supply chain communication, increase focus on supply chain risk management and contingency planning, (2) increase focus on contingency planning, (3) stop setting up facilities in natural catastrophe areas, increase raw and finished goods inventory. Shifting facilities from natural catastrophe prone areas was not part of the factors (see Figure 44 and App. 15.4.3.3 for details).



Figure 30: Types of future supply chain changes in the company. Based on factor analysis.

Relationships between the type of future and past supply chain change were tested for. Based on the factor analysis, there is a relationship between (1) increase focus on contingency planning and and supply chain risk management in the past as well as improve supply chain communication and impose risk management on suppliers in the future, between an (2) increase focus on contingency planning and supply chain risk management, improve supply chain communication and impose risk management, improve supply chain communication and supply chain risk management, improve supply chain communication and impose risk management, improve supply chain communication and impose risk management, improve supply chain communication and impose risk management on suppliers in the past and an increase focus on contingency planning in the past and an increase finished goods inventory and not increase focus on risk management in the future, as well as (4) improve supply chain communication and impose risk management in the future (see App. 15.4.3.5 for details). Based on the contingency analysis without factors, there is a relationship between those companies that have been shifting current facilities, increasing the number of suppliers, imposing risk management practices, increasing raw and finished goods inventory,

improving supply chain communication, and increasing the focus on risk management and contingency planning in the past and are doing the same in the future (see App. 15.4.3.5 for details). Based on the above analysis of the results, the following conclusions can be drawn with regards to the hypotheses (see Figure 31):

Hypothesis	Торіс	Accepted/ rejected
3A	Supply chain strategy change	Accept*
3B	Less likely to change with no previous natural catastrophe impact on supply chain	Rejected
4A	Shift current facilities away from natural catastrophe prone areas	Rejected**
4B	Stop setting up facilities in natural catastrophe prone areas	Rejected**
4C	Decrease number of suppliers from natural catastrophe prone areas	Rejected**
5A	Increase their inventory of finished goods	Partially**
5B	Increase their inventory of raw goods	Partially**
5C	Increase their number of suppliers	Accepted**
6A	Increase focus on contingency planning	Accepted**
6B	Increase focus on risk management	Accepted**
6C	Impose risk management on suppliers	Partially**
6D	Improve supply chain communication	Accepted**

* These hypotheses have been accepted or rejected solely on the basis of a frequency analysis. The acceptance or rejection should therefore be viewed accordingly. ** These hypotheses are accepted, rejected or partially accepted on the basis of their relative occurrence to one another. Accepted hypotheses are accepted on the basis of their highest relative occurrence. Rejected hypothesis are rejected on the basis of their lowest relative occurrence. Partially accepted hypothesis are partially accepted based on their relative medium occurrence relative to the others.

Figure 31: Hypothesis regarding type of changes undertaken

10.2. Interview results

This sub-chapter will cover the in-depth interviews conducted. The eight interviews conducted will be outlines through an overview table followed by a concise description of each interview (see App. 15.5 for details). An overview of the findings is to be found in Figure 32 and Figure 33. Interviews were conducted with international organizations from various industries and countries, both in persona and telephone/skype and with senior management personnel, thereby adding credibility to the results.

	Case Company A (Electronics)	Case Company B (Pharmaceuticals)	Case Company C (Textiles)	Case Company D (Pharmaceuticals)
Dependency on key suppliers	n/a	No	No	No
Dependency on key buyers	Yes	n/a	No	n/a
Dependency on regions	Thailand, Malaysia, Phillipines & Japan	Denmark, France, USA & China	Japan & Taiwan	Japan, New Zealand & The Netherlands
Assess catastrophic risk	Yes	Yes	Yes	Yes
Impacted by a Natural Catastrophe	Yes	Yes	Yes	Yes
What type of Natural Catastrophe	Flooding in Thailand	Tohuko Earthquake	Tohuko Earthquake	Tohuko Earthquake
Type of effect on the business	Factory flooded	Production site closed for two weeks	Delay in the supply of goods	Shortage of raw and packaging material
Perception change	No	Yes	Yes	Yes
Change undertaken as a response to the Natural Catastrophe	1) Added multiple locations, 2) Built more confidence in quality systems, 3) expanded their risk management	Built a temporary distribution center	1) Move production for key products away from Japan, 2) Implement second capability for suppliers 3) Assess regional dependencies	 Build a new factory, 2) Demand suppliers to conduct risk management, Increased stock levels
Consequences for the company as a result of reaction and changes undertaken	1) Obtained contracts with big customers within the industry, 2) Reputation of reliability in the industry	Market share increased	n/a	n/a
Future changes planned	Implement better risk systems	1) Decrease lead time, 2) Improve Business Conituity Plan, 3) Build a second factory	1) Move production for key products away from Japan, 2) Implement second capability for suppliers 3) Assess regional dependencies	1) Re-adjust stock level to avoid stock out, 2) Make buildings earthquake proof, 3) Complementary production for major products 4) Safety training

Figure 32: Overview of the interview results

	Case Company E (Wholesaler)	Case Company F (Textiles)	Case Company G (Biotechnology)	Case Company H (Wholesaler)
Dependency on key suppliers	Yes	No	No except for raw material of glycerol	Yes
Dependency on key buyers	Yes	No	n/a	Yes
Dependency on regions	Europe	Italy, Germany, Austria and Bulgaria	Singapore (glycerol)	Europe (focus on Germany), Asia
Assess catastrophic risk	No	No	Yes	Yes
Impacted by a Natural Catastrophe	No	No	Yes	Yes
What type of Natural Catastrophe	n/a	n/a	Tohuko Earthquake, Missouri river flooding	Tohuko Earthquake
Type of effect on the business	n/a	n/a	No severe effect on operations	Minor delay in supply of products
Perception change	No	No	No	No
Change undertaken as a response to the Natural Catastrophe	Change internal processes to ensure a second alternative for production/suppliers in face of catastrophe	n/a	1) Built reinforcements at the production facility, 2) Re-routed products to another facility	1) Risk assessment, 2) Add more suppliers
Consequences for the company as a result of reaction and changes undertaken	n/a	n/a	Improved their position in the market	n/a
Future changes planned	n/a	n/a	1) Multiple locations for production, 2) Enhance risk management for site location decision making 3) Quick shift of production when needed	Improve risk assessment

Figure 33: Overview of the interview results

Company A operates in the electronics industry with operations in over 20 countries. The industry is highly fragmented with unique and customized products, thereby making buyers and suppliers highly dependent of one another once contracts have been arranged. Company A is the single source (90 %) for certain products with some customers. Consequently supply reliability is imperative. The firm is not particularly powerful in the industry. The company has most production in-house except for parts of the assembly line as this gives them more control. They stress the importance of ensuring multiple supply sources and to ensure that this exists several tiers down, as

the origin of the raw material is important – especially with natural catastrophes. They argue for a thorough risk management process that enables to assess all risks and scenarios. The company and its CEO have been through various crisis situations, from which they accumulated learning and best practices. The CEO experienced the currency crisis in Asia in 1997 from which lessons on external influences on companies were drawn. The company experienced the Volcano in Iceland in 2010 and used the CEO's currency crisis experience to react quickly and reserved an airplane and ships to ensure their supply chain. This helped minimize the impact and ensured deliveries. The third crisis was the Tohuko earthquake in Japan in 2011, and the fourth crisis was the flooding in Thailand in 2011, which the interview was focused on. The flooding in Thailand affected the company because of a newly acquired company, operating in Thailand in a region most affected by the floods. Their production facility was flooded and production stopped with no back up capacity. The CEO acted fast and had a team on site within two days, which was faster than any other company. This was programmed from previous crisis situations and their main concern was to get the equipment out of the facility and moved to continue production. This process was completed in two to three weeks and no large disruption was caused. Due to knowing what to do and reacting fast in the crisis situation it increased their position with customers. Recent natural catastrophes did not change their perception of the degree and probability that a natural catastrophe can impact a business. It remained the same. As a response to the natural catastrophe they implemented three main changes that were motivated from within the company they (1) added multiple sites in certain locations (e.g. Thailand, Philippines and Malayisa), (2) enhanced risk management assessments to identify single source suppliers in the second and third tier, (3) established more confidence in quality systems and regionalized them. They plan to continue to enhance their internal systems e.g., ERP systems (see App. 15.5.1 for transcript).

Company B is the Japanese affiliate of a global company active within pharmaceuticals and present in over 190 countries with their products. The Japanese affiliate is highly dependent on the imported products and raw material coming from Denmark, France, USA and China. In Japan, Company B is not dependent on any key supplier as they can always import the finished goods from other key production sites. Certain raw material is provided in the Japanese market and the Japanese production plant, located 60 km away from Fukushima, makes the fittings and necessary controls for the products. For one of their products, there exits no substitute on the Japanese market and many of their products are life saving products, thus making them vital to keep supplying to the market. They assess risk and especially catastrophic risk, as Japan is an earthquake prone area. There is a law by the government stating that pharmaceutical firms operating in Japan must have a business continuity plan for catastrophes. The Tohuko earthquake affected them in March 2011. Their production plant was closed and evacuated for two weeks due to risk for radiation. Products were moved to another facility. The company had stocks that could last for two weeks, meaning they could provide products to customers. Due to the tsunami that came as an affect of the earthquake, many roads were blocked and customers difficult to reach. The company adapted their distribution according to the roads that were accessible and made sure to deliver their products free of charge to their customers in the affected areas. As it was not known for how long the production plant had to be closed and since stock lasted only for two weeks, they decided to import finished goods with Japanese labeling and cartooning from Europe. They accepted products without a certain packaging that enables the customer to see if it had been used or not, to ensure that the customers received the life saving product. Consequently reputation with government and customers improved and market share increased. They state that their perception has increased. Previously, they did not predict that such a big earthquake would happen and neither did they have the perfect business continuity plan. However, after March 2011, they realized the importance to be prepared and to have a perfect business plan. Supply chain changes are temporary changes during the crisis situation such as adding a distribution center, importing the entire final product and accepting products without standard packaging material. In the future, they will improve their business continuity plan and ensure better response. They will increase the stock levels in raw material and finished products while decreasing lead-time even further. For the future they hope to build a second production plant to diversify risk (see App. 15.5.2 for transcript)

Company C is a global company located in 30 countries working in the textile industry, with global sales offices and production in the USA, Japan, Europe and China. Their procurement of textiles and flow of goods is global to decrease regional dependencies, of which the largest dependency is Taiwan and Japan for raw material. The biggest supplier accounts for 15% their total purchasing volume and buyer dependency is low. They conduct risk assessments for the last 1.5 years with a focus on financial stability and regional dependencies with the main outcome being contingency planning and identifying second source supplies for risk reduction. They also assess third tier suppliers. They were affected by two natural catastrophes (1) Hurricane Katrina indirectly through suppliers of oil and (2) Tohuko earthquake stopped production due to flooding by the Tsunami and closure of ports leading to inventories and products shipments being stopped. The net effect was an inability to serve the customer and respond to the demand. The recent natural catastrophes have
changed their perception of the impact such an event can have on a supply chain. Furthermore, they acknowledge that the frequency of such events is increasing and it is vital for companies to take these catastrophes into consideration in their supply chain strategy. However, they go on to argue that it is not possible to calculate this type of risk. The biggest change that they undertook, as a response to the natural catastrophe in Japan was to add multiple suppliers to key materials that flow into commodity products. This realization came from the incident in Japan where it was seen that certain materials in products are only found in Japan and cannot be found in it single source in other areas. Thus, making it vital to identify some other supplier able to produce the same type of material. Furthermore, they made sure to have second capability for suppliers, meaning that each supplier is backed up. Another change was to increasingly assess regional dependencies to overcome disruption when a crisis situation occurs. In the future, they see these changes as persisting and aims to continue to focus on these factors. The motivation for all of these changes is coming from the inside and their aim is not to communicate to the external environment, rather it is something that they are doing to be able to better cope with a disastrous situation (see App. 15.5.3 for transcript).

Company D is a Japanese company with global diversified operations within pharmaceuticals, service, environment, community development, lifestyle, and heavy industry spread across 67 subsidiaries and 15 associated companies. The interviewed affiliate operates in pharmaceuticals. They have three factories in Japan that mostly (98%) serve the local market with prescription and non-prescription drugs, where the aim is never to run out of stock for both of them. Most raw material suppliers are Japanese and some are global. The only difficult to source input comes from New Zealand and Holland. They assess catastrophic risk through their Business Continuity Plan, which is used on the executive level and factories, where the main focus is employee safety and business continuity is the second most important factor. The Tohuko earthquake impacted their production facilities, where electricity shortages caused them to change the time of operation, and disruptions in raw materials from Japanese suppliers, which caused packaging material shortages. This did not impact supply of products to market. However their perception changed, despite having used BCP prior, as they now comprehend the magnitude that earthquakes can have. The main supply chain changes undertaken were to (1) consult to build a new production facility to diversify risk, (2) demand risk management procedures at suppliers to ensure their standards and dependency and (3) increase their stock to ensure supply reliability, (4) implement complementary production of the main products in different facilities to spread risk, (5) ensure employee safety and training. The main motivation comes from within (i.e. financial) and to satisfy stakeholders (see App. 15.5.4 for transcript).

Company E is a wholesaler of textiles and confronted with nearly monopolistic suppliers and with a stringent certification process for their protective wear textiles. They operate globally with subsidiaries in Germany, France, England and Asia-Pacific. Most raw materials come from Europe and fewer amounts are from Asia and USA. Sales orientate around large tenders for which materials, color, price etc. are pre-determined, making inventory keeping impossible. They aim for buffers where possible. They assess financial, production and distribution but not catastrophic risk. They have not been impacted by natural catastrophe but acknowledge the disruptive effect it could have, given their supply structure. Recent natural catastrophes did not change their perception of the risk, however they acknowledge the need to secure themselves against such events and think that these will increase going forward. The main supply chain changes undertaken have been to ensure dual sourcing possibilities (see App. 15.5.5 for transcript).

Company F produces sportswear in Austria and Bulgaria. They source raw materials from Italy, Germany and Austria, where they have low dependencies due to the availability of suppliers. They are not dependent on key buyers. They do not undertake risk assessment or scenarios for disastrous events, as they do not see the need to do so given their regional dependency. They have not been affected by a natural catastrophe; however acknowledge needing to secure supply in such an event – which they do through dual or triple sourcing strategies. They have continuity plans for machine issues (i.e. operational risk). Their natural catastrophe risk perception did not change due to their European focus and limited Asian exposure. They do not see a need for future supply chain changes (see App. 15.5.6 for transcript).

Company G is a global biotechnology company. They sourcing their commodity products globally and hence not posing a risk, except for price and face low switching costs. If they face natural catastrophe risk, then so will their competitors. They undertake risk assessment of catastrophic risk, however this is not their core competence and recognize the necessity to increase focus on this. Previously they have been affected by the Tohuko earthquake and Missouri river flooding in June 2011. The Tohuko earthquake affected them minimally, however no activities were disrupted. The Missouri river flooding caused facility building process delays close to the river. They reacted quickly with facility reinforcements and production shifting. The impact was therefore minimal. Consequently, natural catastrophe did not change and are seen as low probability risks for which mitigation resources ought not to be spent as they are too costly compared to the risk. Protection wall construction and product re-rerouting to other plants were the main changes undertaken. In the future, they will not make major changes. The main focus will be on quickly shifting production to other sites and diversify location of sites. They will increase risk management focus, especially with site location decision-making (see App. 15.5.7 for transcript).

Company H is a wholesaler of construction material, confronted with constant cost pressure and high supplier dependencies, of which some are single source. Sourcing is Asia (i.e. Japan, Taiwan, Malaysia, China and Vietnam) and Europe focused, sales are Europe focused. Sourcing in Asia is done for cost reasons to maintain competitive. The main risk exists on-route between Europe and Asia. Risk assessment of first tier suppliers is done in a non-systematic manner. They were impacted by the Tohuko earthquake, which caused a supplier to stop production due to electricity shortages. This did not have a negative affect on the company as they could source the same product from Europe. This changed their perception of natural catastrophes, making them more responsive and careful. The executives are pushing for more suppliers and more due diligence in Asia. The main changes undertaken have been to (1) try to develop second and third suppliers for important products (2) implement more thorough risk assessment. In the future, they will have a more stringent process when looking to source from Asia and will assess the suppliers supply reliability (see App. 15.5.8 for transcript).

11.Discussion

Having provided the results of the research, this section will discuss these in the light of the previously reviewed literature and implications for managers.

11.1. Configuration

The first sub-research question regards the type of supply chain disruptions that natural catastrophes cause: *If so, what kind of supply chain disruptions do natural catastrophes cause for international organizations and what are the consequences of these*?

The majority (54%) of the respondents indicated having experienced a supply chain disruption due to a natural catastrophe in the past ten years. This is in line with BCI $(2011)^6$, where 61% (total

⁶ BCI conducted a similar study to that of this paper, however the research was found late in the writing process and could not be the basis for the research undertaken. BCI had diverse respondent profiles with no exclusive focus on natural catastrophes.

sample) or 48% (supply chain managers) experienced the same in 2011. The difference may be explained by the time horizons, where most impact in this research's sample occurred in 2011 as well. When impacted, most respondents (83%) noted that supplier experienced the same. BCI (2011) found the same, with most disruptions occurring in the first or second tier of suppliers. Different to BCI (2011), most disruptions are caused by geophysical incidents (54%) rather than weather-related incidents (46%). The difference may also be explained geographical scope of the studies, where BCI (2011) had mostly UK and this study mostly German and US American respondents. Disruptions occurred mostly in North America, Asia-Pacific and South-Asia. This matches the overall MunichRe (2011c) and EM-DAT (2012) findings. When disruptions were experienced, indirect (i.e. logistics issues and missing production input) prevailed over direct (i.e. facility and inventory damage) disruptions. This is in line with the increasing interconnectivity, length, and internationalization (Wagner et al, 2006; Sodhi et al, 2012;) of supply chains, previously discussed. As such, there is a higher probability that supply chain disruptions will originate outside the locus of control of the company rather than within. Managers need to be aware of this so that they can structure their supply chain strategy changes accordingly. Furthermore, managers must be aware of the high probability of experiencing disruptions when operating in North America, South-Asia and Asia-Pacific.

In terms of the impact of supply chain disruptions from natural catastrophes, the number of customers (82%), sales with existing customers (52%), profit (52%) and reputation (60%) maintained the same in most cases. This is not in line with results from Singhal & Hendricks (2003) who claimed that there was a negative impact on the company measured in stock prices. BCI $(2011)^7$ found that 17% experienced a negative impact on reputation compared to 13% in this research. Profit decreased for 23%, which is smaller than the approximately 34% who experienced the same in BCI (2011). Sales with existing customer decreased by 34%, which is in line with BCI (2011) where 32% experienced a loss of revenue. An increasing outbound logistics issue influences this. As outbound logistics has a direct impact on the sales with existing customers, it is important that supply chain managers ensure that outbound supply is maintained. Increasing the inventory of finished goods, which was found to have a positive outcome on the firm, may be one way of doing so. It is interesting to note that BCI (2011) found that most (83%) had damages below €1mn, 14% between €1mn to €10mn, and 2% more than €10mn. Supply chain managers must be aware that

⁷ It is hereby to be noted that BCI (2011) does not only focus on natural catastrophes but supply chain disruptions based on a multitude of origins. Consequently the results must be viewed with this constraint in their ability to be compared.

even though consequences may not always be severe, in others they will be. Given their goal setting and performance measurement, this should be taken into account.

Referring back to the first sub-research question, it can be asserted that natural catastrophes can cause supply chain disruptions more frequently and with less impact than may be expected; especially when considering the high amount of indirect disruptions. This is different to Knemeyer et al. (2009) and Kleindorfer et al. (2005), because natural catastrophes may not strictly be considered low probability and high impact risks as a large amount of the sample was affected and with less severe consequences. This is also confirmed by BCI (2011). Consequently, and more in line with Woodman & Hutchings (2011) and WEF (2012a), natural catastrophes may be considered tending towards mid-probability and mid-impact risks. As such, natural catastrophes, when considered in the light of the previously mentioned increasing interconnectivity, should be regarded as risks occurring with a higher probability and lower impact than may normally be expected. This is especially so in the international context. Consequently, it is proposed to classify supply chain disruptions caused by natural catastrophes as is depicted in Figure 34.



Source: Classification scheme of risk events. Adapted from Brindley (2004)

Consequently, this necessitates a different management approach to managing risk outside a company's immediate locus of control. Irrespective of this, supply chain managers still need to acknowledge the potentially higher impact and lower probability of a direct supply chain disruption. The management implications with regard to the configuration have been summarized in the following Figure 35.

Figure 34: New classification of supply chian disruptions caused by natural cataststrophes

No.	Research Findings	Implication for Organizations	Recommendation for Managers
1	Natural catastrophes are a mid-probability and mid-impact supply chain disruption risk	Risk profile may be different than is expected in most international organizations	Change awareness and approachIncrease priority
2	Indirect supply chain disruptions prevail over direct supply chain disruptions	Managing the risk is outside the immediate locus of control of the international organization	 Increase focus on indirect disruption risk Decrease suppliers in natural catastrophe areas Impose risk management on suppliers Increase number of suppliers
3	North American and Asian regional dependencies increase probability of supply chain disruption	US and Asian organizations as well as those with dependencies in these region have a higher risk exposure to natural catastrophes	 Decrease dependency on regions Spread risk through increasing supply and production base
4	Consequences are not as severe as may be expected	International organizations may neglect these risks due to the low expected impact	• Natural catastrophes should increase in priority due to higher probability of occurrence and accumulation of smaller impacts
5	Outbound logistics is related to sales with existing customers	International organizations financial performance may be affected due to inability to deliver	Increase finished goods inventoryBack-up for logistics routes to customers

Figure 35: Implications for managers (Configuration)

11.2. Transformation

The second research questions tries to understand the transformation process: *Why do international organizations decide to change their supply chain strategies based on supply chain disruptions caused by natural catastrophes?*

A perception change regarding the impact (73%) and probability (69%) of a supply chain disruption due to natural catastrophes occurred for most respondents, irrespective of previous experience. Company H who "sees that the frequency and impact of natural catastrophes are increasing and getting stronger" underlines this. The majority (58%) disagrees that investing into risk assessment and management of natural catastrophes will not pay-off due to the low probability of occurrence, irrespective of previous experience. Company E, which did not get impacted claims that: "one should secure (...) towards natural catastrophes and I do think that there will be an increase of them." As there is no difference between companies with and without previous disruptions, the learning school (Mintzberg et al. 1998) cannot confirm that companies' change in perception is based on learning. However, notable is Company A who clearly indicated a learning curve based on previous experiences with natural catastrophes. Their fast reaction and process enabled them to excel during the catastrophic flooding in Thailand. Thus, one cannot clearly determine the role of the learning school (Mintzberg et al. 1998). Companies are more responsive to occurrences in the environmental school (Mintzberg et al. 1998). Companies are more responsive to occurrences in the environment rather than on previous experience.

Increasing buyer, but not supplier, dependency amplifies the change in an overall perception. The power school (Mintzberg et al. 1998) and prospect theory with regards to gains over losses (Khaneman et al., 1979) may explain this, as high buyer dependency may increase the realization

that sales need to be maintained despite disruptions. The non-existence of an influence of supplier dependency, despite this being quiet high in most companies, may be explained by supply chain managers' performance being measured by the ability to satisfy customers. This is underlined by the fact that sales, number of customers, and reputation influence perception; whereas profit, which does not relate to perception and is consisting as of costs such those from the supply side, did not. Further, facility and inventory damage was found to impact perception of impact. This is related to the learning school (Mintzberg et al., 1998) and organizational learning (Kahneman, 2011). Managers must come to realize that a perception change will occur in their companies based on direct impact but not indirect impact on the supply chain.

However, perception did not explain supply chain change. This is different than what may be expected based on e.g. Cohen et al. (2007), Slovic et al. (2002). As such, managers should not only focus on trying to change perception in the company if they wish to induce supply chain change. This could be explained by the cognitive school (Mintzberg et al., 1998), where information gets distorted through the layers of the organization and where one manager's perception may therefore not lead to an organizational decision to change. This may be further undermined by the cultural school (ibid), where despite a change in perception, a cultural barrier to change may exist. Finally, prospect theory (Khaneman et al. 1979) may further support this, where managers will be willing to take a risk rather than investing into a lower yield supply chain change, irrespective of their change in perception. Alternatively this finding could also be explained by interpretation in the primary research of (1) respondents not comprehending the question, as was also experienced during the interviews, or (2) that other variables are better at explaining change. Managers must acknowledge this and apply a stringent change management to convince others of the necessity to change.

Most companies (77%) undertook supply chain changes and were motivated internally. As fewer companies experienced a supply chain disruption than decided to change, companies decided to change irrespective of previous experiences. In terms of the supply chain, it is not only the learning school (Mintzberg et al., 1998), where previous disruption induces change (Kunreuther et al., 1997), or the shifting of reference points (ibid), but also the environmental school (Mintzberg et al., 1998) that may explain this, where observations of the environment or mimetic isomorphism (Meyer et al., 1977) may induce change. However, internal motivation (sales with existing and number of customers, profit and reputation) prevails external motivation (competitor pressure) contradicting that mimetic isomorphism (Hawley, 1968) and competitor pressure/inspiration (Dimaggio et al., 1983) are motivating factors. Other constraints (Kunreuther et al., 1997) in the form of sales or

profit may be stronger motivations for change to occur. As such, supply chain managers must acknowledge that if they wish to drive supply chain strategy change, they must argue based on financial facts rather than competitor actions. The implications for managers have been summarized in Figure 36.

No.	Research Findings	Implication for Organizations	Recommendation for Managers
1	Perception does not impact supply chain strategy change	Drive to change the supply chain strategy may be hindered within the organization	Managers must apply a change management approach of convincing others to change the supply chain strategy
2	Internal motivation (sales, profit, reputation) drives supply chain change	Decision to change is based on financial performance of the firm, both long and short term	Managers who want to change the supply chain strategy must argue based on financial facts rather than competitor actions

Figure 36: Implications for managers (transformation)

11.3. Transformed configuration

The third research questions concerns the transformed configuration: *How do international organizations change their supply chain strategies and what consequences do these have?*

Supply chain management (i.e. increasing focus on risk management and contingency planning, improving communication, imposing risk management on suppliers) and design changes (i.e. increasing the number of suppliers, raw material and finished goods inventory) prevailed over supply chain location (i.e. facilities and supplier located in natural catastrophe areas) changes. Given, that most disruptions were indirect, this seems plausible to the extent that the number of suppliers in natural catastrophe prone areas was not decreased. Negative consequences regarding the number of and sales with existing customers, as well as a high dependency on Asia-Pacific influenced the decision to increase the finished goods inventory, which may be explained by the learning school (Kunreuther et al., 1997) where companies learn from previous experience that they need to maintain supply reliability as well as the environmental school (Mintzberg et al., 1998) where companies realize the threat in these areas, but since they cannot change this - as described above - inventories are increased. As such, "to avoid (a) stock out (Company D) increased the stock of our major products." Given the positive outcome of finished inventory increases, and the strong demand side impact experienced, this should receive more focus. As is to be seen, undertaking a supply chain does not guarantee boosting performance, but in most cases maintaining it. However, this should not discourage supply chain managers from undertaking changes. The reason being, that if supply chain managers do not change their supply chains, then a supply chain disruption may have a larger impact on the company than without the changes, which would need to

be tested further but holds for findings with Company A. Company A and its CEO had drawn lessons from previous supply chain disruptions and thereby reduced the impact in proceeding disruptions. Furthermore, due to this, they were even able to increase their overall market position.

It was found that some supply chain changes centered on supply chain design and management decreased profitability and in some cases (i.e. increase supply base and raw material inventory) decreased reputation. Profitability may be related to the cost factor of undertaking a change. Increasing supply base and raw material inventory may be related to negative feedback from suppliers towards supply chain managers regarding these changes. Managers should be aware that change comes at a financial and relationship cost. However, as was previously stated, it seems the overall outcome of supply chain change is constant or positive.

Actual exposure to natural catastrophe areas did not decrease significantly. This may be related to the finding that most impact was indirect in nature. However, no relationship between direct exposure and direct impact was to be found. In the case of companies not shifting current facilities, this may be related to the sunk-cost fallacy argument (Khaneman et al., 2011) where a path (i.e. maintaining facilities in the current locations) is continued based on the money, time or effort that has already been spent. The constrained to change argument (Kunreuther et al., 1997) may also restrict shifting current facilities due to a limited amount of capital available to do so. The reason why this did not occur, may be related to the inability of supply chain managers to convince the organization of the financial means that would be needed to undertake such an action. Supply chain managers need to employ scenario planning and total cost techniques to convince management.

Buyer dependency explains shifting current and stop setting up facilities in natural catastrophe areas, where a previous damage and a higher buyer dependency may induce the realization to uphold supply reliability. However, given a statistically weak relationship, this may also not be the case. Further, negative profit and number of customer consequences as well as sales and reputation explain the action of stop setting up new and shifting facilities in natural catastrophes areas, respectively. From a learning school perspective (Mintzberg et al., 1998) previous bad experience induce change. Once again, Company A is provides as clear indication of previous bad experiences guiding future behavior.

With regards to decreasing the number of suppliers from natural catastrophe areas and given the high supplier dependencies indicated, it might difficult for firms to reduce them, as is explained by Company H: "when you think (...) they only produce our goods in those areas then we can only

procure goods in those areas. Because if there were (other) availabilities we may also consider that (...) but we also see (...) that all of our competitors have the same issue." As such, despite a shift in reference points actions are constrained (Kunreuther et al., 1997). They concluded that they: "are currently in some projects in Asia where (they) clearly have to ask (themselves), does this price benefit really weigh off the risk." Company C also claims that they "have a product from Japan and (...) are thinking of how to get it produced in another country or outside of Asia." Thus, the firm considers gamble over losses (Kahneman et al., 1979), if the firm's total cost structure would not support the gains to be earned they would decide to shift activities accordingly. As such, dependency on regions in terms of price and products as well as competitive thoughts determines the inability to decrease supply from these areas. The global specialization of manufacturing sites is asserted by the World Economic Forum (2012c). Furthermore, regional sourcing dependency on North America, China, Asia-Pacific, Africa and possibly South Asia explained increasing the number of suppliers in general. As is exemplified by Company H: "Taiwan is currently on our plateau and we need a second capability for this product platform in another country" companies may be trying to increase suppliers in alternative countries. Given that most supply chain disruptions are indirect and originated due to supply dependencies in these areas, managers should focus on trying to mitigate risk or decrease their overall exposure if possible.

Companies that undertook change in the past, decided to do the same in the future. Thus, this finding shows evidence of the learning school in practice (Levitt et al., 1988; Kahneman et al., 2011). Despite the fact that the outcome of undertaking supply chain management changes was not positive for most companies, these still remain the most pursued types of changes in the past and future. Given that many of the disruptions occurred in 2011, it may be that companies are still pursuing past supply chain management changes and therefore the outcome are not yet visible. Following this, firms will stop setting up new facilities in natural catastrophe area and increase raw and finished goods inventories. Little shifting of current facilities or decreasing the number of suppliers in natural catastrophe prone areas is planned. As such, companies will continue to be exposed to natural catastrophes in the future but will try to manage this risk through supply chain design and management. Given that supply chain management did not bear the most positive outcome, managers should try to focus on trying to minimize exposure in the future or using supply chain strategy experienced that reputation and number of customers either increased in some or maintained the same in most cases. Other relationships were not found. A summary is found in Figure 37.

No.	Research Findings	Implication for Organizations	Recommendation for Managers
1	International organizations sourcing and producing in areas with high natural catastrophe risk will increase their overall number of suppliers or decrease their number of suppliers from areas with high natural catastrophe risk. Increasing the amount of suppliers occurs more frequently than decreasing suppliers from natural catastrophe areas.	Regional dependency on areas with high natural catastrophe risk increase probability to experience a supply chain disruption. It is challenging to decrease the number of suppliers from natural catastrophe areas due to the high dependency.	If a sourcing or production dependency on natural catastrophe areas should reduce the dependency by decrease suppliers from these areas and increasing overall supply base. Decreasing the number of suppliers from natural catastrophes will decrease exposure and increase the overall supply base will mitigate the risk. The former is important to consider.
2	Some supply chain design and management changes decrease profitability. Other changes either did not change or increased performance.	Financial driven organizations may be discouraged to undertake changes due to this	Supply chain managers need to persuade that not undertaking changes may lead in higher losses than undertaking changes
3	Increasing raw materials and the supply base may harm supplier relationships	Procurement may suffer from undertaking certain supply chain changes	Executive supply chain managers need to persuade procurement staff through incentive setting based on risk management and ability to supply, rather than supply relationships
4	Supply chain exposure to natural catastrophe risk did not decrease significantly. This change is driven by financial performance (i.e. sales and profit)	International organizations may still be at risk due to the financial means associated with decreasing exposure	Supply chain managers need to convince senior managers through financial analysis using a total cost or scenario planning approach
5	Past supply chain change determines future change	Once companies undertake change, and a type of change, they will continue doing the same	Supply chain managers need to be aware that convincing may be necessarily only one time and should therefore not get discouraged

Figure 37: Implications for managers (transformed configuration)

12.Conclusion

This paper set out by describing how the hydrological and geophysical natural catastrophes in Thailand and Japan 2011, respectively, and their impact on international supply chains, inspired the authors to conduct explorative research. The paper went on to describe the research motivation on a more formalized level, by bringing forth research motivations and research gaps. From this a research aim and question were developed. These provided the basis for the theoretical framework, which was based on the configuration school of strategy formation, whereby the current configuration described a state of increasing supply chains becoming increasingly dispersed around the globe in lengthy networked structured supply chains (supply chain location), which are also becoming increasingly designed for cost-efficiency and leanness (supply chain design) and managed for increased collaboration and integration across the various echelons (supply chain management). Companies are following these supply chain strategies believing that they increase their competitive position and financial performance. However, this remains uncertain. Arguably, the more usage of these strategies is shown to induce increasing amount of vulnerability towards risk. The paper discussed natural catastrophes as being one of these risks, which have been increasing in impact and frequency over the past 20 years of coherent global measurements especially in Asia and North America. The paper brought these trends together and came to assert that a paradoxical development is present, where supply chains are increasingly vulnerable to risk due to their underlying strategies and that the risk of natural catastrophes is increasing. Following this, the paper discussed the process of transformation through strategy formation schools with elements of management perception, decision-making and organizational learning. These will explain the change undertaken in the changed configuration. Possibilities of such configurations were then brought forth. This was followed by the research section, which was explorative in nature, whereby a mix-method approach, combining qualitative research in the form of in-depth interviews and quantitative research in the form of an online questionnaire, was taken. Based on 75 responses to the online questionnaire and 8 in-depth interviews with supply chain managers and corporate executives in international organization from a variety of countries, the results were presented. It was found that based on the sample of 83 organizations, more than half of them experienced a supply chain disruption due to natural catastrophes in the past ten years. Most disruptions were indirect in nature, meaning that it also impacted their suppliers, and occurred in North America, South-Asia and Asia-Pacific in 2011. Most did not experience negative consequences in terms of profitability, the number of customers, sales with existing customers or their reputation. Though some indicated that they did. Combined with findings from other studies, it was asserted that the common view of natural catastrophes being low-frequency and high-impact risks may not be appropriate; especially so, when considering the indirect disruptions and the increasing interconnectivity of supply chains. Many companies that experienced a disruption undertook supply chain strategy changes as a response to this. Most changes focuses on supply chain management changes centered on risk management, contingency planning, or supply chain communication. Fewer undertook supply chain design changes with regards to increasing finished goods and raw material inventories or the number of suppliers. Supply chain location, in the form of indirect and direct exposure to natural catastrophe areas, was the change least undertaken. As such, companies are changing their supply chain strategies by focusing on risk mitigation rather than elimination. This may be explained by the high cost of shifting facilities and difficulty of switching suppliers away from natural catastrophe areas. Equally as many will continue to undertake supply chain changes in the future that are of a similar nature. The research tried to explain the reasons behind the transformations undertaken. It was found that companies were mostly motivated internally through profit, sales, or reputation, whereby perception, or a change therein, did not play an important role. Buyer dependency was a strong explanatory factor, whereas supplier dependency was not. Having described the findings, the paper went on to discuss the findings within the light of the theoretical framework and brought forth implications for managers. It was found that not only one school of strategy formation was able to explain the change, but that each had a time and place,

as is explained by the configuration school. Implications for managers are centered on acknowledging that regional dependencies in areas with high natural catastrophe risk, such as parts of Asia and North America, will increase the probability to experience a supply chain disruption. Further, they must acknowledge that supply chain disruptions due to natural catastrophes may occur more frequently and with less impacted than expected. Also, they tend to cause more indirect than direct disruptions. Supply chain managers must understand that undertaking supply chain changes may not yield any immediate positive results, but may rather be negative for the financial performance. Supply chain managers must convince senior managers that however not undertaking any changes will possibly yield worse financial results when not undertaking changes than when undertaking changes. As perception does not influence supply chain change, managers must argue using financial facts. Limitations and future research will be presented in the following section.

13. Limitations and Further Research

The paper possesses limitations in relation to the research conducted. The study of BCI (2011) was not readily available at the start of the research process, thus their list of alternatives, especially in relation to type of consequence with regards to natural catastrophe impact, was not used as a benchmark. The BCI (2011) study used answer alternatives that were specific and easy for a manager to relate to, whereas the study in this paper made use of more generic answer possibilities. This may have been the reason why many respondents indicated that a lot of the factors "maintained the same". In future research it is therefore advisable to focus on less generic consequences and rather drill down to the specific of the situation. Furthermore, the questionnaire should have asked more about the second and third tier suppliers as well as about the monetary impact of the natural catastrophe. Also the questionnaire could have been more precise in asking about management perception, for example through the use of proxies. Additionally, the questionnaire experienced a low response rate. This was an issue as there were not enough responses to the different questions - however this is the nature of the study conducted. Another issue is that the research was of an explorative nature, meaning that it is more difficult to draw conclusions. However, this also provides grounds for future research where it is recommended to use this explorative research as a starting point for more confirmatory research, centered more around the details of the types of changes and the causes of these, as well as the overall impact structure on a more detailed level.

14.References

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15.Appendices

15.1. Configuration

15.1.1. Supply chain trends

15.1.1.1. Supply chain design: Discussion on performance benefits of lean strategies Lean supply chain strategies are often regarded as, what Hofer et al. (2012), coin the "gold standard" of supply chains (e.g., Guinipero et al., 2005; Goldsby et al., 2006) due to the fact that efficiency and effectiveness are the ideals of many supply chain managers (Christopher & Towill, 2002). This is in line with a study conducted by the Boston Consulting Group in 2011, where Ryeson et al. (2011) assert that many industrial goods manufacturers have used "lean manufacturing" in one way or another through the use of an array of techniques. The reason why this is the case, is because it is expected by practitioners that the implementation of lean strategies will result in higher operational performance (i.e. inventories, throughput time etc.) and consequently have a positive effect on financial performance of a firm (Hofer et al., 2012). This follows the observation by Kilgore (2003), Eyeoftransport (2011), and Radjou (2002) who assert that increasing efficiency, decreasing costs has received much attention in past years. However, based on the review of the literature by Hofer et al. (2012) it seems where some studies claim that the relationship between the adoption of lean strategies and financial performance is uncertain (Chen et al., 2007, 2005; Eroglu & Hofer, 2011; Swamidass, 2007; Koumanakos, 2008; Capkun et al., 2009; Cannon, 2008) other studies find that there is a positive relationship (Inman & Mehra, 1993; Callen et al., 2000; Fullterton & McWatters (2001); Germain et al., 1996; Kinney & Wempe, 2002; Fullerton et al., 2003; Fullerton & Wempe, 2009; Yang et al., 2011). This is complemented by a contributeion by Lee (2004) in the Harvard Business Review, where he draws upon his many years of research within the field an comes to assert that many companies with efficient and costeffective supply chains did not gain a sustainable advantage over rivals but rather their supply chain performance decreased. Despite this observation, Ryeson et al. (2011) of the Boston Consulting Group assert that many companies have been able to achieve a reduction in their costs, an increase in their quality, an increasingly engaged workforce and more satisfied customers but only few producers are able to reap the full benefits and create a "world-class" operation; which in turn is due to an array of issues such as the appliance of too broad initiatives that only scratch the surface of the organization. In a very recent paper, Olhager & Prajogo (2012) come to conclude that make-toorder and make-to-stock firms are impacted by lean strategies, supplier rationalization and
integration in opposite manners. Where make-to-order firms profit from supplier integration, this cannot be said about make to stock firms. The make-to-stock firms benefit from lean strategies and supplier rationalization. This makes it important to differentiate between the type of firm when discussing the impact of supply chain initiatives (Olhager & Prajogo, 2012). As such, lean supply chains are bested suited for longer lead times and more predictable situations of demand (Christopher & Towill, 2002).

Despite the difficulties and large expenses associated with its implementation, many firms developed just-in-time strategies in their manufacturing plants to remain competitive trough cost savings (Makelprang & Nair, 2010). Similar as to the forth-mentioned relationship between adopting lean strategies in general and the performance benefits, the evidence is mixed (Dean and Snell, 1996; Ward, 2003 in Makelprang & Nair, 2010). Some research is not conclusive as to the relationship between just-in-time and its impact on financial performance (Kim and Takeda, 1996; Heiko, 1989 in Makelprang & Nair, 2010; Maiga & Jacobs, 2009) and others indicate that it has a positive effect (Anyane-Ntow, 1991; Balakrishnan, Linsmeier, & Venkatachalam, 1996; Fullerton & McWatters, 1999; Huson & Nanda, 1995; Mia, 2000; Ockree, 1993; Fullerton & McWatter, 2000). This performance uncertainty is further underline by a lacking consensus of what constitutes just-in-time strategies, making it difficult for firms to implement (Goyal and Deshmukh, 1992; Shah and Ward, 2007; White, 1993; Handfield, 1993 in Makelprang & Nair, 2010).

15.1.1.2. Supply chain design: offshore-production vs. offshore-outsourcing

As the concepts of outsourcing and offshoring and outsourcing tend to be used interchangeably, it is necessary to differentiate these before embarking on an in-depth discussion (Berry, 2006; in Lewin & Volbreda, 2011). Outsourcing - in its most simple definition - refers to the act of relocating activities and processes that have previously been carried out within the boundaries of the firm to another firm (Lewin & Volbreda, 2011). Offshoring - in its most simple definition - refers to the act of transferring activities and processes from one country (often the home country) to another country (Erber & Sayed-Ahmed, 2005; Levy, 2005; in Lewin & Volbreda, 2011). In its basic definition, offshoring does not differentiate if these are carried out internally or externally of the firm under scrutiny. However, in more specific terms, cross-boarder offshoring refers to the act of relocating activities and processes from the representation of the firm in one country to another representation in a different country. As such, it is only the national boundaries that are changed (Erber & Sayed-Ahmed, 2005). Combining the concepts of offshoring and outsourcing, so called offshore-outsourcing refers to the act of simultaneously relocating a processes that have been

previously carried out within the boundaries of the firm and its home country and relocating them to another country and firm (Erber & Sayed-Ahmed, 2005). The distinction of these concepts is summarized in Figure 38: Defining and Differentiating Offshoring and Offshoring.

Concept	Relocating processes and activities	Relocating processes and activities
	across national boundaries	across firm boundaries
Outsourcing	Not specifically defined	Yes
Offshoring	Yes	Not specifically defined
Cross-boarder	Yes	No
offshoring		
Offshore-outsourcing	Yes	Yes

Figure 38: Defining and Differentiating Offshoring and Offshoring

Having established that there is a clear differentiation between these two concepts and given the focus on geographical dispersion, the following will focus on the concepts of offshore-outsourcing (i.e. change in firm and national boundary) and cross-boarder offshoring (i.e. change in national boundary).

15.1.1.3. Supply chain design: Development of outsourcing

Before the 1950's companies where highly vertically integrated organizations (Stigler, 1951) conducting most of their activities internally (Hättönnen & Erkisson, 2009). Until the 1980's, Hättönnen & Eriksson (2009) claim that, firms outsourced mainly their non-core element to maximize profits, relying mostly on arms-lengths relationships manifested in contracts. This has been identified as the era of the big ban that lasted from the 1980's to the end of the 1980's (ibid). The 1980s and 1990s focused much on the outsourcing of manufacturing activities. Outsourcing became increasingly prominent in the early 1990s (Morgan, 1999), which was also strongly pushed by the prominent article by Hamel & Prahalad (1990) on the core competences of companies and marked, what Hättönnen & Eriksson (2009) claim as being the era of the bandwagon. As such, firms did not only outsource competences that were not part of their core, but also those that were part of their core. With this, outsourcing moved from being solely cost focused to being more focused on skills, knowledge, capabilities etc. With this, "strategic outsourcing" emerged (Alexander & Young, 1996b; Quinn & Hilmer, 1994), in which functions of an increasingly

strategic nature were being outsourced and relationships with the outsourcing partners became more important. Furthermore, the international aspect of outsourcing became more interesting for firms. In the early 1990's researchers were particularly concerned with the question as to where to outsource; especially so due to the improvements in ICT and the reduction of national boundaries. This brought rise to the term of offshore outsourcing, which is increasingly becoming important for firms (Hättönen & Eriksson, 2009). Since the 2000s the focus has shifted more and more towards the outsourcing of services (Ellram et al., 2008).

15.1.1.4. Supply chain location: Global sourcing

International purchasing was a topic that was prevalent as a major research field in the 1980's and the 1990's (Trent & Monczka, 2003). Today, global sourcing is still an important practice for many firms (e.g., SCM World, 2011). This is shown in a survey that was conducted with 750 supply chain representatives from companies around the world, the nearly 50% source more than half from abroad, with only 16% sourcing less than 10% from abroad (SCM World, 2011). This is manifested in the decision wheter or not to source from externally (Higgins, 1955; Venkatesan, 1992). Once this has been taken, the firm must decide from where it ought to source externally (Choi and Hartley, 1996; Nassimbeni, 2006) or internally (Skinner, 1964; Ferdows, 1997). In this survey, it was indicated that China, the USA, and Germany are the most prominent places from which to source (ibid). The trend to source from China is underlined by Steve Matthesen - a vice president for supply chain management at the Boston Consulting Group - who claims that low cost country sourcing is a current trend in supply chain management (BCG & Wharton, 2006; Trent & Monzcka (2003) conclude by asserting that sourcing on an international level is one of the few possibilities for companies to remain successful in those markets that are highly competitive in nature. Murray (2001) suggests that firms can reach such advantages through strategic alliance international sourcing. The increasing existence of international sourcing - both in practice and in terms of research - is based on several considerations, of which cost reductions are the most prominent ones. As such in the 1980's and 1990's the research motivation was based on a declining competitiveness of many Western companies and the understanding that purchasing on an international level would help restore their previous position (Trent & Monczka, 2003). According to Murray (2001) managers tend to view international purchasing as a means to achieve short term cost reductions, rather than taking a more sustainable long-term approach. Yet, based on the reviews conducted by Petersen et al. (2000), many research studies have come to the conclusion that the unit price has been reduced through international, not necessarily total cost reduction. This may be due to the fact

that sourcing decisions are more operational/ tactical in nature as they tend to be taken in independence of other units and at a lower level in the organization (Guinipero & Monczka, 1990). Furthermore, due to the fact that global sourcing "involves the worldwide integration of engineering, operations, and procurement centers within the upstream portion of a firm's supply chain" (Trent & Monczka, 2003: 607), this also makes it complicated and risky. In their review of the literature on global sourcing Holweg et al. (2011) claim that much research has been focused on the benefits of global sourcing (Levy, 1995; Nassimbeni, 2006) and about its strategic vs. operational nature (Monczka & Trent, 1991; Bozarth et al., 1998); however, little focus on the actual costs has been placed. Following this line of thought, Holweg et al. (2011) conduct a study of the costs that are incurred through global sourcing. In tis study, they split the costs of global sourcing to be economically insensible. However, they do not consider natural catastrophes as part of the hidden costs. This is interesting, as they consider political or economical instability risk, which is also non-predictable (Holweg et al., 2011) and has an impact on the wider business environment, such as natural catastrophes.

15.1.1.5. Supply chain location: Offshore-outsourcing and offshoring

There are arrays of theories that are trying to explain the phenomena of offshore-outsourcing. Dunning's (1980, 1988, 2000) eclectic paradigm could also be used to explain the phenomena, as was argued by Doh (2005), Graf & Mudambi (2005) and Palvia (2004) and was summarized by Hättönnen & Eriksson (2009). Dunning's eclectic paradigm is a combination of internationalization, organizational, and geographical-location theory and argues that if ownership, internalization and location advantages exist, then it is justified for international production to exist (Dunning's eclectic paradigm summarized by Hättönnen & Eriksson, 2009). According to Hymer (1972), offshore outsourcing includes the ownership and location advantages, however not the incentive of internalization; which may only hold true given the older definitions of internalization that focus on learning and risk avoiding (cf. Johanson and Wiedersheim-Paul, 1975; Johanson and Vahlne, 1977; Luostarinen, 1979). As such, evolution and learning (e.g., Nelson & Winter, 1982) may better describe this. Economic geography theory (Ohlin, 1933) as well as geographical-location theory (Weber, 1958; Vernon, 1974) could be an alternative to explaining the offshore outsourcing phenomena. In line with the findings from Karimi-Alaghehband et al.'s (2011) study, Lacity et al. (2011) agree that transaction cost economics gives mixed results when attempting to explain the reason for information-technology outsourcing.

From a summary of the literature on outsourcing and offshoring, Temouri et al., (2010) emphasize that location specific aspects are the reason for the offshoring and outsourcing to occur. Temouri et al. (2010) claim that for hi-tech companies it is firm-specific knowledge as well as ownership advantages that may be the decisive factor as to why firms outsource or offshore. In terms of trying to argue for why firms choose certain locations, part of the above explanations could also be used. However According to Hätönen (2009) there is still unclarity in research as regards the location decision in offshore outsourcing, which has also received little attention in research (Bunyaratavej et al. 2007; Doh, 2005; Kotabe and Murray, 2004). Based on Graf & Mudambi (2005) as well as Palvia (2004), Hättönen (2009) claims that situational factors (i.e. the expectations of the customer and type of outsourced activity), internal factors (such as the experience of the company and its objectives), locational factors (i.e. country risk, government, infrastructure, human capital and culture), as well as external factors (such as stakeholder requirements) all influence the choice of location. Lacity et al. (2010) propose an endogenous framework to argue for the occurrence of information-technology outsourcing, in which cost reduction, access to skills, process improvements, political and technical motivations all drive the decision, where as security or loss of control concerns stifle the decision to outsource. Yet, Hätönen (2009) asserts that non-locational factors (namely the situational and internal factors) are the most influential in terms of deciding to offshore outsource. Furthermore, prior positive experience of offshoring has a positive effect on offshore outsourcing in the future (Hätönen, 2009). As such, many different explanations of the phenomena exist.

Classification	Definition (EM-DAT, 2012)	Main Event	Sub Event
Geophysical	"Events originated from solid earth"	Earthquake	Ground shaking, Fire following, Tsunami
		Volcanic eruption	Volcanic eruption
		Mass movement dry	Subsidence, Rockfall, Landslide
Meteorologic al	"Events caused by short-lived/small to	Tropical storm	Hurricane, Typhoon, Cyclone
	meso scale atmospheric	Extra-tropical storm	Winter storm, Blizzard/Snowstorm

15.1.2.1. Classification of Natural Catastrophes

	processes (in the spectrum from minutes to days)"	Convective storm	Severe storm, Thunderstorm, Lightning, Hailstorm, Tornado
		Local storm	i.e. Foehn, Bora Bora, Mistral
Hydrological	"Events caused by deviations in the normal water cycle and/or overflow of	Flood	General flood, Flash flood, Storm surge, Glacial lake, outburst flood
	bodies of water caused by wind set- up"	Mass-movement wet	Subsidence, Avalanche, Landslide
Climatologic al	"Events caused by long-lived/ meso to macro scale processes	Extreme temperature	Heat wave, Cold wave / frost, Extreme winter conditions
	(in the spectrum from	Drought	Drought
	intra-seasonal to multi-decadal climate variability"	Wildfire	Forest fire, Bush fire, Brush fire, Grassland fire
Biological	"Disaster caused by	Epidemic	
	the exposure of living organisms to germs and toxic substances"	Insect infestation	
	and toxic substances	Animal stampede	

Source: Based on MunichRe (2011a) and EM-DAT (2012)





Source: EM-DAT (2012)





Natural catastrophes worldwide 1980 - 2011

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Source: MunichRe (2012a)

15.1.2.4. Development of the Number of Global Weather Catastrophes (1980-2011)



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Source: MunichRe (2012a)

15.1.2.5.

Great Global Natural Catastrophes (1950-2011)



Source: MunichRe (2012b)





Source: Worldometer (2012)





Source: MunichRe (2012a)

15.1.2.8. Weather Related Natural Catastrophe Global Impact (Losses) 1980-2011



Source: MunichRe (2012a)

15129	Top 10 economic	losses due to natural	catastrophes	(1980-2011)
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Date	Event	Country/Region	Economic Loss (USD Millions)	Insured Loss (USD Millions)	Fatalities
Mar. 11, 2011	EQ/Tsunami	Japan	210,000	35,000	15,844
Aug. 25-30, 2005	Hurricane Katrina	United States	125,000	66,900	1,833
Jan. 17, 1995	Earthquake	Japan	102,500	3,075	6,434
May 12, 2008	Earthquake	China	85,000	425	87,000
Jul-Nov. 2011	Flooding	Thailand	45,000	10,789	790
Jan. 17, 1994	Earthquake	United States	41,800	15,300	57
Sep. 6-14, 2008	Hurricane Ike	U.S.; Caribbean Islands	37,600	15,600	195
May-Sep. 1998	Floods	China	32,000	1,000	3,656
Feb. 27, 2010	EQ/Tsunami	Chile	30,000	8,500	525
Dec. 2010 - Jan. 2011	Floods	Australia (Queensland)	30,000	2,420	36

Source: AON Benfield (2011)

15.1.2.10. Top 10 insured economic losses due to natural catastrophes in 2011

Exhibit 1: Top 10 Insured Loss Events in 2011

Event Date	Event Name Or Type	Event Location	# Of Deaths	# Of Structures/ Claims	Economic Loss Estimates (USD)	Insured Loss Estimates (USD)
3/11	Earthquake	Japan	15,844	1,100,000	210.00 billion	35.00 billion
2/22	Earthquake	New Zealand	182	156,313	*30.00 billion	13.50 billion
7/25-11/30	Flooding	Thailand	790	4,000,000	45.00 billion	10.78 billion
4/22-4/28	Severe Weather	U.S. (Southeast, Plains, Midwest)	344	700,000	10.20 billion	7.30 billion
5/21-5/27	Severe Weather	U.S. (Plains, Midwest, Southeast)	181	750,000	9.10 billion	6.75 billion
8/22-8/30	HU Irene	U.S., Bahamas, Caribbean Isl.	46	835,000	8.55 billion	5.00 billion
12/21-1/14	Flooding	Australia (Queensland)	36	58,463	30.00 billion	2.42 billion
4/3-4/5	Severe Weather	U.S. (Midwest, Southeast, Plains)	9	225,000	2.80 billion	2.00 billion
6/13	Earthquake	New Zealand	1	53,963	*30.00 billion	1.80 billion
4/14-4/16	Severe Weather	U.S. (Plains, Southeast, Midwest)	48	150,000	2.50 billion	1.70 billion
				All Other Events	86.69 billion	20.90 billion
				Totals	434.84 billion	107.15 billion
*The New Zealar	d government has only relea	sed a combined USD30 billion economic lo	oss total for the	September 2010, Febru	ary 2011 and June 2011	EQ events.

Source: AON Benfield (2011)

15.1.2.11. Development of the number of Asian natural catastrophes (1980-2011)



Source: MunichRe (2011c)

15.1.2.12. Development of the number of Asian weather related natural catastrophes (1980-2011)



Source: MunichRe (2011c)





Source: MunichRe (2011c)

15.1.2.14. Development of the number of weather related natural catastrophes (1980-

2011)



Source: MunichRe (2011c)

15.1.2.15. Average annual damages caused by reported natural catastrophes (USD bn) between 1990 and 2011



Source: EM-DAT (2012)

15.2. Transformation





Mintzberg et al. (1985)

15.2.2. Summary description of types of strategies

Table 1.	Summary	description	of types	of strategies
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Strategy	Major features
Planned	Strategies originate in formal plans: precise intentions exist, formulated and articulated by central leadership, backed up by formal controls to ensure surprise-free implementation in benign, controllable or predictable environment; strategies most deliberate
Entrepreneurial	Strategies originate in central vision: intentions exist as personal, unarticulated vision of single leader, and so adaptable to new opportunities; organization under personal control of leader and located in protected niche in environment; strategies relatively deliberate but can emerge
Ideological	Strategies originate in shared beliefs: intentions exist as collective vision of all actors, in inspirational form and relatively immutable, controlled normatively through indoctrination and/or socialization; organization often proactive vis-à-vis environment; strategies rather deliberate
Umbrella	Strategies originate in constraints: leadership, in partial control of organizational actions, defines strategic boundaries or targets within which other actors respond to own forces or to complex, perhaps also unpredictable environment; strategies partly deliberate, partly emergent and deliberately emergent
Process	Strategies originate in process: leadership controls process aspects of strategy (hiring, structure, etc.), leaving content aspects to other actors; strategies partly deliberate, partly emergent (and, again, deliberately emergent)
Unconnected	Strategies originate in enclaves: actor(s) loosely coupled to rest of organization produce(s) patterns in own actions in absence of, or in direct contradiction to, central or common intentions; strategies organizationally emergent whether or not deliberate for actor(s)
Consensus	Strategies originate in consensus: through mutual adjustment, actors converge on patterns that become pervasive in absence of central or common intentions; strategies rather emergent
Imposed	Strategies originate in environment: environment dictates patterns in actions either through direct imposition or through implicitly pre-empting or bounding organizational choice; strategies most emergent, although may be internalized by organization and made deliberate

Mintzberg et al. (1985)







Kunreuther et al (1997)

15.2.4. Design school

The design school of thought is based on the classical SWOT model, where the strategy formation should fit the internal and external opportunities and requirements. The founding fathers of this school are Chandler (1969) with his book on Strategy and Structure and Selznick (1957) on Leadership in Administration. The design school is built on the premise of conception and has been criticized for lacking to acknowledging learning (Mintzberg et al., 1998). When assessing strength and weaknesses it is evident that one cannot fully know if a strength will actually persist a strength in the real situation, thus how can a company know this fact prior to the actual event taking place (ibid). Another common criticism to the design school is the definition that structure should follow strategy (Chandler, 1969; Mintzberg et al., 1998). This statement takes no account for past knowledge and structures, thus it is inferring that when a company changes its strategy it entirely erases the past structure and start all over. This is highly unlikely and therefore, Mintzberg et al.

(1998:35) put forth the definition *"that structure follows strategy the way the left foot follows the right foot in walking"*. To sum up, the design school is overly simplistic and limited in its application, however it has contributed to the underpinnings of strategic management (Mintzberg et al., 1998)

15.2.5. The Planning school

The planning school was developed by Igor H. Ansoff in his book Corporate Strategy (1965). The planning school relies on a formal set of steps advocated from the top that companies should execute to formulate strategies (Ansoff, 1965). Thus, the planning school was relying on the machine assumption of "produce each of the component parts as specific, assemble them according to the blueprint, and the end product (strategy) will result" (Mintzberg et al., 1998:57). The actual strategies became part of tools and plans throughout the organization such as budgets, key performance indicators and operating plans. Scenario planning is one tool that has been widely used by the planning school (ibid). To be able to perform strategic planning, one need to be able to predict, control or stabilize the future environment in which the company is operating in (ibid). If not, a plan is useless as the environment might change. The planning school does not account for the human element in strategic planning rather it relies on systems. Thus, the process of internalizing, comprehending and synthesizing information is not accounted for. This is known for the fallacy of formalization. Another fallacy of the planning school is the lack of acknowledging action in strategy formation (ibid). The planning school has one major fallacy and that is its name, it should have been called strategic programming due to its nature of being a process that formalizes how strategies are made (ibid).

15.2.6. The Positioning school

The positioning school is founded on the same premises as the design and planning school but it adds one more element, the content. Michael Porter (1980) was one of the main contributors of introducing content in strategy making, which was inspired by the industrial organization theory. This refers to the importance of acknowledging the actual strategy not the mere process of it and furthermore it added element (Mintzberg et al., 1998). The main contribution of the positioning school was its argument that only a limited amount of strategies are wanted in an industry at the same time (ibid). Thus, the positioning school put forth a range of generic strategies that was seen as superior (ibid). In this era, the BCG growth marix, Porters five forces, generic strategies and value chain were introduced (Porter, 1985). The positioning school renders the same critiques as the

two previous schools (Mintzberg et al., 1998). Furthermore, the criticism of the positioning school is one of being too narrow in its focus, context, process and strategies (Mintzberg et al., 1998).

15.2.7. The Entrepreneurial school

The entrepreneurial school came into force from economics and from Schumpeter's notion of creative destruction (Schumpeter, 1950). This relates to how capitalism is continuing forward where the driver of that continuity is the entrepreneur (ibid). The entrepreneurial school is the first of the schools of thought that is of a descriptive nature, meaning that it wishes to understand the strategy formation process (Mintzberg et al., 1998). It focuses on strategy formation as a perspective that aims to provide direction to the company. It is highly dependent on the leader that formulates the vision and strategy formation is dependent on the leadership of the one leader. Vision is the key to the entrepreneurial school of thought and is defined as: *"a mental representation of strategy, created or at least expressed in the head of the leader"* (Mintzberg et al., 1998:124). The disadvantage of this school is the focus on one individual's behavior and visionary leadership style (ibid). Furthermore, vision might not be specific enough to be beneficial, as it might narrow the minds of the employees to think in only one direction where other directions are lost. It is also argued that depending on one person can be risky business as all the knowledge, motivation and vision rests with that person. Even though the entrepreneurial school has its limitation, it works in some businesses and keeps on being followed (Mintzberg et al., 1998).

15.2.8. The Cultural School

The main contributors to the cultural school of thought are Rhenman (1973) and Normann (1977), which introduced a conceptual framework, a theorizing approach and methodological approach to culture in strategy formation process. Similar to the cognitive school the culture school involves an objective stand and subjective stand (Mintzberg et al., 1998). The objective stand refers to the behavior of people formed by social and economic relationships (ibid). The subjective strand involves an interpretation process that is not connected to logic (ibid). The culture school of thought involves the study of culture as (1) an outsider or (2) as an insider to the organization (ibid). In the cultural school strategy formation is seen as "a process of social interaction, based on the beliefs and understandings shared by the members of an organization" (ibid, 1998:267). Furthermore, socialization and acculturation is the means by which individuals obtain their cultural beliefs (ibid). It is difficult for members of a culture to fully describe the culture and beliefs that they share as it is largely tacit in nature (ibid). This means that strategy becomes perspectives that are collectively

understood and intended which means that strategy is in many cases deliberate (ibid). Culture is not open to strategic change, but if change is needed, it is mostly seen as small shifts in the strategic perspective held by the company (ibid).

The interlinkages between strategy and culture are manifold. Culture is argued to have an influence on how people take decisions in organizations through its "perception filter" (Mintzberg et al., 1998:269). Strategic change can be hard to accomplish if a company possess a strong culture, as culture is rooted in tacitness and beliefs which are in general difficult to change (ibid). Thus, culture acts as an internal barrier to strategic change. Much research has been about how to overcome the resistance to strategic change by culture (ibid). One tool that has been proposed is to write down the beliefs that the organization possesses, making them less ambiguous and more concrete (ibid). This should be accompanied with cultural audits that conclude a consensus on the common beliefs (ibid). Furthermore, successful organizations are said to possess dominant values that give them the opportunity to enjoy a competitive advantage (ibid). Culture school has often touched upon the situations of cultural influence on mergers and acquisitions. It has often been stated that culture brings about a clash that make such a strategic move difficult to pursue (ibid). Culture can be described as material culture where there is interplay with the tangible resources and the beliefs held by the employees (Mintzberg et al., 1998). Culture can also provide a motivation for differentiation making organizations different and enabling excess market rents to be earned (Mintzberg et al., 1998). The Resource-Based View (RBV) touches upon this aspect where one look inside for a competitive advantage (Wernerfelt 1984, Barney, 1991). Dynamic capabilities are something that has developed from the RBV, however as a theory it belongs in the learning school as it involves learning over time (Teece et al., 1997). Lastly, culture can provide a barrier for imitation as culture is highly tacit and intangible, thus making it difficult for someone outside to understand let alone copy it (Mintzberg et al., 1998). The culture school is argued to be falling short of being able to be conceptualized on a general level (ibid). Another critique of this school is the lack of desire to undertake strategic change, which is might lead to stagnation of the organization's performance (ibid).

15.2.9. Organizational learning

The process of organizational learning, as described by Child et al. (2005) takes place on the strategic, systemic and the technical level. On the strategic level, organizational change is manifested in a shift in the mindset of the management; especially with respect as to what they determine as being organizational success (ibid). Systemic learning refers to a shift in the systems

of an organization, whereby increasing the integration of different systems in the organization is the most important (Child et al., 2005). There are different classifications of how organizations learn. For example, Fiol & Layles (1985) as well as Meyer (1982) claim that learning can occur on a low or a high level. Senge (1990) takes a differentiation of learning by classifying it as being either generative or adaptive in nature. Dodgson (1991) asserts that learning can be tactical or strategic in its nature. Argyris & Schön (1978) differentiate between single and double loop type of learning, as well as deuteron learning. According to Ørberg Jensen (2009) one can relate these views of learning to the view taken by Child et al. (2005) where systemic learning can be seen as more operational in nature and is hence occurring on a lower level, adaptive manner and tactical level. On the other hand, strategic level learning is situated on a higher level, is generative and strategic in nature (ibid).

15.3. Transformed configuration

15.3.1. Other strategies

One of these strategies is that of postponement, which relates to strategies that ensures and postpones product differentiation (Sodhi et al., 2012). Thus, this means that the company produces a generic product to all their customers in the start and then we exact demand and preferences are known from the customers, the company can customize their product accordingly (ibid). This strategy can also be called cost-effective mass customization tool (ibid). In the event of a catastrophic disruption such as a natural catastrophe, this strategy enables the company to quickly respond and change their product configurations (ibid).

Another supply chain strategy change is one relating to economic supply incentives (Sodhi et al., 2012). This is especially important for companies that cannot utilize a large supplier base (ibid). Thereby, by making use of economic incentives to suppliers the company can ensure some flexibility (ibid). It is argued that by making use of these incentives schemes, companies facing disruptions can quickly adjust order quantities (ibid). Flexible transportation is another robust strategy that enables easier facilitation during a disruption (ibid). There are three approaches to flexible transportation: (1) multi-modal transportation (diversify the mode of transportation), (2) multi-carrier transportation (alliance within transportation providers) and (3) multiple routes (use various routes to reach the same goal) (ibid).

Revenue management is another supply chain strategy change that involves dynamic pricing and promotion, similar to that used in the airline business to sell seats with unknown demand (Sodhi et

al., 2012). It can enable a company to manage demand and satisfy customer demand while being hit by a disruption (ibid). Assortment planning is the eight robust supply chain strategy that involves influencing customer buying behavior based on displays of products, location of products on shelves and labels (ibid). Thus, this can be used when a company is faced with a disruption to influence the customer to buy the goods that were not affected by the disruption (ibid).

Another strategy change regards make or buying decision, meaning that you have certain products in-house and other non-core products outsourced (Sodhi et al., 2009). This enables the supply chain to be more resilient in the face of a disruption as production can be shifted to other locations and demand to other products (ibid). Thus, quick response is ensured in the face of a natural catastrophe (ibid).

Flexible supply contracts are another strategy that can ensure effective response to a disruption (Sodhi et al., 2009). This means that companies are able to adjust the quantity ordered over time to reduce the supply risk (ibid) Flexible manufacturing process means that companies have multiple plants for multiple products (ibid). This process enables the company to shift production of products to certain locations that were not hit by a disruption and thus, ensured low impact of a disruption on the company (ibid) Recovery planning systems is one form of this type of flexible manufacturing process (ibid).

Another robust supply chain strategy is silent product rollover, which means that new products are put into the market without any announcement (Sodhi et al., 2009). This means that the full benefits of the products is not clear to the customers and they will likely buy the products that they know and are available (ibid). This is a strategy to discourage customers to buy the product that the company has out of stock or that are being phased out (ibid). This strategy enables the company to have substitute products that can smoothen demand fluctuations during a disruption (ibid).

15.4. Results – Quantitative Research

15.4.1. Background information and the respondents' companies

The following chapters of the App. present the background information and the respondents' companies.

15.4.1.1. Data modifications

A total of n=107 partially and fully complete answers beyond the first page of the questionnaire

were collected in the time period between June and July 2012. However, of these n=107 responses, only n=75 could be used in the final analysis of the results, to be seen in this paper. The n=32 responses that were taken out of the data set were done so on the basis of two reasons. One of the reasons was related to the fact that respondents did not go beyond answering the question regarding the company's previous impact by a natural catastrophe. Given that this is one of the central questions of the questionnaire and the fact that it was obligatory to answer, these respondents were removed from the data set. These constitute the majority of the results that were removed. The minority of the respondents that were removed, were removed based on the finding that they chose to answer only those questions that were obligatory to answer in order to move to the next set of questions. Given that this resulted in the majority of the other questions remaining unanswered, these respondents were also removed from the data set. After removing these two groups of n= 32 respondents, this yielded a total of n=75 responses that are used in the following analysis.

15.4.1.2. Level of Employment of the Respondents

Given that vice presidents (n=3), senior managers (n=22), and board members/ CEO/ presidents (n=11) are to be seen as holding senior positions, n=36 hold such positions which constitutes close to half, as to be seen in Figure 39: Level of Employment of Respondents. Senior managers (n=22) have the strongest representation. The sum of middle managers (n=13) and manager/ line manager/ project manager (n=16) adds to n=29 respondents. As the questionnaire necessitates a holistic view of the company, its supply chain and environment, the employment level is a positive indication of the results' validity.



Figure 39: Level of Employment of Respondents

15.4.1.3. Years of Work Experience of the Respondent

From the sample of n=75 respondents, it can be observed that when summing the respondents (n= 20) with 0 to 5 years (n=9) and 6 to 10 years (n=11) and contrasting this to the remaining respondents (n=55), the majority have over 10 years of work experience, with the group between

11 to 25 years of work experience (n=36) and 26 to 40 years of work experience (n=18) representing the largest respondent groups. Similar to the above, the fact that a large majority holds a significant degree of work experience, adds to the validity. This is seen in Figure 40: Years of Work Experience.



Figure 40: Years of Work Experience

15.4.1.4. Job Division of the Respondents

Based on the sample of n=75 respondents for the question pertaining to the division that respondents belong to, it can be said that the overwhelming majority (n=59) work within areas that associated to the supply chain, operations and sourcing. This is further complemented by the fact that (n=7) working within business development & strategy. Given the fact that the nature of the study is related to the field of supply chain management (i.e. also operations and sourcing), as well as strategy (i.e. also business development), this further adds to the overall validity of the results. This is seen in Figure 41: Job Division.



Figure 41: Job Division

15.4.1.5. Industry Type of the Respondent's Company

Grounded in the n=75 responses to the question regarding the type of industry of the respondent's company, three three industry types prevail. These are manufacturing (n=12), energy & natural

resources (n=11), and logistics (n=10). Furthermore, professional services (n=6), healthcare & pharmaceuticals (n=6), consumer goods (n=6) and IT & Technology (n=5) also have a significant amount of responses. Fewer responses are from the communications (n=3), chemicals (n=3), automotive (n=3), government (n=2), wholesale, (n=1), service industry (n=1), non-profit (n=1), construction & real-estate (n=1), and agricultural (n=1) industry. Overall, a breadth of responses from various industries exists, as seen in Figure 42: Industry Type.



Figure 42: Industry Type

15.4.1.6. Country of Origin of the Respondent's Company

Based on n=69 responses to the question regarding the country of origin of the respondent's company, the majority of the companies are from Germany (n=13) or the USAn (n=13). With a large gap this is followed by the United Kingdom (n=4) and The Netherlands (n=4). The remaining countries are represented by three companies or less and are spread and from all continents. The amount of companies in these countries can explain the amount of respondents from Germany and the USA. When contrasted with companies from Japan or China a further explanatory factor would be the level of English and their presence on the professional networking sites that were used. Despite the majority of respondents from Germany and the USA, the well spread amount of countries from different continents is a positive sign in terms of the overall validity of the results. This is seen in Figure 43: Country of Origin.



Figure 43: Country of Origin

15.4.1.7. Global Annual Revenue of the Respondent's Company

Grounded in n=74 responses to the question regarding the global annual revenue, it can be said that, with the firms having a revenue of \$ 499k or less (n=7), \$ 500k to \$999k (n=4), and \$ 1mn to \$999mn (n=11), \$ 100mn to \$ 499mn (n=18), and \$500mn to \$ 999mn (n=5), the majority of the firms (n=45) have under \$1bn in revenues. The remaining firms, with \$1bn to \$ 4.9bn (n=13), \$ 5bn to \$ 9.9bn (n=6), and \$ 10bn or more (n=10), make up the minority (n=29) of the responding firms, as seen in Figure 44: Global Annual Revenue.



Figure 44: Global Annual Revenue

15.4.1.8. Regional Sourcing Dependency of the Companies

Based on the n=75 the regional sourcing dependency of the companies (i.e. in which regions do you source more than 25% of your resources?), it was found that the majority (n=13) have a strong sourcing dependency upon Western Europe, as well as North America (n=7), South Asia (n=6), and Asia-Pacific (n=5). Following this is China (n=4) as well as Eastern Europe and Western Europe (n=4). The dependency on Africa, the Middle East, and South America are low, to be seen in Figure 45: Regional Sourcing Dependency.



Figure 45: Regional Sourcing Dependency

15.4.1.9. Regional Production Dependency of the Companies

Grounded in the n=75 responses to the question regarding the regional production dependency of the companies under scrutiny (i.e. in which regions do you produce more tan 25% of your goods and services?), the majority (n=18) has a dependency upon Western Europe. As such, North America (n=8), Asia-Pacific (n=6) and China (n=6) display a significantly smaller production dependency. The production dependencies in the Middle East, Africa and South America are the lowest.





15.4.1.10. Regional Sales Dependency of the Companies

Based on the n=74 responses to the question regarding the regional sales dependency of the companies under question (i.e. in which regions do you sell more than 25% of your goods and services?), it was found that the majority did so in Western Europe (n=22). With a significant gap, the next large regional sales dependency was in North America (n=9). Furthermore, Asia Pacific (n=4), a combination of Western Europe and North America (n=4), as well as a combination of Western Europe, North America and Asia-Pacific (n=4) also represent large regional sales dependencies. As such, South Asia, China, Africa, the Middle East, and South America are not large sales dependencies for the companies participating the survey.



Figure 47: Regional Sales Dependency

15.4.1.11. Factor analysis behind overall regional sales dependency

At first, and based on the eigenvalues and the scree plot, 10 factors were chosen. However, the significance test recommended to use 13 factors, which were then also chosen.





Unrotated Factor Loading

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11	Factor 12	Factor 13
Sourcing: Western Europe	0.164608	-0.063420	-0.045694	-0.207350	-0.148957	0.097728		0.758739	0.075698	0.043996	0.078717	0.066929	0.128287
Sourcing: Eastern Europe		-0.109382	0.097774	0.086786		-0.062120		0.264303	0.207776	0.651864	-0.072642	0.077275	-0.238414
Sourcing: North America	0.064477	0.975247	-0.137207	0.148833									
Sourcing: South America	-0.081407	0.115995		-0.078230	0.709573	0.292581	0.079965			-0.087095	-0.074187	0.108056	0.336949
Sourcing: China	0.098043			0.110695	0.230494	-0.114114		-0.220226	0.573080	0.068742	-0.150468	0.252169	0.190208
Sourcing: South Asia	0.120034	-0.234466	-0.152713	0.245376	0.203149	-0.131286	0.333895		-0.135763	-0.144976	-0.204951	0.133102	-0.092947
Sourcing: Asia Pacific	0.149205	-0.124788		-0.063567	-0.041897	0.052919	0.225583	-0.341829	0.153336		0.411335	0.163769	0.129202
Sourcing: Middle East	0.132140	0.108484	0.950485	0.236418	-0.080070								
Sourcing: Africa	-0.062099			-0.077180	-0.098748	0.760254	0.632361						
Producing: Western Europe	0.113517	-0.185397	-0.135449	-0.246411	-0.070918	-0.167672	0.108506	0.886530		-0.051511	0.047974		
Producing: Eastern Europe			0.215684	0.129956	-0.073719	-0.084664		0.082091	0.064344	0.783075	-0.141358	0.248929	
Producing: North America	0.221794	0.601823	-0.139602	0.215063	0.066668	-0.300876	0.185634	-0.060841		-0.054918		-0.115217	-0.238397
Producing: South America	-0.089825	0.226014	0.266185		0.931042								
Producing: China		-0.074562	0.063211	0.173658	0.113664	-0.167514	0.085481	-0.128622	0.907535	-0.057526			
Producing: South Asia		-0.129872	-0.183275	0.531918	0.134709	0.186380	0.099856		-0.290495	0.081398	-0.121858		-0.354902
Producing: Asia Pacific			-0.069255			0.273347	0.139913	-0.269670		0.079221	0.796864	0.082914	-0.073209
Producing: Middle East	0.266493	-0.143541	0.488764	0.214850	-0.149528			-0.183247	-0.219448	-0.160177	-0.114534		
Producing: Africa	0.097171		0.243271		-0.148447	0.497563	0.279283	-0.157882	-0.063056	0.115908	0.047665	-0.181741	
Selling: Western Europe		-0.153732		-0.301113	-0.201174	-0.138010		0.636493	0.147372	0.031004	-0.111426	0.221443	-0.065524
Selling: Eastern Europe	0.104443	0.081774	0.215409	0.356064		-0.187202	0.153690	0.245287		0.463855	0.093707	-0.143028	0.173730
Selling: North America	0.139895	0.532193	-0.124396			-0.648230	0.505628						
Selling: South America			-0.115880	0.289143	0.428575					0.239610	-0.041152		0.410783
Selling: China	0.162125			0.329161		-0.145961	0.086442	0.113039	0.321881	0.100206	0.307188	0.198062	
Selling: South Asia		-0.299906	-0.268250	0.914717									
Selling: Asia Pacific		-0.143136	-0.153214	0.191551	-0.079243	-0.041747	0.174061	-0.046979	0.082682	0.041200	0.553283	-0.061678	0.141931
Selling: Middle East	0.881144												
Selling: Africa	0.471368	-0.115514	0.114587	0.047099	-0.047291	0.268461		0.132668		0.263973		-0.595529	0.073543

Significance Test

Test H0: no common factors. HA: at least one common factor.	E 351.0	OF ChiSqua 00 936.86	re Prob>ChiSq 35 <.0001*		
Test	DF	ChiSquare	Prob>ChiSq		
H0: 13 factors are sufficient.	78.000	93.172	0.1158		

Test H0: 13 factors are sufficient. HA: more factors are needed.

Rotated Factor Loading

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11	Factor 12	Factor 13
Sourcing: Western Europe	0.804899	-0.072567	-0.031854	-0.081055	0.078949		-0.078977	0.059118		0.087007	0.089795	-0.132127	0.081483
Sourcing: Eastern Europe	0.180088	-0.068171		0.089129	0.735103	-0.046906	0.128095	-0.035741		0.093918			-0.146534
Sourcing: North America	-0.110890	0.823145	0.096756			-0.112508		0.099013	-0.066093	-0.101961	0.041762	-0.492888	0.117837
Sourcing: South America	-0.060001	-0.077032	0.808051	-0.052840	-0.145956		0.051534	0.166404	-0.092502	-0.077130			0.164035
Sourcing: China	-0.134936		0.185758		0.125517		0.659524	-0.095258	-0.067139	-0.148677	0.159965		0.167132
Sourcing: South Asia			0.088949	0.388050	-0.078080	-0.060310				-0.109192	0.108661	0.484205	
Sourcing: Asia Pacific	-0.172739	-0.070039		-0.153856		0.553749	0.140977	0.142443		-0.073998	0.154394	0.112439	0.041440
Sourcing: Middle East	-0.065264			-0.101745	0.186423		0.058169	0.065438	0.952112	0.093262		-0.106973	
Sourcing: Africa			0.060380		-0.085184	0.122654	-0.061719	0.975364	-0.074931				
Producing: Western Europe	0.943970		-0.055421				-0.077384	-0.095092	-0.120244	0.113765		0.148535	
Producing: Eastern Europe					0.864715	-0.047332			0.098900		0.062620		0.133523
Producing: North America	-0.121013	0.784256		0.116977				-0.089524			0.110969		-0.121330
Producing: South America	-0.128467	0.119487	0.944821			-0.064504		-0.094771	0.100895		-0.078063		-0.192089
Producing: China	-0.030314					0.095164	0.942229	-0.056918		0.090568	-0.118382		-0.106756
Producing: South Asia	-0.151049			0.713988	0.113126	-0.074288	-0.186365	0.117404				0.081006	-0.136079
Producing: Asia Pacific	-0.164696		0.062713			0.815500	-0.091446	0.197811	-0.102628			-0.176162	-0.193171
Producing: Middle East	-0.183444	-0.101087	-0.121617	0.088939	-0.055900	-0.074019	-0.091766		0.615635		0.209378	0.118685	
Producing: Africa	-0.164361	-0.093292			0.036594	0.099608	-0.111166	0.581039	0.187107	0.226271			
Selling: Western Europe	0.715958	-0.108371	-0.179047	-0.147795	0.154811	-0.171251		-0.085765	-0.074175	-0.136534			-0.072398
Selling: Eastern Europe	0.132107	0.230859		0.140141	0.478905	0.137031		-0.049296	0.249179	0.320990	-0.086537		0.264231
Selling: North America		0.879252	-0.052411	-0.150722		0.064557	0.062923	-0.133014				0.395440	0.088684
Selling: South America	-0.103272		0.471189	0.193118	0.173334	0.047117	0.088727	-0.095721	-0.111721	0.071490			0.421932
Selling: China	0.165086	0.197542		0.206113	0.179289	0.386539	0.322509	-0.100678	0.083073	-0.051429	0.078629	-0.058647	
Selling: South Asia	-0.110568		-0.078441	0.913449		0.144658	0.173183	-0.123078		0.077864			0.256285
Selling: Asia Pacific			-0.091698	0.125748		0.624579				0.141415	-0.060510		0.116894
Selling: Middle East	0.101442	0.134772	-0.037504			0.067755			0.140642	0.225931	0.815831	0.063394	
Selling: Africa	0.076486	-0.066794		0.032814	0.114365			0.218850	0.083579	0.779435	0.287906	-0.075171	

15.4.1.12. Key Supplier Dependency of the Companies

Based on the n=75 respondents to the question regarding the dependency of the companies upon their key suppliers, the vast majority indicated that this was either high (n=29) or very high (n=28). Fewer respondents indicated a medium dependency (n=15). Only a very limited amount indicated a low (n=2) or no dependency (n=1), with no respondents indicating a very low dependency (n=0). As such it can be concluded, the , the majority has a high to very high dependency upon its key suppliers.



Figure 48: Key Supplier Dependency

15.4.1.13. Key Buyer Dependency of the Companies

Supported by the n=75 respondents to the question regarding the dependency of the companies upon their key buyers, the majority indicated that this was either high (n=32) or very high (n=21). Fewer respondents indicated a medium dependency (n=17) and very few indicated a low (n=3), very low (n=1), or no dependency (n=1). As such, it can be summarized that there is an overall high dependency of the companies towards their key buyers.



Figure 49: Key Buyer Dependency

15.4.1.14. Risk Assessment

Based on the n=75 answers to the question if the firms are undertaking any risk assessment of catastrophic risks, 52% (n=39) indicated that they did not undertake such an assessment, where as 48% (n=36) indicated that they did. Of the respondents undertaking risk assessment, n=29 responded to the question on what types of risk assessment they undertake. Here, the majority is undertaking some form of scenario planning either singly (n=11) or in combination with other tools (n=7). Other tools of risk assessment being undertaken by the respondents are having a business contingency plan (n=1), business continuity management (n=1), early planning & emergency response management (n=3), failure mode & effect analysis (n=1), hurricane preparation analysis (n=1), Monte-Carlo simulation (n=2), SCM Ecosystem Analysis (n=1), single sourcing and risk evaluation processes (n=1), stress tests (n=1), standard operation procedure evaluation (n=1), as well as supplier assessment (n=1).



Figure 50: Risk Assessment

15.4.2. Configuration

The following chapter provides the detailed results that are relevant to answer the first sub-research question from a quantitative perspective.

15.4.2.1. Location and year and type of previous natural catastrophe

In some cases, it was possible to obtain further information as to the year, location and type of natural catastrophe that they were affected by. Of the n=32 respondents that were given regarding the location in which the natural catastrophe impacted the company, it seems that Japan (n=11) and the USA (n=7) are those showing the highest frequencies. Furthermore, Thailand (n=3) and Iceland (n=3) also display an frequent location of impact.



Figure 51: Location of Previous Natural Catastrophe Impact With regards to the question on the year in which the respondent's company was impacted by the natural catastrophe, the n=35 respondents, seem to indicate that with n=17 responses, 2011 was the year in which most of the companies were impacted. Furthermore, 2010 was (n=7) was also a year in which the impact is high. In some cases, there is a regular exposure to natural catastrophes. One of these relates to a United National agency that helps with disaster relief and another a company that was affected by cyclones four times in the past ten years in Australia.



Figure 52: Year of Previous Natural Catastrophe Impact

In terms of the type of natural catastrophe that had an impact on the companies, it seems that from the n=31 responses, that tsunamis and earthquakes in combination (n=11), flooding (n=6), hurricanes (n=5), volcanoes (n=4), earthquakes (n=3), storm (n=2), cyclones (n=1), and droughts (n=1) are the natural catastrophes that firms are confronted with. As such, it seems that in sum, earthquakes (n=14) are they natural catastrophes that had the largest frequency. When clustering these occurrences into those that are weather related and those that are geophysical determined it becomes apparent that geophysical catastrophes (n=18) had a more frequent impact than did weather-related catastrophes (n=15).



Figure 53: Type of Previous Natural Catastrophe Impact

15.4.2.2. Factor analysis of type of past natural catastrophe impact

To determine the type of past natural catastrophe impact on the company, a factor analysis was conducted whereby only those responses were used that also claimed they had been impacted. Based on the eigenvalues and the screeplot, it was decided to use three factors. The statistical information behind the choice can be seen in Figure 54: Factor analysis of the type of past impact on supply chains



Unrotated Factor Loading

	Factor 1	Factor 2	Factor 3
Company Past Natural Catastrophe Impact: Inbound logistics	0.968574	0.248675	
Company Past Natural Catastrophe Impact: Production input missing	-0.083042	-0.050724	-0.142165
Company Past Natural Catastrophe Impact: Facility damage	-0.445520	0.895259	0.004769
Company Past Natural Catastrophe Impact: Inventory damage	-0.188546	0.387347	-0.046354
Company Past Natural Catastrophe Impact: Outbound logistics issues	0.358487	0.347882	-0.007212
Company Past Natural Catastrophe Impact: No Impact	-0.172530	-0.184675	0.967537

Significance Test					
Test H0: no common factors. HA: at least one common factor.	[15.00	DF 00	ChiSqua 25.09	re 92	Prob>ChiSq 0.0487*
Test H0: 3 factors are sufficient. HA: more factors are needed.	DF 0.000	С	hiSquare 1.517	Pı	rob>ChiSq

Rotated Factor Loading			
	Factor 1	Factor 2	Factor 3
Company Past Natural Catastrophe Impact: Inbound logistics	-0.223776	0.974639	0.001439
Company Past Natural Catastrophe Impact: Production input missing	-0.005481	-0.097250	-0.142100
Company Past Natural Catastrophe Impact: Facility damage	0.999772	0.015223	0.015005
Company Past Natural Catastrophe Impact: Inventory damage	0.431127	0.010266	-0.041947
Company Past Natural Catastrophe Impact: Outbound logistics issues	0.144546	0.478176	
Company Past Natural Catastrophe Impact: No Impact	-0.094778	-0.236772	0.966931

Figure 54: Factor analysis of the type of past impact on supply chains

15.4.2.3. Type of past natural catastrophe impact

The following represent the impact of previous natural catastrophes on the supply chain of the company.



Figure 55: Impact of Previous Natural Catastrophe on Supply Chain

When looking at the impact that natural catastrophes had on the suppliers from a case perspective,

then it can be asserted that in most cases (n=6) the suppliers did not experience any issues. The second most prominent case is when the suppliers experienced all of the issues provided as answer possibilities (n=5). This is followed by cases when the supplier experiences all incidents except for inventory damage (n=3) and only those relating to facility damage (n=3).



Figure 56: Impact of Previous Natural Catastrophe on Supplier's Supply Chain

15.4.2.4. Type of consequence

The majority indicated that their reputation maintained the same (n=23, 60.5%). In some instances, the reputation either increased (n=6, 15.8%) or strongly increased (n=2, 5.23%). In fewer cases, the reputation of the firm decreased (n=4, 10.5%) or strongly decreased (n=1, 2.63%). In terms of the sales with existing customers, the majority indicated that this remained the same (n=20, 52.6%). The second largest group was those that indicated that it decreased (n=8, 21.1%) or strongly decreased (n=5, 13.2%). The smallest group indicated that the sales with existing customers increased (n=4, 10.5%).

15.4.2.5. Relationship between past natural catastrophe impact and type of consequence for the company

Overall, it can be asserted that there is no difference in the type of impact that the natural catastrophe had on the supply chain and the type of consequence that this had for the company. As is to be seen in the reporting of the results below, the only significant difference that was found is

that relating to outbound logistics and the consequences in terms of sales with existing customers. However, given the fact that many of the cells in the contingency table analysis had a count that was less than five, there is also a suspect in terms of the Chi-Square and consequently the significance of the results.

Relationship between the Type of Impact that the Natural Catastrophe had on the Supply Chain and the Consequence it had on the Reputation: Based on the answers from n= 38 respondents, it can be asserted that there is no relationship to be found between the type of impact that the natural catastrophe had on the supply chain and the consequence this had on the reputation of the company. Undertaking a contingency analysis and testing it through the use of Pearson's Chi-Square it was found that there was no significant difference between the companies that had an impact in terms of their inbound logistics x^2 (5, N=38)=3.20, p= 0.67, production input missing x^2 (5, N=38)=4.62, p=0.46, facility damage x^2 (5, N=38)=2.03, p=0.84, inventory damage x^2 (5, N=38)=4.83, p=0.44, outbound logistics x^2 (5, N=38)=5.78, p=0.67, or no impact x^2 (5, N=38)=0.67, p=0.98 were impacted and the consequence that it had for there reputation at the 5% significance level ($\alpha = 0.05$). Furthermore, it is to be remarked that there is a warning regarding the Chi-Square as 20% of the cells had a count of less than 5.

Relationship between the Type of Impact that the Natural Catastrophe had on the Supply Chain and the Consequence it had on the Sales with Existing Customers: Undertaking a contingency analysis and testing it through the use of Pearson's Chi-Square it was found that there was no significant difference between the companies that had an impact in terms of their inbound logistics x^2 (4, N=38)=4.56, p=0.36, production input missing x^2 (4, N=38)=0.93, p=0.92, facility damage x^2 (4, N=38)=5.63, p=0.23, inventory damage x^2 (4, N=38)=3.28, p=0.53, or no impact x^2 (4, N=38)=0.92, p=0.92 were impacted and the consequence that it had for there sales with existing customers at the 5% significance level ($\alpha = 0.05$). However, it was found that at the 5% significance level ($\alpha = 0.05$) there was a significant difference between those companies whose outbound logistics x^2 (4, N=38)=16.06, p=0.0029* were impacted and the consequence that it had on the sales with the existing customers. However, given the fact that 20% of the cells had an expected count that was less than 5, there remains as a Chi-Square suspect.

Relationship between the Type of Impact that the Natural Catastrophe had on the Supply Chain and the Consequence it had on the Number of Customers: From the n=38 responses, it can be asserted

that there is no significant differences in those companies whose supply chain affected was in a certain manner and the consequence this had on their number of customers. This can be shown through the use of a contingency analysis and testing it through the use of Pearson's Chi-Square, where it was found that companies that had an impact in terms of their inbound logistics x^2 (4, N=38)=4.33, p= 0.36, production input missing x^2 (4, N=38)=2.09, p=0.72, facility damage x^2 (4, N=38)=5.69, p=0.22, inventory damage x^2 (4, N=38)=2.48, p=0.65, outbound logistics x^2 (4, N=38)=4.92, p=0.30, or no impact x^2 (4, N=38)=0.23, p=0.99 did not show a significant difference in terms of the consequence that this for their number of customers at the 5% significance level ($\alpha = 0.05$). Furthermore, it is to be remarked that there is a warning regarding the Chi-Square as 20% of the cells had a count of less than 5.

Relationship between the Type of Impact that the Natural Catastrophe had on the Supply Chain and the Consequence it had on the Profitability: Based on the n=38 responses, it was found that there is no significant difference for those that companies whose supply chain was impacted by the supply chain in a certain way and the consequence that this had for their profitability. Through the use of a contingency analysis and tested through the use of Pearson's Chi-Square it was found that firm's whose inbound logistics were impacted $x^2(4, N=38)=4.81$, p= 0.38, production input missing $x^2(4, N=38)=1.41$, p=0.84, facility was damaged $x^2(4, N=38)=4.48$, p=0.34, inventory was damaged x^2 (4, N=38)=1.33, p=0.86, outbound logistics had issues x^2 (4, N=38)=8.01, p=0.09, or who experienced no impact $x^2(4, N=38)=0.92$, p=0.92 did not show a significant difference in terms of the consequence that this for their profitability at the 5% significance level ($\alpha = 0.05$). Furthermore, it is to be remarked that there is a warning regarding the Chi-Square as 20% of the cells had a count of less than 5.

15.4.3. Transformed configuration

15.4.3.1. Type of past supply chain change by the company

The type of past supply chain change was looked at from the perspective of those companies that undertook a change. The reason for this is because no change or change was a question that would later on diver the respondent. Given this, four eigenvalues above 1 and given the screeplot, it was chosen to employ 4 factors.
Unrotated Factor Loading											
	Factor 1	Factor 2	Factor 3	Factor 4							
Past Supply Chain Change, Type: Facilities - Shift current facilities to areas/countries with lower natural catastrophe risk	0.58619	-0.05915	0.10644	0.25333							
Past Supply Chain Change, Type: Facilities - Stop setting-up facilities in areas/countries with high natural catastrophe risk	1.00000										
Past Supply Chain Change, Type: Sourcing - Increase the number of suppliers	0.20116	0.36246	0.09930	-0.15325							
Past Supply Chain Change, Type: Sourcing - Decrease sourcing from areas/countries with high natural catastrophe risk	0.47183	0.10316	0.04774	-0.33856							
Past Supply Chain Change, Type: Sourcing - Impose risk management practices on suppliers		-0.23128	0.36467	0.08977							
Past Supply Chain Change, Type: Inventory - Increase raw material inventory	-0.09840	0.91670	0.04159	-0.06909							
Past Supply Chain Change, Type: Inventory - Increase finished goods inventory	0.08146	0.36063		0.50651							
Past Supply Chain Change, Type: Communication – Improve supply chain communication	0.07647	0.10226	0.66625	0.29540							
Past Supply Chain Change, Type: Risk Management – Increase focus on supply chain risk management		-0.24474	0.71788	-0.29528							
Past Supply Chain Change, Type: Risk Management – Increase focus on contingency planning	0.05524	0.13002	0.67721	0.13426							

Rotated Factor Loading

	Factor 1	Factor 2	Factor 3	Factor 4
Past Supply Chain Change, Type: Facilities - Shift current facilities to areas/countries with lower natural catastrophe risk	0.591235	0.154172	-0.089400	0.203219
Past Supply Chain Change, Type: Facilities - Stop setting-up facilities in areas/countries with high natural catastrophe risk	0.996906		0.076719	
Past Supply Chain Change, Type: Sourcing - Increase the number of suppliers	0.169770		0.417371	
Past Supply Chain Change, Type: Sourcing - Decrease sourcing from areas/countries with high natural catastrophe risk	0.457660		0.262778	-0.266971
Past Supply Chain Change, Type: Sourcing - Impose risk management practices on suppliers	0.045314	0.389851	-0.195084	
Past Supply Chain Change, Type: Inventory - Increase raw material inventory	-0.169973		0.863132	0.285387
Past Supply Chain Change, Type: Inventory - Increase finished goods inventory	0.060032	0.052934	0.146628	0.604565
Past Supply Chain Change, Type: Communication – Improve supply chain communication	0.066242	0.699554	0.077095	0.218504
Past Supply Chain Change, Type: Risk Management – Increase focus on supply chain risk management		0.669164		-0.463027
Past Supply Chain Change, Type: Risk Management – Increase focus on contingency planning		0.679800	0.162220	0.080585



Variance Explained by Each Factor

Factor	Variance	Percent	Cum Percent
Factor 1	1.6223	16.223	16.223
Factor 2	1.5815	15.815	32.038
Factor 3	1.0944	10.944	42.982
Factor 4	0.8318	8.318	51.301

Significance Test

Test H0: no common factors. HA: at least one common factor.	ב 45.00	DF ChiSqua 00 156.63	re Prob>ChiSq 37 <.0001*
Test	DF	ChiSquare	Prob>ChiSq
H0: 4 factors are sufficient.	11.000	12.370	0.3365

HA: more factors are needed.

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15.4.3.2. Type of supply chain changes by the competitors

The question regarding the type of supply chain changes undertaken by the competitors was also structured using a factor analysis. Given this, four eigenvalues above 1 and given the screeplot, it was chosen to employ 4 factors.



	Factor 1	Factor 2	Factor 3	Factor 4
Past Supply Chain Change and Competitor Change, Type: Facilities - Shift current facilities to areas/countries with lower natural catastrophe risk	0.167157	0.112918	0.687122	-0.069528
Past Supply Chain Change and Competitor Change, Type: Facilities - Stop setting-up facilities in areas/countries with high natural catastrophe risk	0.602942		0.382050	
Past Supply Chain Change and Competitor Change, Type: Sourcing - Increase the number of suppliers	0.054085	0.206817	0.090075	0.388698
Past Supply Chain Change and Competitor Change, Type: Sourcing - Decrease sourcing from areas/countries with high natural catastrophe risk	0.680840	-0.062437	0.436633	0.181963
Past Supply Chain Change and Competitor Change, Type: Sourcing - Impose risk management practices on suppliers	-0.168993	0.587633	0.077175	0.187839
Past Supply Chain Change and Competitor Change, Type: Inventory - Increase raw material inventory	0.943801	0.120381		0.081882
Past Supply Chain Change and Competitor Change, Type: Inventory - Increase finished goods inventory	0.129919	0.075016	0.659268	0.082417
Past Supply Chain Change and Competitor Change, Type: Communication – Improve supply chain communication	0.069986	0.196605	-0.100716	0.972782
Past Supply Chain Change and Competitor Change, Type: Risk Management – Increase focus on supply chain risk management		0.546733		0.173881
Past Supply Chain Change and Competitor Change, Type: Risk Management - Increase focus on contingency planning	0.270474	0.944005	0.171579	0.079111

Unrotated Factor Loading				
	Factor 1	Factor 2	Factor 3	Factor 4
Past Supply Chain Change and Competitor Change, Type: Facilities - Shift current facilities to areas/countries with lower natural catastrophe risk	0.264031	-0.179361	0.213882	0.608305
Past Supply Chain Change and Competitor Change, Type: Facilities - Stop setting-up facilities in areas/countries with high natural catastrophe risk	0.214627	-0.097696	0.623540	0.258474
Past Supply Chain Change and Competitor Change, Type: Sourcing - Increase the number of suppliers	0.256413	0.358335		0.103596
Past Supply Chain Change and Competitor Change, Type: Sourcing - Decrease sourcing from areas/countries with high natural catastrophe risk	0.214632	0.115643	0.720558	0.335496
Past Supply Chain Change and Competitor Change, Type: Sourcing - Impose risk management practices on suppliers	0.537258	0.141274	-0.322471	
Past Supply Chain Change and Competitor Change, Type: Inventory - Increase raw material inventory	0.377105	0.070968	0.859439	-0.161768
Past Supply Chain Change and Competitor Change, Type: Inventory - Increase finished goods inventory	0.225570		0.186970	0.614462
Past Supply Chain Change and Competitor Change, Type: Communication – Improve supply chain communication	0.265124	0.964214		
Past Supply Chain Change and Competitor Change, Type: Risk Management – Increase focus on supply chain risk management	0.537258	0.141274	-0.134719	-0.056138
Past Supply Chain Change and Competitor Change, Type: Risk Management – Increase focus on contingency planning	0.999999			

15.4.3.3. Relationship between type of past company and competitor changes Based on the factor analysis the following was found:

X: Reduce exposure to natural catastrophe prone areas (facilities and suppliers)

Y: Stop setting up facilities and decrease the number of suppliers from natural catastrophe prone areas, as well as increase the raw material inventory

There is a relationship between those companies that shifted current facilities and stopped setting up new facilities as well as decreased the number of suppliers in natural catastrophe prone areas, as well as the competitors that stopped setting up facilities and decreased the number of suppliers in natural catastrophe prone areas as well as increased their raw material inventory. This relationship is represented by the function y=0.45x+0.09, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.40 and is significant at the 95% level with p=0.0006* (n=75) and mean of 0.07 and 0.12 respectively for X and Y. The R² is 0.15.



X: Impose risk management, improve supply chain communication, increase risk management and contingency planning

Y: Stop setting up facilities and decrease the number of suppliers from natural catastrophe prone areas, as well as increase the raw material inventory

There is a relationship between those companies that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning, as well as the competitors that stopped setting up facilities and decreased the number of suppliers in natural catastrophe prone areas as well as increased their raw material inventory. This relationship is represented by the function y=0.69x+0.64, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.30 and is significant at the 95% level with p=0.0006* (n=75) and mean of 0.07 and 0.60 respectively for X and Y. The R² is 0.09.

Correlation					
Variable (F3) Type of Past Competitor Supply Chain (+ Own Change): Stop setting up facilities and decrease suppliers in natural catastrophe areas and increase raw material inventory 0. (F2) Type of Past Supply Chain Change: Impose risk management, improve supply chain communication, increase risk management and contingency planning 0.	Mean 0.073025 0.699027	Std Dev 0.340031 0.773545	Correlation 0.304124	Signif. Prob 0.0080*	Number 75
Parameter Estimates					
Term Intercept		Estimate 0.6485043	Std Error 0.087651	t Ratio 7.40	Prob>iti <.0001*

		Analys	is of V	/ariance		
Summary of Fit				Sum of		
RSquare	0.092491	Source	DF	Squares	Mean Square	F Ratio
RSquare Adj	0.08006	Model	1	4.095475	4.09548	7.4400
Root Mean Square Error	0.741934	Error	73	40.184052	0.55047	Prob > F
Observations (or Sum Wqts)	0.099027	C. Total	74	44.279528		0.0080*
by Charlos (modes) (mo	_					

X: Impose risk management, improve supply chain communication, increase risk management and contingency planning

Y: Impose risk management, increase risk management and contingency planning

There is a relationship between those companies that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning, as well as the competitors that decided to impose risk management practices on their suppliers, increase their focus supply chain risk management, and increase their focus on contingency planning,. This relationship is represented by the function y=0.69x+0.44, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.57 and is significant at the 95% level with p=0.<0001* (n=75) and mean of 0.36 and 0.69 respectively for X and Y. The R² is 0.32.

Correlation					
Variable (F3) Type of Past Competitor Supply Chain (+ Own Change): Impose risk management on suppliers, increase focus on risk management and contingency planning (F2) Type of Past Supply Chain Change: Impose risk management, improve supply chain communication, increase risk management and contingency planning	Mean 0.365223 0.699027	Std Dev 0.643564 0.773545	Correlation 0.570001	Signif. Prob <.0001*	Number 75
Parameter Estimates					
Term Intercept (F3) Type of Past Competitor Supply Chain (+ Own Change): Impose risk management on suppliers, increase focus on risk management and contingency	planning	Estimate 0.4488037 0.6851249	5td Error 0.0851 0.115589	t Ratio 5.27 5.93	Prob>ltl <.0001* <.0001*

Summary of Fit

Analysi	s of V	/ariance			RSquare
Source Model	DF 1	Sum of Squares 14,386469	Mean Square 14.3865	F Ratio 35,1323	RSquare Adj Root Mean Square Erro
Error C. Total	73 74	29.893059 44.279528	0.4095	Prob > F <.0001*	Mean of Response Observations (or Sum



0.324901 0.315653 0.639917 or 0.699027 Wgts) 75

X: Impose risk management, improve supply chain communication, increase risk management and contingency planning

Y: Shift current facilities away and decrease suppliers from natural catastrophe prone areas, as well as increase the finished goods inventory

There is a relationship between those companies that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning, as well as the competitors that decided to shift current facilities away and decrease suppliers from natural catastrophe prone areas, as well as increase the finished goods inventory. This relationship is represented by the function y=0.69x+0.59, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.36 and is significant at the 95% level with p=0.0017* (n=75) and mean of 0.15 and 0.69 respectively for X and Y. The R^2 is 0.12



X: Impose risk management, improve supply chain communication, increase risk management and contingency planning

Y: Improve supply chain communication

There is a relationship between those companies that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning, as well as the competitors that decided to improve their supply chain communication. This relationship is represented by the function y=0.88x+0.61, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.32 and is significant at the 95% level with p=0.0043* (n=75) and mean of 0.09 and 0.69 respectively for X and Y. The R² is 0.10



Based on the contingency analysis the shift current facilities away from natural catastrophe prone areas is shown by a Pearson x^2 (1, N=75)= 12.745, p=0.0004* and LR x^2 (1, N=75)= 7.664 p=0.0056*, where Fisher's Exact Test, Left: p=0.0091* Shift = Shift and Fisher's Exact Test, 2-Tail: p=0.0091* Difference in distributions show a positive relationship. The stopping of setting up facilities catastrophe prone areas is shown by Pearson x^2 (1, N=75)= 17.990, p=0.0133* and LR x^2 (1, N=75)= 6.123 p=<0.0001*. The increase the number of suppliers is shown by Pearson x^2 (1, N=75)= 24.255, p=<0.0001* and LR x^2 (1, N=75)= 21.746 p=<0.0001*, where Fisher's Exact Test, Left: p=<0.001* Increase number of suppliers = Increase number of suppliers and Fisher's Exact Test, 2-Tail: p=<0.0001* Difference in distributions also show a positive relationship. Further, a decrease sourcing from natural catastrophe prone areas is shown by Pearson x^2 (1, N=75)= 4.853, p=0.0276*. The imposing of risk management practices on suppliers is shown by Pearson x^2 (1, N=75)= 11.538, p=0.0023* and LR x^2 (1, N=75)= 9.319 p=0.0007*, where Fisher's Exact Test, Left: p=0.0032* Impose risk management = Impose risk management and Fisher's Exact Test, 2-Tail: p=0.0032* Difference in distributions show a positive relationship. Further the improving of supply chain communication is shown by Pearson $x^2(1, N=75)= 4.607$, p=0.0318* and LR $x^2(1, N=75)= 4.359$ p=0.0368*, where Fisher's Exact Test, Left: p=0.0450* Improve supply chain communication = Improve supply chain communication and Fisher's Exact Test, 2-Tail: p=0.0450* Difference in distributions show a positive relationship. Also, the increasing focus on supply chain risks management is shown by Pearson $x^2(1, N=75)= 22.00$, p=<0.0001* and LR $x^2(1, N=75)= 22.260$ p=<0.0001*, where Fisher's Exact Test, Left: p=<0.0001* Increase focus on supply chain risk management = Increase focus on supply chain risk management and Fisher's Exact Test, 2-Tail: p=<0.0001* Difference in distributions also indicate a relationship that is positive. Finally, the increasing focus on contingency planning is shown by Pearson $x^2(1, N=75)= 17.690$, p=<0.0001* and LR $x^2(1, N=75)= 17.934$, p=<0.0001*, where Fisher's Exact Test, Left: p=<0.0001* Test, Left: p=<0.0001* Increase focus on contingency planning is shown by Pearson $x^2(1, N=75)= 17.690$, p=<0.0001* and LR $x^2(1, N=75)= 17.934$, p=<0.0001*, where Fisher's Exact Test, Left: p=<0.0001* Test, Left: p=<0.0001* Increase focus on contingency planning = Increase focus on contingency planning as well as Fisher's Exact Test, Test, 2-Tail: p=<0.0001* Difference in distributions also indicate a positive relationship.

15.4.3.4. Types of future supply chain changes by the company

Based on the three eigenvalues that have a value of above 1 and the analysis of the scree plot, which shows a sharp drop at this point, it was decided to take three factors.



				Significance Test				
Variance Explained by Each Factor				- Test H0: no common factors.	45.0	DF ChiSq 00 155	uare Pro 5.771	b>ChiSq <.0001*
Factor	variance	Percent	Cum Percent	HA: at least one common factor.				
Factor 1	1.8843	18.843	18.843	Test	DF	ChiSqua	re Prob>	ChiSq
Factor 3	0.6674	6.674	42.579	H0: 3 factors are sufficient. HA: more factors are needed.	18.000	10.24	47 0.	.9236
Rotated F	actor Loadiu	na						
notatou i		.9				Factor 1	Factor 2	Factor
Future Supply	Chain Change, T	vpe: Facilities -	Shift current facilities to areas/	countries with lower natural catastrophe	risk	-0.027431	-0.001962	0.12045
Future Supply	Chain Change, T	vpe: Facilities -	Stop setting-up facilities in area	as/countries with high natural catastroph	e risk	-0.082257	0.473105	0.34170
Future Supply	Chain Change, T	vpe: Sourcing -	Increase the number of supplie	rs		0.300776	0.323194	-0.13973
Future Supply	Chain Change, T	vpe: Sourcing -	Decrease sourcing from areas/	countries with high natural catastrophe r	isk	0.308673	-0.065346	-0.15501
Future Supply	Chain Change, T	ype: Sourcing -	Impose risk management pract	ices on suppliers		0.565809	-0.081576	-0.07890
Future Supply	Chain Change, T	ype: Inventory	- Increase raw material inventor	'y		-0.049069	0.973636	-0.22276
Future Supply	Chain Change, T	ype: Inventory	- Increase finished goods inven	tory		-0.041004	0.550945	0.26673
Future Supply	Chain Change, T	ype: Communic	cation – Improve supply chain co	ommunication		0.499280	-0.088082	-0.06215
Future Supply	Chain Change, T	ype: Risk Man	agement – Increase focus on su	ipply chain risk management		0.819961	0.261784	0.12530
Future Supply	Chain Change, T	ype: Risk Mana	gement – Increase focus on co	ntingency planning		0.667195	0.198126	0.58820
Unrotated	Factor Loa	ding						
						Factor 1	Factor 2	Factor
Future Supply	Chain Change, T	ype: Facilities -	Shift current facilities to areas/	countries with lower natural catastrophe	risk		0.03104	-0.1164
Future Supply	Chain Change, T	ype: Facilities -	Stop setting-up facilities in area	as/countries with high natural catastroph	ie risk	0.38855	0.15561	-0.4149
Future Supply	Chain Change, T	ype: Sourcing -	Increase the number of supplie	rs		0.33104	0.24737	0.2089
Future Supply	Chain Change, T	ype: Sourcing -	Decrease sourcing from areas/	countries with high natural catastrophe r	isk	-0.04424	0.18927	0.2929
⊢uture Supply	Chain Change, T	ype: Sourcing -	Impose risk management pract	ices on suppliers		-0.08961	0.44696	0.3538
⊢uture Supply	Chain Change, T	ype: Inventory	- increase raw material inventor	y		1.00000	-0.00000	0.0000
Future Supply	Chain Change, I	ype: inventory	- increase inished goods inven	lory		0.47901	0.16890	-0.3440
Future Supply	Chain Change, I	ype: Communic	auon – improve supply chain co			-0.09641	0.39544	0.3086
Future Supply	Chain Change, T	ype: HISK Mana	agement - increase focus on su	ippiy chain risk management		0.18673	0.81457	0.2412
Future Supply	Ghain Ghange, T	ype. nisk iviana	igement – increase locus on col	iungency planning			0.08401	-0.2192

15.4.3.5. Relationship between type of previous and future supply chain change Based on a factor analysis the following relationships were found.

X: Increase focus on contingency planning

Y: Increase focus on contingency planning and supply chain risk management, as well as improve supply chain communication and impose risk management on suppliers

There is a relationship between those companies that increased the focus on contingency planning as a consequence of a natural catastrophe impact in the past and those that want to increase the focus on contingency planning and supply chain risk management, as well as improve supply chain communication and impose risk management on suppliers in the future. This relationship is represented by the function y=0.15x+0.13, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.40 and is significant at the 95% level with p=0.0003* (n=75) and mean of 0.69 and 0.24 respectively for X and Y. The R² is 0.16.



X: Increase focus on contingency planning and supply chain risk management, as well as improve supply chain communication and impose risk management on suppliers

Y: Increase focus on contingency planning and supply chain risk management, as well as improve supply chain communication and impose risk management on suppliers

There is a relationship between those companies that increased the focus on contingency planning and supply chain risk management, as well as improved supply chain communication and imposed risk management on suppliers in the past and those that want to increase focus on contingency planning and supply chain risk management, as well as improve supply chain communication and impose risk management on suppliers in the future. This relationship is represented by the function y=0.61x+0.46, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.40 and is significant at the 95% level with p=<0.0001* (n=75) and mean of 0.69 and 0.89 respectively for X and Y. The R² is 0.28.



X: Increase focus on contingency planning

Y: Increase finished goods inventory and not increase focus on risk management

There is a negative relationship between those companies that increased the focus on contingency planning in the past and those that want to increase the finished goods inventory in the future, but not increase the focus on risk management. This relationship is represented by the function y=-0.27x+0.22, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is -0.31 and is significant at the 95% level with p=0.0065* (n=75) and mean of -0.05 and 0.24 respectively for X and Y. The R² is 0.09.



X: Increase focus on contingency planning and supply chain risk management, as well as improve supply chain communication and impose risk management on suppliers

Y: Increase finished goods inventory and not increase focus on risk management

There is a negative relationship between those companies that increased the focus on contingency planning and supply chain risk management, as well as improved supply chain communication and imposed risk management on suppliers in the past and those that want to increase the finished goods inventory in the future, but not increase the focus on risk management. This relationship is represented by the function y=-0.69x+0.85, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is -0.25 and is significant at the 95% level with p=0.0065* (n=75) and mean of -0.04 and 0.89 respectively for X and Y. The R² is 0.06.



Based on a contingency analysis, the relationship with a shift in facilities is shown by Pearson $x^{2}(1,$ N=75)=4.925, p=0.0265*. The increase the number of suppliers is shown by Pearson $x^2(1, N=75)=$ 8.477, p=0.0036* and LR x^2 (1, N=75)= 8.119 p=0.0044*, where Fisher's Exact Test, Left: p=0.0052* and Fisher's Exact Test, 2-Tail: p=0.0059* show a positive relationship and the odds ratio of 5.5 shows that the odds of not increasing the number of suppliers in the future and not having done so in the past is higher than, not increasing the number of suppliers in the future and having done so in the past. In terms of risk imposing risk management, this is shown by Pearson x^2 (1, N=75)= 10.060, p=0.0015* and LR x²(1, N=75)= 8.830 p=0.0030*, where Fisher's Exact Test, Left: p=0.0037* and Fisher's Exact Test, 2-Tail: p=0.0037* show a positive relationship. The odds Ratio of 6.47 shows that the odds of not imposing risk management practices on suppliers in the future and not having done so in the past is higher than, not imposing risk management on suppliers in the future and having done so in the past. Further, the increase in raw material inventory is exemplified by Pearson $x^2(1, N=75) = 8.012$, p=0.0046* and LR $x^2(1, N=75) = 11.955$ p=0.0005*, where Fisher's Exact Test, Left: p=0.0198* and Fisher's Exact Test, 2-Tail: p=0.0198* show a positive relationship. The increase finished goods inventory is shown by Pearson $x^2(1, N=75)=$ 4.526, p=0.0334*. The improving of the supply chain communication is shown by Pearson $x^{2}(1,$ N=75)= 12.801, p=0.0003* and LR $x^{2}(1, N=75)= 12.417$, p=0.0004*, where Fisher's Exact Test, Left: p=0.0006* and Fisher's Exact Test, 2-Tail: p=0.0006* show a positive relationship and the odds ratio of 7.1 shows that the odds of not improving supply chain communication in the future and not having done so in the past is higher than, not improving supply chain communication in the

future and having done so in the past. Increase supply chain risk management is shown by Pearson $x^2(1, N=75)=8.905$, p=0.0028* and LR $x^2(1, N=75)=9.019$, p=0.0027*, where Fisher's Exact Test, Left: p=0.0031* and Fisher's Exact Test, 2-Tail: p=0.0042* display a positive relationship, whereby the odds ratio of 5 shows that the odds of not increasing supply chain risk management practices in the future and not having done so in the past is higher than, not increasing supply chain risk management practices in the future and having done so in the past. In final the increase focus on contingency planning is exemplified by Pearson $x^2(1, N=75)=11.404$, p=0.0007* and LR $x^2(1, N=75)=11.540$, p=0.0007*, where Fisher's Exact Test, Left: p=0.0008* and Fisher's Exact Test, 2-Tail: p=0.0015* show a positive relationship and the odds ratio of 5.3 shows that the odds of not increasing the focus on contingency planning practices in the future and having done so in the past is higher than, not increasing contingency planning practices in the future and having done so in the past is higher than, not increasing contingency planning practices in the future and having done so in the past.

15.4.3.6. Consequences of previous supply chain change

Based on the factor analysis of companies undertaking change and the competitor not undertaking change, imposing risk management, improving supply chain communication, as well as increasing risk management and contingency planning results in a lower profit. This is shown by the function of y=0.34 + -0.25x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.44 and is also statistically significant (p=0.0431*) at the 95% confidence level. The mean is at 0.62 and 0.19 for x and y respectively. Further, increasing the number of suppliers and the raw material results in a lower profit. This is shown by function of y=0.37 + -0.34x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.44 and is also statistically significant (p=0.0235*) at the 95% confidence level. The mean is at 0.52 and 0.19 for x and y respectively.

Increasing the number of suppliers and the raw material results in a lower reputation. This is shown by function of y=0.27 + -0.25x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.46 and is also statistically significant (p=0.00319*) at the 95% confidence level. The mean is at 0.52 and 0.14 for x and y respectively. The R² is 0.22. Based on the factor analysis of companies undertaking change and the competitor undertaking change increasing the finished goods and not the risk management result in a higher reputation. This is shown by function of y=0.29 + 0.41x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.46 and is also statistically significant (p=0.00190*) at the 95% confidence level. The mean is at -0.14 and 0.23 for x and y respectively. The R^2 is 0.18.

Increasing the finished goods and not the risk management results in higher sales with existing customers. This is shown by function of y=0.19 + 0.31x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.46 and is also statistically significant (p=0.00487*) at the 95% confidence level. The mean is at -0.14 and 0.15 for x and y respectively. The R² is 0.13. This can be seen in appendix **Error! Reference source not found.**

It can be seen that with regards to the reputation, companies that undertook a supply chain change experienced a very strong (n=2, 3%) or strong (n=20, 39%) increase in their reputation. Conversely, a small amount that undertook changes experienced a decrease (n=4, 7%). The largest group experienced a constant in their reputation (n=22, 64%). Companies who did not undertake a change experienced that their reputation maintained the same (n=12, 80%). Six respondents did not know. With regards to the consequence on the number of customers, of those that undertook a change in their supply chain, some saw an increase (n=14, 27%), the majority experienced a constant (n=32, 62%) and few a decrease (n=2, 4%).



Figure 57: Consequence on reputation (left) and sales with existing customers (right)

In terms of the number of customers, the vast majority (n=31, 81.6%) claimed that these maintained the same. The second largest group indicated that the number of customers decreased (n=2, 5.2%)or strongly decreased (n=2, 5.2%). A small amount of respondents indicated that it increased (n=2, 5.2%). One respondent indicated that they did not know (2.63%). In terms of the profitability of the company, the largest proportion indicated that this remained the same (n=20, 52.6%). The second largest amount of respondents indicated that it decreased (n=7, 18.2%) or strongly decreased (n=2, 5.26%), whereas the third largest group claimed that it increased (n=6, 15.8%). Three (7.9%)claimed that they did not know. This can be seen in Figure 58: Consequence on number of customers and profitability.



Figure 58: Consequence on number of customers and profitability

Type of Past Supply Chain Change: Consequence of Supply Chain Change + No Competitor Change: Imposing risk management, improving supply chain communication, as well as increasing risk management and contingency planning results in a lower profit. This is shown by function of y=0.34 + -0.25x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.44 and is also statistically significant (p=0.0431*) at the 95% confidence level. The mean is at 0.62 and 0.19 for x and y respectively.

Correlation	•									
Variable (F2) Type of Pas Past Supply Cha	st Supply Chain Change a	ain Change: Impose nd No Competitor C	e risk management, imp hange, Consequence: F	rove supply chain o Profit	communication, increase risk management and contin	Mean gency planning 0.624461 0.190476	Std Dev 0.651938 0.370006	Correlation -0.44525	Signif. Prob 0.0431*	Number 21
Parameter	r Estima	tes								
Term Intercept (F2) Type of Pa	ast Supply C	hain Change: Imp	ose risk management,	improve supply c	hain communication, increase risk management a	nd contingency planning	Estimate 0.3482774 -0.252	 Std Error 0.103934 0.116586 	t Ratio 3.35 -2.17	Prob>ltl 0.0034* 0.0431*
Analys	is of V	ariance			Summary of Fit					
Source Model Error	DF 1 19	Sum of Squares 0.5428162 2.1952790	Mean Square 0.542816 0.115541	F Ratio 4.6980 Prob > F	RSquare RSquare Adj Root Mean Square Error Mean of Response	0.198246 0.156048 0.339913 0.190476				



Increasing the number of suppliers and the raw material results in a lower profit. This is shown by function of y=0.37 + -0.34x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.44 and is also statistically significant (p=0.0235*) at the 95% confidence level. The mean is at 0.52 and 0.19 for x and y respectively.



Increasing the number of suppliers and the raw material results in a lower reputation. This is shown by function of y=0.27 + -0.25x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.46 and is also statistically significant (p=0.00319*) at the 95% confidence level. The mean is at 0.52 and 0.14 for x and y respectively. The R² is 0.22.



Parameter Estimates					
Term	Estimate	Std Erro	rtRatio	Prob>Itl	
(F2) Type of Past Supply Chain Change: Increase suppliers and raw material inventory	-0.251661	0.108698	3 -2.32	0.0319*	
Correlation					
				Signif.	
Variable	Mean	Std Dev	Correlation	ı Prob	Number
(F2) Type of Past Supply Chain Change: Increase suppliers and raw material inventory	0.52756	0.52248	-0.46909	0.0319*	21
Past Supply Chain Change and No Competitor Change, Consequence, Reputation	0 142857	0 280306			

Summa	ry of	Fit				
RSquare			0.	220043		
RSquare A	dj		0.	178992		
Root Mean	Square	Error	0.	253984		
Mean of Re	sponse		0.	142857		
Observatio	ns (or Si	um Wgts)		21		
Analysi	s of V	ariance)			
		Sum	of			
Source	DF	Square	es	Mean S	quare	F Ratio
Model	1	0.345781	1	0.3	45781	5.3603
Error	19	1.225647	′5	0.0	64508	Prob > F
C. Total	20	1.571428	86			0.0319*

Type of Past Supply Chain Change: Consequence of Supply Chain Change + Competitor Change: Increasing the finished goods and not the risk management results in a higher reputation. This is shown by function of y=0.29 + 0.41x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.46 and is also statistically significant (p=0.00190*) at the 95% confidence level. The mean is at -0.14 and 0.23 for x and y respectively. The R² is 0.18.

st Supply Chain Chaine	-0.3 Type of ase red good		0.2 0.3 0.4 Chain Chang crease risk	+ 0.5 0.6 C	7.7						
Summar RSquare RSquare Ad Root Mean S Mean of Res Observation	ry of Square sponse s (or Si	Fit Error um Wgts)	0.181142 0.151897 0.357355 0.233333 30)							
Source Model Error C. Total	DF 1 28 29	Sum Square 0.790985 3.575681 4.366666	of es Mean 56 0. 1 0. 57	Square .790986 .127703	F Ratio 6.1940 Prob > F 0.0190*						
Paramet Term Intercept (F2) Type of	Past S	stimate	S in Change	: Increas	ə finished g	oods and not increase risk managemen	Estimate 0.2938434 t 0.4139228	e Std Erro 4 0.06962 3 0.16631	r t Ratio 7 4.22 7 2.49	Prob>ltl 0.0002* 0.0190*	
Correlat Variable (F2) Type of Past Supply	Past S	Supply Cha Change an	in Change d Competi	: Increase tor Chang	e finished g ge, Conseq	oods and not increase risk managemen Jence: Reputation	Mean t -0.14619 0.233333	Std Dev 0.398994 0.38804	Correlation 0.425607	Signif. Prob 0.0190*	Number 30

Increasing the finished goods and not the risk management results in a higher sales with existing customers. This is shown by function of y=0.19 + 0.31x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is -0.46 and is also statistically significant (p=0.00487*) at the 95% confidence level. The mean is at -0.14 and 0.15 for x and y respectively. The R² is 0.13.



15.4.4. Transformation

15.4.4.1. Relationship between past and future change

This relationship is represented by the function y=0.64x+0.32, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.72 and is significant at the 95% level with p=<0.0001* (n=75) and mean of 0.70 and 0.78 respectively for X and Y. The R² is 0.36. Based on the factor analysis it was found that there is a relationship between those companies that were motivated by profit, sales with existing customers, number of customers and reputation in the past are also those that are motivated by profit, sales with existing customers, number of customers and reputation in the future. This relationship is represented by the function y=0.64x+0.32, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.72 and is significant at the 95% level with p=<0.0001* (n=75) and mean of 0.70 and 0.78 respectively for X and Y. The R² is 0.36. This can be seen in appendix 15.4.4.8. Based on a contingency analysis and in terms of a relationship between the type of motivation to change, it has been found that those firms that were motivated to change based on considerations of profitability, sales with exiting customers and number of customers, reputation, stakeholder demand

for previous change were also motivated for the same reason for future change. Given the limited amount of space available in this research paper, the detailed statistical results behind this finding can be found in appendix 15.4.4.8.

15.4.4.2. Relationship between types of perception

When determining the relationship between the change in perception of the likelihood of natural catastrophes impacting the supply chain and the perception of the invested time and money to assess or manage these risks paying off despite the low probability of occurrence, it can be seen that with x^2 (25, N=66)=56.77, p=0.0003* there is a statistically significant on the 95% confidence level that there is a difference between the changes in the perception of the likelihood and the general perception on the paying off of the invested time and money to assess and manage the risks, meaning that the H₀ of no difference can be rejected. As such, 68% who "agree" that their perception of natural catastrophes changed either due to recent occurrences or an indirect or direct impact, also "disagree" with the fact invested time and money to assess and manage risks will not pay off.

In terms of the relationship between the change in perception of the impact that natural catastrophes can have on the supply chain and the perception of the invested time and money to assess or manage these risks paying off despite the low probability of occurrence a similar relationship can be found as with the previous. When undertaking a contingency analysis, it is found that with x^2 (25, N=66)=54.71, p=0.0005* there is a significant difference on the 95% confidence level in terms that claim that the invested time and money will not pay off and those whose perception on the impact that natural catastrophes have changed due to recent natural catastrophes or an indirect or direct impact. This means that the H₀ of no difference can be rejected. As such, 62% whose perception of the impact has changed also claimed that they disagree with the fact that the invested time and money will not pay off.

To determine if there is a relationship between the past impact of a natural catastrophe and the change in perception with regards to the impact and likelihood of occurrence of a natural catastrophe, as well as the perception of the investment vs. likelihood trade-off, a contingency analysis was undertaken and tested through the use of Pearson's Chi-Square. In sum, the results indicate that there is no significant difference in the perception of the responding companies across those companies that had been or had not been previously impacted by a natural catastrophe. This is manifested in the results, which exemplify that in terms of the change in the perception of the

impact x^2 (5, N=70)=6.60, p=0.25, and likelihood of a natural catastrophe occurrence x^2 (5, N=66)=6.19, p=0.29, as well as the trade-off between investment and the low likelihood of occurrence x^2 (5, N=66)=2.83, p=0.73, that on the 5% significance level ($\alpha = 0.05$), there is no significant difference between those companies that had been previously impacted and those that have not been previously impacted. As such, it is not possible to reject the H₀ hypothesis of no differences on the 95% confidence level. This means that the previously stipulated hypothesis stating that there is a relationship between the previous impact of a natural catastrophe and the perception cannot be accepted.

When undertaking a contingency analysis to determine if there is a relationship between the buyer dependency and the perception as well as perception change of natural catastrophes, an relationship can be found. When relating the degree of dependency on the buyers to the change in the impact that natural catastrophes can have on the supply chain – irrespective of observation or previous impact - $x^2(25, N=70)=43.22$, p=0.0132*, as well as the change in perception of the likelihood – irrespective of observation or previous impact - $x^2(25, N=70)=43.22$, p=0.0132*, as well as the change in perception of the likelihood – irrespective of observation or previous impact - $x^2(25, N=66)=49.19$, p=0.0027*, as well as the general perception on the investment/ likelihood payoff $x^2(25, N=70)=44.29$, p=0.0101* a statistically significant difference can be found on the 95% confidence level. This means that the H₀ of no differences can be rejected. As such, there tends to be a relationship between a higher dependency upon key buyers and the tendency to have changed the perception of the likelihood of the impact and the impact that natural catastrophes can have on the supply chain as well as the general perception of the investment and likelihood trade-off.

When undertaking the same analysis for the supplier dependency, no statistically significant difference is to be found at the 95% or 90% confidence level. When applying a Cochran-Mantel-Haenszel Test through the use of a third blocking category (past natural catastrophe impact) it remains impossible to find a statistically significant relationship.

In terms of the consequence that the natural catastrophe had on the reputation of the company, it can be said that with regards to the change in perception of the likelihood $x^2(25, N=36)=38.68$, p=0.04* as well as the general perception of the investment/ likelihood trade-off x^2 (25, N=70)=44.21, p=0.0103*, a statistically significant relationship was found at the 95% confidence level, meaning that it was possible to reject the H₀ of no differences. However, given the fact that 20% of the cells have an expected count that is less than 5, the ChiSquare results are susceptible. However, it was not possible to find the same relationship with regards to the relationship between

the reputation and the change in the perception on impact $x^2(25, N=37)=31.57$, p=0.17.

When looking at the sales with existing customers it is possible to identify that the impact perception change $x^2(20, N=37)=49.72$, p=0.00002*, as well as the likelihood perception change $x^2(20, N=36)=47.65$, p=0.0005*, and the general perception of the investment/likelihood trade-off $x^2(20, N=36)=52.33$, p=0.0001* are distributed significantly differently with respects to the consequences that the natural catastrophe had on the sales with existing customers, meaning that it is possible to reject the H₀ of no differences. However, it is hereby to be noted that with 20% of the cells having an expected count of less than 5, the Chi-Square is under suspect.

With respect to the consequence that the natural catastrophe had in term of the number of customers, it can be said that with respect to the perception change of the impact x^2 (20, N=37)=48.45, p=0.0004*, the perception change of the frequency x^2 (20, N=36)=52.11, p=0.0001* and the general perception of the investment and likelihood tradeoff x^2 (20, N=36)=45.72, p=0.0009*, that there is a significant difference in the distributions on the 5% significance level. As such, it is possible to reject the H₀ of no difference, yet only with the understand that given the fact that 20% of the cells have a count of less than 5, the Chi-Square is under suspect.

When undertaking an analysis of the consequence of the natural catastrophe on the profit and relating this to the difference in the distribution across the perception, no significance can be found on the 95% confidence level.

There is a relationship between those companies that encountered a facility and inventory damage and those that experienced a change in their perception towards the impact that natural catastrophes can have on their supply chains. This is manifested in a function of y=0.25 + 39x, which is statistically significant at the 95% confidence level. The Pearson correlation coefficient is 0.35 and is also statistically significant (p=0.0299*) at the 95% confidence level. The mean is at 0.34 and 0.39 for x and y respectively.

<u>ب</u>							
Dast Natural Catastrophe Impact -0.2 0 0.2 0.4 0.6 0.8 1 (F1) Type of Past Natural Cata -0.2 0 0.2 0.4 0.6 18 1 (F1) Type of Past Natural Cata -0.2 0 0.2 0.4 0.6 18 1 (F1) Type of Past Natural Cata Denote the type of type of the type of th	1.2 1.4 1.6 strophe						
Summory of Fit	lainage						
RSquare 0.12770 RSquare Adj 0.10277 Root Mean Square Error 0.57068 Mean of Response 0.39189 Observations (or Sum Wqts) 3	12 19 14 12 17						
Analysis of Variance							
Sum of Source DF Squares Mean Model 1 1.668755 11.398813 11.398813 C. Total 36 13.067568	Square F Ratio 1.66875 5.1239 0.32568 Prob > F 0.0299*						
Parameter Estimates							
Term Intercept (F1) Type of Past Natural Catastrophe	Impact: Facility and in	nventory damage	Estimate 0.2531143 0.3987214	Std Error 0.112075 0.176145	t Ratio 5 2.26 5 2.26	Prob>ltl 0.0303* 0.0299*	
Correlation							
Variable (F1) Type of Past Natural Catastrophe Past Natural Catastrophe Impact Perc	Impact: Facility and in	nventory damage	Mean 0.348057 0.391892	Std Dev 0.539977 0.602485	Correlation 0.357354	Signif. Prob 0.0299*	Number 37

15.4.4.3. Relationship between type of impact and type of changes

Based on contingency analysis it can be asserted that a statistically significant relationship on the 95% confidence level exists between those companies that experienced inbound logistics issues and those that decided to improve their supply chain communication $x^2(1,N=75)=4.13$,p=0.04* and LR(1,N=75)=4.06,p=0.04*, where Fisher's Exact Test, Right p=0.0385* and Odds Ratio=2.77, as well as increase the focus on contingency planning $x^2(1,N=75)=8.74$,p=0.003* and LR(1,N=75)=8.78,p=0.003* where Fisher's Exact Test, Right p=0.0034*, 2-Tail, p=0.0056* and Odds Ratio=4.43. Furthermore, a relationship exists between those that experienced outbound logistics issues and those who decided to improve their supply chain communication $x^2(1,N=75)=12.1$,p=0.0005* and LR(1,N=75)=12.52,p=0.0004* where Fisher's Exact Test, Right + 2-Tail, p=0.0007*+p=0.0025* and LR(1,N=75)=7.12, p=0.0055*, where Fisher's Exact Test, Right + 2-Tail, p=0.0071* and . Odds Ratio=7.36. Companies whose production input was missing also decided to improve their supply chain communication $x^2(1,N=75)=3.84$,p=0.0501 and

LR(1,N=75)=3.67,p=0.0553 where Odds Ratio=3.19.

X: Outbound and inbound logistics issues

Y: Impose risk management on suppliers, improve supply chain communication, increase supply chain risk management, and contingency planning

There is a relationship between companies facing outbound and inbound logistics issues as a consequence of a impact of a natural catastrophe, and those that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning. This relationship is represented by the function y=0.45x+0.53, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.33 and is significant at the 95% level with p=0.0037* (n=75) and mean of 0.36 and 0.69 respectively for X and Y. The R² is 0.11.



15.4.4.4. Previous supply chain change motivation

Based on the two eigenvalues above 1 and the analysis of the scree plot it was decided to take two factors.



Variance Explained by Each Factor

Factor	Variance	Percent	Cum Percent
Factor 1	1.5391	25.652	25.652
Factor 2	0.5495	9.158	34.810

Test H0: no common factors. HA: at least one common factor.	[15.0	DF ChiSqua 00 58.1	re Prob>ChiSo 00 <.0001
Test H0: 2 factors are sufficient. HA: more factors are needed	DF 4.000	ChiSquare 2.952	Prob>ChiSq 0.5659

Unrotated Factor Loading

	Factor 1	Factor 2
Past Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability	0.666387	-0.285277
Past Supply Chain Change, Motivation: Sales with existing customers	0.587722	0.106061
Past Supply Chain Change, Motivation: Number of customers	0.584417	0.065616
Past Supply Chain Change, Motivation: Reputation	0.632068	0.128558
Past Supply Chain Change, Motivation: Stakeholder demand	0.198373	0.336382
Past Supply Chain Change, Motivation: Competitor pressure	0.035714	0.539268

Rotated Factor Loading

	Factor 1	Factor 2
Past Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability	0.694936	-0.206201
Past Supply Chain Change, Motivation: Sales with existing customers	0.571489	0.173397
Past Supply Chain Change, Motivation: Number of customers	0.572889	0.132842
Past Supply Chain Change, Motivation: Reputation	0.612932	0.200877
Past Supply Chain Change, Motivation: Stakeholder demand	0.158091	0.357088
Past Supply Chain Change, Motivation: Competitor pressure		0.539776

15.4.4.5. Relationship between previous motivation to change and the types of changes undertaken (Factors)

Furthermore, there is a relationship between those companies that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.64x+0.33, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.60 and is significant at the 95% level with p=<0.0001* (n=75) and mean of 0.69 and 0.78 respectively for X and Y. The R² is 0.36. Additionally, there is a relationship between those companies that to increase their number of suppliers as well as the raw material inventory and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.61x+0.62, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.31 and is significant at the 95% level with p=0.0060* (n=75) and mean of 0.27 and 0.78 respectively for X and Y. The R^2 is 0.09. This is also the case between those companies that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.61x+0.15, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.72 and is significant at the 95% level with p = <0.0001* (n=75) and mean of 0.89 and 0.70 respectively for X and Y. The R^2 is 0.52. Furthermore, there is a relationship between those companies that decided to stop setting up new facilities in natural catastrophe prone areas as well as to increase their raw and finished goods inventory and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.69x+0.63, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.27 and is significant at the 95% level with p=0.0187* (n=75) and mean of 0.09 and 0.70 respectively for X and Y. The R^2 is 0.07. Additionally, there is a relationship between those companies that decided to increase their focus on contingency planning and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.164x+0.30, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.61 and is

significant at the 95% level with p=0.< 0.0001^* (n=75) and mean of 0.24 and 0.70 respectively for X and Y. The R² is 0.38. Based on a factor analysis it can be said that there is a relationship between those companies that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.64x+0.33, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.60 and is significant at the 95% level with p=< 0.0001^* (n=75) and mean of 0.69 and 0.78 respectively for X and Y. The R² is 0.36.

Summary of Fit										
RSquare	0.36191	Analysi	is of V	/ariance						
RSquare Adj Root Mean Square Error Mean of Response Observations (or Sum Wgts)	0.353169 0.668261 0.783559 75	Source Model Error C. Total	DF 1 73 74	Sum of Squares 18.489842 32.599797 51.089639	Mean Square 18.4898 0.4466	F Ratio 41.4039 Prob > F <.0001*				
Parameter Estimates										
Term Intercept (F2) Type of Past Supply Chain Change: Impose risk r	nanagement, improve	supply chain com	munication	, increase risk mar	nagement and continge	ency planning	Estimate 0.3318495 0.6461973	Std Error 0.104319 0.100426	t Ratio 3.18 6.43	Prob>ltl 0.0022* <.0001*
Correlation										
Variable (F2) Type of Past Supply Chain Change: Impose risk man (F5) Past Supply Chain Change Motivation: Profit, sales w	agement, improve supp ith existing and number	ly chain communica of customers repu	ation, increa tation	se risk managemer	nt and contingency plann	Mean 0.699027 0.783559	Std Dev 0.773545 0.830903	Correlation 0.601589	Signif. Prob <.0001*	Number 75



There is a relationship between those companies that to increase their number of suppliers as well as the raw material inventory and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.61x+0.62, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.31 and is significant at the 95% level with $p=0.0060^*$ (n=75) and mean of 0.27 and 0.78 respectively for X and Y. The R² is 0.09.



There is a relationship between those companies that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.61x+0.15, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.72 and is significant at the 95% level with p=<0.0001* (n=75) and mean of 0.89 and 0.70 respectively for X and Y. The R² is 0.52.

Cumment of Fit		Analys	is of V	/ariance		
Summary of Fit				Sum of		
RSquare	0.526565	Source	DF	Squares	Mean Square	F Ratio
Root Mean Square Error	0.52008	Model	1	23.575478	23.5755	81.1924
Mean of Response	0.704929	Error	73	21.196689	0.2904	Prob > F
Observations (or Sum Wgts)	75	C. Total	74	44.772167		<.0001*





There is a relationship between those companies that decided to stop setting up new facilities in natural catastrophe prone areas as well as to increase their raw and finished goods inventory and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.69x+0.63, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.27 and is significant at the 95% level with p=0.0187* (n=75) and mean of 0.09 and 0.70 respectively for X and Y. The R² is 0.07.

Parameter Estimates					
Term Intercept (F7) Type of Future Supply Chain Change: Stop setting up facilities in natural catastrophe aras, increase raw and finished goods inventory	Estimate 0.6368564 0.6992744	 Std Erro 0.09152 0.29061 	r t Ratio 6 6.96 7 2.41	Prob>ltl <.0001* 0.0187*	
Correlation					
Variable (F7) Type of Future Supply Chain Change: Stop setting up facilities in natural catastrophe aras, increase raw and finished goods inventory (F8) Future Supply Chain Change Motivation: Profit, sales with existing customers, reputation	Mean 0.097347 0.704929	Std Dev 0.301531 0.777836	Correlatior 0.271077	Signif. Prob 7 0.0187*	r

	-				Summary of Fit	
İ	s of V	ariance			RSquare	0.073
		Sum of			BSquare Adi	0.06
	DF	Squares	Mean Square	F Ratio	Boot Mean Square Error	0 753
	1	3.289971	3.28997	5.7897		0.750
	73	41.482196	0.56825	Prob > F	Mean of Response	0.704
74	1	44.772167		0.0187*	Observations (or Sum Wgts)	



There is a relationship between those companies that decided to increase their focus on contingency planning and those that are motivated by profit, sales with existing customers, number of customers and reputation. This relationship is represented by the function y=0.164x+0.30, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.61 and is significant at the 95% level with p=0.<0.0001* (n=75) and mean of 0.24 and 0.70 respectively for X and Y. The R^2 is 0.38.



Prob

Number

75

15.4.4.6. Relationship between previous motivation to change and the types of changes undertaken (Non-factor)

Based on a contingency analysis an array of relationships between the motivation to change and the types of changes undertaken were to be found. The types of relationships found will be summarized in the following. A shift in facilities was motivated by an improvement in profitability. Increasing the number of suppliers was motivated by sales with existing customers, the number of customers and the competitor pressure. Imposing risk management practices was related to the maintenance or improvement of profitability, and reputation. An increase in the raw material inventory is exemplified by the increase in sales with existing customers. The increase in finished goods inventory is motivated by sales with existing customers. An improvement in supply chain communication is motivated by maintaining or improving profitability, sales with existing customers, the number of customers, reputation and stakeholder demands. An increasing focus on supply chain risk management was motivated by profitability, the number of customers, reputation, stakeholder demand and competitive pressure. Increasing focus on contingency planning is motivated by profitability, sales with existing customers, number of customers, reputation, stakeholder demand and competitor pressure. Not to change is motivated by considerations of profitability, sales with existing customers, number of customers, reputation, and stakeholder demand

Based on a contingency analysis it can be found that a shift in facilities was motivated by an improvement in profitability as to be seen by the Pearson $x^2(1, N=75)=5.487$, p=0.0192* and LR $x^2(1, N=28)=5.518$, p=0.0188*. Furthermore, the Fisher's Exact Test, Right: p=0.0295* Improve profit = shift and Fisher's Exact Test, 2-Tail: p=0.295* Difference in distributions show that there is a positive relationship.

Increasing the number of suppliers was motivated by sales with existing customers, the number of customers and the competitor pressure. In terms of the sales with existing customers this is shown by Pearson $x^2(1, N=75)=8.128$, p=0.0044* and LR $x^2(1, N=28)=8.034$, p=0.0046*, whereby the Fisher's Exact Test, Right: p=0.0049* Increase sales = Increase suppliers and Fisher's Exact Test, 2-Tail: p=0.0059* Difference in distributions show that this relationship is positive. The relationship with the number of customers is shown by Pearson $x^2(1, N=75)=4.563$, p=0.0327* and LR $x^2(1, N=28)=4.401$, p=0.0359*, where the Fisher's Exact Test, Right: p=0.0336* Increase s customers = Increase suppliers and Fisher's Exact Test, 2-Tail: p=0.0469* Difference in distributions show that there is a positive relationship. In terms of the competitor pressure, the

Pearson $x^2(1, N=75)= 3.872$, p=0.0491* and LR $x^2(1, N=28)= 4.342$, p=0.0372* show that there is a relationship, yet no indication to the direction can be made.

Imposing risk management practices was related to the maintenance or improvement of profitability, and reputation. The maintaining or improvement of profitability is shown by Pearson $x^2(1, N=75)= 6.198$, p=0.0128* and LR $x^2(1, N=28)= 6.070$, p=0.0138*, Fisher's Exact Test, Right: p=0.0149* Increase risk management = Increase profitability and Fisher's Exact Test, 2-Tail: p=0.0182* Difference in distributions show that the relationship is positive in nature. Furthermore, the reputation linkage is shown by Pearson $x^2(1, N=75)= 5.497$, p=0.0146* and LR $x^2(1, N=28)= 5.969$, p=0.0191*, where Fisher's Exact Test, Right: p=0.0197* Increase risk management = Increase reputation and Fisher's Exact Test, 2-Tail: p=0.0235* Difference in distributions show that this is a positive relationship.

An increase in the raw material inventory is exemplified by the increase in sales with existing customers, where the Pearson $x^2(1, N=75)=11.745$, p=0.0006* and LR $x^2(1, N=28)=11.533$ p=0.00007* show the relationship and Fisher's Exact Test, Right: p=0.0012* Increase raw material inventory= Increase sales with existing customers as well as Fisher's Exact Test, 2-Tail: p=0.0012* Difference in distributions undermine that it is of positive nature.

The increase in finished goods inventory is motivated by sales with existing customers, such as is exemplified by Pearson $x^2(1, N=75)= 5.789$, p=0.0161* and LR $x^2(1, N=28)= 5.554$ p=0.0184*, where the Fisher's Exact Test, Right: p=0.0218* Increase finished goods inventory= Increase sales with existing customers and Fisher's Exact Test, 2-Tail: p=0.0297* Difference in distributions show a positive relationship.

An improvement in supply chain communication is motivated by maintaining or improving profitability, sales with existing customers, the number of customers, reputation and stakeholder demands. Maintaining or improving profitability is exemplified by Pearson $x^2(1, N=75)=11.979$, p=0.0005* and LR $x^2(1, N=28)=11.991$ p=0.0005*, where Fisher's Exact Test, Right: p=0.0007* Improve supply chain communication= Maintain or improve profitability and Fisher's Exact Test, 2-Tail: p=0.0010* Difference in distributions show a positive relationship. Sales with existing customers is shown by Pearson $x^2(1, N=75)=8.128$, p=0.0044* and LR $x^2(1, N=28)=8.034$,

p=0.0046*, where Fisher's Exact Test, Right: p=0.0049* Improve supply chain communication = Increase sales with existing customers and Fisher's Exact Test, 2-Tail: p=0.0059* Difference in distributions also show a relationship that is positive. Furthermore, the number of customers is shown by Pearson $x^2(1, N=75)=4.563$, p=0.0327* and LR $x^2(1, N=28)=4.401$, p=0.0327*, where the Fisher's Exact Test, Right: p=0.0049* Improve supply chain communication= Increase sales with existing customers and Fisher's Exact Test, 2-Tail: p=0.0059* Difference in distributions show a relationship that is positive in nature. Reputation is exemplified by Pearson $x^2(1, N=75)=13.187$, p=0.0003* and LR $x^2(1, N=28)=12.862$, p=0.0003*, where Fisher's Exact Test, Right: p=0.0005* Improve supply chain communication= Increase reputation and Fisher's Exact Test, 2-Tail: p=0.0008* Difference in distributions also show a positive relationship. In final, the stakeholder demand, as shown by Pearson $x^2(1, N=75)=13.276$, p=0.0003* and LR $x^2(1, N=28)=13.179$, p=0.0003*, and Fisher's Exact Test, Right: p=0.0006* Improve supply chain communication= Stakeholder demanded it as well as Fisher's Exact Test, 2-Tail: p=0.0006* Difference in distributions.

An increasing focus on supply chain risk management was motivated by profitability, the number of customers, reputation, stakeholder demand and competitive pressure. As such, maintain or improve profitability was related based on a Pearson $x^2(1, N=75)= 6.641$, p=0.0105* and LR $x^2(1, N=28)=$ 6.544 p=0.0100*, where Fisher's Exact Test, Right: p=0.0108* Increase supply chain risk management focus= Maintain or improve profitability and Fisher's Exact Test, 2-Tail: p=0.0166* Difference in distributions show a positive relationship. Further, the number of customers was related with a Pearson $x^2(1, N=75) = 8.920$, $p=0.0040^*$ and LR $x^2(1, N=28) = 8.293$ $p=0.0028^*$, where the Fisher's Exact Test, Right: p=0.0046* Increase supply chain risk management focus= Increase number of customers and Fisher's Exact Test, 2-Tail: p=0.0056* Difference in distributions also show a relationship that is positive. Further, the reputation was related as to be seen by a Pearson $x^2(1, N=75) = 8.600$, $p=0.0034^*$ and LR $x^2(1, N=28) = 8.129$ $p=0.0044^*$, where Fisher's Exact Test, Right: p=0.0049* Increase supply chain risk management focus= Improve reputation and Fisher's Exact Test, 2-Tail: p=0.0083* Difference in distributions also show a relationship that is positive. Furthermore, the stakeholder demand is also somewhat related with a Pearson x^2 (1, N=75)= 3.852, p=0.0497*. The pressure from competitors is also related with Pearson $x^{2}(1, N=75) = 5.284$, p=0.0215* and LR $x^{2}(1, N=28) = 5.235$ p=0.0221* but no indication of direction.

Increasing focus on contingency planning is motivated by profitability, sales with existing customers, number of customers, reputation, stakeholder demand and competitor pressure. As such, to maintain or improve profitability is related by Pearson $x^2(1, N=75) = 18.303$, p=<0.0001* and LR x^{2} (1, N=28)= 18.684 p=<0.0001*, where Fisher's Exact Test, Right: p=<0.0001* Increase contingency planning= Maintain or improve profitability and Fisher's Exact Test, 2-Tail: p = <0.0001 * Difference in distributions show a positive relationship. Sales with existing customers is related with Pearson $x^2(1, N=75) = 5.074$, p=0.0243* and LR $x^2(1, N=28) = 5.040$ p=0.0248*, where Fisher's Exact Test, Right: p=0.0028* Increase contingency planning= Sales with existing customers and Fisher's Exact Test, 2-Tail: p=0.0291* Difference in distributions also show a positive relationship. The number of customers is related with Pearson x^2 (1, N=75)= 7.702, p=0.0055* and LR $x^2(1, N=28)= 7.830$ p=0.0051*, where Fisher's Exact Test, Right: p=0.0062*Increase contingency planning= Number of customers and Fisher's Exact Test, 2-Tail: p=0.0110* Difference in distributions show a positive relationship. Furthermore, the reputation is related through Pearson $x^2(1, N=75) = 13.201$, p=0.0003* and LR $x^2(1, N=75) = 13.151$ p=0.0003*, where Fisher's Exact Test, Right: p=0.0004* Increase contingency planning= Reputation and Fisher's *Exact Test*, 2-*Tail: p*=0.0005* *Difference in distributions also show a positive relationship. In final,* stakeholder demand is related with Pearson $x^2(1, N=75) = 6.597$, p=0.0106* and LR $x^2(1, N=75) =$ 6.530 p=0.0102*, where the Fisher's Exact Test, Right: p=0.0145* Increase contingency planning= Stakeholder demand and Fisher's Exact Test, 2-Tail: p=0.0233* Difference in distributions show a *positive relationship.* Competitor Pressure is in a slight relationship, with $LR x^2(1, N=75) = 3.888$, p=0.0486*.

Not to change is motivated by considerations of profitability, sales with existing customers, number of customers, reputation, and stakeholder demand. The relationship with profitability is shown by Pearson x^2 (1, N=75)= 12.822, p=0.0003* and LR x^2 (1, N=75)= 18.311 p=<0.0001*, where Fisher's Exact Test, Left: p=0.0001* improve profit = Change, rather than no change and Fisher's Exact Test, 2-Tail: p=0.0005* Difference in distributions show a relationship that is positive. Furthermore, the sales with existing customers is shown by Pearson x^2 (1, N=75)= 11.441, p=0.0007* and LR x^2 (1, N=75)= 16.646 p=<0.0001*, where Fisher's Exact Test, Left: p=0.0003* Difference in distributions show a relationship that is positive. Furthermore, the sales with existing customers and Fisher's Exact Test, Left: p=0.0003* Difference in distributions show a relationship that is positive.
Pearson $x^2(1, N=75)= 11.441$, p=0.0113* and LR $x^2(1, N=75)= 16.646$ p=0.0015*, where Fisher's Exact Test, Left: p=0.0068* No change = Number of customers and Fisher's Exact Test, 2-Tail: p=0.0085* Difference in distributions show a positive relationship. Also, the reputation is exemplified by Pearson $x^2(1, N=75)= 12.120$, p=0.0049* and LR $x^2(1, N=75)= 7.910$ p=0.0005*, where Fisher's Exact Test, Left: p=0.0025* No change = Reputation and Fisher's Exact Test, 2-Tail: p=0.0037* Difference in distributions show a positive relationship. In final, the stakeholder demand is also in a slight relationship, with LR $x^2(1, N=75)= 4.642$ p=0.0312*.

15.4.4.7. Future supply chain change motivation

Based on the eigenvalues, it seems that 3 factors are necessary. However, based on the scree plot, it seems that 2 factors are necessary. Due to the fact that motivation has been looked up from two factors previously, the same has been done in this instance.



28.618

HA: more factors are needed.

Rotated Factor Loading		
	Factor 1	Factor 2
Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability	0.400673	-0.243807
Future Supply Chain Change, Motivation: Maintain or improve our sales with existing customers	0.999634	-0.027034
Future Supply Chain Change, Motivation: Maintain or improve number of customers	0.153440	-0.084265
Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve our reputation	0.402183	
Future Supply Chain Change, Motivation: External motivation: External stakeholders demanded it. If yes, kindly specify who:		0.216988
Future Supply Chain Change, Motivation: External motivation: Competitors did it, then so did we	-0.204810	0.463200
Unrotated Factor Loading		
Unrotated Factor Loading	Factor 1	Factor 2
Unrotated Factor Loading Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability	Factor 1 0.40712	Factor 2 -0.23289
Unrotated Factor Loading Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability	Factor 1 0.40712 1.00000	Factor 2 -0.23289 0.00000
Unrotated Factor Loading Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability Future Supply Chain Change, Motivation: Maintain or improve our sales with existing customers Future Supply Chain Change, Motivation: Maintain or improve number of customers	Factor 1 0.40712 1.00000 0.15566	Factor 2 -0.23289 0.00000 -0.08009
Unrotated Factor Loading Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability Future Supply Chain Change, Motivation: Maintain or improve our sales with existing customers Future Supply Chain Change, Motivation: Maintain or improve number of customers Future Supply Chain Change, Motivation: Maintain or improve number of customers Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve our reputation	Factor 1 0.40712 1.00000 0.15566 0.40136	Factor 2 -0.23289 0.00000 -0.08009 0.03576
Unrotated Factor Loading Future Supply Chain Change, Motivation: Internal motivation: Maintain or improve profitability Future Supply Chain Change, Motivation: Maintain or improve our sales with existing customers Future Supply Chain Change, Motivation: Maintain or improve number of customers Future Supply Chain Change, Motivation: Maintain or improve our sales with existing customers Future Supply Chain Change, Motivation: Maintain or improve our sales with existing customers Future Supply Chain Change, Motivation: External motivation: External stakeholders demanded it. If yes, kindly specify who:	Factor 1 0.40712 1.00000 0.15566 0.40136 0.01595	Factor 2 -0.23289 0.00000 -0.08009 0.03576 0.21750

15.4.4.8. Relationship between past and future motivations for change

Based on a factor analysis, there is a relationship between those companies that were motivated by profit, sales with existing customers, number of customers and reputation in the past are also those that are motivated by profit, sales with existing customers, number of customers and reputation in the future. This relationship is represented by the function y=0.64x+0.32, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.72 and is significant at the 95% level with p=<0.0001* (n=75) and mean of 0.70 and 0.78 respectively for X and Y. The R² is 0.36.

Analysis of Variance											
Source Model Error C. Total	DF 1 73 74	Sum of Squares 18.537769 32.551871 51.089639	Mean Square 18.5378 0.4459	F Ratio 41.5723 Prob > F <.0001*							
Parame	eter Es	stimates									
Term Intercept (F8) Future	Supply	Chain Chang	e Motivation: Pro	ofit, sales wi	th existing customers, reputation	Estimate 0.3299622 0.6434646	Std Error 0.104378 0.099798	t Ratio 3.16 6.45	Prob>ltl 0.0023* <.0001*		
Correla	tion										
Variable (F8) Future (F5) Past S	Supply Supply C	Chain Chang hain Change	e Motivation: Pro Motivation: Profi	ofit, sales with t, sales with	th existing customers, reputation existing and number of customer: mmarv of Fit	s reputation	Mean 0.704929 0.783559	Std Dev 0.777836 0.830903	Correlation 0.602369	Signif. Prob <.0001*	Number 75
nain Change Motivation:		: ·		RSc RSc Roo Mea	uare juare Adj t Mean Square Error n of Response	0.362848 0.35412 0.667769 0.783559	3 2 9				

Based on a contingency analysis, in terms of a relationship between the type of motivation to

change, it has been found that those firms that were motivated to change based on considerations of profitability, sales with exiting customers and number of customers, reputation, stakeholder demand for previous change were also motivated for the same reason for future change. In terms of the profitability this is shown by Pearson $x^2(1, N=75)= 18.303$, p=<0.0001* and LR $x^2(1, N=75)=$ 18.684, p=<0.0001*, where Fisher's Exact Test, Left: p=<0.0001* and Fisher's Exact Test, 2-Tail: p=<0.0001* show a positive relationship and the odds Ratio of 9.14 shows that the odds of not wanting to maintain or improve profitability in the future and not having done so in the past is higher than, not doing so in the future and having done so in the past. Furthermore, the sales with existing customers is exemplified by Pearson $x^2(1, N=75)= 16.213$, p=<0.0001* and LR $x^2(1, N=75)= 16.213$, p=<0.0001* N=75)= 16.463, p=<0.0001*, where the Fisher's Exact Test, Left: p=<0.0001* and Fisher's Exact Test, 2-Tail: p=<0.0001* show a positive relationship and the odds Ratio of 9.14 shows that the odds of not increasing sales with existing customers in the future and not having done so in the past is higher than, not doing so in the future and having done so in the past. Further, the number of customers is shown by Pearson $x^2(1, N=75)= 8.711$, p=0.0032* and LR $x^2(1, N=75)= 8.519$, p=0.0035*, where Fisher's Exact Test, Left: p=0.0041* and Fisher's Exact Test, 2-Tail: p=0.0049* show a positive relationship and the odds Ratio of 9.14 shows that the odds of not wanting to increase the number of customers in the future and not having done so in the past is higher than, not doing so in the future and having done so in the past. The relationship in terms of the reputation is shown by Pearson $x^2(1, N=75) = 13.386$, $p=0.0003^*$ and LR $x^2(1, N=75) = 12.801$, $p=0.0003^*$, where Fisher's Exact Test, Left: p=0.0005* and Fisher's Exact Test, 2-Tail: p=0.0006* show a positive relationship, and the odds Ratio of 9.14 shows that the odds of not wanting to increase reputation in the future and not having done so in the past is higher than, not doing so in the future and having done so in the past. In final the demand by stakeholders is shown by Pearson $x^{2}(1,$ N=75 = 25.821, p=<0.0001* and LR x²(1, N=75) = 16.237, p=<0.0001*, where Fisher's Exact Test, Left: p=<0.0001* and Fisher's Exact Test, 2-Tail: p=<0.0001* show a positive relationship and the odds Ratio of 9.14 shows that he odds of stakeholders not demanding it in the future and not having done so in the past is higher than, not doing so in the future and having done so in the past.

15.4.4.9. Relationship between regional and key buyer/supplier dependency and the type of changes undertaken

On the basis of a factor analysis it was found that companies with a strong sourcing, producing and selling dependency upon Asia Pacific have increased their finished goods inventory and not increased their focus on supply chain risk management. This is shown by the function y=-0.13 +

0.20x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.39 is significant at the 95% confidence level with a p=0.0004*. The mean is located at 0.39 for x and -0.04 for y. The R2 has a value of 0.15. Also, companies with a strong sourcing and producing dependency upon Africa have decreased their overall exposure to natural catastrophes. This is shown by the function y=0.09 + 0.37x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.27 is significant at the 95% confidence level with a p=0.0199*. The mean is located at 0.07 for x and 0.12 for y. The R2 has a value of 0.07. Furthermore, companies with a strong sourcing and producing dependency upon the Middle East have increased their risk management and contingency planning as well as imposed risk management practices upon suppliers and improved their supply chain communication in the past. This is shown by the function y=0.63 + 0.69x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.23 is significant at the 95% confidence level with a p=0.0494*. The mean is located at 0.09 for x and 0.69 for y. The R2 has a value of 0.05.

On the basis of a factor analysis, the following results were found:

Companies with a strong sourcing, producing and selling dependency upon Asia Pacific have increased their finished goods inventory and not increased their focus on supply chain risk management. This is shown by the function y=-0.13 + 0.20x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.39 is significant at the 95% confidence level with a p=0.0004*. The mean is located at 0.39 for x and -0.04 for y. The R² has a value of 0.15.



Companies with a strong sourcing and producing dependency upon Africa have decreased their overall exposure to natural catastrophes. This is shown by the function y=0.09 + 0.37x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.27 is significant at the 95% confidence level with a p=0.0199*. The mean is located at 0.07 for x and 0.12 for y. The R² has a value of 0.07.



Companies with a strong sourcing and producing dependency upon the Middle East have increased their risk management and contingency planning as well as imposed risk management practices upon suppliers and improved their supply chain communication in the past. This is shown by the function y=0.63 + 0.69x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.23 is significant at the 95% confidence level with a $p=0.0494^*$. The mean is located at 0.09 for x and 0.69 for y. The R² has a value of 0.05.



On the basis of a contingency analysis it can be asserted that there is a statistically significant relationship between the dependency of the company on its suppliers and the decision to shift its current facilities to countries and areas with lower natural catastrophe risk $x^2(5, N=75)=14.739$, p=0.0115* as well as to stop setting up new facilities in such areas $x^2(5, N=75)=19.00$, p=0.0019*. As such, the H₀ of no differences can be rejected. However, the it must be asserted that with 20% of the cells in the contingency analysis having a count of less than 5, and the Likelihood Ratio not indicating the same relationship, the Chi-Square is also under suspect.

Through the use of a contingency analysis and supported by a Pearson's Chi-Square x^2 (4, N=75)=10.62, p=0.0312* and a Likelihood-Ration test (4, N=75)=10.901, p=0.277*, it was found that there is a statistically significant difference in the companies that had a certain dependency on their key suppliers and those that imposed or did not impose risk management practices on their suppliers. However, it is to be remarked that with 20% of the cells having a count of less than 5 responses, the Chi-Square remains under suspect. As such, the H₀ of no differences can be rejected. Based on the analysis of the contingency table, it can be asserted that in over 90% of the cases when supply chain risk management practices were imposed on the suppliers, the dependency on key suppliers was either high (73.3%) or very high (20%). Furthermore, in 93% of the cases when the supplier dependency was low, no risk management practices were imposed.

Of the other combinations of the key buyer and supplier dependency in accordance with types of change undertaken, no statistically significant differences were found.

A statistically significant relationship was found between those companies that increase their number of suppliers and those that source from North America $x^2(1, N=75)=4.041$, p=0.0444* and LR (1, N=75)=3.928, p=0.0475*, China $x^2(1, N=75)=6.463$, p=0.0110* and LR (1, N=75)=6.361, p=0.0117*, South Asia $x^2(1, N=75)=4.183$, p=0.0408* and LR (1, N=75)=4.018, p=0.0450*, Asia-Pacific $x^2(1, N=75)=6.506$, p=0.0108* and LR (1, N=75)=6.315, p=0.0120*, and Africa $x^2(1, N=75)=5.889$, p=0.0152* and LR (1, N=75)=6.595, p=0.0102*. Furthermore, Fisher's Exact Test claims that with for those companies that source from North America (p=0.0423*), China (p=0.115*), Asia (p=0.0421*), Asia-Pacific (p=0.0121*), and Africa (p=0.0385*) the probability of increasing the number of suppliers is greater than not increasing the number of suppliers. Furthermore, using Fisher's Exact Test the 2-Tail test shows that with p=0.154* and p=0.0385* the probability of increasing the number of suppliers when sourcing from Asia-Pacific or Africa is

different across increasing or not increasing the suppliers.

There is a statistically significant difference in the distribution of those companies who decrease the amount of sourcing from areas and countries that have a high exposure to natural catastrophe risk and those that source from South Asia $x^2(1, N=75)=7.251$, p=0.0071* and LR (1, N=75)=5.652, p=0.0174*, Asia-Pacific $x^2(1, N=75)=4.630$, p=0.0314* and LR (1, N=75)=4.048, p=0.0442* and Africa $x^2(1, N=75)=4.853$, p=0.0276*. Using Fisher's Exact Test, the right side test comes to exemplify that there is a greater probability to decrease the number of suppliers than not to do so when the company sources from South Asia (p=0.0287*). Furthermore, the 2-Tail test shows that probability to source from South Asia (p=0.0287*) is different across those companies that decrease their number of suppliers than those who do not.

Imposing risk management practices on suppliers, or improving the supply chain communication, shifting current facilities, or increasing the focus on contingency planning, is not in relationship with regional sourcing dependencies.

A statistically significant difference in the distribution of those companies who increase their raw material inventory and those that source from Western Europe $x^2(1, N=75)=5.906$, p=0.0151* and LR (1, N=75)=6.267, p=0.0124*. Using Fisher's Exact Test, the right side test comes to exemplify that there is a greater probability to increase the raw material inventory when the company sources from Western Europe (p=0.0164*). Furthermore, the 2-Tail test shows that probability to source from Western Europe (p=0.0214*) is different across those companies that increase their raw material inventory than those that do not.

A statistically significant difference in the distribution of those companies who increase their finished goods inventory and those that source from Africa $x^2(1, N=75)=7.692$, p=0.0055* and LR (1, N=75)=4.850, p=0.0276*. Using Fisher's Exact Test, the right side test comes to exemplify that there is a greater probability to increase the finished goods inventory when the company sources from Africa (p=0.0451*). Furthermore, the 2-Tail test shows that probability to source from Africa (p=0.0451*) is different across those companies that increase their finished goods inventory than those that do not.

With regards to the those firms that increase the focus on supply chain risk management, a statistically significant difference in the distributions was found with firms sourcing from China x^2 (1, N=75)= 9.554, p=0.0020* and LR (1, N=75)=9.285, p=0.0023*. Furthermore it was found using Fisher's Exact Right Side Test that there is a great probability for firms sourcing from China that

they will increase the focus on supply chain risk management than those that will not ($p=0.0027^*$). The 2-Tail test shows that there is a difference in distributions across those firms that increase the focus on supply chain risk management than those who do not when the source form China ($p=0.0030^*$).

A statistically significant relationship was found between those companies increasing their number of suppliers and those producing in Western Europe x2(1, N=75)=4.710, p=0.0300* and LR (1, N=75)=4.855, p=0.0276* and Africa $x^2(1, N=75)=7.963$, p=0.0048* and LR (1, N=75)=8.908, p=0.0028* . However, using the Fisher's Exact Test for the left side, it was found that companies producing in Western Europe have a great probability to not increase their number of suppliers than to increase them (p=0.0260*). With the right side test, the opposite was found for companies producing in Africa (p=0.0123*) Furthermore, there is a difference in the distributions according to the 2-Tail test in Western Europe (p=0.496*) and Africa (p=0.0123*).

There is a statistically significant relationship between those companies producing in Northern America and those increasing the focus on contingency planning $x^2(1, N=75)=5.476$, p=0.0193* and LR (1, N=75)=5.398, p=0.0202*. Fisher's Exact Test indicates that companies producing in Northern America have a great probability to increase this focus than not to do so (p=0.0193*). Furthermore, there is a difference in the distributions of increasing or not increasing the focus for those companies producing in Northern America (p=0.0357*).

A statistically significant difference in the distributions can be found for the companies increasing the focus on supply chain risk management and those producing in China $x^2(1, N=75)= 4.133$, p=0.0421* and Asia Pacific $x^2(1, N=75)= 5.013$, p=0.0252* and LR (1, N=75)=7.939, p=0.0048*. Using the Fisher Exact Right Side Test, it was found that there is a higher probability for companies to increase their focus on supply chain risk management than not do so when producing in China (p=0.480*). However the opposite was found for companies producing in South Asia (p=0.0195*).

With regards to increasing the inventory of finished goods, a statistically significant difference in the distributions was found with companies producing in Asia-Pacific x^2 (1, N=75)= 11.510, p=0.0007* and LR (1, N=75)=8.650, p=0.0033*. When applying Fisher's Exact Right Side Test, it was found that increasing the inventory had a greater probability than not doing so with companies producing in Asia-Pacific (p=0.0046*). Furthermore, a difference in the distribution of firms increasing or not increasing the finished goods inventory was found with those producing in Asia Pacific (p=0.0046*).

15.4.4.10. Relationship between regional dependency and future supply chain changes Based on a factor analysis it was found that companies with a strong sourcing, producing and selling dependency upon North America will increase their focus on contingency planning in the future. This is shown by the function y=0.17 + 0.08x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.29 is significant at the 95% confidence level with a p=0.0119*. The mean is located at 0.81 for x and 0.24 for y. The R2 has a value of 0.08. Also, companies with a strong sourcing, producing and selling dependency upon North America will increase their focus on contingency planning and risk management as well as supply chain communication and imposing risk management on their suppliers in the future. This is shown by the function y=0.68 + 0.26x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.28 is significant at the 95% confidence level with a p=0.0132*. The mean is located at 0.81 for x and 0.89 for y. The R2 has a value of 0.08. Further, companies with a strong sourcing and producing dependency upon Africa will increase raw and finished goods inventory as well as stop setting up facilities in natural catastrophe prone areas. This is shown by the function y=0.08 + 0.29x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.28 is significant at the 95% confidence level with a p=0.0136*. The mean is located at 0.07 for x and 0.09 for y. The R2 has a value of 0.08. Additionally, companies with a strong sourcing, producing and selling dependency upon the Middle East will increase their focus on contingency planning in the future. This is shown by the function y=0.21 + 0.37x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.32 is significant at the 95% confidence level with a p=0.0046*. The mean is located at 0.09 for x and 0.24 for y. The R2 has a value of 0.10. Finally, companies with a strong sourcing and producing dependency upon the Middle East will their increase their focus on risk management and contingency planning, as well as improve supply chain communication and impose risk management practices. This is shown by the function y=0.77 + 1.30x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.36 is significant at the 95% confidence level with a p=0.0014*. The mean is located at 0.09 for x and 0.89 for y. The R2 has a value of 0.13.

Companies with a strong sourcing, producing and selling dependency upon North America will increase their focus on contingency planning in the future. This is shown by the function y=0.17 + 0.08x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.29 is significant at the 95% confidence level with a $p=0.0119^*$. The mean is located

at 0.81 for x and 0.24 for y. The R^2 has a value of 0.08.



Companies with a strong sourcing, producing and selling dependency upon North America will increase their focus on contingency planning and risk management as well as supply chain communication and imposing risk management on their suppliers in the future. This is shown by the function y=0.68 + 0.26x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.28 is significant at the 95% confidence level with a $p=0.0132^*$. The mean is located at 0.81 for x and 0.89 for y. The R² has a value of 0.08.



Companies with a strong sourcing and producing dependency upon Africa will increase raw and finished goods inventory as well as stop setting up facilities in natural catastrophe prone areas. This is shown by the function y=0.08 + 0.29x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.28 is significant at the 95% confidence level with a $p=0.0136^*$. The mean is located at 0.07 for x and 0.09 for y. The R² has a value of 0.08.



Companies with a strong sourcing, producing and selling dependency upon the Middle East will increase their focus on contingency planning in the future. This is shown by the function y=0.21 + 0.37x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.32 is significant at the 95% confidence level with a $p=0.0046^*$. The mean is located at 0.09 for x and 0.24 for y. The R² has a value of 0.10.



Companies with a strong sourcing and producing dependency upon the Middle East will their increase their focus on risk management and contingency planning, as well as improve supply chain communication and impose risk management practices. This is shown by the function y=0.77 + 1.30x, which is significant at the 95% confidence level. Furthermore, a Pearson's correlation coefficient of 0.36 is significant at the 95% confidence level with a $p=0.0014^*$. The mean is located at 0.09 for x and 0.89 for y. The R² has a value of 0.13.



15.4.4.11. Relationship between the type of previous consequence and the type of change undertaken

When trying to determine if there is a relationship between the type of consequence that the natural catastrophe had on the supply chain and the type of changes that were undertaken the following statistically significant relationships are found at the 95% confidence level.

The consequence on the reputation and sales with existing customers in combination with a shift in the facilities away from natural catastrophe affected areas and countries: x^2 (5, N=38)= 11.259, p=0.0465* and x^2 (4, N=38)= 17.944, p=0.0013* and LR (4, N=38)=10.125, p=0.0384*, respectively. However, given the fact that there is a count of 5 or less in 20% of the cells, there is a suspect of the Chi-Square. Irrespective of this, it is hereby to be remarked that the two companies that decided to shift their facilities experienced an increase in their reputation and increase in their sales with existing customers as a consequence of the natural catastrophe impact.

The distribution in the consequence on the sales with existing customers and the number of customers is statistically significantly different to the distribution of those companies that increased their finished goods inventories, x^2 (4, N=38)= 13.181, p=0.0104* and LR (4, N=38)=11.741, p=0.0194*, x^2 (4, N=38)= 11.798, p=0.0189* However, given the fact that there is a count of 5 or less in 20% of the cells, there is a suspect of the Chi-Square. Despite this, it is to be noted that of those n=6 companies that decided to increase their inventory of finished goods, 50% (n=3) had experienced an increase and 50% (n=6) had experienced a stagnation of their sales with existing

customers as a consequence of the natural catastrophe. Conversely, of those companies that did not undertake the same measures, the majority had experienced a maintenance (N=17, 44%) decrease (n=8, 21%) or strong decrease (n=5, 13%) of their sales with existing customers. Similarly as with the forth-mentioned, 33% (n=2) of the companies that experienced an increasing or a constant (n=4, 66%) of customers, undertook an increase in their finished goods inventory.

In terms of the relationship between the consequence on the number of customers and the consequence on the profit in combination with a stopping of setting up new facilities in natural catastrophe prone areas, it can be said a statistically significant relationship of the differences it to be found at the 95% confidence level $x^2(4, N=28)=18.486$, p=0.0010* and $x^2(4, N=38)=11.982$, p=0.0175*, respectively. However, there are 20% of the cells that do not have a count above 5, meaning that the Chi-Square stands under suspect.

15.4.4.12. Relationship between previous impact and type of previous supply chain change

There is a relationship between companies facing outbound and inbound logistics issues as a consequence of a impact of a natural catastrophe, and those that decided to impose risk management practices on their suppliers, improve their supply chain communication, increase their focus supply chain risk management, and increase their focus on contingency planning. This relationship is represented by the function y=0.45x+0.53, which is significant at the 95% confidence level (n=75). Furthermore, Pearson's correlation coefficient is 0.33 and is significant at the 95% level with p=0.0037* (n=75) and mean of 0.36 and 0.69 respectively for X and Y. The R² is 0.11.

15.5. Results – Qualitative Research

15.5.1. Case Company A

Industry: Electronics

Level of employment of interviewee: CEO

The interview was conducted via skype

Interviewee: Well, first of all you have always to go and say that catastrophes are a part of business. And if you are not are prepared for a catastrophe of whatever type then that cant be. And it does not always have to be natural catastrophes. I think that a lot of companies do not do a good job anyways is risk management or risk assessment. A lot of them talk about it but then they very quickly do not understand how their supply chains come together and so forth. You could think of ... you know if you go back to 1997 a really big catastrophe for businesses was the currency crisis. The currency crisis, there is nothing natural about it, but all the currencies collapsed and so business came to a standstill. So it does not really matter if it is a tsunami or a currency crisis or whatever, something can always bring a supply chain to stop.

In 2009, you know it was just the financial markets that so you could not get a letter of credit out, you could not get goods loaded into a container just because there was no financing instruments. And so that again just throws up supply chains pretty severely. And then you have the additional thing when currency crisis or a natural crisis where just the supplier is hit, they go bankrupt, they get washed under water you know whatever it is.

So I think that one of the things that for us as a company we have a couple of things. Well over 90% of our customers are single source and these are all big companies and they are all leaders in their areas. You might think: what is the solution for a company that has single source? And then you just go out and get a second source; and then they are backed-up. What happens in a lot of cases is that the supply chains – even though someone says well I have got two suppliers – often – because it is a similar type of product – in the supply chain, the raw material or something else may be the same. For the industry that we are operating in it is very difficult to get a product that performs identical. So then even though you may say you have two suppliers and they are on different models, you are still back to single source. So I think, therefore the way we look at it: single source is not bad, it actually makes companies more efficient as then they can put their volumes together with one supplier, get better pricing potentially then splitting it. And in some cases you know, the companies have tried strategies like Nokia used to do it, called having multiple suppliers. They said I have to have three suppliers; but then what usually ends up giving way is innovation. SO if you have two suppliers or three suppliers, well they are all not going to innovate at the same speed so then you will usually slow yourself down in introducing innovations because you need all of your suppliers to be up to speed before you can innovate something. So, if you look at it, a company like Nokia generally had a great supply chain but they fell through because they could not innovate and because they could not compete on the market. Someone, like a Apple has very few suppliers for the product, they usually only have single suppliers. Or you know, a lot of the smartphone companies. They can innovate faster.

What I think the emphasis has to be is not that you need to have more suppliers, but that you need to have different; first of all you need to have a very strong risk management so that you understand what are your risks. It could be anything like okay and you just have to play all different scenarios there are: what happens if we have a revolt in the country. You know, in the Philippines we have a test facility: what happens if you know there is a communist takeover, what happens if there is an earthquake, what happens if there is a hurricane. You know, there is all the normal stuff you would think of. But then you need to, your supply chains needs to be divided into lower and lower levels. And that is where most companies fail and they say: well I have got my supply chain backed up. I have got multiple manufacturing locations, I have one in Thailand, I have on in the Philippines, I have one in Europe and then what they fail to recognize is that lets say all of the glue or the plastic that is used/that is approved for that product all comes from the same factory in Japan. Japan, which has been in an earthquake zone.

So you have to really dig deep very low to know where your single source is. And then if you are single sourcing, then you know what is your back-up. Some of our customers what they will say and do is that in the worst case if our company can not deliver, I have a 6 months disaster scenario; by then they will be able to do something. So what they will do is that they say: "okay, we will make sure that there is six months of raw material or finished goods in the pipeline." Which in itself is another risk because it could happen that the material gets spoiled or something happens that this material does not function or you have a model change and you do not want to use that material anymore and you are stuck with it. So we play those types of scenarios.

So our situation as far is that we have been through the volcano in Island, we had Fukushima, the tsunami, the nuclear reactor problem and we have had the Thailand floods. And we have gone through all of them pretty well.

Thailand floods got us problems because we had just bought a company and the company that we bought had their production in Thailand in Ayutthaya. Their products did not have a back up and we had just bought them so we were then scrambling to clean that up.

Their factory basically flooded and we had to go in and take out all of the equipment out of the facility and move it to another facility and find an empty facility, move it into that and set it up and keep it running. At the same time to not miss any delivery. We did that about in two to three weeks. When a crisis like that happens, first thing is that you have a flood, well you can't get a boat. First

thing you need to get is people there. I think that is the biggest response that you have to do. That is the difference we saw from our competitors. Is that a lot of competitors went on the phone to talk to their suppliers or send an email. Trying to get information. But when there is a crisis like that, no one has time. What we do is that we go there. We had teams there within two days and I went down there and spent some weeks there as well. There is nothing like being on the ground then you can react. And when you are in a flood situation, the things that you normally have available, just disappear. You can't get enough across and boats forget it, boats are not available. So what we do is that we go around buying all the things that we need. We bought boats in the US and in China.

The thing to natural disasters is that you need to plan against it and plan for the worst and hope for the best. But then those things happen then you need to act very quickly.

When the volcano happened in Iceland, we reserved an airplane and had them sitting on the runway. We had a plane to get our goods out to Dubai and because they said that no public airlines will fly. We also then reserved, we went as far south as we could, in Italy, and reserved shipments out of there. Before anybody else has the chance to react, because otherwise those capacities will be gone. So it is really about having quick reaction.

Interviewer: So it seems that your company even before these three catastrophes: Iceland volcano, tsunami in Japan and Thailand flooding – already had a pretty good perception on what to do when a natural catastrophe hits the business?

Interviewee: Yeah, well we run a very very detailed risk management. We run this all the time. Personally, we brought that in because I was in the currency crisis and I have been running production in Asia and bad things happen. This is not new and this has always been the case. There have been disasters, thyphoon, floods and everything as long as I have been working. So you can't sit there and say: I was surprised that this happened. Those things are going to happen. No one can predict a nuclear disaster and a second fukushima. Those are real events and you have to understand your supply chain to say that if a real event happens whatever it may be, what is my fall back?

Interviewer: Would you say that especially after this year of 2011, your perception on these events sharpened even more?

Interviewee: I don't think anything what we did is, we basically accelerated for the company we bought, we simply accelerated our plans. We would have probably done it anyway, it was on our roadmap, but we did it faster. We were forced to certain things faster. So we got a lot of brownie points from our customers because a lot of our much bigger competitors, they are a big companies,

they said that they will get their Thailand plants running in June 2012. So what do you do, you are telling your customers that you can't deliver and it is not as if, when you are supplying to certain industries, you have really long approval cycles, so when you are moving our production to another site, you can't just say that it is emergency and I am just going to deliver it now. It needs to go through the approvals and those are huge events at customers.

Interviewer: But how is that possible when you had to move the production in Thailand then?

Interviewee: Because it was the same equipment and we then deliver it in the fall. We have the same equipment that was the big advantage and the same process so we basically duplicated it on another site. We had to get a deviation to be allowed to do that. It was either that or we had to shut down. The customers will also respond faster in an event like that than what they would normally do.

Interviewer: So you would say that your perception has remained the same prior to 2011.

Interviewee. Yes. The old statement that shit happens is a true one.

Interviewer: Okey great. So the other part that I wanted to talk with you about is if there are any things that you are planning to change or going to adapt in your supply chain. For example I read in your annual report from 2011, that you want to expand your supplier base in a certain part of your business.

Interviewee: Right! Because that was the one that was pretty much concentrated in Thailand and we have added multiple sites in those locations. Looking at the different areas that ... So we have expanded into the Philippines were we already had production and even within Thailand we established other locations in Thailand to be able to back each other up. So once again, one very far away, more in the highlands, so further away from any flood areas. Because again Thailand is going to flood and it is more a matter of when. Then also using Malaysia as a back up.

There are probably one thing we changed, is that not trusting that our suppliers have multiple sites. We noticed that sometimes our suppliers tell us they have a plant but unless you go and really check it you do not know how good it is. Then when you do go in and check then you realize that the plants are not that solid and then you can't rely on them. They are basically coming back to a single source or raw material. You may have a supplier that is manufacturing on two sites but then it might be that he has only one supply for one part of the product. So what happens if that supplier crashes? The biggest thing is to really to get it right.

Sometimes it is about the really simple stuff. Sometimes if you can't get screws then you can't make a phone. You may have taken care of everything else but then you do not have the screws but then you can't make the phone. So it is also making sure that you know what is a commodity and what is it that we really need and can't be without. Really looking at those and that those are backed up. That is really a lot of work!!

Interviewer: Yeah I can imagine that! That really is a lot of work. If you would take out the three major changes after the Thailand flooding - what do you think they would be?

Interviewee: Well, three major changes have been that we (1) qualified additional sites (2) we expanded the depth of our risk management assessment (3) established more confidence with our firms quality systems and it is all regionalized now.

One of the things is that when you have another supply chain disruption might be some quality excursion hits your system and then your analytical tools needs to be really good. How quickly can you analyze the problem and bring a solution to the problem. So that's were we put a lot of our efforts in.

And another thing is that we realized, it is maybe not a change but more a realization, that what we have been preaching for a long time is that our company is still manufacturing its own goods where a lot of companies within the industry has gone to the model of letting other people manufacture as well. Well that just pushes the problem somewhere else and it really takes control away from you. We found that if we want to make superior margins and higher profitability, we have to offer our customers something for that and the thing that we offer is that we control the supply chain and we have it in our own hands. So again, the realization that you don't want to just give up your supply chain, you obviously want to give away the part of the supply chain to supplier where they can do better than you, but too often companies just assume that suppliers can do something and they just want to save a cost and that can often be very very expansive. When everything works wonderfully it can be good but when things go bad it can really really kill you.

Interviewer: So what I can understand from the net prior to our conversation is that the only part that is really still outsourced is the assembly.

Interviewee: Parts of the assembly is outsourced. The assembly is where we have multiple sites doing assembly for us.

Interviewer: And you basically insourced most of the final testing and the packaging?

Interviewee: The final test has always been on our company's side on our core business side and even now for our new acquisition we do usually insource that. And then the assembly is... because the technology is always changing so now it is closer to what we would normally use as a manufacturing process so you can start insourcing parts of it again. And we have been doing that.

It is okey to have outsourced stuff but you have to have some competencies because if you don't have any competencies inhouse and if you are not making anything it is hard to have a competency in a process and you may have a natural disaster at a vendor more related to the quality excursion and if you don't have any people inhouse that can solve those problems you can't send anyone to a vendor to fix it.

Interviewer: Yeah that is true. I just find that interesting because it is very unusual nowadays to have so many elements of your value chain done in house actually.

Interviewee: I think that a lot of companies look at that and somebody has to pay for the manufacturing and so you can run different models on how you can do that. Now companies that have put more manufacturing outside when manufacturing gets tight when there is a disaster what they normally end up doing is writing big checks to guarantee a production access. Than go to a vendor and say that I'll reserve the capacity with you and I'll pay you even if I don't use it. That is different type of risk. You may not always have that available to you. So for us we have too many dependencies of customers who have one to one or only dependent on us. Therefore we can't take the risk that we also outsource everything in our supply chain.

Interviewer: What do you think has been the biggest motivating factor to say that you would undertake the three major changes that you have taken? (The extra sites, depth of risk management and regionalizing the quality teams)

Interviewee: It is protecting our customers and being able to work with our customers and show them that we are extremely robust and we can use this as a differentiator towards our competitors because our competitors can't do that.

Interviewer: What I am trying to ask is.. I know for example that Toyota after the fukushima crisis actually forced its suppliers to implement more risk management practices. Would you say that there was a similar pressure from your customers or was it more something that came from within

the company?

Interviewee: The pressure came from the inside we were already way ahead of our customers. We were the only supplier that I know of, that was with such a large team in Thailand. We were there before anyone else barely even understood that there was a crisis.

Interviewer: But would you say that this is mostly based on your personal experience, you said that you done business in the Asian currency crisis, or are there also other people in the company that pushes it as much as you.

Interviewee: We have a good team but it obviously starts with the values that we are going to run in the company. Supply chain and operational excellence is something that I set a lot of importance on and so obviously we have not always been that way. We have a lot of experienced people put together in teams to get land on that. Someone got to give end for this and I give the end for this as a differentiator for us with our customers.

Interviewer: The next thing that I want to talk to you about is how the changes that you have undertaken will affect your generic strategies. You mentioned that it differentiates you more from your competitors?

Interviewee: Correct! What do you mean exactly?

Interviewer: How do you think it will effect your position on the market?

Interviewee: I think it will reinforce what we have always said. For ten years I been saying that we have to emphasize on that we will never give up our manufacturing, we will always implement better systems and for instance one of the big things that we started off many years ago and continued to improve is our ERP systems. Our ERP are totally global and fully integrated, our sales forces are integrated into it as well. That gives us the ability to run those type of programs on all those multiple sites. If you do not have good ERP systems you are lost. Constantly reinforcing and building on what we have already said, is very very important.

Interviewer: Do you think that the fact that you proven yourself to your competition, do you think this will make customers choose more of your products in the future?

Interviewee: Absolutely! It already has! As a result of our efforts in Thailand we had a major Korean customer telling us that they have never seen a company response so fast. And we got the blind share of the business as a result of that. That is exactly due to that, it is very clear.

It doesn't take away that your product is not good but if anyone has any doubts on anything else, that will push you over the line.

Interviewer: So there is definitely a very positive impact on your position in the market then?

Interviewee: Very positive! Disaster is a great time to create positive residence, even if it is your fault, it is how you manage the disaster that is important.

Interviewer: And we briefly touched upon this before, do you think there are any other competitors that have also undertaken changes that are good changes that might also help improve their position in the market?

Interviewee: Competitors?

Interviewer: Yes!

Interviewee: I am sure that a lot of people, I think the really best in class companies in our business they follow similar models as we do. They always continue to manufacture and they do not take short cuts on manufacturing and supply chain in general. I think too many companies are driven by what the financial market expects of them. They set these plans and they may want to change but in many cases they don't have the long-term commitments to make these changes. This is not something that we can go out now and lets say that you had a problem with fukushima or with the flooding in Thailand and you can say okey now I am going to change... you really need to hire people that are able to address these changes within the company. Unfortunately most companies they chalk it up and say well that's bad luck and they take the insurance money, they loose a few customers and nobody can really see how badly it has hurt them, because nobody can see inside too deeply. But over time it really start to cut them quite deeply. Personally I think people don't learn their lesson out of it.

Interviewer: One more thing that I wanted to ask you about is regarding your expansion of your facilities in the Philippines. The Philippines has far as I know been hit fairly frequently by natural disasters, that is something you obviously taken into consideration but you still decided to continue expanding in the Philippines?

Interviewee: Interviewer, that is always a big discussion. You have typhoons, earthquakes, uncertainties, disasters, not stable governments. However, what are the benefits, you have an extremely educated workforce, it is based in English, you got the rule of law maybe in china you

don't have as much of that, as you might loose IP. The demographics are good, a lot of young people coming into the workforce and even from a standpoint of the government and all the instabilities that are there, they have never been violent towards companies, it has always been corruption under Marcos regime and so forth but it has been against themselves. So we look at a lot of those factors. And when we built the industrial park that we are in, it has its own power supply. So we make sure things like that, that we have fall back, we can generate our own power. The new facility that we are building is actually much safer than the old one because it can take any hurricane or typhoon that has ever hit the island and more the way it is built. We have a lot of back up systems in there, it got its own satellite system and phone system in there. So if all the phone lines got cut we could still run our Philippines facility fully linked to into our production. So we tried to build as much as we can but you are right, something could happen and then what would be our fall back? Will we maintain Europe as a second manufacturing location and that would be much more costly to do the same type of manufacturing here and we would have to scramble on some of the equipment, we have a lot of it here, but it is doable. Now as the facilities get bigger and bigger it becomes more difficult. And then you have to start thinking, do I want to have everything in one big facility and you know I used to work for another American company and their sites were never more than 500 people at a site. You know we used to run 55 plants around the world so we got physically just about turn on dine and did not produce anything anywhere else. But the manufacturing that we are in, is more expensive at time and you can't just go around and duplicating. I mean it is nice to be ready for disaster but your customers aren't going to pay you for that. They want you to be ready but they won't pay extra for it. So it is a little bit of finding these mixed models where you can react and you say within the time frame that I need, how quick can I get this up and running. So what we have done with the Philippines is that we have taken our test equipment's suppliers and say that we want you to be able to deliver us 20 testers in three weeks and make sure that you always have enough and then you stage and you have enough raw materials and component to build 20 testers. We actually run models on this. So you build up stuff like that. Usually when a disaster strikes it is not going to wipe everything out, I mean in that sense the tsunami was very different as it did wipe out everything. But you saw how quick those factories got build up.

Interviewer: But it must be a difficult decision to take from a management point of view to say that I am aware that there is a potential risk but I am still going to take because the benefit is overweighing that. Interviewee: Well what is the lower risk, the daily risk in like a place like Indonesia or Malaysia is to say that I can't get enough quality people. In the Philippines that is the big advantage and it is more stable. Plus that my costs are not going to go out of control. The risk in china is IP theft and remedy is going to explode and the demographics and the wage constraints are going cost you much more over a longer period of time and you won't have the stability in your workforce and you won't bring out the same quality. So those are all the assessment that we make when we go around and look at different countries. If you look at Malaysia and it is a country I know very well. Then why not go to Malaysia, well most of the engineers that you are hiring at factories and Pa Nang and elsewhere are from Philippines anyways. So then it is easier to go to the Philippines and then you have it strait up at the front door.

Interviewer: But the decision to expand in the Philippines that was taken prior to the floods in Thailand?

Interviewee: Yeah, we decided that a long time ago and we have been in the Philippines for five years now.

Interviewer: But the new site is going to be done in October right?

Interviewee: Yeah it is right across the street from our existing facility.

Interviewer: And I am sorry to jump back to Thailand, it is just a detail that we discussed before. Just to get some detail on the extra sites that you built in Thailand, you said that you built an extra site higher up in the mountains.

Interviewee: We expanded into a site with our manufacturing partner into a place called lampoon.

Interviewer: And the production facility that was previously used by the supplier in the affected area, you are not using that any more?

Interviewee: No we have not moved back there but it is now up and running. We decided to stay where we are, we are in Bangkok and Lampoon now. So we will have to see what our next steps are going to be.

Interviewer: Would you theoretically move back to the one that got flooded?

Interviewee: If we saw that.. Now we understand what caused it and what we would have to do to prevent it. In Bangkok we built a wall around the factory, a waterproof wall and did a lot of other

things. If some of those steps could be proven then we might move back but we staged.. we own a lot of boats and plantoons and things now so theoretically we have a response force. It is not an easy decision and it is an area that is.. it is basically one meter above sea-level. So once it floods it is very hard for the water to drain. So they have a pretty sophisticated dike system but they mismanaged it and it wasn't a natural disaster it was a human induced disaster. So that disaster would maybe not be totally reverted but it would have not been as bad as it was, had the government managed it properly. Then you have things like political issues.

Interviewer: But in the long term, do you think you will stay in Thailand? Or is it a country that you are going to try to get out of in the ten years?

Interviewee: No I don't think so. We invest a lot in our manufacturing partners and we do a lot of training. And it is very expensive to just leave that.

Interviewer: What is your power relative to your customers?

Interviewee: I think it is reasonable, we are not overly powerful, we can't take it or leave it. The industry we are in is pretty fragmented market, there are a number of players but there aren't so many that have the same competencies and that is why we need to have so many. The whole model needs to be differentiated enough to allow us to supply. The other thing is that we are relatively, we are medium size company with close to a 500 million dollars in revenue so we are much smaller player compared to many other large players. So we have to be very innovative in our products in order for us to be successful. Also, you can see that this part of the market is very profitable with huge margins and the only way you do that is by really having big differentiation in the product. So our market is a tough business but it is a very profitable business if you do it right. So we have been building a very nice name for ourselves now and it is getting better and better. Where we were ten years ago we didn't have a lot of clap with our customers and today we have more clap with our customers. You get better over time as you build and your volumes increase.

Interviewer: And you said that for 90 % of your customers your are the single source for them?

Interviewee: Right! More than! For many, we are the absolute single source. For most of our customers, these are all number one companies, all big big guys. If we are the single source there, we may be responsible for several billions of dollars in revenue at a given customer. If we do not supply, he is gone. That is something they do not take lightly and neither do we.

Interviewer: Would you then say that that is one of the key success factors in the industry, the ability to deliver?

Interviewee: I think that is definitely.. it got forgotten for a long time you know everybody thought someone else will take care of the manufacturing and we do not need to worry about it and lets just go for the innovation part and they forgot how much the supply chain means to that. That is the good thing about the last 2008 you had a financial meltdown and volcano, Fukushima, floods, it has really focused everybody on how critical these things actually is. They got reminded.

Interviewer: Fantastic! Do you have anything else that you would like to add?

Interviewee: No. I think it is good topic Interviewer and I think that this is something that if you look at how much contract manufacturing they are doing and the companies that are really good, they spend a lot of time on their contract manufacturing. And you can also see how important it is to your reputation and prestige if you have people who aren't doing a good job then you will get bashed reputationally. A company like apple get bashed by what happens at Foxcon and who would think that you know. So I think that a lot of the things that companies are recognizing are also from an environmental standpoint questions and we get a lot of environmental standards. The fact that we are a member of the UN global compact, all of those things are one big total picture. So it is not enough to say that I can make it and I can deliver. These are important part and companies are spending a lot of time and effort on this.

Interviewer: I guess as you said, it is becoming a more important topic again especially after 2011.

Interviewee: Oh yeah! And also if you think about the environmental concerns and labor concerns. Companies can't get surprised any more and they can't say that i get my stuff made in China and I don't care if they pull it over there or if they use child labor. Those things will come back and will and can do billions of dollars of damage to a company. So they have to know exactly what is in their supply chain.

15.5.2. Case Company B

Industry: Pharmaceuticals

Level of position of interviewee: Senior Vice President of Quality Management

Interview was conducted at the company's office in Tokyo

Interviewee: I would like to explain our supply chain situation. Our company in Japan is an affiliate of the global organization. We only have one factory. It is in the center of the Fukushima, close to the, 60 km.

We have only one production plant, this is very critical. And this earthquake, so our product is based on our production site from Denmark, France, China and the USA. So different places. But almost all of our products are imported and make the product and the buyer product here, so just fitting the product. No cartooning and so that we.. we have a buyer product and a cartridge product, and preferbility product. So cartridge so assembled by the plastic frame. Se we call prefarbility product is our main product. So almost, more than 80 % accountable to this product. And cartridge product is 50 %. The remaining is the buyer product. That's a lot!

It is a very big, so we have a responsibility for continuously providing in the market. And our other product, we have a 37 % share. So number one in this market.

There are 6 companies that sell our product in Japan. For one of our products there exist no substitute product in Japan.

This is our main business areas. We have an alliance in Japan that sell these in japan.

Two of our products need special equipment which is made by a Japanese company. So this is our product and almost a life saving product. It helps small children, so we have to provide it in the market. We have very critical and life saving products.

Once a disaster happened. We have a responsibility to continuously providing in such a situation.

Production, in the factory, the import the naked product and they conduct the necessary control and abide by the law. They conduct the visual inspection and decide what is contaminated and what is not. After that, they label and cartoon. Then they deliver it to distribution center, we only have one distribution center in Tokyo. Our distribution center distribute to wholesale branch in Japan.

And logistics, supply chain establishment already in 2000 and the product chain. Japan was also involved in the supply chain. So how to establish a god supply chain.

So I was a factory manager at that time and I was factory manager in July 1999. So I was called to establish the supply chain. And the computer system determine the stock level by each countries. And the production time improvement. And gradually stock level is inclining and getting better system. Then I was factory manager and the stock level is 4.5 sales over month. Now 2010, it was 2.5. And this year, our target is 2.3.

So we achieved our target to the good supply chain system.

Interviewer: So the earthquake affected the factory the most? What was the effect of the 2011 earthquake on your company here in Japan?

Interviewee: So we were suppose to change the supply chain system after the earthquake. Because our product, packaging.. our product site is not available for our Japanese product. The finishing of the product is produced in Japan. So we had to change this system. The delivering and the cartooning, everything was Japanese law. So this was very controlled by the Japanese law. Just after the earthquake. The factory expected to be influenced by the radiation and therefore no production. Therefore, we stopped production and we evacuated for two weeks. But we had to continue to provide to the customer. So we had enough stock for two weeks. But we doubt to continue to work after two weeks after.. so that we discussed with head of this production site to import the finishing product from the factory in France and the Denmark factory with Japanese labeling and cartooning. So we decided that, if the factory continued to stop working.

Two years ago we introduced improve design and computer system. So already the introduced two years ago so that we can make a Japanese labeling until March. So Denmark prints Japanese labeling, cartooning by a design computer system. Production also adjust for the Japanese products and packaging done. We established a Denmark site... From the fast finished product, so imported from the Denmark and France factories, so in a very short time we established the supply chain. So we imported the finished product with Japanese supply chain.

Interviewer: So now the plant is not producing anymore?

Now it is ready for producing the Japanese supply chain of the finished goods. It is advantage, that the Japanese supply chain have by Denmark and France it is this advantage compared to the product packed in Japan. Because japan is one cartoon, there are two products in a cartoon. Denmark has more pieces in a cartoon. This is new for our supply chain. So if we meet our requirement of two pieces of products. So this is a emergency case that we accept 5 pieces in a cartoon. So the new products do not have a pyropack, but the Japanese product have a pyropack. The Denmark production machinery does not have a pyro machine but we accept the product without pyro. Pyro is a tamper proof function. You can see if it is used or not. It means that is has not been used.

Products without pyropack, the patient can't see if the product has been used or not. So we have to compromise on emergency import. But now it is no program calm down on the Now the factory is producing the finished products. But now we are ready for import for the finished product because of the supply chain. So this is one change of the big change and also the distribution center, we have only one distribution center. And all of our products are distributed from here. This big danger, there will be big weather forecasts that will be put into the new forecasts by the Tokyo university. There will be two earthquakes in the Tokyo area and same size as the last year. So more than 70% possibility of it happen. So for that we need preparation and such a big earthquake happen here so that the only one distribution center is very dangerous. Just after the last earthquake we had the other distribution center in the Chu area, here (showing on the map) Chu is here. And this distribution center here so we had the other distribution center temporary here. And all finished products, produced by the factory was transferred to this distribution center just after the earthquake. So the radiation issue was the reason and no enter the other factory.

Interviewer: so then after the earthquake the Tokyo distribution was closed?

Interviewee: Tokyo also but very limited.

Interviewer: Ok

Interviewee: Also we need additionally stock immediate. Because no production some months we expected.

Interviewer: And in the future, you said that there is prediction of new earthquakes, so you will have another distribution center?

Interviewee: Yes, we used this as the temporary distribution center and this years we brought it here (show on map). Two different.

Interviewer: so you will add a new one this year.

Interviewee: While we are planning to improve our business continuity plan.

Interviewer: But in the future, before the March 2011 earthquake, did your company assess these kind of risk as well? Did you have meetings about the potential of an earthquake hitting Japan.

Interviewee: We have procedure, we didn't expected that a big earthquake would happen. We would have to change the mind and that we can have such a big earthquake so soon.

So that we can quickly prepare and such a critical solution. So we are ready for such a big earthquake.

Interviewer: So how would you say that your perception has changed?

Interviewee: So we need to close communication to make a measure is needed. We cannot do that by ourselves so we need a cooperation with other organizations. Such like government, medical society etc.

This is, the earthquake happened here, the Tokyo area. Tokyo is here (showing on map), three roads were blocked so this is the access to our customers.

We couldn't use these roads and this one is a limitation for the car in the highway. We can only use this one here and this route are closed for our distribution center. It looks like a fishbone. Our distributor does not know that the roads are not able to accessed.

The doctor take the product to the patient. The first one week we established the access and we have to confirm that we are able to deliver our product. The next one month, we had to provide our products to the patients in the affected area. We decided to not charge for our product for the patients and the cooperation with the doctors. No distribution costs and no product cost. So we learned from that.

Interviewer: So that was your business continuity plan for the future?

Interviewee: Yes.

Interviewer: So you would agree to the fact that your company need to take more attention to earthquakes in the future?

Interviewee: Yes.

Interviewer: With regards to the earthquake in March 2011, so I understand that you had to stop production for 2 weeks in your plant and after 2 weeks you had start production again? How did this affect your competitive position? Did you loose market share because of this? What was the consequence?

Interviewee: There was no damage. We had good reputation with the customers and the government. We did not decrease distribution but we adapted it accordingly.

Supplier factory got damaged – they cannot provide the needle for that. They had a shortage of this stock. But we covered them with our product. We ourselves 220 000 increase in March. Then after

that our market share increases.

Interviewer: Your market share increased after the earthquake.

Interviewee: Yes. We have never no stock during this time.

Interviewer: And your competitor run out of stock?

Interviewee: Our competitor is located here (show on map – far away from Fukushima). They were not damaged. Our factory was located here and no damage for production. No critical damage for the factory.

Interviewer: So if I understand you correctly – after the earthquake – because your company handled the situation so well that the reputation increased and also the sales of your company increased?

Interviewee: Yes! Immediately it went up but other products is the same to the competitor. Not above, no further than the stocks. And we handled it very well the doctor and the patients fear that our delivery so that there is overstocks but that we handled that. So we have enough products. We provided information to the wholesaler to calm down. So we got the.. the accident happened in March, so some reputation from the customer coming next day, Saturday and Sunday, so that I informed them that the stock level is enough to handle the situation. But also over the country. We gave that message to the medical centers that we can provide the products. We already established our sales and our roads.

Interviewer: May I ask – how is it normally with your stock level? How do you – do you have a limit with three weeks stock level or how is it normally?

Interviewee: No much stock level. I am concerned, that such a cases is normal situation. They have a behavior to overstock inhouse or in hospital. I am worried about that. How to communicate to the customer is very important. I check everyday how to deliver the product.

(showing the forecast)

This is everyday. So my management is on this paper. You have the different regions of the country. Then you have the Tohuko area, east Japan. There are many wholesaler here. So next Monday, March 13^{th} to next Thursday so 17, how to go by the product. The amount is getting bigger every day. (\rightarrow Forecast)

Interviewer: so that is your forecast you could say.

Interviewer: I have another question – for the future, the main changes that you are going to take is related to distribution? So what is the motivation for this? Is it from the inside of company (japan or Denmark) or is it the customers that demand it?

Interviewee: We need a good system and communication with our customers. So that they believe in our product supply. We are responsive for no out of stock and the high quality. Once a quality issue happened or out of stock,... So our responsibility is safety delivery of supply and high quality for our products. So that, when such a big earthquake happens so how extremely good system in the supply system we need to communicate and to improve also. We need to communicate.

Interviewer: Do you think that these change in the future, will they also increase the reputation of your company in Japan?

Interviewee: Mmm yeah the reputation is surviving....

(... They have another meeting. We will move to here.)

We have continuously avoided the no stock in ten years. Our business strategy established 2003 and new business strategy in two years. Now the next one is mission 2012. We are now making business plan over the next three years. So in these years we have never had out of stock. Such a behavior shows our customers to win our trust and in product supply and quality. This is our reputation.

Interviewer: Do you think in the future – if you add the distribution center you were talking about. Do you think this will also push the reputation?

Interviewee: Our expectations have changed since last year. We did not predict such a big catastrophe, so we have to meet our plan to such a big catastrophe. So we have to improve our business continuity plan and our supply chain. Our stock level is going down, which is better for our business but critical for our business in the case of a catastrophe. So we solved this dilemma with a better supply chain.

Finished the product produced at the production sites. Also, investigating the license. Current one is only produced in Japan, but we have to still study the flexible supply chain.

Interviewer: Do you think in the goal in future you will continue to take down the stock level?

Interviewee: Yes!

And raw material, in process and the finishing product. The lead time is shorten and because we have a high stock level.

Interviewer: One thing we haven't touched upon – during the earthquake – was it problem to get the raw material – or was this not impacted?

Interviewee: It was not impacted. We have had a global cooperation to support Japan. Total standard stock level has gone down to improve our financial situation but our stock level consist of three levels. So we have to see the total stock level, not only Japan stock level, so the big point to improve is, how to decrease the lead time, total, so process (Denmark production, the import and the factory production). So total lead time shorten? If we can do that then we are able to get low stock level.

So Denmark now and product supply have KPI and the lead time in each process. They have a goal yes!

The quality is very important!

Interviewer: From which region do you source more than 20 % of your products? Does it come from Japan or from outside?

Interviewee: Outside Japan. All of our raw material come from outside of Japan.

Interviewer: And the sales is all in Japan. And one more question, will your competitor also undertake changes?

Interviewee: Yes, The government introduced a law for companies need to have a business continuity plan. Not enough compared to the last earthquake.

Interviewer: So the decision to have a new distribution center is it because of the government?

Interviewee: Not the government, more on a general level. Foreign companies have a duty to have such a plan. Need communication with competitor to supply the products.

Interviewer: Do you think in the long term that you will have a second factory?

Interviewee: Maybe. I hope so! [©] It is more expensive than other countries. Denmark is expanding the production sites in China and in other regions.

Interviewer & Interviewer: Thank you very much for the interview.

15.5.3. Case Company C

Industry: Textiles

Level of employment of interviewee: Head of procurement Europe

The interview was conducted via skype

Interviewer: So the first question that I have to you concerns the area of procurement. Where would you say is the biggest geographical dependency in terms of the procurement in your company?

INTERVIEWEE: So, one of the largest – but not the biggest – dependency is currently centered on Taiwan and Japan and this mostly for the raw materials. For the procurement of textiles, the stream of goods is very global, which means that we buy produce from Asia, Europe, and America and we do this to ensure that the dependencies do not get too large. However, Asia, with a special focus on Taiwan and Japan are those areas where we have the largest dependencies. In Europe, we have an equal spread between 12 countries.

Interviewer: And how about in terms of the production. IS there also a dependency towards Asia, or is this focused on Europe?

INTERVIEWEE: So, our production takes part in the three areas of Europe, American and Asia. So we have our own production facilities in Japan, in China, and the USA as well as in Europe. And the production facilities are spread as well as the distribution streams, which are also spread.

Interviewer: And I would assume that this is similar from the sales side?

INTERVIEWEE: The sales side is set up in a regional manner and this is also different within the different business units. Our consumer business is a global business, which mans that global customers buy from the global availabilities of product portfolios that is produced globally. And in the consumer area, it is focused mainly on the Asian area in terms of the manufacturing and also in terms of the distribution streams. In terms of the more technical area, and this is the area that I can speak of the most, the distribution looks a bit different. If we take the consumer business, then I would say that around 70% is the Asian area, which concerns the supply base as well as the production side.

INTERVIEWER: And to what extent would you say that you are currently dependent of your key

suppliers?

INTERVIEWEE: So you means as a percentage of our total sales?

INTERVIEWER: Yes.

INTERVIEWEE: So, if I would say the biggest supplier in contrast to all of our other suppliers, then it would be approximately 15%.

INTERVIEWER: The next question that I wanted to ask you if there is currently some sort of a risk assessment with regards to catastrophic risk?

INTERVIEWEE: In all of our areas we are driving a supply chain strategy. To these supply strategies we have a lot of measures such as the financial stability and all other things that concern the key performance indicators. The topic of regional emphasis and the dependency of these is something that is increasing in focus, especially out of the consideration of some of the crisis areas that we have seen to develop. This is also important and this is something that we have had running since about 1.5 years; and this also especially due to the Japanese crisis so that we are able to evaluate certain types of risks. Ok, what does it mean to evaluate, it is more about taking certain risks and putting them in the foreground and to then think about ideas on how to work against these or as we call it in our company, to work more on contingency planning in the form of capabilities or to build up a second source. An example, earthquakes are constantly coming back topic and especially within Japan this is a determining factor currently.

INTERVIEWER: This also brings us to one of the main questions and to certain extent the main topic of today. IN the past tend years, has your company ever been impacted directly or indirectly by a natural catastrophe?

INTERVIEWEE: Yes. Yes. Yes, and of the ones that we were impacted by and I am not going to call it the atomic catastrophe but the tsunami in March 2011 in Japan. This has been the youngest issue that we have seen. Another natural catastrophe was a fire approximately four years ago; this was a large-scale fire in the production facility of one of our suppliers. And in the USA it was Hurricane Katrina, which indirectly affected our supply chain because a lot of the supply of the oil stopped due to this and so there was not enough material anymore on the market. I would say that these have been the last major three occurrences.

INTERVIEWER: And in Japan, what was the impact on your supply chain? It was caused through the tsunami...?
INTERVIEWEE: Yes, it was in principal the atomic catastrophe that was caused by the tsunami, and then on one of the parts the ports got closed and this with produce that was in the inventory and ready to be delivered. And lets take out the entire topic on if the product was contaminated or not by the nuclear crisis. In any case, a lot of things could not be shipped which means that the material arrived late or extremely late to our company and this in turn caused a lot of delays in our supplies. So this means that on one side that the existing work in progress materials or the ready at stock materials could not leave the port and the other side was the production facilities were partially flooded and hence could not be operated and this means that the capacity was not available for a certain amount of time. And this also lead to the same topic, delays in the supply and hence our inability to deliver to the customers. And the other topic was that of the under supply of electricity, and this was also due to the Tsunami, but this did not have the largest impact on us

INTERVIEWER: And these production facilities you are talking about, are your own facilities?

INTERVIEWEE: These are the ones of our suppliers. Our own production facility was not affected.

INTERVIEWER: And the incident in the USA, with the Hurricane Katrina, this was indirectly or directly or how can I understand this?

INTERVIEWEE: No, this was indirectly towards our suppliers. What you have to understand that in this area there are a lot of chemical production companies such as refineries and in this area some of the platforms were completely stopped and some of them got destroyed and this lead to the fact that some of the chemical material in the USA were in under supply or temporarily not available on the market and this forced us to purchase on other world markets in order to be able to continue to supply our customers, or at least to do so with a delay. So we are concretely talking about some chemical plastics in the polymer and pre-polymer status.

INTERVIEWER: And if we go back to Japan, what would you say has been the most severe consequences out of this incident? In the sense that you said that the ability to supply was stopped.

INTERVIEWEE: So the most severe consequence was that in this area there exist highly technological products that you do not get that easily on the market in its single production / and many of the elements that are in the further process are processed are also produced there; such as products to make color are produced in Japan and we had to get these from other suppliers in order to secure ourselves so that we could ensure that we would be able to continue producing in other production areas. So the most severe was the realization that there are certain key-products that

flow into commodity products that we are not able to that easily get from other places because these get made in Japan. This was one of the most severe realizations that we had.

INTERVIEWER: And this already takes us very nicely to the next topic and this is concerned about the perception. So I wanted to ask you how your perception changed based on the three catastrophes that you have just listed for me?

INTERVIEWEE: So the topic of natural catastrophes or incident is a topic and is always a thing that we should take seriously in terms of the supply chain and we should consider it in our strategy. That means that the risk assessments should be undertaken and in the case of a potential probability, and this does not have to be out of the blue such as the potential of an earthquake in Germany, but we are speaking about hard facts such as the risk of regular occurrence over the past five years of earthquakes in a certain area, that we are able to secure certain capabilities in another country or area of the world. This does not mean that we have to automatically buy the product there, but to consider the possibility of being able to procure from there and to build up something in a foreseeable amount of time. So the perception that we have is that it is an existing risk, it is not possible to calculate this risk if it will actually or when it will actually happen, and when it happens, it is mostly to such a degree that many resources of crisis management will have to be used to take of this. And in this case you have to at least work against it through the use of dual capabilities. This is the perception that we have. And we also see that it is increasing. The frequency, and the impact are getting stronger rather than weaker and it is at least the perception that we have.

INTERVIEWER: That is is interesting that you say that.

INTERVIEWEE: Well, I will tell you very honestly. I am currently in China to talk about the Asia-Pacific sourcing strategy and there we are talking about dependencies of companies as well as of regions. This is a part of it. So for example, Taiwan is currently on our plateau and we need a second capability for this product platform in another country. We have a product from Japan and we currently thinking about it actively to for this product to at least technically try to get it produced elsewhere in another country and even outside of Asia to then know to see if we could build up a second production facility.

INTERVIEWER: And this also takes us to the next set of questions that we have and this is concerned about changes in your supply chain practices. Since you have listed three natural catastrophes, I would say that we take the most recent one, so for example the one that occurred in Japan as an example. What would you say, in a very linear manner, are the three main changes that

you undertook as a result of this catastrophe?

INTERVIEWEE: So in Japan the biggest change, and the one where we are actively doing something about is, is a key product a key technology that we – up until now – only get our of Japan. And so we want to try to get these things produced in another country in Asia and also in Europe. This is an active change that we are doing out of the Japanese crisis. There have also been products from our own production site that have been transferred to other production sites for the time being and temporarily. So that means that we have the possibility to move our own products, however the problem is that if the material that we need for these products is not possible to obtain then I can also not move the production site. This is the second step. So the first is the core products, which are very unique and very special and that we can only get from Japan, and to reproduce this is another place. If we know that this is possible then we can talk about a single source with a second capability. That means that we know that for the circumstances "X" we can also reproduce the product there, or if we are de-facto speaking about a second source and we spread out the volumes and buy actively the volume "X" from one of them and the volume "Y" from the other. But this would only be the third step. But in in any case we are looking for further capabilities for this product and are doing so in an active manner. At the same time we are looing for our internal technology, so technology that we are doing internally in Japan, we are thinking about how we can use these capabilities of the very thin materials to transfer them to other production sites. So these are the two steps that we are currently undertaking.

INTERVIEWER: And what would you say motivated you to do this? Where these things that only came from within or where these things that were requested from you customers?

INTERVIEWEE: No, this was something that came from within. Amazingly the funny thing is that none of the end-customers come back and ask us about our abilities to deliver. So, as soon as the market – an this is at least the case in our industry – returns back to normal, then everyone had forgotten and forgiven everything. So there was a very short-term wave of issues, but as soon as it broken down and so as soon as we went back to the normal routine, the topic was gone and the topic was not sustainable and not present. And so it was purely intern that we decided to control the high impact of this issue.

INTERVIEWER: And how as it with your competitors. Do they also buy from Japan and did they also get affected by the crisis?

INTERVIEWEE: So I think that the competitors probably also buy from Asia, but if they buy

specifically from Japan I would say yes. But the brands that are only in the certain area that got affected in terms of the clothing and also actively source, produce, or sell in Japan where surely hit the hardest. But I the case of our company that set up in a more global way and also have a broader product portfolio then we have more possibility to maneuver in these situations. But we de-facto have competitors who were affected and still are.

INTERVIEWER: Do you know of any changes that occurred with your competitors as a consequence of the crisis?

INTERVIEWEE: Not really. This is not something that I consider. I am working on my own business and I am not concerned about the competitors.

INTERVIEWER: So you said that the customers did not request you to changes this, but would you say that the changes still had a positive impact on them? Or did they really not care about it?

INTERVIEWEE: So we currently do not communicate this topic if we are working on this topic. This is not something that we use in our marketing or as an argument for our sustainability or ability to deliver and we do this solely out of our own endeavor so that in the case that something happens we are able to handle the situation better. And of course this is also a business orientated topic and so you always have to do a cost and return calculation and as such there is no 100% security but the hotspots can be identified and at least you can try to work against them.

INTERVIEWER: And now to the last block of questions that I have. We are still talking about changes in the supply chain but much more focused on the entire globe and not only thinking about Japan but thinking in a more holistic manner. What would you say will be – if at all – the next three big changes that you will undertake in order to deal with catastrophes in the future?

INTERVIEWEE: So the biggest change will be that we will ... erm ... do you mean in general or for our company?

INTERVIEWER: For your company.

INTERVIEWEE: For our company. The three biggest changes will be that we increasingly talk about second capability. So that is the same as I have talked about before. The key technologies that we buy in in the form of textiles that we will identify these and that in an annual process we will evaluate these to see where are we standing and where are the hot spots that we need to take care of and what are our resolutions mechanisms in the case that something would happen. So the biggest crisis area the we currently have is de-facto Asia, Asia with Japan and Taiwan is the most critical and here we go through all of the products, all of the delivery routes etc and try to take care of the largest dependencies and the risk areas. And so we try to figure out what are the alternative per product per supply chain.

INTERVIEWER: And how deep do you go into this topic? Only into the first or also the second and third tier of your suppliers?

INTERVIEWEE: We go into the third tier.

INTERVIEWER: ...

INTERVIEWEE: So we are definitely going to think more about the topic of second capabilities rather than just being dependent on one supplier. And we will also look at the regional dependencies of our suppliers. This will surely be the biggest change that we will undertake.

INTERVIEWER: And the motivation to do so is the same as the one you mentioned before, it is an internally driven motivation?

INTERVIEWEE: Yes, it is. The motivation is to ensure that the delivery does not halt/ with the minimal amount of impact to pursue it. So it is like I said, I split up a product and then start with two suppliers – this is the extreme option. The other possibility could be that I set up an capability and keep in contact with them for the case that something does happen and then I can produce the product there in say something like six weeks. SO we have the broad portfolio and we have the crisis areas but we will do the same for all of our products and their supply chains. The motivation is to not let the stream break down, that is the only motivation that we have.

INTERVIEWER: So that was actually the last question from my side. I wanted to ask if you have any further remarks?

INTERVIEWEE: No, not really. Of course we talked about natural catastrophes but there is also the risk of politics – which are also an issue. And this is something that is going to be an issue in the future I think and this is also an issue that we should look at in the future but this is something that the industry can not take part into this and the end-consumer is possibly not able to take care of these things from a risk and return perspective.

15.5.4. Case Company D

Industry: Pharmaceuticals

Level of employment of interviewee: Senior Manager at Fuji Factory

This interview was a company visit to the factory in Fuji. Observation and tour of the factory was conducted.

Interviewer: I think if we can go through it in the same format as the interview protocol and if I have any questions then I can ask them along the way when we talk about the individual parts. Is that ok?

Interviewee: Yes, it is okay.

Interviewer: Thank you very much for this! It is very, very nice!

Interviewee: This is our background information and this is the first question that you asked. Which are the three regions from which your source, produce and sell more than 20%? This is our answer. We have three factories in Fuji: Fuji, Nagoya, and Mohka. 30% of products are produced in Fuji factory. Fuji factory produces medicinal products, and health care products. Medicinal products account for more than 90% of all. 60% of the medicinal product is OTC drug and the other is ethical (prescription) drug. Our products are provided to six distribution centers in Japan (in Hokkaido, Saitama, Chiba, Osaka, and Saga).

Over 98% of the products produced in Fuji are for the Japanese market, these go to the distribution centers in Japan. The remaining 2% are shipped directly via waterway to China, Taiwan and South Korea.

Interviewer: And then from these distribution centers it is distributed to China, Taiwan and South Korea?

Interviewee: For export we have another group.

Interviewer: And for export?

Interviewee: We have some subsidiary company in China and in South Korea. But it is a very small amount.

Interviewer: How much approximately are we talking about? I mean, is it over 90% that is for the domestic market?

Interviewee: It is 98 % for the domestic market. Regarding the Fuji factory.

Interviewer: Ok I understand.

Interviewer: And the sourcing of raw materials is it mostly from Japan or from elsewhere?

Interviewee: It is most of our raw materials we purchase domestic.

Interviewer: So it is over 90 %?

Interviewee: Maybe!

Interviewer: Or, more maybe?

Interviewee: So some things such as vitamins, we purchase from foreign countries like China. Because China is very cheap, it is not expensive. And China and India is very common for the API (active pharmaceutical ingredient).

Interviewer: And that is shipped here via plane or ship? Or how does it get here?

Interviewee: Maybe all of it is via ship. Because we purchase from a Japanese supplier. So the maker is a Chinese or an Indian company.

Interviewer: So the origin of most API is from abroad?

Interviewee: Almost all of the raw material is purchased from Japan. Some APIs are purchased from China and India.

Interviewer: To what extent do you depend on your key suppliers and key buyers?

Interviewee: We purchase all API and excipients that are ingredients (raw material) and packaging material from suppliers.

Interviewer: And the suppliers of the API, are they the only suppliers in the world of the special API that you are buying or are there many of these types of suppliers in the world?

Interviewee: The API that we purchase is sold by many, many suppliers. And these suppliers are all around the world.

Interviewer: So the reason why I am asking the question is because it is interesting to know if for example you are not able to purchase the active ingredients anymore from your supplier in China, then are there other alternatives?

Interviewee: But we have a sub-channel for API and for these types of raw materials that import raw materials.

Interviewer: So like a back-up?

Interviewee: Yes!

Interviewer: Also from China, or from different parts of the world?

Interviewee: It depends on the product but some are in China and some are in India and some are in the USA.

Interviewee: Sometimes the API supplier is limited to some countries and then in some cases it is not possible to have different suppliers for one API.

Interviewer: So for one API, it is always the same supplier from one region?

Interviewee: Sometimes we want to have a different back-up from different countries but as along as another supplier exists for the API we can do it, but sometimes API is produced by the same countries and sometimes the APIs one of the APIs is produced by another country. But we try to have a backup.

Interviewee: I talk about lactose. It is a vey important ingredient for the manufacturing of the tablet. But the manufacture of the lactose is very limited all over the world. One or two companies in the world manufacture this lactose. Very limited amount of companies when it comes down to lactose.

Interviewer: And where do they produce the lactose?

Interviewee: New Zealand or Netherlands.

Interviewer: So these are the only two place in the world where they produce lactose?

Interviewee: Yes, it is very limited.

Interviewer: Does your company assess catastrophic risk in relation to your supply chain? If yes, how?

Interviewee: We built a Business Continuity Plan committee as a company wide organization to handle the risk management. The chief executive of the committee is the CEO and we have BCP committee and organizer. Factories belong to factory section meetings in the pharmaceuticals task force. We evaluate the risk of catastrophe in the BCP. We organize information of the material

supplier, carrier and dealer which for our major products. And we have questionnaire to the material provider and evaluate them.

Interviewee: So I am sorry that this is written only in Japanese, but this is the organization chart of the BCP. The CEO and the President is in charge of the BCP. And there is a BCP committee in each of the departments and this is a pharmaceutical section and the pharmaecutal factory section. And the Fuji factory belongs to this section and we do the entire BCP activity for the entire company.

Interviewer. And what kinds of BCP activities do you do as a factory?

Interviewee: Many kinds of activities. For example, risk assessment and risk management to continue the business to protect the employees. Yes, there are many, many subjects that we have.

Interviewee: One of things that we do is that we send out a questionnaire.

Interviewee: So the purpose of the BCP is based on our situation like an earthquake or the influenza flu, there may be an urgent case that we have to deal with and first security of our people and then contingency of the business is the second.

Interviewee: We have different parties, and every concern is dependent upon the section.

Interviewer: In the past ten years, has your company ever been impacted directly or indirectly by a natural catastrophe?

Interviewee: We were affected by the massive earthquake that occurred in March, 11, 2011.

Interviewer: How was your company impacted by these natural catastrophes?

Interviewee : Due to shortage of electricity, we had to change the time of operation and also the day off work. And some materials were disrupted because of the suppliers were suffered from the earthquake.

Interviewer: And these suppliers, they were Japanese suppliers that suffered from the earthquake?

Interviewee: Yes.

Interviewer: What were the consequences of the natural catastrophe for your company?

Interviewee: We consult on the BCP for employees, facilities and materials. We changed our stock levels and positively now keep the major products for 3 months in stock. Positively, we are trying to purchase materials from several companies.

Interviewer: So, with the consult on the BCP, this is the immediate action? What did you mean with this?

Interviewee: So with the BCP, I mean the BCP committee. So, we built a BCP committee to save our employees and also our production. We built a BCP committee.

Interviewer: And for the "we are making stock of our major products for three months". This was a consequence of the catastrophe you now produce stock for three months?

Interviewee: If we suffered from the earthquake last year, then we could not make our products, so we have to save our stocks in the house or the distribution center so just we are thinking about increasing our stock. So, last year we did not suffer for he earthquake but in the future if we had a suffer from the earthquakes so now we are increasing our stock. So before the earthquake, the inventory level was one to two months and now we try to have three months.

Interviewer: So you ran out of stock after or during the earthquake?

Interviewee: So the Fuji factory did not have that much impact so it was okay so it did not run out of stock.

Interviewer: But the stock level probably went down quiet a bit, or?

Interviewee: The other factories were impacted more drastically so this also had an impact on the stock level, but the Fuji factory itself was not so much impacted.

Interviewee: But he mentioned before, we have some shortage of the raw material or the packaging materials.

Interviewer: So the stock of three months, that is for raw materials and finished goods?

Interviewee: Finish goods is the stock level of three months

Interviewer: And for raw materials?

Interviewee: We did not increase the stock of raw materials.

Interviewer: How did the natural catastrophe change your perception of the degree and probability to which natural catastrophes can impact your business?

Interviewee: We think the impact is quite large and especially safety of the employee is top priority. We have duty to supply ethical drugs, so we have to continue to produce and supply for patients. For OTC drugs, we should avoid the risk of stock out because we have lots of competitors in Japan. Interviewer: Do you think that for your company, and especially that it is located in Japan where there are many earthquakes happen quiet frequently, is this something that now – with the very unfortunate earthquake of March 2011 – is the company more and more alert towards earthquakes?

Interviewee: Many Japanese companies are concerned about the BCP and we have the committee and also have a meeting with the government and also we are talking about the BCP with other members of the BCP committee and we are talking with them on how to take actions.

Interviewer: To what extent do you agree with the following statements?

Interviewee: We agree with the first one. (Recent natural catastrophes have changed my perception of the impact that they can have on supply chains)

Interviewer: And what about the probability?

Interviewee: What do you mean?

Interviewer: Like probability, frequency ...

Interviewer: The reason why I am asking is because many companies are aware that there is a very large impact of natural catastrophes, but we also wanted to ask about your perception of the probability, the rate of occurrence. If you look at the data form the United Nations, there is a trend that the number is increasing, not so much for earthquakes, but for other catastrophes such as floods, extreme weather or the like.

Interviewee: So you are asking about our perception change in terms of the likelihood and the frequency?

Interviewer: Yes

Interviewee: They are perceived ... exactly ... I mean ... umm ... the likelihood itself ... and maybe the frequency ... because there is so many possibility that Fuji-san may erupt and that there may be a big flood ... but they really became very serious about that a big natural catastrophe may be coming. But BCP itself exist before the March 11, but the perception itself drastically changed afterwards.

Interviewee: And the aspect is that there are so many suppliers of raw materials in Japan it is spread a lot. Some of them may have an impact from the natural disaster, even though the Fuji factory did not have an impact so they care about the possibility that they may have an impact from the natural catastrophe.

Interviewer: It makes it very complicated.

Interviewee: Because they have to care further ... a lot bigger area ... covering the suppliers, all the suppliers in Japan ... in terms of the natural catastrophe

Interviewee: Did I answer? ©

Interviewer: Yes, yes you did. Thank you! ©

Interviewer: What were the three main supply chain changes your company undertook as a result of previous natural catastrophes?

Interviewee: First one is that we ask suppliers to conduct risk management and also we are considering new suppliers to reduce the risk of supply. We started to consult new factory in Hamamatsu city, Shizuoka prefecture, as dispersion of risk. To avoid stock out, we increased the stock of our major products.

Interviewer: May I ask a question with regards to the new suppliers? Are these suppliers that are then chosen in different areas, or how did you choose these new suppliers?

Interviewee: I would mention that we do have to consider the location of the suppliers for a backup. But the suppliers are very limited in terms of the product and the materials that we are looking for. We see the suppliers form the view-point of the production for the raw materials compared with the location.

Interviewer: So the quality of the material is more important than the location?

Interviewee: Yes, so the capabilities are the most important.

Interviewee: This is because the number of the suppliers is limited, so we can not always choose the regions because for example there are two suppliers in the same region.

Interviewee: As you know, there are many, many volcanoes in Japan. The risk is very high.

Interviewee: We also look at how companies manage the risk.

Interviewer: And how far back do you look in their supply chain? Do you only look at the supplier or also further back into their suppliers?

Interviewee: We consider the origin of the material.

Interviewer: Of the raw material that is then used?

Interviewee: Yes. So we look at the raw material of the raw material ③

Interviewer: I think that this is very interesting as many of the companies do not do this. They only look at diversifying on the first tier, and not at the second tier, where as a matter of fact, the second tier may be the same supplier for the first tier. Therefore, the risk exposure does not change that much ...

Interviewee: But you know, our company is a worldwide company, with many subsidiaries over the world. This is one of our companies strengths. We have a network all over the world. Our purchasing section is looking for the raw materials all over the world. It is our strength.

Interviewer: What motivated your company to undertake these changes?

Interviewee: Financial affairs and our clients and customers. As financial affairs are production and sales.

Interviewer: To the best of your knowledge, were your key competitors undertaking any supply chain changes as a result of the natural catastrophes? If yes, what were the three main supply chain changes your competitors undertook as a result of previous natural catastrophes?

Interviewee: (Key competitors) Installation of in-house power generation. Our company intend to do the same.

Readjustment of amount of stock to avoid stock out. Consult or enhancement of our factory to be earthquake proof.

Interviewer: And did your company already have an in-house power generation before?

Interviewee: Before March 11?

Interviewer: Yes.

Interviewee: As I explained in the introduction of the site, there is a RnD section in this site. The RnD have four generators for the lab. IN the factory, there was no generator before. We intended to ... After March 11 we intended to have a power generator to protect the data and the production. So to have it as a back-up.

Interviewer: What have been the consequences of your company's and your competitors' supply chain changes for your company?

Interviewee: To improve social reliability of BCP. Preservation of stable supply and reliability for existing. Difficult to evaluate.

Interviewer: Do you think that because of the changes that your company undertook, do you think that you will enjoy a better reputation, or that this will increase the sales with the existing customers?

Interviewer: So maybe consequence is difficult to understand ... what is the outcome of the changes that you undertook? SO you said that you have new suppliers, or consulting to move part of the production. What is the outcome? Does this increase the reputation; do your existing customers say that your company is a reliable company? What is the bottom line so to speak?

Interviewee: But we are just doing some changes. We cannot evaluate the outcome ... now.

Interviewee: So the customers of our OTC products are drug chains and we are saying that we are trying to back-up or support them if they are impacted or damaged by the natural catastrophe. So that will sort of improve their relationship with the drug stores. So this is sort of part of the outcome.

Interviewer: Ok, thank you very much.

Interviewer: Based on the continued risk of impact from natural catastrophes, will your company undertake any supply chain changes in the future?

Interviewee: Yes we would!

Interviewer: What are the three main supply chain changes that your company would undertake in the future to be able to cope with natural catastrophes?

Interviewee: We are going to have complementary production for our major products to install facilities on existing facilities. Same as before. We are going to establish a system of stability supply for materials and products by BCP. Fulfilling the safety of employees, including the training of enhancement of the connect system for safety confirmation after the natural catastrophe.

Interviewer: So this means that you will have new facilities in Fuji or ...

Interviewee: A new facility in Hamamasu. But we have the Nagoya and the Mahoka factory besides Fuji. We investigate some equipment for each factory and cover the product areas of each other.

Interviewee: So maybe in the Fuji factory install the production machine for the product that we do not normally produce here but to be able to cover these for the urgent cases.

Interviewer: But these production facilities will then otherwise stand still in Fuji or will you also produce smaller amounts, smaller batches of the products that are normally produced in the other places?

Interviewee: So currently some of our lotion products are only produced in the Fuji factory, and in the future we will produce them both in Fuji and Hamamtsu for the sake of risk management.

Interviewer: And this is a consequence of March 2011?

Interviewee: At first our company had decided to build a new facility on this site here in Fuji, but the president decided to move the facility from Fuji to Hamastu after March 11 ...

Interviewer: to spread the risk more?

Interviewee: ... Yes, to spread the risk more, yes.

Interviewer: And this will be done for all of the product groups within pharmaceuticals?

Interviewee: No, not for all. Just for some. The important ones. It is very difficult to cover all of the products.

Interviewer: ... and probably also very expensive?

Interviewee: ...

Interviewer: May I ask, what it is you mean with the second point: "We are going to establish a system of stability supply for materials and products by BCP"?

Interviewee: We have to consider the purchasing of the supplier of materials and purchasing materials. We have to build and establish a system of stability supply.

Interviewer: So this means engaging with your suppliers?

Interviewee: Yes. It includes to see the second supplier and the stock of the products for the catastrophe, like we mentioned before.

Interviewer: Ok.

Interviewee: The third one is to prepare the safety of the employees including of training of enhancement of the safety connect system for the situation of a catastrophe.

Interviewer: May I briefly ask what it is that you mean with the connect system?

Interviewee: We have a network system about the employee safety. If we have some accident by an

earthquake and we cannot go to the company we have a connection system.

Interviewer: Ah, so through the telephone?

Interviewee: We have a safety training periodically, periodically. Like a sort of a simulation test.

Interviewer: What motivates your company to undertake these changes in the future?

Interviewee: It is the same as before, so financial affairs and our client and customer. So this is everything form our side.

Interviewer: Thank you very much.

Interviewee: One of the strengths that we have in Japan is that we operate through a direct sales system. Normally, there is a wholesale sales system, but in our case it is a direct sales to the drugstores. It is one of the strengths that we have.

For example, if you have a wholesaler then you can not provide the finished goods to the end, to the customer because you do not have control. But right now we have a direct control to the drug stores so we can do something measures to secure the supply to the drugstore. This is a really good point for now. Already established before March 2011, but it is a strength of our system that we changed form a wholesaler to being direct sales. Also, we have various divisions, so we are very diversified in terms of the business. This is why sometimes the supply chain is cut somewhere to the places where the earthquake was hit, but we can, we have some other businesses that we can, that sort of support the transport of the goods to the final location. So that is another strength. If we have only the pharmaceutical division, then we would end up doing nothing, but we have another division that sort of help us to transport to supply the good to the drugstores where the earthquake was hit.

Interviewer: Do you think that the direct sales system was also implemented with the thought in mind that there could be a supply chain disruption or was there a different motivation to implement this?

Interviewee: Originally we aimed at decreasing the inventory of the supply chain, and also trying to avoid the goods from returning, but, a sub-outcome was the risk management.

Interviewer: That is very interesting. Thank you very much.

Interviewee: Do you have any other questions?

Interviewer: No, I think we went through all of the points very well. And I am very happy that you

gave me very straightforward and clear answers. And it gave me a very good idea of your company and I want to thank you very much for the time that you have taken.

15.5.5. Case Company E

Industry: Wholesaler

Level of employment of interviewee: Head of Supply Chain

The interview was conducted via skype

INTERVIEWEE: I have been contacted already at the beginning year to speak about this topic and have consequently already thought about this topic. Hence, you are sort of running into an open door!

INTERVIEWER: So, I have a bit of an idea of your company from what I can find online, but it would be great if you could tell me more about your company, especially from a supply chain perspective, and also about what your role is in the company.

INTERVIEWEE: We are company, that if you look at the supply chain element, in the first place is concerned about creating value in terms of creating clothing. This means, that we work together with textile producing companies. We provide materials to these textile-producing companies, which means that we have an own raw material purchasing department. This raw material is then sent to an inventory at the respective textile producing companies and these then produce the textile and then this goes back to our inventory system, which we have in our different locations. We have locations all across the world; and I am going to tell you a bit more about that now. And in these different international locations our respective subsidiaries have inventories. And the textile producing companies then directly supplies these inventory locations. We have a strong focus on Germany and this is also where our headquarter is located. This is also were we have a German subsidiary and we have further subsidiaries in France, England, Asia-Pacific - so Australia and Hong-Kong – and from these subsidiaries we have split up the world into different regions. So for example England delivers the entire Arabic area, the Germans deliver the entire African area. So even though we do not have our own subsidiary or inventory in this area, it is always an own national subsidiary that is responsible to deliver to this market through their inventory. Supply chain within the context of our company refers to everything that includes procurement/ sourcing, production and distribution, and of course maintain the inventory. So this is also my responsibility

within the entire group. So in terms of the clothing, we produce all types of uniforms and other types of clothes that people wear to work, and we have a very strong focus within the area of PPE, personal protective equipment, which means that it is clothing that underlies a certain requirement that also has to be certified. There is a certificate and the clothing needs to adhere to this certificate. And I am responsible for the entire function of supply chain management and this is for the entire group, worldwide.

INTERVIEWER: So, you have already provided a nice transition in to the next question of mine. I wanted to ask you from where you source the majority of your resources?

INTERVIEWEE: Yes, so we get the majority of our raw materials from the European area, and that also applies for our textile services, such as the textile production. So, Europe is the main area for us but we also get smaller amount from the USA and also smaller amount from Asia and we also produce smaller amounts in Asia and in the USA.

INTERVIEWER: And the majority of the production is also in Europe?

INTERVIEWEE: Yes, the majority of the production is in Europe.

INTERVIEWER: And in Europe, is it in East-Europe?

INTERVIEWEE: Yes, the majority is in East-Europe.

INTERVIEWER: And like you said, the sales is world-wide?

INTERVIEWEE: Yes, exactly.

INTERVIEWER: And the majority of your sales is where?

INTERVIEWEE: It is difficult to say. I would say that it is well spread (sales). We have relatively big tenders, so the this is a tender business and these tenders have relatively large volumes. So if for example the city of Hong Kong has a tender for a fire-fighting clothes than this is a large volume. So, it always depends on the tenders. So there is no focus, I would say that it is distributed very well.

INTERVIEWER: And to what extent would you say that you are dependent of your main suppliers? Is there a large dependency?

INTERVIEWEE: Yes! Absolutely! SO, you have to understand that in our area that what concerns the raw materials as well as the production of the textiles we are forced to go into business with monopolistic relationships. It is exactly pre-determined what types of materials we have to use, what types of clothes we have to produce and we have to do this according to an exact structuring of the textiles and we can also only use these certain types of suppliers, with certain types of materials or colors that only come from one certain type of supplier. So we do not have any possibility to have any types of substitutes. So, we are completely and utterly at the mercy of our suppliers and our textile producers.

INTERVIEWER: But if I understand it, then the dependency is not that large in terms of you key buyers?

INTERVIEWEE: So, with the buyer it depends. So, the buyer makes a tender and if I win this tender and get to supply our buyer, than the buyer does not have any possibility to replace us. So the buyer is exactly as dependent on me as I am on him if I have one a tender in the first place.

INTERVIEWER: So lets start with one of the questions that is directly related to the topic that we are talking about today. Within the area of supply chain is there a risk assessment of natural catastrophes?

INTERVIEWEE: Not in a structured way. We have risk assessment but this is more concerned about the ability of customer and suppliers to pay. But it does not have anything to do with natural or man-made customers. So, not, in terms of extreme events there is no risk analysis that is being undertaken by us.

INTERVIEWER: OK, and in the past ten years, have you ever been impacted directly or indirectly by a natural catastrophe?

INTERVIEWEE: No. This has not yet happened to us.

INTERVIEWER: OK, this means there has never been an instance, even that is deeper within your supply chain, that has had an impact on you?

INTERVIEWEE: No. So the only thing that I can think of, and this is really super mini, mini, mini, minimal. We once had a supplier who made labels for us, and labels are a really small thing for us, burned down. Yes, this was a natural catastrophe, but this was maybe something that was 1000 or maybe 2000 Euro in damage that was caused. So this is nothing that we should consider here. SO there has not been anything where I would say that it had a serious impact on us.

INTERVIEWER: So, this is an interesting case for us to look at because you have not been hit by a

natural catastrophe. But I am assume that you read the news, watch TV and have a good understanding of what is happening in the world around us and have an idea of the impact that natural catastrophes have had on supply chains, also for example in 2011 with the catastrophe in New Zealand, in Japan or Thailand. So, I wanted to know how the occurrence of natural catastrophe has changed your perception of these?

INTERVIEWEE: Hmm ... so okay, it is difficult because we are of course profiting from catastrophes. SO for example fi there is a crisis in New Zealand, then our customer in New Zealand will of course order fire-fighting clothes from us. Of course we read the newspaper, we know the topics, we know the issues. And we are trying, to within a normal risk insurance, to set up our processes in such a way, that we are in the position to have a second alternative. So we are working in such a way that we are documenting our processes and insure them, that we are in the position that if a there is a bigger issues that we are able to exist or circumvent it. This is the case. It is like I told you before, due to our special position, the thing is this that our customers do not have a different possibility then our customers do not have a choice because they are in the position as me and I am in the same position as they are. So the customer does not have the possibility to go to someone else for their clothing. They will then have to wait until the factory is built up again or until I have certified another production place. So I am basically in the same boat as my customer. This is not nice for all of the participants but it is not possible to avoid this, which of course makes the entire thing a bit easier. For example, if I think about the consumption goods industry, there is of course much easier to replace the products. But this is not the case in our industry and in such a way we have a very special position.

INTERVIEWER: OK, so if I understand it correctly. The topic of being able to have a second supplier is something that you have had before and something that has not changed as a consequence of natural catastrophes?

INTERVIEWEE: No, we have always had this before. So we try to keep the possibility to have another possibility, especially with regards to the producers. With respect to our suppliers there is a pre-determined material, and one supplier in the entire world only produces this. And if this suppliers burns down then we have problem. However, there is no strategy in this world that will help me to circumvent this. In the case of the our producers we try to have more alternatives, and of course we at least to have a second one certified, so that we could accelerate a post-certification process, if this was necessary. However, this would also not minimize the risk, but would just give us more time.

INTERVIEWER: But have these being these that have always been the case for you or all these things that you have done out of a change in your perception?

INTERVIEWEE: No, these are things that we do out of a certain perception, but these are things that we do not do out of the topic of natural catastrophes or other extreme situations, but more form the topic of the textile industry, which is an extremely price sensitive industry, which means that we always try to produce there, where it is the cheapest. So out of this thought, we always try to get textile producers where the cheapest possibilities are occurring. SO, this is not concerned about the topic of being able to secure our supply chain but much more about being able to maintain a certain price.

INTERVIEWER: So if I would read out the following sentence to you, and please excuse that I am doing so in English: "Recent natural catastrophes have changed my perception of the impact that they can have on supply chains", then how would you agree with this?

INTERVIEWEE: More towards no. So, for me this is not a consequence out of natural catastrophes, but this is a normal consequence out of normal entrepreneurial decisions.

INTERVIEWER: How about if I say natural catastrophes are unlikely to happen and for this reason it does not make any sense to secure myself against it because of the money that will cost me. Would you agree to this?

INTERVIEWEE: No, I would not agree to this. I do think that there will be an increasing amount of natural catastrophes and I am also of the opinion that it is necessary to secure yourself against these, but due to the previously mentioned restrictions in our industry, it is basically impossible to do anything about this.

INTERVIEWER: So if we go away from the area of procurement or the production and we talk about your inventory keeping methods, would you see that there are ways to temporarily secure yourself, given that it is impossible to procure any longer?

INTERVIEWEE: The problem is that we purchase according to the orders that we get in. So if we have a big order then we also place a big order with our suppliers. But the problem is that I cannot just buy and keep an inventory of raw materials, because I will never know if I will get an order over exactly this type and quantity of raw material and this is especially the case because for each

order we have a specifically certified material that we use. So for example, we have eight different types of upper textiles, and each one of our customers want to have a different upper textile and of course a different color. So it does not make any sense if I buy 2000 meters of a certain type of textile in a certain color because the next customer may want to have something that is totally different textile and a totally different color. So yea, we do have a certain type of inventory, but it would not make any sense to split this up and this would simply be too expensive and with the volumes that we need this is also not possible at all. What we do currently do, is that with our suppliers we do try to have a certain security buffer and also this is only done for our AAA plus products. So this is not for those cases where we have 10.000 different types of raw materials and we are maybe talking about five of those materials where we have a bit of security stock.

INTERVIEWER: So this means if I understand it correctly, you are set up in such a way that is purchase and produce to order?

INTERVIEWEE: Yes, exactly.

INTERVIEWER: And so, like you just described before, there is no possibility to get away fro this?

INTERVIEWEE: Exactly

INTERVIEWER: Okay, well then we have already skipped quiet a lot of the other questions that I had.

INTERVIEWEE: Yes, it is really super difficult in our company. It is very out of the ordinary.

INTERVIEWER: But yes, you are not the only company in which is the case. Many companies say that yes we see are risk but of course it is difficult for us to do anything about it and moreover it is also expensive to do something about it and of course it is very expensive.

INTERVIEWEE: Yes, exactly that is the way it is.

INTERVIEWER: But none the less. If I understood it correctly at the beginning of the interview. You are still thinking about this topic?

INTERVIEWEE: Yes of course. We are thinking about this and we are trying to think in alternatives. And especially for the main topics, we are tying to consider if we can have some sort of a secondary strategy but of course this is very much limited. And of course for the topic of material we are absolutely subject to our suppliers and everything else is only possibly in a very limited way, such as with distribution or being able to keep an inventory – this would work

possibly. But like I said before, the main problem in our case is the suppliers that deliver our raw materials that we can only get from one source.

INTERVIEWER: And in those areas where you say that there are possibilities, what kinds of thoughts are you having?

INTERVIEWEE: We are thinking about this from an order based perspective. So if we get a big order then we are trying to think about being able to secure the production or our distribution and are thinking about a secondary strategy that if something that does not work with the capacity, and of course this could also be because of a natural catastrophe yet the main think is about a strike or there are no employees but the normal situation is not a natural catastrophe but something else that happens within the company such a as breakdown of the machines. Then this is one of the topics of which other producers would work for us and how can we in a quickly manner move our production there? We do this for big projects. Risk mitigation is maybe a bit too much to term for this but it does go into this area. We do think about what type of risks exist and we do think how high the probability is that these will occur and how probable is it and then we think about measures that we could take to circumvent this. And this is also something that we control on a regular basis during the project. SO these identified risks will also be incorporated and discussed in the regular project meetings and they will also be updated and re-validated.

INTERVIEWER: But like you said, this does not necessarily have anything to do with natural catastrophes but is more related to risk in general?

INTERVIEWEE: Yes, exactly. This is related to all the possible risks that have to do with this project.

INTERVIEWER: So if we would take a view into the future and we maintain on the topic of natural catastrophes, are there any things where you would say that you are at least going to try to change them, or is everything you going to stay the way it is?

INTERVIEWEE: Well, it is not really in our hands. Our business is driven by tenders and very much focused on the customers. So the only way that we can deal with it is if everyone would focus on standardization and everyone would buy the same product. But this is never going to happen. Our customers are too independent and the national authorities are too different and too focused on their special requests and I cannot imagine that there is going to be any form of standardization. I would be very surprised if this would become the case. The only thing that would help us if there would be some sort of a standardization that would then allow us to purchase a large part of the

materials under a consideration of the risk and would then build up inventories in some areas and would then also produce to stock. But of course, this would require a certain type of standardization of our products.

INTERVIEWER: So now that we have talked about national authorities. As I would imagine, these of course have a certain type of power in certain markets. Do they not come along and say come and show us your supply chain and show us what you are doing in the area of risk management? Is this not a topic for them?

INTERVIEWEE: Yes, it is a topic for them. However, they also know that the topic of a natural catastrophe is very low in its probability. SO, we also need to consider that these national authorities are also the ones who will often deal with these extreme events that we are talking about here so these are the ones that are also thinking about how we can set ourselves up to deal with such an event. And so they do not shove these types of thoughts to their suppliers but they try to design their activities to be able to deal with such a situation. But there are no strategies where they try to secure there distribution roots. SO what we could think about, and this is of course a very unlikely scenario, that if for example the Bundeswehr is taking part in some sort of flooding activities that you support us with some sort of mobile inventory where we are able to change our clothes. These type of things do not exist because they do not think about these types of things. National authorities try to solve these types of situations because they have very high inventories and then take care of supplying the troops from their own inventories.

INTERVIEWER: So if you would put it this way, they do their own risk management?

INTERVIEWEE: Yes. And the international customers that do these types of risk assessments they go more into the are of procurement risk in terms of trying to figure out things such as how high the probability is that the cotton price will increase in the coming years and how high the volatile is of the different types of strings that we use. So this is going more into this type of a direction and less into natural catastrophes.

INTERVIEWER: If we think about your competitors, do they also buy from the same suppliers as you do?

INTERVIEWEE: Yes, yes, of course.

INTERVIEWER: SO this means, that if one your suppliers is hit for example by a natural

catastrophe then this will not influence you, but also your competitors?

INTERVIEWEE: Yes, yes, that is the way that it is. So the materials are pre-determined. So it is exactly pre-determined which textiles from which producers are allowed to be used and everyone has to buy there and everyone gets the same price and the same conditions so if something happens then everyone has the same problem.

INTERVIEWER: So, these suppliers you said they are in East-Europe, so this is Hungary, or where are they?

INTERVIEWEE: No, so it is in Europe, not only in East-Europe but also Middle-Europe such as France.

INTERVIEWER: And these companies, do they only produce in one place?

INTERVIEWEE: Yes.

INTERVIEWER: And your group also has no power over them to change anything?

INTERVIEWEE: No, for that our products are too special and the volume is too small and this is not worth it for them.

INTERVIEWER: I think it is interesting to observe these power differences. So if I understand it correctly that is something would happen to these companies, then this would have an impact on the entire industry?

INTERVIEWEE: Ya, well definitely. Yes, this is the way it is. So for example if there is an issue with a supply then the entire industry would not be supplied with this material. So you have an extreme power in this industry.

INTERVIEWER: Yes, it is an interesting industry and I hope that there will never be a serious impact on your industry and on your suppliers because this would definitely be a very difficult situation.

INTERVIEWEE: Yes, definitely it would be.

INTERVIEWER: So this is the end of the interview. I wanted to ask if you have any other comments or comments to this topic.

INTERVIEWEE: No, I think we talked about everything but if you have questions then please ask me. No problem.

INTERVIEWER: Thank you.

INTERVIEWEE: Thank you too and have a nice.

INTERVIEWER: Thank you. The same to you.

15.5.6. Case Company F

Industry: Textiles

Level of employment of interviewee: CEO

The interview was conducted via skype

INTERVIEWER: In which regions do you source more than 20% of your products?

INTERVIEWEE: If we talk about the sourcing of our raw material, then I must say that we source the majority from Central Europe: Italian, Germany, Austria. If we are talking about the sourcing of the finished products, then I must say that we produce quiet a lot in Austria, and we have a second big production in Bulgaria. But the majority is in Austria.

INTERVIEWER: And if I understand it correctly from your website, there is also a production in Germany?

INTERVIEWEE: No, that is just for the sales.

INTERVIEWEE: The second question I do not understand. What do you mean with the extent to which you depend?

INTERVIEWER: I am talking about the dependency that you have towards your main suppliers?

INTERVIEWEE: To the extent?

INTERVIEWER: Yes.

INTERVIEWEE: As a responsible company we have the a second source for the most important materials in the equal sizes. We are not really dependent of any of them. There are maybe one or two that we are dependent upon. But we are usually set up dually so we have nearly all of the materials two times.

INTERVIEWER: And on the sales side, is there also a strong dependency on the buyers. I am not sure, is it set up through wholesalers?

INTERVIEWEE: Yes, of course. We have key accounts that have a wholesale structure behind them. But again, we have different types of customers and we are not dependent on of them. Of course, there it is a big deal if one of the customers is bankrupt and if they exit the business is some sort of way, but in the size of our business this tends to be a small thing that would not affect us. So we are talking about 1000 customers that we have.

INTERVIEWEE: If we are doing risk assessment ...

INTERVIEWER: So if you are doing any risk assessment within your supply chain?

INTERVIEWEE: No, we do not do that (referring to risk assessment). Like I said, the risk assessment is done in such a way that we say a business can not only go under because of a catastrophe but because of the entire business and financial situation. And with that, I have already given the question away, we always have a second supplier or for some of the most important products a third supplier that can help us if something is really an issue. I of course have not built up this topic over the issue of natural catastrophes but I think that it is the responsibility of every responsible company that you are able to secure the most important supply chains in a double manner.

INTERVIEWEE: Natural catastrophes ... in the past ten years ... no, we have not been affected by any natural catastrophes ... luckily ... and also not even indirectly through a supplier and not even any other way

INTERVIEWER: So there has never been any disruption of your supply chain due to a natural catastrophe?

INTERVIEWEE: No, not really.

INTERVIEWER: OK.

INTERVIEWEE: How was your company impacted? Not at all ... because nothing happened. And the consequences are also not present ... no I am sorry, I do not have any answers there for you ... I hope that we are on the way in a very protected manner ...

INTERVIEWER: OK, but in any case. If we are speaking about the topic of perception. So if I give the example of Thailand 2011, or Japan 2011, did you perception change or the perception of the potential that such an event could have on you, did this change in any sort of way?

INTERVIEWEE: No, not at all. Because, we are fully ... due to the fact that we are an European

company and this not only from the sales but also form the production side. So from this we are very focused on Europe and things that happen in Asia and in Japan are things that are so far away for us that have never impacted us and where we have always tried to not focus on these regions. SO like I said, there are scenarios that concern our business and these are to 99% business issues such as things such as suppliers go bankrupt or something like that and it is not so much focused on if they go down because of an earthquake or something like that. And also on the production side we are set up in a very broad manner where we have six or seven partner production sites in Bulgaria and if something would happen there that concerns the nature then this would happen in one region and not over the entire of Bulgaria and if it hits the entire of Bulgaria then of course it is an issue.

INTERVIEWER: OK, I understand ...

INTERVIEWEE: ... So in this respect we do not have a scenarios. So I do not have any papers that say if the world goes down in Indonesia then we need to move our production elsewhere.

INTERVIEWER: OK ... and then logically speaking if this topic is not of concern for you, then I would assume that you have also not taken any consequences and have not change anything out of it?

INTERVIEWEE: No, not really.

INTERVIEWER: But how about in the future, are there any things that you would change, with natural catastrophes? respect to INTERVIEWEE: No, because we are of the opinion that our production and purchasing strategy is actually set up in a very good manner. And due to the fact that we are set up in a very diverse way, and have not focused our business at one point, I do not see any necessity to change anything. There are of course scenarios of the most important machines in the production that we have some sort of exist strategies and have emergency plans to see what happens if the machine breaks down, but these are things that are requested by the company and of course also by the insurers that every registered and legal entrepreneur in Europe has to follow. These however have nothing to do with anything in the environment, such as natural catastrophes. And I must also say that when I read your questionnaire that this did not ... I did not even have the "aha" effect such as "I should think about this too" ... I am just too far away from this topic ... I also think that in Central Europe in the region where we are there could of course .. and you always have to hit on wood ... that nothing will happen ... and it is not like in Italy in Friaul where you would have earthquakes and storms on

a regular basis and in the region where we are located this is basically non existent.

INTERVIEWER: OK, but there is one thing that I wanted to ask you. So I looked on your website and I saw some of the materials that you are using in your production and for one of them I know that they for example produce some of these products in Asia ...

INTERVIEWEE: ... ok but there is also a very strong tendency from our side ... that we only buy products for this company that are produced in Europe. We are very consequent in our small business that we have here. We are a European company and we basically do not work together with any Asian companies. We are very consequent with the choice of materials that we are using. I give you the right, together with the large supplier company that you talked about and with respect to supply chain we are only able to control the supply chain to such an extent that the supplier is giving us grant to control this supply chain. *But as of a certain point in time, there are responsibilities that go from one company to another and where you then do not have anything to say or to do.*

INTERVIEWER: OK ...

INTERVIEWEE: But you are right. Especially with this large supplier company that you are talking about, but they are sitting in the United Kingdom and our materials are often produced in the United Kingdom and on the other side I can assure you that in the small amount that we produce our products that this is maybe a 10 minute production for this large supplier company. And with this, the risk that we do not get supplied by them is more or less zero.

INTERVIEWER: OK ...

INTERVIEWEE: And on the other side, there are a lot of other supplier in terms of the materials that we could of course also use.

INTERVIEWER: But okay, I guess this has already taken us very nicely to the end of our interview. It was very interesting to hear your point of view.

INTERVIEWEE: But how does it work with the others? Everyone gets scared and realizes that they have to put themselves on to two legs?

INTERVIEWER: You said something very interesting at the beginning and you said that what I am doing with having at least two suppliers is a part of my normal way to secure my business and it is really the case that many of the companies that we have talked with thus far have focused very much on single sourcing of the past years, due to cost reasons that of course create a certain

monopolistic dependency on these suppliers. This was also the reason why we asked you about the dependencies at the beginning and if your dependencies are of course not that large, then there is of course very little reason to undertake much change in this direction because you are already set up in a very flexible manner right from the start. But there are of course many companies, and this also in your industry - whose names I am not allowed to say – but there are many companies that are focused very much on single sourcing and this also especially in the Asian are and these of course caused problems form the viewpoint of single sourcing and of course other aspects and of course they need to watch out about this now ...

INTERVIEWEE: But you also need to consider here that it is necessary to differentiate between producing companies and not sourcing companies and as a producer with more than 200 employees here in Central Europe, under the obligation by law, and also of course to have the right types of insurances, it automatically comes to the case that ... for example we have a business interruption insurance, and if a business interruption insurance is signed, then the agent of this insurance or the insurance company is concerned about checking and controlling and verify and audit if there are actions in place if for example a machine breaks down then you have alternatives to replace this. So the insurance basically pays the interruption, so for example if the machine breaks down due to a fire then we must have alternatives for this otherwise the insurance would not work. So in our case the pressure comes form somewhere totally different. This has nothing to do with the natural catastrophes but much more based on the insurance and the legal regulations in our country. As such, it is a much different world because we are producing in our country. So if I go to Asia today and I say I am going to buy 100 products, then as a purchaser I can bring forth these topics, but I am not always the driver but the secondary driver that at the end of the day has to accept what the main driver is doing. And this is why there is a different view of things and as a producer, and especially if you are in Central Europe, then you have a different requirements to fulfill then if something like this would happen in Asia.

INTERVIEWER: But of course there are also many companies that are of course also able to sue these types of catastrophes as a way to market themselves because they handled them very well.

INTERVIEWEE: And this is also our intention as a Central European country to react very quickly to these types of things. So we are very near to the customer, we do not need any three weeks to drive around with the ship, but we have the possibility to properly judge the current weather situations and we also have the possibility to very quickly produce more if needed, and from this

perspective, these are the assets that we have with a production site in Central Europe.

INTERVIEWER: That is true ...

INTERVIEWEE: This is a totally different topic then what you have in your questionnaire, but just so you understand why I am not really able to answer to them ...

INTERVIEWER: No, this is clear and this is still good because it provides us with a different view, which is very important and I was happy to receive it because I have thus hoped to receive these types of answers from you so that we could take a different view of the issue.

INTERVIEWEE: Okay super!

INTERVIEWER: Yes, super. Fantastic!

INTERVIEWER: Well then I would like to thank you for the interview and want to wish you a wonderful day!

INTERVIEWEE: Thank you, the same to you!

15.5.7. Case Company G

Industry: Biotechnology

Level of employment of interviewee: Senior director of supply chain management and global planning

The interview was conducted via skype

Interviewer: In which regions do you (a) source (b) produce (c) sell more than 20% of your resources?

Interviewee: Our company uses commodities as our raw materials, which can be sourced from many suppliers and from many places around the world. Therefore, raw material sourcing does not play a very critical role in terms of the risk that it poses for our company. The only thing that could pose a risk in terms of the raw materials is that we would then have to buy the raw materials on the commodity market and that this way the price might be a problem. Other than that, the sourcing of raw materials is not an issue. The only raw material that may be an issue, in terms of the dependency, is getting Glycerol from Singapore, as this is one of the main suppliers in the world. Hence, this could pose a problem. Other inputs may be more of an issue, but in terms of the

immediate sourcing, the raw materials are not so much of an issue. In terms of the raw material, it also does not really matter that much if we buy raw materials from other sources as we normally do, as this would not severely impact the final product. For example, in some of our products this would maybe cause the final product of the end-customer not to be as white etc. as it may normally be the case but this is not assumed to make a severe difference to the customer, at least so it is assumed. Furthermore, if our company is experiencing an issue with the supply then probably so are some of the competitors.

Interviewer: To what extent do you depend on your (a) key suppliers and (b) key buyers?

Interviewee: We do not really depend very much on our key suppliers in raw materials. For other inputs this may be a bit different, but for raw materials this is generally not so high.

Interviewer: Does your company assess catastrophic risk in relation to your supply chain? If yes, how?

Interviewee: Yes, we do assess catastrophic risks but this is definitely not one of our strengths but more of a weakness. This is something that we should focus more on. However, we do assess the risks of our decisions in the supply chain. Yet, there are of course a lot of vulnerabilities that we have seen when assessing our supply chain. For example, if something were to happen in one of our plants in China, then this could have a severe impact and could stop our production for three months, or more as we do not have an alternative to this. It is similar for some of our other production sites that may be extremely exposed to risk. This is similar with some of the other plants around the world. For example, if we were to have an electricity shortage in one of our plants in Demark then this could have a very large impact as this may cause the product to deteriorate very quickly. However, with all of these risks that we have identified (and be they because of political or natural catastrophes etc.) they are very, very, very unlikely to happy and that therefore they are not considered enough. Furthermore, if we were to overcome some of these risks with some form of insurance then this would costs us 100 of millions (by e.g. building a new plant or the like) and this would simply not pay off. If however something would happen, then this would severely impact them.

Interviewer: In the past ten years, has your company ever been impacted directly or indirectly by a natural catastrophe?

Interviewee: Japan, earthquake in March 2011. However, there is only research and development in Japan and luckily the radiation did not impact the research and development activities.

USA 1, flooding. This impacted the delivery of machinery and the possible operation of the plant.

USA 2, lighting directly on the plant

Interviewer: How was your company impacted by these natural catastrophes?

Interviewee: In Japan

USA 1. In the United States we were building a new facility that was close to the Missouri river. Some of the production parts for the plant were being delivered from China and due to the fact that the river was so flooded and the ports were not accessible it was difficult to deliver some of the parts to the plant. Furthermore, we were also scared that plant would be flooded. This is why we built some reinforcements around the plant that were enough to keep back the 05. Meters of water. This flood that occurred on the river was the highest in 100 years. Due to the fact that we were so quick to receive the warnings of the flood, we were able to build the reinforcements and also ensure that we would be able to produce in our other plant in the USA. One of the very good things about our company in this case is that we are extremely fast to respond to such events and especially to this one as it is easy to get quick information about the flooding. As such, we also re-routed some of the products to another plant in order to keep it safe but this is of course also quiet difficult to do.

USA 2, lighting. This stopped the production for some hours.

Interviewer: What were the consequences of the natural catastrophe for your company?

Japan, was actually able to improve their position in the market and it may have been the same case for some of the suppliers.

USA 1, no severe consequences as nothing happened in the end.

USA 2, no severe consequences.

Interviewer: How did the natural catastrophe change your perception of the degree and probability to which natural catastrophes can impact your business?

In the company the perception has not changed. In general, we see these risks as having a very very very small probability and that the organization is so flexible that is it highly unlikely that it will severely impact us. In many cases it would be an extremely costly intervention (for example if we

had to build a new factory or the like) and therefore we have not undertaken many changes. In general, the company has not been hit severely enough or had too severe consequences and therefore this is not seen as a thing that is of particular danger and the events that have struck our company before have not changed their position. However, I am not happy about this and said that it is unfortunate that this is not receiving more priority in the company and it is an important topic. Basically, we realize that there is a risk and that in some cases the impact could be really high as mentioned before but we think that this risk to impact us is so little and that the cost of doing something about it is so high that we do not really do anything about it. Overall, our perception did not change. But I think that more should be done within the company and that someone should be assigned with this task to focus more on this type of stuff.

Interviewer: To what extent do you agree with the following statements?

Interviewee: Recent natural catastrophes have changed my perception of the impact that they can have on supply chains

Interviewee: No, it has not.

Interviewee: Recent natural catastrophes have changed my perception of the likelihood that they can affect supply chains

Interviewee: No, it has not

Interviewee: Natural catastrophes are unlikely to happen. I doubt that the invested time/money to assess and manage this risk will pay off

Interviewee: I agree with this statement.

Interviewer: What were the three main supply chain changes your company undertook as a result of previous natural catastrophes?

Interviewee: We did not undertake any severe changes as a consequence of the aforementioned natural catastrophes. We only had some very minor things that are not noteworthy to mention.

With regards to the example of the flooding of the Missouri river in the United States this was a flood that would occur every 100 years and that in this case the flood did not even go to the factory and the factory now has a protection around it that would cater for a flooding height of one meter and that last time the river only reached a height of half a meter and that therefore the probability that something would happen is so low that we have not really undertaken any changes. The only

things that we have is a plan on how to go about it should something like this happen again. But this seems to apply in general is that we have a plan on what to do. In Japan we also did not undertake any changes.

Interviewer: What motivated your company to undertake these changes?

Interviewee: Internally, we did not see that it was necessary to make any large changes in the planning team and our company in general. The customers also did not put much pressure on to it, only very few of them.

Interviewer: To the best of your knowledge, were your key competitors undertaking any supply chain changes as a result of the natural catastrophe?

Interviewee: Not sure if they were impacted and consequently I am not sure of any changes that were undertaken.

Interviewer: If yes, what were the three main supply chain changes your competitors undertook as a result of previous natural catastrophes?

What have been the consequences of your company's and your competitors' supply chain changes for your company?

Interviewee: No changes, no consequences.

Interviewer: Based on the continued risk of impact from natural catastrophes, will your company undertake any supply chain changes in the future?

Interviewee: Not anything severe. However one of the things that we are trying to focus more on though, and this may not necessarily be linked to natural catastrophes in general, but to risk management overall, is to try and ensure that we can produce their products in a multitude of different places to spread the risk a little bit in this way and so that we could quickly shift some of their production to other places if need be. Of course this is also very costly so it is only happening to some extent. Difficult to say if this attributes to the natural catastrophes in general. It also attributes for example to China were there is a lot of political risk and we need to know that we are able to maintain their intellectual property rights there etc.

Interviewer: What are the three main supply chain changes your company will undertake in the future to be able to cope with natural catastrophes?

Interviewee: Apart from the above, I would like to have more focus on risk management activities especially in site location decision making which is one of the things that his team is in charge of. Of course we consider some risks today when we evaluate the site locations but still it should have more of a focus especially because this is not necessarily his area of expertise and that we need to have someone to check this out. But this is just his opinion and not necessarily that of all the others.

Interviewer: What motivates your company to undertake these supply chain changes in the future?

Interviewee: Most of the motivation comes from within and from the supply chain planning team. I want to do more on this topic, but in general in our company it is not receiving enough attention. Only very few customers want to have and risk management in place.

15.5.8. Case Company H

Industry: Wholesaler

Level of employment of interviewee: Head of purchasing

The interview was conducted via skype

INTERVIEWER: I had a chance to look a bit into the activities of your company online, however I have not been able to find that much about your supply chain. Could you maybe tell me a bit about your supply chain and purchasing?

INTERVIEWEE: We have a purchasing volume of approximately 70 million Euros. and Of this, approximately 15% come from the Asian area. The rest of this is Germany and Europe. This means that our risk source is the way between Europe and Asia. We do not have any contacts to the USA. So we do not have any products we have buy there. Nor do we have any contacts to Black Africa or any of these types of countries. So like I said Europe and Asia are the main sources. And in Asia it is in many different countries. So you can say that it is approximately 13 million Euros that comes from the Asian area.

INTERVIEWER: And so if I understand it correctly, you are in charge of the entire division of purchasing?

INTERVIEWEE: I am responsible for the entire purchasing department and I have two colleagues who are responsible for the entire purchasing within Asia.
INTERVIEWER: I wanted to ask, from which geographical areas you source the majority of your products?

INTERVIEWEE: So, like I said before it is approximately 85% that we get from German and Europe and approximately 15% from the Asian area. Asia is then split up from Japan, to Taiwan, to Malaysia, to China, and partially to Vietnam. These are the four to five countries where the majority of the products come from.

INTERVIEWER: But the sales take part to the majority in Germany, if I understood that correctly from your website?

INTERVIEWEE: Germany and Europe (sales). And we also have to make a small adjustment here, we also have a smaller subsidiary in China. However, this only makes up a very small part, so every single year it only makes up approximately 1 to 2 million Euros in revenue per year. It is a small plant.

INTERVIEWEE: So what happens, is that the products come here to Germany and then they get repackaged our put in to our company design and then in some cases it gets returned back to China.

INTERVIEWER: And to which degree would you say you are dependent of your key suppliers?

INTERVIEWEE: At the moment we are experiencing a higher risk within this area. I would say that in certain product areas we are 100% dependent. Not in all. But we have some product areas were we are 100% dependent. So, if the chain rips, then we have a problem. This is similar for some of our competitors who also have to buy from Asia because there is no more production that is taking place in Europe. This is also one of the main reasons why we buy a lot of the products exclusively in Asia but also our competitors.

INTERVIEWER: How about your key buyers, is it similar there?

INTERVIEWEE: Yes, it is also similar there.

INTERVIEWER: To what extent does assessment play a role within your company? Do you do things such as scenario planning or Monte-Carlo simulations, or do you talk about this topic a lot?

INTERVIEWEE: Yes, we have a lot of risk management within the mother company of our company. We have also spoken about this topic often with our executives but we are having troubles finding a solution because when you think about the fact that they only produce our goods in those areas then they we can only procure our goods from those areas. Because if there were

availabilities to buy these products in Europe or Germany then we may also consider that but if no one is willing to produce these products here, well then we cannot do much about it. So we clearly have a risk. But we also see it in that way that all of our competitors have the same issue.

INTERVIEWER: In the past ten years, has there been an incident when you have been impacted by a natural catastrophe, either in a direct or indirect manner?

INTERVIEWEE: Yes, one time. That was the catastrophe in Japan in March 2011 where we purchase certain types of screws from a producer in Japan. However, we are not 100% dependent on this supplier and we can also get these screws from Germany. The thing is that the Japanese producer had problems with their electricity supply caused by the natural catastrophe and could not maintain the production. And of course, some of the ports could not be approached anymore in Japan. However, this did not have such a big impact on our company because we could also buy the same products from Europe. The only reason why I currently buy it in Asia is for price reasons.

INTERVIEWER: So if I understand it correctly, this did not have any negative consequences for you?

INTERVIEWEE: No, this did not have any negative consequences for our business, i.e. that we were not able to deliver.

INTERVIEWER: Nonetheless, how would you say that this occurrence of a natural catastrophe has impacted your perception of the degree and probability of natural catastrophes?

INTERVIEWEE: It has absolutely increased. And this is also the same with the corporate executives. And one is clearly focused on, with those products where we have certain revenue, and those where we have a certain dependency on a certain supplier, that we in those cases try to develop a second or third supplier for these products. So the sensitivity definitely has increased. And this is also what we are doing, so for the products with higher revenues we try to look for alternatives. Also, in those areas where we are 100% dependent. But we are having a hard time with this, because we simply can not find any production sites within Europe that can producer us these types of screws that we are looking for. But it definitely increased a lot in its sensitivity due to the incident in Japan.

INTERVIEWER: So if I understand it correctly, the perception has changed, but there has not been a severe change since then?

INTERVIEWEE: No, there has been a change and this is that we are currently trying to look for

second and third suppliers more intensely than we did before. There is definitely a strong perception change. Lets take it worse case, if we did not get any products anymore from Asia, so for example if there are no more ships that are coming in from Asia, then we can easily have 20 million less in revenue.

INTERVIEWER: But as you have said, it is difficult to find a solution

INTERVIEWEE: In some areas, yes

INTERVIEWER: So, as for example the case you have outlined with the screws from Japan you were lucky that you had suppliers from other areas?

INTERVIEWEE: So you have to know one thing, the products that we sell, so as you just gave the example of the screws, there are no more production sites in Germany or in Europe for our products. Everything has gone to Asia or the Far-East either because they have moved or because they have shut down due to the fact that they are not able to stay competitive. And the traders of course followed all of this ... this is a situation that we have all created together because no one wanted to buy anymore in Germany and wanted to move to Asia and so for the companies here it was not worth it anymore so they either closes, moved, or focused only on the production of very specialized screws or other product categories.

INTERVIEWER: So, out of interest and a bit off of the normal route of the interview guideline, how was the perception of natural catastrophes about 10 years ago within your industry? Was this a topic or was it only focused on being able to reduce the costs through going to Asia.

INTERVIEWEE: In our industry, much like the food industry, we have an enormous pressure. And we constantly need to get new markets and from a purchasing perspective we constantly have to get new products in to stay competitive due to the fact that you are not able to have price increases on the market. So there is an enormous pressure to have to buy cheaper and cheaper and then you have to get to new markets. So back in 1997 I went to Taiwan and we had all of our production in Taiwan. And at the beginning of 2000 I was in China and then these were cheaper and the Taiwanese had been too expensive already. And then now everything is going to Malaysia, and before that it was the Philippines, and now everything is in Vietnam. So now at the moment Vietnam is the cheap producing country. So it is s bit schizophrenic, Taiwan was too expensive at one point.

INTERVIEWER: But would you say that over the past years - and this from the perspective of your

industry – the risk perception also increased or is this something that only came after 2011?

INTERVIEWEE: No, not really. I mean, we are always on the search for new markets and the main focus is always on getting the same product but cheaper. And you know, I can also understand this. When you think about what some things for example cost at a supermarket discounter, and I know approximately how much a freight transport cost – because that is always the same for everyone – then they must be able to produce so cheap.

INTERVIEWER: So, to get back to the year 2011 and the impact that situation in Japan had on you, like you said, this has changed your perception.

INTERVIEWEE: Yes, it has increased our perception. I mean, we knew that we had a risk. But, we have been asked by our corporate executives to continue an increased search for alternatives.

INTERVIEWER: This search for new alternatives has been the biggest change that you have undertaken since?

INTERVIEWEE: Yes. This has been very cleared ordered by our corporate executives with suppliers where we have a high dependency and for those that geographically that are located in unfavorable locations so to look for alternative suppliers in these areas.

INTERVIEWER: And to the best of your knowledge, I assume that there was also some problems in terms of those that procured form Japan?

INTERVIEWEE: Yes.

INTERVIEWER: And would you say that they have also changed something?

INTERVIEWEE: So I can only really talk from the company that owns our company. They had a similar problem and they have categorized all of their products into different risk groups. They did this in a very, very empirical way. And then based on the situation they have categorized where the risk is high etc.

INTERVIEWER: But at your company you did not approach it in such an empirical manner?

INTERVIEWEE: No, well we do not have the same mass of products. But we can do the same thing according to the suppliers that we. That is the way that we did it. So yes, we also went over the products and we determined if a certain product group or a certain supplier is a high risk category for us.

INTERVIEWER: And would you say that this search for more alternatives in terms of the supply, has their been a positive response form your customers or is this something that they did not care much for?

INTERVIEWEE: No this is something that they did not really perceive or care much about. So, our customer wants the screw and then that is it. So for the customer, it is something that they simply expect. So you can also see in this way that we as a company are away from the market if we are not able to move as fast as the rest in order to get to new sources for our supplies. So if we would continue to buy our products in Europe as opposed to doing so in Asia, then I could not sell any products anymore with the cost structure that I am confronted with. We would not have a chance to sell any of our products anymore.

INTERVIEWER: And if we would speak about the future, we see a lot of research showing that there is an increase in the impact and the frequency of natural catastrophes and that this has been the case for the past 20 years. In the future, would you say that there are going to be any changes within your company in order to be able to deal with such a risk?

INTERVIEWEE: So, like I said, we are definitely a lot more responsive and careful. So when we are trying to get new products from Asia, then we are going to try to consider the issue of risk. So we are going to consider the issue of their ability to deliver as well as issues in the supply chain. So, you have to see that this is a consideration that has never been around before, because before that it was always only focused on being able to buy the same produce in Asia but at a cheaper price so it is a new thing for us to be inclusive of these types of things in our decision making. So we are currently in some projects in Asia where we clearly have to ask ourselves, does this price benefit really weigh off the risk that we may be confronted with. So what we also have to say at this point, is that we are not only talking about the risks of natural catastrophes but also the risk of currencies – which are very high at the moment – so when the Euro is going to continue to lose in value then we are going to make our import more expensive and then all of sudden Europe gets more interesting again for us. And this is something that I cannot influence and of course the logistics from Asia is also getting more expensive. So there are a couple of risks that we are focusing on at the moment. So, if we are shifting something to Asia then we are definitely approaching it with a bit more due diligence than we did before.

INTERVIEWER: So that means that these risks are going to be taken into focus more in terms of finding new suppliers?

INTERVIEWEE: Yes, absolutely. So this is a behavior that has very strongly changed.

INTERVIEWER: So, I think that this has been the interview from my part. I wanted to ask if you have anymore remarks or questions for us?

INTERVIEWEE: So the only thing that I said towards the end, so this is maybe not part of you studies right now, but there are other risks that are a part of what we are considering at the moment. So there are a couple more risks that have come together over the past years that we can not lose out of focus and these are risks that we did not have in our focus maybe 5 or 10 years ago ... But I can say that from Asia, which is something that I have experienced since 1997, the quality has increased over the period and there are also many quality and checking institutes that are focused on this area. But many suppliers that export heavily from Asia have been focusing on this more and more to ensure that the European customers get the quality standard that they want to have. So this has significantly increased to what was the situation maybe 20 years ago. And this is also the way that they present themselves to us today.

INTERVIEWER: So if we go back to the topic of risk management. Do they also present themselves in such a way that they are a secure company?

INTERVIEWEE: Yes. And we also visit them and they show us their facilities and they also send us examples and probes of their work. So all of this is very professional and all the production sites all have a very high standard.

INTERVIEWER: And to what extent do you have a view on the supply of your suppliers? So that you are able to ...

INTERVIEWEE: None at all. So maybe they will tell us verbally that they for example buy their steel in China or something like that, and that I can believe or not. But I must say that we have also not talked about this yet, that for example we would like to see an invoice from their suppliers. But we also do not do this in Europe and we are only interested in the end product and according to this we do the product testing etc and then the supplier then has to deliver that product.

INTERVIEWER: So then basically your risk assessment is according to only the first tier supplier?

INTERVIEWEE: Yes.

INTERVIEWER: And then this is also not going to change in the future?

INTERVIEWEE: No, I do not think so. So you also have to see, I mean how big is my purchasing

power and you may have a bigger view of this. And we did not have such a big purchasing power that they can do this and with the smaller ones this is no the case. And a producer is not going to show us these things for the amount of screws that we buy. And like I said, they show us their production and all but not anything else.

INTERVIEWER: But if you had the power, then would you ask for it?

INTERVIEWEE: Yes, why not.

15.5.9. Interview Protocol



Researching the Impact that Natural Catastrophes have on Supply Chain Strategy Formulation

Background: Natural catastrophes, such as earthquakes, floods, storms etc. have been increasing in the past years; so has their impact on businesses. 2011 was exemplary as to the effect that they can have on corporations – especially on their supply chains. Research shows that their frequency of occurrence and overall impact is expected to increase going forward.

Purpose: The purpose of this interview is to identify you and your company's perception of the (direct or indirect) impact that natural catastrophes can have on your supply chain and how these might change the way that your company operates in the future.

Approach: The interview will take <u>approx. 30 – 45 minutes</u> to complete and is split into five consecutive sections:

- 1. Background information on you and your company
- 2. Any *impact* your company may have experienced due to a natural catastrophe
- 3. Your *perception* on the impact that natural catastrophes can have on your company
- 4. Any supply chain *changes* you have undertaken to cope with natural catastrophes and the consequences these have had for your company
- 5. Planned supply chain *changes* as a response to increasing occurrence of natural catastrophes

Confidentiality: We will treat your answers with the utmost degree of confidentiality. All responses will be made anonymous and used only for the sake of this research.

Reward for participation: As a gratitude for your participation, we would like to offer a copy of our key findings at the end of our research process in September.

Thank you very much for your participation!

Kind regards,

Elin Larsson & Max Jäger CEMS & Copenhagen Business School

About us: We are an international graduate business student research team from both Copenhagen Business School and the CEMS (Community of European Management Schools) program. We are currently conducting research regarding the impact of natural catastrophes on the conduct of business, especially supply chain strategy.

Background Information

- In which regions do you (a) **source** (b) **produce** (c) **sell** more than 20% of your resources?
- To what extent do you <u>depend</u> on your (a) <u>key suppliers and (b) key buyers?</u>
- Does your company assess catastrophic risk in relation to your supply chain? If yes, how?

Natural Catastrophe Impact

- In the past ten years, has your company ever been impacted directly or indirectly by a natural catastrophe?
- How was your <u>company</u> impacted by these natural catastrophes?
- What were the **consequences** of the natural catastrophe for **your company**?

Natural Catastrophe Perception Change

- How did the natural catastrophe change your perception of the <u>degree</u> and <u>probability</u> to which natural catastrophes can **impact** your business?
- To what extent do you agree with the following statements?
 - Recent natural catastrophes have changed my perception of the impact that they can have on supply chains
 - Recent natural catastrophes have changed my perception of the likelihood that they can affect supply chains
 - o Natural catastrophes are unlikely to happen. I doubt that the invested time/money to assess and

manage this risk will pay off

Past Natural Catastrophe Supply Chain Change

- What were the <u>three main supply chain changes your company</u> undertook as a result of previous natural catastrophes? (i.e. facilities, risk management, sourcing etc.)
- What **motivated** your company to undertake these changes? (i.e. financial, customers etc.)
- To the best of your knowledge, were your <u>key competitors undertaking any supply chain changes</u> as a result of the natural catastrophe? If yes, what were the <u>three main supply chain changes your</u> <u>competitors</u> undertook as a result of previous natural catastrophes?
- What have been the <u>consequences</u> of your company's and your competitors' <u>supply chain changes</u> for your company? (i.e. reputation, sales with existing customers, number of customers, profit etc.)

Future Natural Catastrophe Supply Chain Change

- Based on the continued risk of impact from natural catastrophes, will your company undertake any <u>supply</u> <u>chain changes in the future</u>?
- What are the <u>three main supply chain changes</u> your company will undertake in the future to be able to cope with natural catastrophes?
- What <u>motivates</u> your company to undertake these supply chain changes in the future?

15.6. Questionnaire

Researching the Impact that Natural Catastrophes have on Supply Chain Strategy Formulation

Background: Natural catastrophes (earthquakes, floods, drought, storms, epidemics) have been increasing in the past years; so has their impact on businesses. The year 2011 was an example of the effect that they can have on corporations – especially on their supply chains. Research shows that their frequency of occurrence and overall impact is expected to increase in the future.

Purpose: The purpose of this questionnaire is to identify you and your company's perception of the direct or indirect impact that natural catastrophes can have on your

supply chain and how these might change the way that your company operates in the future.

Approach: The questionnaire will take approximately 10 minutes to complete and is split five consecutive sections: into 1 Background information and on you your company 2. Any *impact* your company may have experienced as a result of a natural catastrophe 3. Your *perception* of the impact that natural catastrophes can have on your company 4. Any supply chain changes you have undertaken to cope with natural catastrophes and the consequences these have had for your company 5. Planned supply chain *changes* as a response to increasing occurence of natural catastrophes

If you have any further remarks or feedback at the end of the survey, we would be veryhappytoreceivethem.

Confidentiality: We will treat your answers with the utmost degree of confidentiality. All responses will be made anonymous and used only for the sake of this research.

Reward for participation: As a gratitude for your participation, we would like to offer a copy of our key findings at the end of our research process in September. Please let us know if you are interested, by providing your email address at the end of the questionnaire or by sending an email to maxjosef.jager@cemsmail.org.

Thank	you	very	much	for	your	participation!
Kind						regards,
Elin	L	arsson	&		Max	Jäger
CEMS	&		Copenhagen		Business	School

About us: We are an international graduate business student research team from both Copenhagen Business School and

the CEMS (Community of European Management Schools) program. We are currently conducting research regarding the impact of natural catastrophes on the conduct of business, especially supply chain strategy.

Section 1: Background Information on You and Your Company

What is your level of employment?

- (1) Deard member/ CEO / President
- (2) Uice president
- (3) Senior manager
- (4) **D** Middle manager
- (5) 🛛 Manager / Line manager / Project manager
- (6) Employee
- (7) Other, please specify _____

How many years of work experience do you have?

- (1) **D** None
- (2) **D** 0 to 5 years
- (3) G to 10 years
- (4) 11 to 25 years
- (5) 26 to 40 years
- (6) Above 40 years

Which division do you work in?

- (1) 🔲 Business Development & Strategy
- (2) Customer Service
- (3) Finance & Accounting

- (4) 🛛 Human Resources
- (5) Investor Relations & Communications
- (6) 🛛 Legal
- (8) 🛛 Research & Development
- (9) 🛛 Supply Chain / Operations / Sourcing
- (10) Other, please specify _____

In which industry does your company operate?

- (1) Aerospace/Defense
- (3) **D** Automotive
- (4) Chemicals
- (5) 🛛 Communications
- (6) Construction & Real Estate
- (7) 🛛 Consumer goods
- (8) 🛛 Education
- (9) 📮 Energy & natural resources
- (10)
 □ Financial services
- (11) Government
- (12) 🛛 Healthcare & Pharmaceuticals
- (13) 🛛 Insurance
- (14) IT & Technology
- (15) Logistics
- (16) 🛛 Manufacturing
- (17) 🛛 Nonprofit
- (19) 🛛 Retail
- (20) 🔲 Travel and tourism
- (21) 🛛 Wholesale
- (22) Dther, please specify _____

What is your company's country of origin?

What is the approximate annual <u>revenue</u> of your company, in US Dollars? (k = thousand USD; mn = million USD; bn = billion USD)

- (1) 3 \$499k or less
- (2) 🛛 \$ 500k to \$999k
- (3) 🛛 \$ 1mn to \$99mn
- (4) 📮 \$ 100mn to \$ 499mn
- (5) 🛛 \$ 500mn to \$ 999mn
- (6) 🛛 \$ 1bn to \$ 4.9bn
- (7) 🛛 \$ 5bn to \$ 9.9bn
- (8) 🛛 \$ 10bn or more

Section 1: Background Information on Your Company

In which regions do you <u>source</u> more than 20% of your resources? (Multiple choices are possible)

- (1) Uestern Europe
- (2) 🗖 Eastern Europe
- (3) 🛛 🔲 Northern America
- (4) 🛛 Gouthern America
- (5) 🛛 China
- (6) 🛛 South Asia (incl. India, Bangladesh)
- (7) 🛛 Asia Pacific (incl. Australia, Japan, Vietnam, Thailand)
- (8) Diddle-East
- (9) 🛛 Africa

In which regions do you <u>produce</u> more than 20% of your goods and services? (Multiple choices are possible)

(1) Uestern Europe

- (2) 📮 Eastern Europe
- (3) **D** Northern America
- (4) **General Southern America**
- (5) 🛛 China
- (6) 🛛 South Asia (incl. India, Bangladesh)
- (7) 🛛 Asia Pacific (incl. Australia, Japan, Vietnam, Thailand)
- (8) Diddle-East
- (9) 🛛 Africa

To which regions do you <u>sell</u> more than 20% of your goods and services? (Multiple choices are possible)

- (1) Ustern Europe
- (2) Eastern Europe
- (3) **D** Northern America
- (4) **D** Southern America
- (5) 🛛 China
- (6) 🛛 South Asia (incl. India, Bangladesh)
- (7) 🔲 Asia Pacific (incl. Australia, Japan, Vietnam, Thailand)
- (8) 🛛 Middle-East
- (9) 🛛 Africa

To what degree do you depend on your key suppliers?

- (1) Ury high
- (2) 🛛 High
- (3) 🛛 Medium
- (4) 🛛 Low
- (5) Ury low
- (6) 🛛 To no degree
- (7) Don't know

To what degree do you depend on your key customers?

(1) Ury high

- (2) 🛛 High
- (3) 🛛 🔲 Medium
- (4) 🛛 Low
- (5) Ury low
- (6) **D** To no degree
- (7) Don't know

Does your company <u>assess catastrophic risk</u> in relation to your supply chain? (Definition of *catastrophic risk*: rare events that bring huge consequences)

- (1) **U** Yes
- (2) 🛛 No

Section 1: Current Risk Assessment Methods

What is the <u>formal catastrophic risk assessment process employed</u> in your company?

(e.g. scenario planning, Monte Carlo simulation techniques, ERM, stress tests)

Section 2: Past Impact of Natural Catastrophes on Your Company

In the past <u>ten years</u>, has your company ever been <u>impacted directly or indirectly</u> by a natural catastrophe?

(natural catastrophe = "A natural process or phenomenon that may cause loss of life, injury or health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage" UNISDR, 2009:24)

(1) U Yes, please specify (year, location, type)

(2) 🛛 No

Section 2: Past Impact of Natural Catastrophes on Your Company

How was your <u>company impacted</u> by these natural catastrophes? (Multiple choices are possible)

- (1) Inbound logistics issues
- (2) **D** Production input missing
- (3) 🛛 Facility damage
- (4) Inventory damage
- (5) **D** Outbound logistics issues
- (6) Other, please specify _____
- (7) 🛛 No impact

How were your <u>suppliers impacted</u> by these natural catastrophes? (Multiple choices are possible)

- (1) Inbound logistics issues
- (2) Droduction input missing
- (3) 🛛 Facility damage
- (4) 🛛 Inventory damage
- (5) **D** Outbound logistics issues
- (6) Other, please specify _____

What were the <u>consequences</u> of the natural catastrophe for <u>your company</u> in terms of your ...

	Strongly	Increase	Maintain	Decreas	Strongly	Don't
	increase	d	ed the	ed	decreas	know
	d		same		ed	
reputation?	(1) 🗖	(2) 🗖	(3)	(4) 🗖	(5)	(6) 🗖
sales with existing	(1) 🗖	(2) 🗖	(3) 🗖	(4) 🗖	(5) 🗖	(6) 🗖
customers?						
number of customers?	(1)	(2) 🗖	(3)	(4)	(5) 🗖	(6) 🗖
profitability vis-à-vis key	(1) 🗖	(2) 🗖	(3) 🗖	(4)	(5)	(6) 🗖
competitors?						

Section 3: Perception on Natural Catastrophes Based on Recent Occurrences

To what extent do you <u>agree</u> with the following statements:

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Don't know
Recent natural	(1) 🗖	(2) 🗖	(3)	(4) 🗖	(5)	(6) 🗖
catastrophes have changed						
my perception of the impact						
that they can have on						
supply chains						
Recent natural	(1) 🗖	(2)	(3)	(4) 🗖	(5)	(6) 🗖
catastrophes have changed						
my perception of the						
likelihood that they can						

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Don't know
affect supply chains						
Natural catastrophes are	(1) 🗖	(2) 🗖	(3)	(4)	(5) 🗖	(6) 🗖
unlikely to happen. I doubt						
that the invested						
time/money to assess and						
manage this risk will pay off						

Section 3: Perception on Natural Catastrophes Based on the Effect on Your Company

To what extent do you \underline{agree} with the following statements:

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	Don't know
The natural catastrophe	(1)	(2) 🗖	(3)	(4) 🗖	(5)	(6) 🗖
changed my perception of						
the impact that they can						
have on our supply chain						
The natural catastrophe	(1)	(2) 🗖	(3)	(4)	(5) 🗖	(6) 🗖
changed my perception of						
the likelihood that they can						
impact our supply chain						
Natural catastrophes are	(1)	(2) 🗖	(3)	(4)	(5) 🗖	(6) 🗖
unlikely to happen. I doubt						
that the invested						
time/money to assess and						
manage this risk will pay off						

Section 4: Implemented Changes in Your Company's Supply Chain as a Result of Previous Natural Catastrophes

What were the <u>three main supply chain changes your company</u> undertook as a result of previous natural catastrophes? (please use the text box for further elaboration)

162	and of previous natural catastrophes? (please use the text box for further elaboration)
(1)	□ Facilities - Shift current facilities to areas/countries with lower natural catastrophe risk
(2)	Facilities - Stop setting-up facilities in areas/countries with high natural catastrophe risk
(3)	Sourcing - Increase the number of suppliers
(4)	Sourcing - Decrease sourcing from areas/countries with high natural catastrophe risk
(5)	Sourcing - Impose risk management practices on suppliers
(6)	Inventory - Increase raw material inventory
(7)	Inventory - Increase finished goods inventory
(8)	Communication – Improve supply chain communication
(9)	Risk Management – Increase focus on supply chain risk management
(10)	Risk Management – Increase focus on contingency planning
(11)	□ Other, please specify
(12)	No change

Section 4: Motivation for Supply Chain Changes

What <u>motivated</u> your company to undertake these changes? (Multiple choices are possible)

- (1) Internal motivation: Maintain or improve profitability
- (2) Internal motivation: Maintain or improve our sales with existing customers
- (3) Internal motivation: Maintain or improve number of customers

- (4) Internal motivation: Maintain or improve our reputation
- (5) External motivation: External stakeholders demanded it. If yes, kindly specify who:
- (6) External motivation: Competitors did it, then so did we
- (7) Other, please specify
- (8) 🛛 Don't know

To the best of your knowledge, were your <u>key competitors undertaking any supply</u> <u>chain changes</u> as a result of the natural catastrophe?

- (1) **U** Yes
- (2) 🛛 🗖 No

Section 4: Implemented Changes in Your Competitors's Supply Chain as a Result of Previous Natural Catastrophes

What were the <u>three main supply chain changes</u> your <u>key competitors</u> undertook as a result of the natural catastrophes? (please use the text box for further elaboration)

- (1) **D** Facilities Shift current facilities to areas/countries with lower natural catastrophe risk
- (2) Gracilities Stop setting-up facilities in areas/countries with high natural catastrophe risk
- (3) \Box Sourcing Increase the number of suppliers
- (4) Gourcing Decrease sourcing from areas/countries with high natural catastrophe risk
- (5) Sourcing Impose risk management practices on suppliers
- (6) Inventory Increase raw material inventory
- (7) Inventory Increase finished goods inventory
- (8) Communication Improve supply chain communication ____
- (9) Risk Management Increase focus on supply chain risk management

- (10) Risk Management Increase focus on contingency planning
- (11) Other, please specify _____
- (12) 🛛 Don't know

Section 4: Impact of Supply Chain Changes on Your Company

What have been the <u>consequences</u> of your company's and your competitors' <u>supply</u> <u>chain changes</u> for your company in terms of your ...

	Strongly increase	Increase d	Maintain ed the	Decreas ed	Strongly decreas	Don't know
	d		same		ed	
reputation?	(1)	(2) 🗖	(3)	(4)	(5)	(6) 🗖
sales with existing	(1)	(2) 🗖	(3) 🗖	(4)	(5) 🗖	(6) 🗖
customers?						
number of customers?	(1) 🗖	(2) 🗖	(3) 🗖	(4) 🗖	(5)	(6) 🗖
profitability vis-à-vis key	(1) 🗖	(2) 🗖	(3)	(4)	(5)	(6) 🗖
competitors?						

Section 4: Impact of Supply Chain Changes on Your Company

What have been the <u>consequences</u> of your company's <u>supply chain changes</u> in terms of your ...

Strongly	Increase	Maintain	Decreas	Strongly	Don't
increase	d	ed the	ed	decreas	know
d		same		ed	

	Strongly increase	Increase d	Maintain ed the	Decreas ed	Strongly decreas	Don't know
	d		same		ed	
reputation?	(1) 🗖	(2) 🗖	(3)	(4)	(5)	(6) 🗖
sales with existing	(1) 🗖	(2) 🗖	(3) 🗖	(4)	(5) 🗖	(6) 🗖
customers?						
number of customers?	(1) 🗖	(2) 🗖	(3) 🗖	(4)	(5)	(6) 🗖
profitability vis-à-vis	(1)	(2) 🗖	(3)	(4)	(5)	(6) 🗖
competitors?						

Section 4: Motivation for Not Implementing Supply Chain Changes

What <u>motivated</u> your company to not undertake any changes? (Multiple choices are possible)

- (1) Internal motivation Maintain or improve profitability
- (2) Internal motivation Maintain or improve sales with existing customers
- (3) Internal motivation- Maintain or improve our number of customers
- (4) Internal motivation Maintain or improve our reputation
- (5) External motivation External stakeholders demanded it. If yes, kindly specify who:
- (6) External motivation Competitors did it, then so did we
- (7) Other, please specify
- (8) 🛛 🗖 Don't know

To the best of your knowledge, were your <u>key competitors undertaking any supply</u> <u>chain changes</u> as a consequence of the previous natural catastrophes?

- (1) **U** Yes
- (2) 🛛 🗖 No

Section 4: Implemented Changes in Your Competitors's Supply Chain as a Result of Previous Natural Catastrophes

What were the <u>three main supply chain changes</u> your key competitors were undertaking as a result of the previous natural catastrophes? (please use the text box for further elaboration)

(1) D Facilities - Shift current facilities to areas/countries with lower natural catastrophe risk

(2) 📮 Facilities - Stop setting-up facilities in areas/countries with high natural catastrophe risk

(3) Sourcing - Increase the number of suppliers

(4) Gourcing - Decrease sourcing from areas/countries with high natural catastrophe risk

(5) Sourcing - Impose risk management practices on suppliers

- (6) Inventory Increase raw material inventory
- (7) Inventory Increase finished goods inventory

(8) Communication – Improve supply chain communication _____

(9) Risk Management – Increase focus on supply chain risk management

(10) Risk Management – Increase focus on contingency planning

- (11) Other, please specify _____
- (12) 🛛 Don't know

Section 4: Impact of Supply Chain Changes on Your Company

What were the <u>consequences</u> of your company not implementing any supply chain changes in combination with your competitors implementing supply chain changes in terms of your company's ...

	Strongly increase	Increase d	Maintain ed the	Decreas ed	Strongly decreas	Don't know
	d		same		ed	
reputation?	(1) 🗖	(2) 🗖	(3) 🗖	(4) 🗖	(5) 🗖	(6)
sales with existing	(1) 🗖	(2) 🗖	(3) 🗖	(4) 🗖	(5) 🗖	(6) 🗖
customers?						
number of customers?	(1)	(2) 🗖	(3)	(4)	(5)	(6) 🗖
profitability vis-à-vis key	(1)	(2) 🗖	(3) 🗖	(4)	(5) 🗖	(6) 🗖
competitors?						

Section 4: Impact of Not Implementing Supply Chain Changes for Your Company

What were the <u>consequences</u> of not implementing supply chain changes (neither on the side of your company or competitors) in terms of your company's ...

	Strongly increase	Increase d	Maintain ed the	Decreas ed	Strongly decreas	Don't know
	d		same		ed	
reputation?	(1) 🗖	(2) 🗖	(3)	(4) 🗖	(5)	(6) 🗖
sales with existing	(1) 🗖	(2) 🗖	(3)	(4)	(5) 🗖	(6) 🗖
customers?						
number of customers?	(1) 🗖	(2) 🗖	(3)	(4)	(5)	(6) 🗖
profitability vis-à-vis key	(1) 🗖	(2) 🗖	(3)	(4)	(5)	(6) 🗖
competitors?						

Section 5: Planned Changes in Your Company's Supply Chain to Cope with Future Natural Catastrophes

Based on the continued risk of impact from natural catastrophes, will your company undertake any <u>supply chain changes in the future</u>?

(1) **U** Yes

(2) 🛛 No

Section 5: Planned Changes in Your Company's Supply Chain to Cope with Future Natural Catastrophes

What are the <u>three main supply chain changes</u> your company will undertake in the future to be able to cope with natural catastrophes? (please use the text box for further elaboration)

- (2) 📮 Facilities Stop setting-up facilities in areas/countries with high natural catastrophe risk
- (3) \Box Sourcing Increase the number of suppliers
- (4) Gourcing Decrease sourcing from areas/countries with high natural catastrophe risk
- (5) Sourcing Impose risk management practices on suppliers
- (6) Inventory Increase raw material inventory
- (7) \Box Inventory Increase finished goods inventory ____
- (8) Communication Improve supply chain communication ____
- (9) Risk Management Increase focus on supply chain risk management
- (10) Carl Risk Management Increase focus on contingency planning
- (11) Other, please specify _____
- (12) 🛛 No change

What motivates your company to undertake these supply chain changes in the

future? (Multiple choices are possible)

- (1) Internal motivation Maintain or improve profitability
- (2) Internal motivation Maintain or improve sales with existing customers
- (3) Internal motivation Maintain or improve our reputation
- (4) Internal motivation Maintain or improve our number of customers
- (5) External motivation External stakeholders demanded it. If yes, kindly specify who:
- (6) External motivation Competitors did it, then so will we
- (7) Other, please specify
- (8) Don't know

Completion of Questionnaire

Thank you very much for your participation! If you are

interested in receiving the results of this survey, kindly leave behind your e-mail address or send us an email at <u>maxjosef.jager@cemsmail.com</u> and we will send them to you upon completion of the research.

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We would highly appreciate any feedback you may have on our questionnaire!

Thank you!

Kind regards, Elin Larsson & Max Jäger CEMS & Copenhagen Business School Feedback: END OF APPENDIX